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Editors

Innovation Performance Accounting

Financing Decisions and Risk Assessment of Innovation Processes

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Foreword

Innovation Profitability Analysis: A Challenge for Business Research and Entrepreneurial Practice

In 2007 Professor Werner Pfeiffer, the doyen of German innovation and technology management, celebrated his 75th birthday. His most well-known works are the "Allgemeine Theorie der technischen Entwicklung als Grundlage einer Planung und Prognose des technischen Fortschritts" ("General theory of technological development as the basis for planning and predicting technological progress"), Göttingen 1971, and the "Technologie-Portfolio zum Management strategischer Zukunftsgeschäftsfelder" ("Technology portfolio for the management of strategic future business areas"), Göttingen 1982, which he co-authored with G. Metze, W. Schneider and R. Amler. His two students, a grandson and a follower of the "Pfeiffer School", wanted through this book, "Innovation profitability analysis", to write a new chapter in innovation research.

Innovation profitability analysis is a theoretical approach which follows the tradition of business accounting in technology and innovation management. It uses the classic tools, techniques, key figures and data of accounting, i.e. the methods of bookkeeping, financial statements and the analysis of financial statements, cost accounting, financing and investment, but also the theory of business taxation to apply these, depending on the nature of the business innovation problem, to calculations which will form the basis of business decisions about innovations. In this way it employs "classic business management" for the purposes of innovation management. In the past innovation and technology management have tended to be characterised by strategic management, (international) innovation marketing and technology transfer, the use of creativity techniques and technical forecasting statements, technology evaluations as part of a technology philosophy, competition, patent and regulatory issues, organisational and innovation business issues and human resources problems.

The aim of innovation profitability analysis is primarily to evaluate business earnings in the form of an investment appraisal and a Balanced Scorecard and/or revenue surplus, e.g. using a future-oriented free cash flow calculation including risk factors.

Hauschildt[1] also sees that "innovation profitability analysis" should have the practical business requirements at least of a development and design department, that is, the function(s) of project, investment, planning and control accounting as well as of a profit and loss statement.

The background is the assumption that most innovations produced by a business can be planned, directed and controlled by means of R&D controlling or innovation marketing [2], to the extent that the technological innovations take place in a concrete development stage [3] or in the stage of an assembly-oriented design phase. According to the contribution of Steinhoff, who discusses the degree of innovation in success factor research, application-oriented, business issues which apply the tools and techniques of controlling, financial statements, the analysis of financial statements and financial controlling to research and technology controlling are seldom found.

In accompanying innovative engineering accomplishments from patent application through the development and design phases, production planning and innovation marketing, including patent evaluation and exploitation with business management accounting of operational and strategic controlling, through to achieving a profitable innovation, the starting point of the book is precisely here.

The basic idea of innovation profitability analysis is to provide value creation management and (competitive) success factor guidance in the sense of the Porter approach or a kind of standard "innovation process chain total accounting" for innovation processes in the company, which integrate project, investment, planning and control accounting as well as profit and loss statements. Innovation profitability analysis in the sense of an innovation process chain approach has to be quantifiable both proactively and retroactively, i.e. from development through to the potential market and vice versa. Innovation profitability analysis thus involves taking an integrated look at the product life cycle, which also has to include the future development cycle of innovation, the market life cycle and the recycling cycle as, for example, in an innovative/new generation of cars.

One example of such a "total accounting concept" is the approach of the Berlin Balanced Scorecard, which shows that strategies and success factors can be guided by innovations, e.g. by means of the technology portfolio, and quantified and, with the aid of value added statements, target costing and the generation of target prices using conjoint analysis, process costing, risk-adjusted cash flow calculations, investment appraisals, human capital calculations, break-even analyses, budget accounting, recognition of intangible assets, funds flow statements etc., present the different problem areas of an innovation process in business terms.

In following this approach, the authors of business innovation research seek to open up another application area, namely to include it in the accounting, and hence in cost-efficiency analysis and profit and loss statements. The corollary of this is that the accounting system has to cope with a new research object, raising the issue of

[1] Hauschildt, "Die Innovationsergebnisrechnung – Instrument des FuE-Controlling", 1974

[2] Schmeisser, Kantner, Geburtig, and Schindler, 2006

[3] See contributions in this book on IFRS accounts presentation and patent valuation.`

how best to apply cost-efficiency analysis and profit and loss statements to R&D, technology and innovation, while taking special account of the risks associated with the relevant technology fields and also bearing in mind the legal protection of industrial property and patent and trademark law.

When one considers that the economics side of business innovation research began with Schumpeter's theory of economic development and the innovative (inventor) entrepreneurs of 1911, and that Werner Pfeiffer, the doyen of a business function of research and development management and innovation management, introduced this into business teaching through his work on the theory of technological progress in 1971 and his "Technology Portfolio" of 1982, we are still dealing here with a very young business function.

Approaches to innovation research from the perspectives of strategic management, organisation research, personnel economics and marketing were and have been comparatively analysed since the 1970s and 1980s, e.g. by Brockhoff, Hauschildt, Trommsdorff and others.

The following topics are covered in the book:

- Whether and which success factors, dimensions and aspects of the phenomenon of "innovation" can be regarded as of central importance to an explanation (e.g. innovation as a contingency factor);
- Which are the dominant questions on the basis of prevailing knowledge and theoretical approach (technological predictions and forecasting techniques for weak signals, technology assessment, methods inventions, creativity techniques, search field analysis, assessment of research projects and research programmes, promoter model, venture capital management);
- Whether and to what extent the results of these approaches can offer practical design hints for the enterprise or for research and development management or innovation management.

Due to the heterogeneity of the individual approaches in innovation research, the practical controlling aspects of development and technology management have tended to be obscured, and since the 1990s research has been directed more at the economics of innovation (Burr 2004) than at a theoretical frame of reference.

In this book on innovation profitability analysis, the emphasis is more on business topics which discuss the methods of accounting, patent valuation and exploitation, the controllability of research results in innovation projects through qualitative tentative ideas in order to then transfer them to commercial calculations in a scenario-specific way. For this reason the discussion centres on the following points of emphasis:

(1) Innovation and technology management as a way of strategically and operationally controlling intangibles within the framework of patent valuation and exploitation, IFRS accounting for development projects and the Berlin Balanced Scorecard approach;

(2) Industry and business analysis and their valuation with the aid of selected business valuation methods and their risk factors, e.g. of the technology portfolio;
(3) Generation of target prices with the aid of selected innovation marketing methods and the cost accounting recording and control of R&D, production planning and innovation marketing activities with the support of the technology portfolio, the Berlin Balanced Scorecard, target costing, process costing and budget accounting;
(4) Analysis of the innovation process and value-added chain with a view to enabling companies to review whether a technological innovation will pay its way;
(5) Innovation controlling and integration of the legal protection of industrial property, especially patent law, into the innovation profitability analysis, and indeed from idea through to the lapse of patent and trademark protection.

If it is possible to provide superior, innovative services on a competitive basis which are important to the customer and the benefits of using them are also perceived, then their success factors must be ascertainable. Target prices can then be set for these innovative services using the tools of market research, they can be defended over time by the patent and costs can be assigned during product development.

This creed is pursued by industry in its practical controlling approaches, and this book also follows this line of thinking. If target prices, sales, market potentials, market growth, costs recognised as cash outflows etc. can be assigned to an innovation, then it becomes possible to perform cost-efficiency analysis and prepare profit and loss statements on innovations and to include intangibles such as patents and technical know-how in the balance sheet.

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Part I
Introduction to Innovation Performance Accounting

Chapter 1
Product Innovativeness in Success Factor Research – Influencing Factor or Contingency Factor?

Fee Steinhoff

1.1 Introduction

The overriding goal of the innovation profitability analysis is to make the innovator aware of what level of (intangible) capital expenditure the exploitation of an innovation on the market warrants. The innovation profitability analysis should also be a project, investment, planning and control plan, as well as a profit and loss forecast (Hauschildt 1994, p. 1018 et seq.). Based on the function of profit and loss forecasting, there is a close connection to innovation success factor research. Success factor research looks for the relevant criteria that make the difference between the success and failure of an innovation: For what specific reasons is one innovation successful in the market while another fails?

A glance at the track record of innovation ideas in practice makes the relevance of success factor research clear: In a cross-sector, empirical, long-term study of product innovations in 116 companies, only 0.6% of the 1,919 product innovation ideas surveyed proved to be marketable and successful. Innovation ideas are put through a stringent selection process: Not even 10% of the initial ideas reached the market as products; of those that made it, some 70% were eliminated by the market as flops . Of the products remaining in the market, 46% made a loss, 33% returned no appreciable profit, and only 21% (ultimately 0.6%, or 11 of the 1,919) were successful (Berth 1993, p. 217).

The flop rate findings highlight the need for experience of success factors of innovations in practice. A large proportion of the failures could be avoided if decision-makers had more relevant, reliable, and proven information and would use it. An interesting question in this context is: What role does the degree of novelty of innovations play? Are innovations of a low degree of novelty (incremental innovations) or those of a high degree of novelty (radical innovations) more promising? Alternatively, is product innovativeness a success factor for innovations at all? Or is it rather a contingency factor?

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This paper addresses that question. For this purpose, we will first look into success factor research (Section 1.2). Section 1.2.1 presents the state of research on the measurement of innovation success. Section 1.2.2 provides an overview of the key findings of success factor research. Section 1.3 focuses on the connection between product innovativeness and success. Based on a perception of product innovativeness as a multi-dimensional construct (Section 1.3.1), a synopsis of available empirical findings on the influence of product innovativeness on success is presented (Section 1.3.2). Finally, the question is pursued as to what extent product innovativeness can be understood as a contingency variable in innovation management (Section 1.3.3). The paper ends with a summary of significant findings (Section 1.4).

1.2 Success Factor Research

The goal of innovation management is success (Hauschildt 1991, p. 452). While appropriate management activities cannot guarantee the success of an innovation, they can substantially increase the chances for success (Lynn et al. 1996, p. 81). Both the practice and science of innovation management are therefore greatly interested in the question of what characterizes the success of innovations.

The concept of success factors stems from the empirical orientation of research established in the 1960s, which has been pursued continuously up to the present. Success factor research aims for both strategic "effectiveness " (do the right thing) and operational "efficiency " (do it right, i.e., economically). The decision to establish an innovation idea as a project is an effectiveness decision ("do the right thing"). Beyond this question of "whether to do it," the project's priority influences its effectiveness: How intensively it is pursued in relation to other activities can also be the right or the wrong thing. This decision of resource allocation must be supported by appropriate methods of analysis. The subsequent product development and marketing within a resource budget is, by contrast, not a question of effectiveness, but rather of efficiency ("do it right"; Cooper 1999, p. 115 et seq.).

In order to assess relevance of management activities for success, the question is initially posed as to what is understood to be innovation success (Hauschildt 1991, p. 452). Section 1.2.1 provides an overview of the state of the research on measurement of innovation success. Then an overview of significant findings of success factor research is presented (Section 1.2.2).

1.2.1 Measurement of Innovation Success

While innovation research has dealt intensively with the topic of the measurement of success (for an overview, see Ernst 2001, p. 165 et seq.; Hulting and Robben 1995, p. 393 et seq.), to date, no universal, context-free measurement approach has caught on (Wall et al. 2004, p. 115; Griffin and Page 1996, p. 483). What constitutes innovation success varies substantially in how it is subjectively experienced, and success is operationalized inconsistently in the research. If the results are supposed to support strategic decisions, common key business management indicators such as ROI are not adequate. Rather, success must then also reflect long-term goals and the objectives of the relevant company or innovation project.

Available approaches for the measurement of innovation success can be differentiated by (1) the level of examination, (2) the success dimensions used, and (3) the underlying data collection method (Hart 1993, p. 23; Hauschildt 1991, p. 464 et seq.). The level of examination (1) is understood to mean the object/area to which the success measurement relates. In this context, a distinction is made between success at company level and success at project level. The examination of company-level success (e.g., sales growth, profitability; for an overview, see Venkatraman/Ramanujam 1986, p. 802 et seq.) is problematic for two reasons. On the one hand, success at company level is determined not only by innovations but also by a multitude of additional internal and external factors. This means that there is no clear causality between successful innovation management and success at company level (Cooper and Kleinschmidt 1996, p. 19; Hart 1993, p. 26). On the other hand, the measurement of success at company level represents a measurement approach based on past activity: A company's current sales and profitability figures reflect the success not of its current but its past innovation activity (Billing 2003, p. 155). As a consequence, scientific research is dominated by the measurement of innovation success at project level (Hart 1993, p. 26).

In terms of success dimensions (2), a distinction is made at project level between results-related and process-related success indicators (Krieger 2005, p. 30 et seq.; Griffin and Page 1996, p. 486). Results-related criteria are output-oriented: They reflect the results of innovation projects or their contribution to change in the economic position of a company (Gerpott 1999, p. 81). Key criteria for economic market success are profit or loss, the market share, and the image improvement of an innovation (Griffin and Page 1996, p. 485; Cordero 1990, p. 188 et seq.; Rubenstein et al. 1976, p. 17). By contrast, the technical success of an innovation and the company's gain in expertise represent significant internal success criteria (Billing 2003, p. 157; Cordero 1990, p. 187 et seq.; Rubenstein et al. 1976, p. 17). While technical success is related to the current, physical result of the R&D process (Olschowy 1990, p. 52), the strategic expansion of internal expertise can be seen as an important future-oriented success indicator (Maltz et al. 2003, p. 189; Hart 1993, p. 25).

Since a successful result presumes a successful process, concomitant process-related success criteria are frequently used (in particular for long innovation processes and in early phases). Behind this is the idea that innovation success is based on the fulfillment of partial performances which can be assessed on a phase-specific basis at predetermined project milestones throughout the entire process (Billing 2003, p. 158; Hauschildt 1991, p. 471). Process-related success criteria can be depicted by the following three goals: the quality/benefit of innovation, the associated expense, and the time needed (Krieger 2005, p. 30 et seq.; Scigliano 2003, p. 51; Pleschak and Sabisch 1996, p. 9).

Finally, the literature on data collection methods (3) differentiates between objective and subjective measurement of success. Objective success measurement is based on value-based, absolute indicators of result- or process-related success criteria (e.g., market share as a percentage, expenses in EUR). Subjective success measurement, by contrast, is based on recording the subjectively perceived degree of target achievement of the underlying success criteria. Intuitive estimates are normally converted into numerical values (e.g., rating the degree of target achievement on a scale of 1–7; Werner and Souder 1997, p. 34 et seq.).

Although the smaller scope for interpretation and the related better inter-subjective comparability represent significant advantages of objective success indicators (Venkatraman and Ramanujam 1987, p. 117 et seq.), subjective success measurement dominates in science (Wall et al. 2004, p. 96; Werner and Souder 1997, p. 35; Hauschildt 1991, p. 464 et seq.). For example, the information policy of many companies does not permit the use of sensitive objective figures (e.g., earnings) (Ernst 2001, p. 168). In addition, in contrast to objective indicators, subjective indicators can also be used to estimate future expectations of success. That is especially relevant for the assessment of projects in which the innovation has not yet or has only recently been introduced on the market. In such cases, reliable objective data are normally not yet available (Werner and Souder 1997, p. 34 et seq.). Finally, subjective criteria show a high level of validity: Strong correlations are reported between subjective and objective success criteria in empirical studies (e.g., Wall et al. 2004, p. 112; Voss and Voss 2000, p. 76).

1.2.2 Overview of the Field of Research

As already presented in the introduction, success factor research aims to identify factors that significantly influence innovation success. High flop rates of innovations in the market led to a general awareness of the problem and to the quest in management research for reasons for success and failure of new products. There is no standard method for success factor research and a wide range of empirical methods are used from qualitative interviews to standardized surveys. Normally, a random sample of cases is investigated for factors that discriminate between success and failure. Frequently, success is operationalized by one or more dependent variables, and independent variables are analyzed as potential success factors using multivariate statistics (Trommsdorff 1991, p. 182).

The current status of success factor research is based on the work of many researchers. Important early studies include the "SAPPHO" study (Rothwell et al. 1974), the "Stanford Innovation Project" (Maidique and Zirger 1984), and the continuously enhanced "NewProd-Project" of Cooper and his research team (e.g., Cooper and Kleinschmidt 1993). In addition to studies that examine a wide range of potential success factors, there are a few that undertake a deeper analysis of a limited number of success factors (e.g., Gruner and Homburg 2000).

The volume of findings concerning innovation success factors has grown to almost overwhelming proportions. Even ignoring many individual studies and focusing on the common elements from synopses and meta-analyses, the quantity of findings is difficult to grasp. However, if an attempt is made to qualitatively

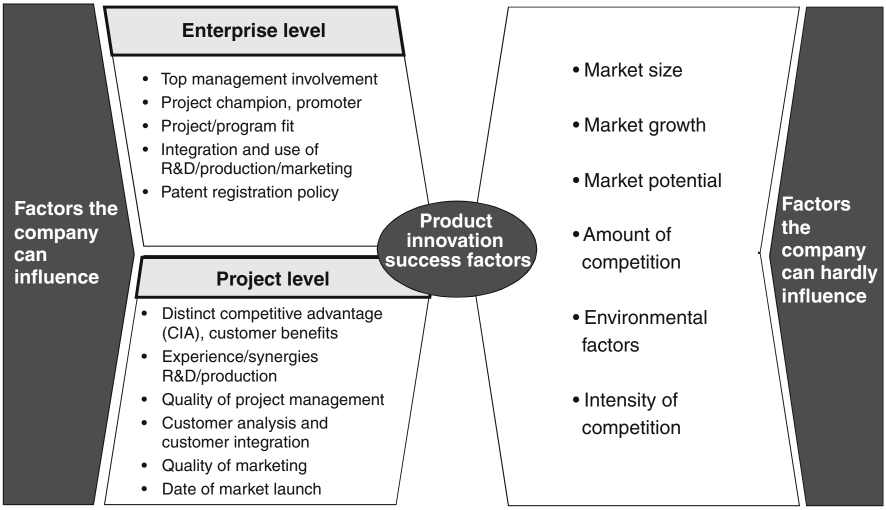

Fig. 1.1 Success factors of innovations after 25 years of research
[Source: Trommsdorff and Steinhoff 2007, p. 70 (Synopsis of numerous studies, including Montoya-Weiss and Calantone 1994; Melheritz 1999; Henard and Szymanski 2001)]

integrate them, with an eye on the prevailing findings that have repeatedly appeared with various methods and in different research contexts, it is possible to generically summarize three decades of success factor research (see Fig. 1.1). It appears that a very large portion of the success/failure variance is caused by factors that, broadly speaking, relate to marketing. Among these factors are strategic and operational marketing decisions and information from (innovation) market research that underlie such decisions.

The findings of success factor research provide great benefits for innovation management, but they have also been criticized in the past. The criticism centers on the fact that findings for the same or similar independent variables vary, in some cases significantly, in terms of the strength of their influence (van der Panne et al. 2003; Henard and Szymanski 2001). Significant points of criticism relate to the use of inconsistent and weak methods of measurement, insufficient theoretical underpinning, as well as the neglect of contextual factors (Ernst 2002; Haenecke 2002; for detailed criticism, see Steinhoff 2006, p. 19 et seq.).

In addition, the operational details of innovation management are highly complex, such that the information requirement for efficiency extends beyond the scope of success factor research. Management needs information regarding precise conditions of innovation from the specific situational analysis. For this purpose, innovation market research must deliver external information, in particular concerning the expected behavior of the target customers, partners, and competitors. Nevertheless, the results of general success factor research can be meaningfully used in practice to support the decision-making process and are substantiated by science. The list is therefore useful as a checklist that should accompany each innovation project.

1.3 Connection Between Product Innovativeness and Success

One criterion that has increasingly been taken into consideration in success factor research in recent years is the degree of novelty of innovations (Ernst 2002, p. 33; Tidd and Bodley 2002, p. 129). The question arises as to what influence this factor has on innovation success. Are slight improvements, so-called incremental innovations, more successful than revolutionary, radical innovations? The exploration of this question initially requires one to wrestle with the construct of degree of novelty. Section 1.3.1 addresses this topic. An overview of findings regarding the influence of product innovativeness on success is then provided (Section 1.3.2).

1.3.1 Product Innovativeness as a Multi-dimensional Construct

Manufacturers of frozen foods, cigarettes, and detergents like to characterize anything that corresponds to a new brand, mixture, flavor, fragrance, or even packaging as an innovation. Providers of financial services combine parameters of conditions into "new products." Each stylish variant of a clothing producer's product is an "innovation." There have been enormous revolutions in business and the economy as a result of new products such as video and CD, PC and Internet, fax and mobile telephone, catalytic converters and ABS. The following may appear fairly innovative: the entry of Mannesmann into mobile telephony, that of Deutsche Bahn AG (German State Railways) into customer-oriented services such as steward services provided by conductors in first class, that of many banks into direct banking, and the founding of countless Internet-based companies. Which of these is more innovative than the others?

An innovation is more or less novel and has a "degree of innovation" on the continuum between the smallest (incremental) change and complete (radical) revolution. The degree of novelty of an innovation (or synonymously: product innovativeness) expresses the degree of difference of an innovation in relation to the previous state (Hauschildt 2004, p. 14). In the literature on innovation management, which is strongly influenced by the United States, a great many terms exist for innovations with a high degree of novelty: radical, really new, discontinuous, architectural, evolutionary, revolutionary, highly innovative, major, break-through, and substantial. The problem is that these terms for the most part are not clearly defined and delineated and are not used consistently. As a result, the comparability of the results of scientific research and the applicability of results in practice is very limited (Garcia and Calantone 2002, p. 110 et seq.; Danneels and Kleinschmidt 2001, p. 358).

Newer approaches regarding product innovativeness conceptualize and operationalize product innovativeness as a multi-dimensional construct on the basis of an analysis of existing research approaches (e.g., Salomo 2003; Billing 2003; Garcia and Calantone 2002; Avlonitis et al. 2001; Hauschildt and Schlaak 2001; Danneels and Kleinschmidt 2001; Green et al. 1995). Considered as a whole, it becomes clear that the novelty of an innovation is not a one-dimensional construct, but rather should be described and operationalized (1) by multiple perspectives ("new for whom?": micro- vs. macro-perspective) and (2) by multiple determinants and consequences ("new in what respect?": market, technology, organization, and environment). Based on the integrated consideration of the existing research by Salomo (2003, p. 412 et seq.) and Billing (2003, p. 30 et seq.), product innovativeness can be conceptualized with the help of the following four dimensions:

- *Degree of market innovation*: The degree of market innovation provides information on how greatly the innovation differs from existing products in the market. From the perspective of the innovating company (micro-perspective), a high degree of market innovation is connected with addressing a new market and new customer groups. Such innovations give rise to relatively high levels of uncertainty, but also to the opportunity to fundamentally improve the company's market position. From the view of the industry (macro-perspective), innovations with a high degree of market innovation offer profoundly new benefits, but are normally also connected with extensive changes in learning and behavior as well as increased adoption risk for potential customers.
- *Degree of technological innovation*: The degree of technological innovation is derived from the scope of technical novelty associated with the innovation. The use of new technological principles makes possible great leaps in performance and, as a result, frequently displaces existing technologies. Consequently, innovations with a high degree of technological innovation both at the micro- and macro-levels are associated with comparatively great technological uncertainties.
- *Degree of organizational innovation*: The degree of organizational innovation focuses on the internal micro-perspective. Profound innovations are frequently associated with new, formal, organizational structures and processes. However, they also affect informal characteristics of organizations, for example by changing corporate culture. This is reflected, for example, in intensified and more open collaboration with external business partners. Strategic realignment is also a feature of innovations with a high degree of organizational innovation.
- *Degree of environmental innovation*: The degree of environmental innovation is an aspect of the industry-wide macro-perspective that has frequently been neglected. Innovations influence not only the direct market players (in particular, providers and consumers), but also the more broadly conceived environment. Particularly radical innovations frequently demand the set-up of new infrastructure, as well as considerable adjustments to regulatory and social conditions.

The conceptualization of product innovativeness as a four-dimensional construct is summarized in the Fig. 1.2.

Product innovativeness can be determined by means of the four dimensions described. Following the approach of Garcia and Calantone (2002, p. 121), different types of innovations can be defined based on the combination of the four dimensions of product innovativeness (Salomo 2003, p. 406 et seq.): Radical innovations show comparatively high levels of discontinuity in all four dimensions. It must be

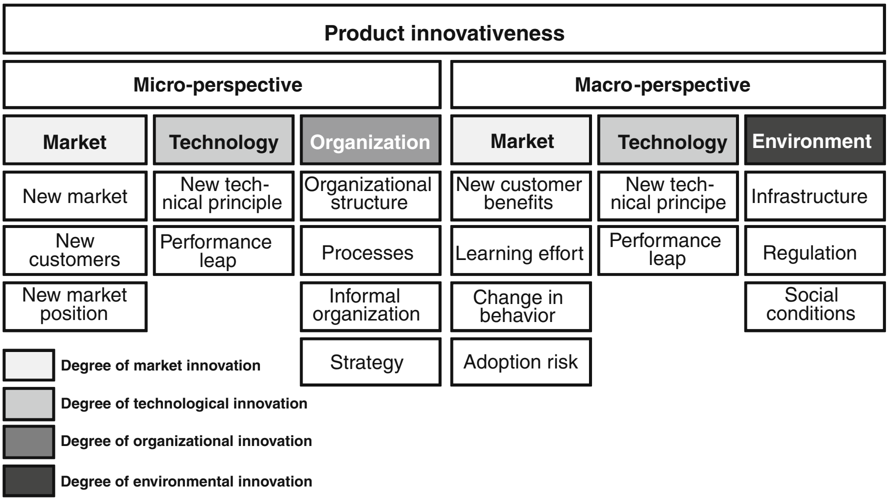

Fig. 1.2 Conceptualization of product innovativeness as a multi-dimensional construct [Source: based on Krieger (2005, p. 16) and Salomo (2003, p. 406)]

assumed that, in particular, the presence of a high degree of environmental innovation distinguishes radical innovations from less profound innovations. By contrast, the opposite extreme of an incremental innovation is limited to discontinuities on the micro-level and as a rule shows changes in only one dimension. All combinations of discontinuities in the areas of market, technology, organization, and environment lying between the two extremes can be classified as moderately innovative. In some cases, the term profound innovation is used for moderately innovative to radical innovations.

1.3.2 Influence of Product Innovativeness on Success

In the general management literature, it is assumed that radical innovations exhibit a risk–reward ratio that deviates from that of incremental innovations (Zirger 1997, p. 295). According to this, radical innovations offer the possibility of sustained differentiation from the competition (e.g., Song and Parry 1999, p. 665) and the opportunity for exceptional success (e.g., Baker and Sinkula 2005, p. 491). At the same time, however, the uncertainties entailed in radical innovations mean that both the probability and degree of success are uncertain (Danneels 2002, p. 1, 106).

The findings of scientific studies regarding the correlation between product innovativeness and the innovation success are conflicting. The literature indicates

- a positive correlation (Zhou 2006, p. 399; Zhou et al. 2005, p. 52; Berth 2003, p. 18; Song and Montoya-Weiss 1998, p. 131; Zirger 1997, p. 295; Gatignon and Xuereb 1997, p. 85; Brinkmann 1997, p. 163; Booz, Allen & Hamilton 1982, p. 8);

- a negative correlation (Min et al. 2006, p. 25 et seq.; Danneels and Kleinschmidt 2001, p. 369; Ali 2000, p. 158; Atuahene-Gima 1996, p. 99; Zirger and Maidique 1990, p. 878; Meyer and Roberts 1986, p. 815);
- a U-shaped correlation (Avlonitis et al. 2001, p. 338; Kotzbauer 1992, p. 224; Kleinschmidt and Cooper 1991, p. 244 et seq.); and
- no clear correlation (Krieger 2005, p. 162; Henard and Szymanski 2001, p. 367; Schlaak 1999, p. 256 et seq.; Calantone et al. 1994, p. 146; Cooper and Kleinschmidt 1993, p. 109).

The empirical results of Song and Montoya-Weiss (1998, p. 131) show, for example, that the average profitability of radical innovations is significantly higher than that of incremental innovations. Zhou et al. (2005, p. 52) can empirically demonstrate that innovations with a high degree of technological innovation or a high degree of market innovation positively influence company and product success. A practice-oriented long-term study (Berth 2003; p. 18) delivers specific comparative figures, which suggest that radical innovation projects achieve average profitability of 14.7%, while incremental innovations only demonstrate 6.9%.

By contrast, empirical studies relating to the synergy of new projects with existing company resources indicate a negative influence of product innovativeness on success. According to these studies, innovation projects that can fall back on internal resources (e.g., R&D and marketing expertise) (normally incremental innovation projects) are more successful than radical projects that require the acquisition of new resources due to a lack of synergies (Danneels and Kleinschmidt 2001, p. 369; Zirger and Maidique 1990, p. 878).

Kleinschmidt and Cooper (1991, p. 241) deal with the conflicting findings in the literature and explain them by way of two opposing effects. On the one hand, radical innovations offer the opportunity of sustained differentiation from the competition (positive influence on success), but on the other hand, there are few synergies with the available internal resources (negative influence on success). The authors can empirically identify a U-shaped progression of the correlation between product innovativeness and success. Accordingly, both incremental and radical innovations exhibit comparably high rates and degrees of success (including ROI and market share), while moderately innovative innovations turn out to be markedly less successful. An average product innovativeness comes with the risk of a "stuck in the middle" position: Moderately innovative products possess neither a sufficient relative edge in the market nor the advantage of internal synergy effects (Kleinschmidt and Cooper 1991, p. 244 et seq.).

Kotzbauer (1992, p. 186) likewise suspects a U-shaped relationship between product innovativeness and innovation success, but in contrast to Kleinschmidt and Cooper (1991) asserts an inverted U-shaped correlation. Kotzbauer (1992, p. 119 et seq.) develops an explanatory model of the optimal level of innovation from a consumer-oriented perspective. Under this model, an increasing perceived product innovativeness is associated with both an expectation of increasing advantages (assumption of benefit), as well as disproportionately increasing acceptance risks (importance and probability of negative purchase consequences). If the potential customers are risk averse, Kotzbauer (1992, p. 125 et seq.) derives the existence of an optimal level of innovation. According to this theory, a product's chances of success initially rise with an increasing product innovativeness up to the point of the maximum perceived benefit. If the level of innovation exceeds this point, then the innovation's prospects of success must be expected to decrease. Kotzbauer (1992, p. 224) managed to generate the first empirical indications of the postulated inverse U-shaped correlation between product innovativeness and the financial success of the new product (Avlonitis et al. 2001, p. 338 made the same finding for service innovations).

In summary, it can be stated that there are contradictory findings in the literature regarding the influence of the degree of the innovation on success. This conclusion is confirmed by the meta-analysis by Henard and Szymanski (2001, p. 367) in which no significant influence on success by product innovativeness can be ascertained. A significant reason for the state of findings is found in the inconsistent conceptualization and operationalization of product innovativeness (Salomo 2003, p. 401 et seq.). Thus it must be assumed that the perspective of novelty ("new for whom?") influences the correlation (Schlaak 1999, p. 107). Studies made from the perspective of the innovating company (e.g., Danneels and Kleinschmidt 2001) tend to detect a negative influence of product innovativeness, while from the perspective of the market, high product innovativeness tends rather to be positively correlated with success (e.g., Song and Montoya-Weiss 1998). At the same time, however, the model in Kotzbauer (1992) indicates that profound innovations are also connected with increased risks from the perspective of the market.

There is a general accord in the research that, at company level, a long-term strategic competitive advantage requires a combination of different types of innovation (Han et al. 2001, p. 11; Tushman et al. 1997, p. 7; Wind and Mahajan 1997, p. 2). At project level, the question arises of whether product innovativeness should be considered not so much an independent variable, but rather a moderating variable. The following section addresses this question.

1.3.3 Product Innovativeness as a Contingency Variable

A moderating effect exists when the correlation between an independent and a dependent variable is influenced (strengthened or weakened) by a third variable (the moderating variable) (Venkatraman 1989, p. 424 et seq.). The rather contradictory findings from success factor research to date indicate that high product innovativeness does not guarantee success. Rather, the development and introduction of profound innovations appears to require special innovation management. That would mean that product innovativeness represents a not so much a criterion for success as a moderating variable:

> (...) many studies have tended to overlook an important reality: that projects can differ substantially in their degree of innovativeness and that this may have an impact on what it takes to achieve success. (de Brentani 2001, p. 170)

The contingency theory anchored in organizational theory (for an overview, see Zeithaml et al. 1988; Drazin and van de Ven 1985) offers potential for a better understanding of how contextual factors impact innovation management. Contingency theory rejects the existence of an organizational structure that is effective under all conditions. Rather, it is assumed that the optimal organizational structure varies depending on given contingency factors, such as company size, strategy, and uncertainty (Zeithaml et al. 1988, p. 39; Drazin and van de Ven 1985, p. 514).

In the context of innovation projects, an industry influence is suspected relatively frequently. Empirical studies often focus on specific industry segments in order to exclude this influence and consequently for reasons of comparability (Hauschildt 2004, p. 49; Ernst 2001, p. 180). However, cross-sectoral contributions of success factor research frequently cannot identify any influence of industry membership on success factors of innovation projects (Ernst 2001, p. 180; see, e.g., Kärkkäinen et al. 2001, p. 398). One supposed reason for this non-finding is that the use of an industry classification insufficiently operationalizes matters that are suspected to have an influence on evidence of success factors. Correspondingly, scientific research is increasingly refraining from the use of the industry classification in favor of other contingency factors (Ernst 2001, p. 180; Melheritz 1999, p. 157).

Tidd (2001, p. 175), on the basis of an analysis of the literature, arrives at the conclusion that two contingency factors in particular have a significant influence on the management of innovations: uncertainty and complexity. Uncertainty represents a constituent feature of profound innovation projects (Lynn and Akgün 1998, p. 13), and profound innovations are frequently very complex (Kim and Wilemon 2003, p. 19). In line with this, product innovativeness is largely universally understood in the literature to be a contingent variable of innovation management (Scigliano 2003, p. 60).

It can be supposed that the degree of novelty of an innovation represents a twofold contingency factor in two respects. In line with the so-called selection approach in contingency theory, organizations adapt their behavior to the context (Drazin and van de Ven 1985, p. 516 et seq.). Profound innovations pose particular challenges to innovation management due to the exceptionally high levels of uncertainty entailed:

> Is it reasonable to expect that an innovation strategy used on an incremental innovation can be equally effective for a radical innovation? Most likely not. Innovation strategies must be tailored to the nature of the innovation and the degree of uncertainties present. (Lynn and Akgün 1998, p. 12)

Furthermore, the question arises as to what extent product innovativeness exhibits a moderating effect on the influence of management factors on success. The interaction approach of contingency theory is subject to the assumption that success increases with an increasing fit between context and management behavior (Drazin and van de Ven 1985, p. 517 et seq.).

Empirical studies show that product innovativeness represents a contingency factor in two respects, i.e., according to both the selection approach and the interaction approach. Thus, empirical studies report, for example, that compared with incremental innovation projects, considerably more qualitative market research methods are used in radical projects (Adams et al. 1998, p. 418; Shanklin and Ryans 1988, p. 492 et seq.). Gruner (1997, p. 177 et seq.) demonstrated for moderately novel innovation projects that customers were comparably less intensively integrated in idea generation, but were much more intensively integrated into the innovation process during market launch. In other words, incremental and radical innovations frequently employ different management activities in practice.

In addition, many empirical studies report moderating effects (e.g., Steinhoff 2006; Krieger 2005; Lee and O'Connor 2003; Lee and Na 1994). Lee and Na (1994), for example, demonstrated empirically that the support of a promoter is more important for the success of radical innovation projects than for the success of incremental ones. Likewise, product innovativeness has emerged as a moderating factor with regard to the correlation between customer orientation and success. Intensive customer orientation (especially that based on qualitative methods) has a positive influence on success, and the strength of the influence increases with an increasing product innovativeness. Thus very novel, radical innovations benefit particularly from a strong orientation to potential customers in the market (Steinhoff 2006).

1.4 Summary

One function of the innovation profitability analysis consists of profit and loss forecasting. It should include expenditures and revenues as well as their net balance as the innovation output (Hauschildt 1994). A close substantive relationship can be seen to the success factor report. The success factor report searches for the factors that make an innovation successful. Product innovativeness represents a potential success factor. New products vary with respect to their degree of novelty: The range extends from minimal improvements (incremental innovations) through moderately innovative new products to revolutionary changes and radical innovations. Innovation decisions are ultimately investment decisions (Hauschildt 1994). The goal must be to achieve the highest possible output with the lowest possible use of resources. The decision as to which innovation ideas should be established as projects and the extent to which resources should be employed in each case is a question of effectiveness ("do the right thing"). In this context, the practice requires recommendations as to which roles the degree of novelty should play in the selection process. Should incremental or radical innovations be preferred in the budget distribution?

This paper has addressed the question as to what extent the degree of novelty represents an influencing factor or a contingency factor in success factor research. Building on an overview of success factor research, the correlation between product innovativeness and success was analyzed. In doing so, it initially became clear that product innovativeness represents a multi-dimensional construct comprising the four dimensions of market, technology, organization, and environment. In a synopsis, it was then pointed out that empirical studies of the correlation between product innovativeness and success produce contradictory findings. Indications have been found of a positive, negative, U-shaped, and even no clear correlation. It can be supposed that a significant reason for this is the inconsistent conceptualization and operationalization of the product innovativeness construct.

Regardless of the influence of product innovativeness on success, the research is in agreement that a long-term strategic competitive advantage requires a combination of various types of innovation. Based on this knowledge, we then explored the question of what extent product innovativeness is less a success factor than a contingency factor. It was demonstrated that product innovativeness represents a contingency factor in two ways. On the one hand, different innovation management activities are frequently used in practice depending on the degree of novelty. On the other hand, empirical studies frequently found a moderating effect of product innovativeness. Thus the correlation between specific management activities and innovation success is influenced by the degree of novelty. According to the current state of research, it therefore is assumed that product innovativeness represents a contingency factor in success factor research. A definitive clarification of the specific role of product innovativeness as a factor influencing success will require a uniform operationalization construct in the future and an accompanying comparability of scientific studies.

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Chapter 2
Financial Evaluation of Innovations: Structure and Implementation. An Analysis Using a Case Study from the Telecommunications Industry

Michael Erner and Volker Presse

2.1 Introduction

The globalization of markets has led to industrialized economies increasingly developing into knowledge societies in which innovation represents the most important strategic resource in global competition. Increasingly shorter product lifecycles (see Gruner 1996, p. 14 et seq.) are forcing companies to write off rising development costs (see Backhaus 1999, p. 16) at an ever faster rate. In the automotive industry, for example, the product lifecycle of the VW Golf has reduced from 9 years (Golf I) to 6 years for the Golf III (see Meffert 2000, p. 1350 et seq.). In the telecommunications industry, due to the opening up of markets and liberalization, completely new providers are also pushing into the market, thus also increasing competitive pressure for all those involved (see Büllingen, Stamm April 2003, p. 25 et seq.). The result is that falling margins and sales are reducing the entrepreneurial and, above all, financial freedom of organizations and thus reinforcing the need for growth.

New products and services are enabling companies to generate new sales and conquer new markets. Innovations are thus, on the one hand, the basis for sustainable corporate growth, whereas on the other, the cost pressures described above result in the further restriction of financial resources. As a result, the need for efficiency when developing innovations is becoming increasingly important. Furthermore, in addition to the development, the definition of the term "innovation" includes "usage" or successful launch on the market (see Brockhoff 1992, p. 28). Accordingly, innovations must be investigated as regards their commercial success (see Kim, Mauborgne 2004, p. 172). Success is established as part of determining the value contribution of the innovations, which is part financial, part strategic. In terms of strategy, this may concern both technological and market perspectives, such as the strategic fit of new IPTV offers to the existing product portfolios of telecommunications companies. In addition to a qualitative assessment, the value contribution must also be assessed quantitatively, i.e., in financial terms. In the following the term evaluation accordingly focuses on the financial evaluation.

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To summarize, it can be said that companies require successful innovations which generate a value for the company. Business literature has long discussed how innovations can be assessed. In addition to the financial evaluation established by Hauschildt (see Hauschildt 1994), strategic and accounting approaches to the market- and technology-orientated assessment of innovations have recently been combined under the key concept of "innovation controlling".

This chapter discusses the terms "innovation" and "innovation management" in Section 2.2. Section 2.3 considers the problems associated with the measurement of innovations, and in the fourth section the structure and implementation of a market-orientated measurement of innovations is presented as an example.

2.2 Innovations

First, the terms "innovation" and "innovation management" will be defined, as well as their properties and dimensions.

2.2.1 Definition

There are numerous definitions of the concept of "innovation" existing in economic and business literature. The significance of innovation was highlighted as early as the beginning of the twentieth century by Schumpeter in his theory on economic development, amongst others. Based on a comparison of various definitions of the term, Hauschildt understands "innovations" to be "[. . .] qualitatively new types of products or processes which differ significantly from their previous state – however that may be defined" (Hauschildt 2004, p. 7).

Innovations can be distinguished from inventions by the criterion of successful launch on the market (product innovation) or the deployment of a new process (process or method innovation) (see a number of authors, e.g., Brockhoff 1992, p. 28; Bullinger 1994, p. 32 et seq.).

Unlike inventions, innovations generate – by definition – an economic value and are accessible to a large group of recipients (see Kumar and Phrommathed 2005, p. 7; Garcia and Calantone 2002, p. 112).

A key differential of innovations is the degree or level of innovation. While minor changes and additions (incremental innovations) generally have calculable effects on a company's business, radical innovations (high level of innovation) present considerable uncertainty for the business model and the entire company.

2.2.2 Innovation Management

In the last few years, innovation management has developed into an independent approach in management theory. Hauschildt defines innovation management as

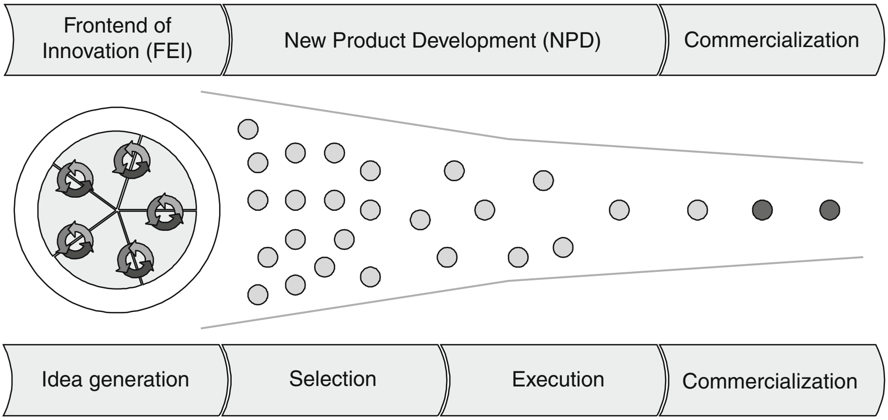

Fig. 2.1 Innovation process according to Koen et al. (2001)

the planning, implementation, and monitoring of activities throughout the entire innovation process (see Hauschildt 2004, p. 30). Koen et al. identify three key phases of the innovation process (see Fig. 2.1): "front-end of innovation," "new product and process development," and the final "commercialization phase" (see Koen et al. 2001). The individual phases can be distinguished as regards the structure of tasks, information requirements, the management tools deployed, and, finally, their contribution to the measurement of innovations (see for the following information Koen et al. 2001).

The first phase ("front-end of innovation") primarily aims at generating new ideas and initiatives. It is frequently characterized by a largely missing organizational structure and high degree of uncertainty such that product and resulting sales expectations cannot be specifically formulated. At the end of this phase, detailed development project proposals are available.

In the second phase ("new product and process development"), the focus is on selecting and developing new products and processes with the aim of creating accessible product and service concepts. These are illustrated by prototypes and demonstrators. This phase is typically carried out within a structured and clearly budgeted project organization. As the degree of maturity of the innovation increases, the value contribution of the investment for the company is forecasted in this phase, whereby generally various product and service concepts are going to be normally assessed.

Once the product development process has been successfully completed, the final step is to commercialize the innovation using standardized market launch processes, e.g., by planning marketing and advertising campaigns. Innovation management uses the classic tools of the marketing mix, such as sales, communication, and price policy, to create a complete marketing plan. More details on value contribution are provided in this phase.

2.3 Financial Evaluation of Innovations

This section discusses the treatment of innovations from the point of view of accounting systems and their structure. We will then go on to present the objectives and methods for the structure and implementation of the measurement of innovations.

2.3.1 Innovations from the Point of View of Investment Appraisals

Innovations aim to sustainably increase a company's sales through successful market launch. However, the success of an innovation poses risks. The implementation of innovation projects entails a long-term commitment of funds (development costs) with the aim of generating funds from their later use (see Mensch 2002, p. 1). Innovations can thus be considered as investments.

For many years, investment appraisals have involved measuring investments, i.e., assessing projects, products, and processes in terms of costs and revenues.

Before it can be demonstrated whether and which investment appraisal method can be used for innovation projects, the underlying logic and structure of the accounting systems must first of all be presented.

2.3.2 Basic Structure of Accounting Systems

The basic structure of business accounting systems comprises four key elements: recording, allocation, measuring, and clearing method.

2.3.2.1 Recording

Recording deals with the question as to which reference objects and data points need to be recorded for the accounting system.

Reference objects are essentially innovation projects and the resulting products are derived measurement objects. In terms of costs for innovation projects, in addition to "direct" project costs for development, integration, and rollout (e.g., personnel expenses), overheads (e.g., laboratory or license costs) are also incurred. The former can normally be collected easily through project controlling. Overheads are initially recorded for the entire organization.

The costs of purchasing (CAPEX), operating (OPEX), or using the innovation must also be recorded. Radical innovations in terms of technology in particular require new cost-intensive investments. The new mobile communications standard UMTS, for example, required high capital expenditure to set up the new network.

The reference objects for recording revenues are essentially the same as those for recording the costs, with a few additional market-related differentials, such as customer groups or market segments. The most important revenue items are sales, which are induced by innovations. Other revenues are possible through the sale of consulting services, licensing, or the use of patents. The majority of revenues are generated after costs have been incurred, since innovation projects generally do not generate any revenue during their lifetime. Revenues cannot be generated or recorded as actual values until the innovation is used or commercialized. However, an attempt must be made as early as possible to forecast revenue items and record them as planned values.

2.3.2.2 Allocation

The second aspect relates to the allocation of costs and revenues to an innovation or innovation project.

When allocating costs and revenues, the type of innovation is decisive. Costs can generally be allocated to innovations in method, process, and infrastructure (see Gemünden and Littkemann 2007, p. 3), as well as to product innovations. This applies for capital expenditure as well as for any cost savings which may be achieved later through improvements.

In terms of costs, the allocation of overheads is the biggest challenge. The breakdown and dedicated recording greatly simplifies subsequent allocation to the relevant innovation projects but entails increased costs.

In addition to traditional overheads, such as personnel expenses, other costs can take on an overhead character, in particular in the case of interconnected products. If several products are based on the same “innovation infrastructure”, e.g., when setting up the UMTS network, these costs must be allocated to the individual innovations.

Revenue allocation is much more complex than cost allocation. Incremental innovations improve existing products, thus increasing the benefits for customers and, in turn, product sales. However, it is difficult to determine whether and, above all, to what extent the increases have actually been triggered by the respective innovation. In the case of declining sales, product improvements must be considered a success if they contribute to maintaining existing revenue levels.

With radical innovations, the question of allocation is often much easier to answer since these innovations can be clearly identified as new benefits for customers. Radical innovations often lead to a completely new product range such that the resulting revenues can be clearly attributed to the relevant innovation.

As mentioned above, in addition to the level of innovation, the type of innovation is also important for allocation. While it is relatively easy to allocate revenues to product innovations of a specific product, this is not generally directly possible for process innovations, but only using a theoretical construct. Method, process, and infrastructure innovations can, however, also make a positive contribution to the market, e.g., through improved quality, faster access times, greater robustness (see Gemünden and Littkemann 2007, p. 3), and must therefore also be reflected in terms of revenue.

2.3.2.3 Measuring

After establishing which operands are to be considered (recording) and how these can be assigned (allocation), the third step is to clarify the question of measurement. Measurement is not subject to legal or other provisions and largely takes place according to entrepreneurial considerations and is therefore market orientated.

Basically, it is easier to measure costs than revenues. With regard to project costs, the costs actually incurred during the project are recorded and stated at the amount spent. The costs for purchasing (CAPEX) and operating (OPEX) the innovation, however, are more difficult to measure since these are merely budgeted figures. For incremental innovations, past purchasing and start-up costs can often be used. Measurement in the case of radical innovations is even more difficult since, depending on the case, this involves the use of completely new technologies for which no market prices exist at present. In contrast, OPEX for incremental innovations as well as completely new technologies can often be measured with reference to past experience. Sales, marketing, call center, or service costs can be taken from existing business and adapted, whereby flat rate values are frequently used.

The measurement of revenues presents the greatest risk due to the fact that they are pure forecasts. The distinction between radical and incremental innovations is also important here.

With radical innovations, the use of customer surveys and market tests are often difficult to perform since the users generally have too little knowledge about the new technologies, which means that no or only limited statements can be made on the anticipated benefits. This makes it difficult to forecast customers' willingness to pay and usage behavior. One possibility for bypassing user surveys is to use and transfer comparable cases from other sectors or foreign markets.

The rollout of mobile data services is given as an example here. European mobile communications providers have tried, albeit with little success, to draw conclusions from the Asian market as regards the rollout of i-mode or EDGE. However, with these types of international comparisons, regional and above all cultural particularities must be taken into account in the transferability of products and services.

To measure revenues from incremental innovations, existing data and past values can be drawn on. However, in shrinking markets in particular, the share of revenue triggered by new innovations is difficult to quantify since the prices in such markets are also subject to a major decline. This can be clearly seen, for example, in the trends in consumer prices for broadband Internet access (DSL access). For example, a 2 Mbit/s access cost around EUR 42 in 2005, while a year later a 6 Mbit/s access still only cost around EUR 43 (see Schwab April 2007, p. 8).

2.3.2.4 Clearing Method

Once the operands have been defined, delimited, and measured, the question of systematic processing is raised. As explained at the start of this section, innovations or innovation projects can be regarded as investments. The static (e.g., cost, profit, or profitability comparative analysis) and dynamic (e.g., capital value, annuities, internal rate of return, or net terminal value method) methods of investment appraisal can be applied accordingly (see Götze 2006, p. 49 et seq.).

2.3.3 Design and Significance of Innovation Profitability Analyses

The aim of innovation profitability analyses is, according to deliberations made previously, to determine the values of innovations or innovation projects in order to provide a decision basis for pursuing or ending these projects (see the central tasks of R&D controlling, Gaiser et al. 1989, p. 33 et seq., for the significance of project selection and the decision to abort projects).

Innovation controlling extends the understanding and tasks of the financial evaluation. In his version of innovation controlling, Bürgel adds the strategic components of a consideration of the market and technology in the future (see Bürgel 1994, p. 102). In addition to the traditional tasks of finance and budgeting, project control and reporting, this includes the tasks of strategic innovation controlling and project selection or measurement (see Bürgel 1994, p. 103).

The design of the financial evaluation is based on three underlying requirements: the project, success, and future orientation of innovations (see Littkemann 2005). Developing innovations in the form of projects provides an internal billing framework so that any costs incurred can be directly allocated to the reference object. At the same time, the project scope schedules the duration of the innovation project, which also simplifies the allocation of revenues and expenses to the relevant period. Success orientation calls for an extension of cost accounting to include a profitability analysis. On the one hand, revenues and expenses are introduced as operands and, on the other, netting these values makes it possible to calculate project profit or loss and thus assess success. The revenue-related view and consideration of income generated beyond the project term permit a reasonable assessment of innovation projects. Without this future orientation, the assessment of innovation projects would almost always be negative, since the innovation sometimes does not generate revenues until some considerable time after the project has been completed (see Gemünden and Littkemann 2007, p. 8 et seq.).

In practice, however, these requirements are frequently implemented inadequately. Usually the focus is predominantly on cost centers, driven by budget considerations, which makes project-related considerations difficult (see Gaiser et al. 1989, p. 37 et seq.). On the other hand, incorrectly understood project orientation often leads to focusing on recording costs and thus pushes cost and time control to the forefront. Thus often insufficient consideration is given to the fact that innovations are also sources of revenue. Projects are therefore generally selected not on the basis of future profits but on the basis of fixed budgets.

However, theories still focus on project and cost orientation, despite the requirements to the contrary. The design of revenue and market models is, in contrast, given little consideration.

Generally it remains the case that in theory and practice both the success and future orientation are frequently insufficiently based on the innovation profitability analysis.

2.3.4 Objective and Approach for Measurement in this article

This article presents the evaluation of innovations, illustrated by an example project. In addition to pure cost considerations, the revenue and market perspectives are also included, thus the use and exploitation of the innovation are taken into account in good time.

First of all the problems and possible settlement of costs and revenues will be described for each phase of the innovation process. Then the planning phase will be presented in detail using an example. A market model developed as part of business practice will also be presented and explained.

2.4 Structure and Implementation of Market-Orientated Evaluation of Innovations

The comments on assessing innovations below refer above all to the main tasks of project evaluation and selection, in particular based on the determined success of the innovation. This requires the continual determination and monitoring of the value contribution of innovations and/or innovation projects.

In the following sections, the individual phases of the innovation process will be presented and analyzed with regard to the criteria set out in Section 2.3 (recording, allocation, measurement, and clearing). Finally, the planning phase will be described in detail, with a three-part model comprising supply, demand, and the cost/benefit analysis resulting from their interaction.

2.4.1 Evaluation of Innovations in the Various Phases of Innovation Management

The following section deals with the evaluation of innovations in the various phases of innovation management: the initiation (“fuzzy front-end”), the planning (“new product and process development”), and commercialization phases (see Table 2.1).

2.4.1.1 Initiation Phase

In the initiation phase, the influence of innovation ideas is generally still very unclear and the technical and economic success is therefore difficult to estimate.

Table 2.1 Overview of innovation phases

	Initiation	Design	Commercialization
Recording	▪ Project ▪ Overall market ▪ Share of overall market ▪ Overall innovation	▪ Project ▪ Individual product ▪ Customer group / segment ▪ Business model	▪ Individual project ▪ Customer group / segment ▪ Business model ▪ Marketing objects and strategies
Allocation	▪ Not or only rudimentarily considered since rough estimate alone does not require this	▪ Issues relating to allocation of costs from other projects and sub-projects ▪ Allocation of revenues from other products	▪ Problems distinguishing revenues from other products ▪ Cost accounting increasingly more precise
Measurement	▪ Market potential ▪ Share of overall market ▪ Total CAPEX	▪ Project-induced revenues ▪ Expenses (if possible based on cost items) ▪ Flat (fixed) rates	▪ Cost differentiated into cost types, products as well as activities ▪ Revenues according to products and revenue types ▪ Differentiated statement of estimated revenue and expenditure
Method	▪ Market estimate / potential analysis ▪ Cost estimate based on CAPEX ▪ Risk analysis	▪ Mathematical methods ▪ Static procedures (profit comparison method) ▪ Dynamic procedures (net present value method)	▪ Integration in operational cost accounting and income statement ▪ Integration in operational planning system

There are only rough economic estimates, and data collection concentrates primarily on the sales volumes of overall and sub-markets as well as the distribution of market shares. Risk analyses are regularly carried out in the initiation phase as regards technical feasibility and economic success (see Gaiser et al. 1989, p. 34).

Precise cost and revenue estimations and allocations can still not be made, since the use of the innovation and its associated products or services has not yet been specified. The recorded values cannot yet be allocated to the innovation. The recording process only indicated the possible leeway. The extent to which this can be filled by the innovation remains open in this phase.

In the first phase, the evaluation of the innovation is based primarily on an estimate of the total investment costs and the forecasted market potential. Potential analyses provide information on the revenue potential which could be tapped in the market by the innovation and how the company's competitive situation could alter as a result (see Gaiser et al. 1989, p. 34). The extent to which the potential can be exploited remains open initially. The analysis is deliberately kept on a superficial level since a more precise analysis would require too much time and too many resources and would be repeated in subsequent phases anyway.

At this early stage, the investment appraisal methods are still not applied since they require much more detailed information on the time of occurrence of input values. The estimate is limited to a basic comparison of investment costs and the revenue and growth potential of the market addressed, augmented by risk-related statements. The cost sheet is to provide an idea of the financial and organizational expenses to be expected.

2.4.1.2 Planning Phase

The planning phase (“new product and process development”) is used to prepare and develop product and service concepts.

The product and service concepts developed build the framework for the values to be considered in this phase. Forecast, potential revenues from products and services, and OPEX form the basis for the calculation. Depending on the nature and design of the innovation, revenues can be broken down into detailed reference values such as customer groups or sub-segments.

The project organization allows project costs to be recorded and allocated directly by project control. The more difficult task is the allocation of overheads with regard to other projects and innovation projects and general revenues from other products. For revenues in particular, an analysis of other similar products is a central component of revenue analysis and forecast. In the context of interconnected or network products, the determination and allocation of the innovation’s value contribution is particularly important. This is described in more detail later in the text.

In the measurement, the project-induced revenues must be compared with capital expenditure over time. Data for the forecast revenues and investment costs should be agreed with the product owners. For interconnected and network products this is difficult since there are generally several product owners.

Financial mathematics provides above all the net present value method as a dynamic investment appraisal method. Under this method, payments received and made over the product lifecycle are compared and discounted to their present value. Corporate earnings and innovation risk are controlled using the specified interest rate.

2.4.1.3 Commercialization Phase

The specified product concepts are launched on the market using traditional marketing tools and on the basis of the product launch processes in the commercialization phase. Internal accounting provides cost and service allocation and forecasts as basic information for this phase.

The innovation profitability analysis focuses on individual products, service offers, product bundles, dedicated customer segments, and sales areas in this phase. There is already a clear idea of production costs and willingness to pay, enabling detailed data to be recorded.

As the data pool improves, the relationship between innovation and origin of cost gradually becomes clearer. In particular, the level of detail and the specific nature of the data make it easier to allocate innovations. Cost accounting becomes increasingly helpful and offers more precise information, especially with regard to

OPEX and the determination of flat rates. However, the integration with internal accounting only helps with cost allocation; revenue forecasts and measurement of innovations continue to be problematic. In particular, the difficulty in identifying the share of revenue induced by the innovation remains and is rendered all the more difficult by the problems concerning interconnected products, as mentioned above.

The data quality of the values also continually increases. As mentioned above, with regard to measuring costs, the actual values can increasingly be referred to as a basis for comparison. Despite the problems concerning revenues from interconnected products, the knowledge of customers' willingness to pay in particular increases through market and acceptance tests.

Company accounting and the company's planning systems provide a wide range of tools in this phase with which both cost and revenue-related planning and control can be achieved.

2.4.2 Detailed Concept for the Evaluation of Innovations in the Planning Phase

Having presented the special features of the evaluation of innovations in the individual phases of the innovation process, this chapter focuses below on how innovations are evaluated in the planning phase. The input parameters comprise the information already recorded and analyzed in the initiation phase, with the data points growing more and more specific over the entire innovation process.

2.4.2.1 Overview

The aim of the financial evaluation in the planning phase is the market-orientated measurement of innovations which are developed to preliminary product maturity. A market- and revenue-related analysis and evaluation are required in addition to a cost assessment here. This analysis relates both to the supply and demand side. The result is finally expressed in the profitability of the innovation project which is determined in the business case (see Fig. 2.2). Due to the high interdependency of supply and demand, and profitability as resultant, it is difficult to consider these separately, although a separation in terms of content helps to highlight the differences. The innovation to be measured in the following example is not a product innovation. Rather it is an innovation with the character of infrastructure in the sense defined above, which is described as an "enabler" in the telecommunications sector. "Enablers" are not direct market products but merely enable the "production" of such products. Quite simply, these are infrastructure components that are located between the pure network level and the application, i.e., product level.

In the following we will first deal with the supply and demand module and then profitability as the resulting outcome. The procedure is presented using an innovation project from the area of transmitting multimedia digital objects (e.g., videos, music tracks).

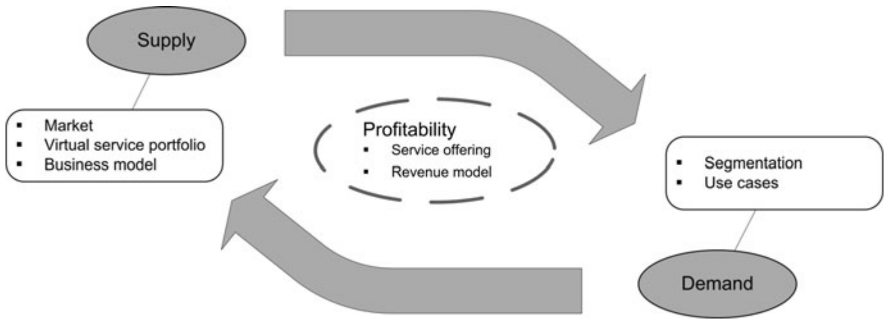

Fig. 2.2 Plan for assessing innovations

2.4.2.2 Supply Module

The aim in the planning phase is not to describe a defined and differentiated product range in full detail, but rather to determine the basic range of services in the form of product and service concepts. In order to evaluate the innovation on the supply side, the market to be addressed must first be identified. This is often already determined by the nature of the innovation. It is followed by an analysis of the products and services that can be offered, improved, or extended by the innovation. This process finally leads to the determination of a potential offering. Finally, the offer must be anchored in a business model which describes the value chain and the distribution of value added amongst the partners involved, including their own share.

The first step involves identifying the relevant market. Next, the size of the market must be determined by the quantitative specification of the market volume. Using in-house research and consulting informative studies, a quantitative statement is made on size and development. In addition, a qualitative analysis should be carried out. Information on general trends which concern and influence the structure and nature of the identified market is especially important here. Technological trends must also be considered.

The digital multimedia distribution market was identified and investigated in terms of trends for the example project. Three overall development trends were identified:

- Internet content is becoming more and more multimedia orientated.
- The performance of terminal devices is increasing.
- The number of broadband Internet accesses is growing.

These trends all have a positive impact on the development of the digital distribution market and strengthen the positive market assessment.

After the relevant market has been evaluated in terms of quantity and quality, the next step is the fine-tuning or specialization of the offer. Possible actions must be shown highlighted in the form of potential offers ("virtual service portfolio"). The potential offer results from the evaluation of the character of the innovation.

The following questions are to be answered in this context: Which products can be generated as a result of the innovation? What impact does the innovation have on products and services? Where does the innovation achieve added value in the form of an improvement?

In the example project, four product groups with the relevant definitions were identified (see Fig. 2.3):

In this example, due to the enabler character of the innovation, as described above, there is a specific characteristic that has an influence on the virtual service portfolio and on the service offering as the final offer, which is considered in more detail later on. In this specific case, the virtual service portfolio should be considered not only as potential in the sense of "provisional" but also as virtual in the sense that it cannot be provided directly by the innovation at all, but only be supported indirectly. It is nevertheless necessary to specify a virtual portfolio in order to be able to carry out a market- and revenue-related evaluation of the innovation.

After developing the potential offer, the activities focus on designing the business model. According to Timmers, a business model comprises three basic components (see Timmers 1998, p. 4):

- Architecture of products and services, which includes the presentation of various players and their roles
- Description of benefits for the partners involved and for potential customers
- Revenue drivers and sources

The central point when determining the business model is therefore the setup and analysis of the value chain which describes the interaction between the various partners as regards value added. In the digital distribution market, the delivery chain

	Realtime (Streaming)	Delayed (Download)
Unicast (Point-to-point delivery)	**Multimedia "on demand"** („Immediate Satisfaction"): ▪ News, Internal Communication, E-learning applications ▪ „Hollywood" Content, Video / music on Demand/ Juke-Box ▪ Investor Relations	**Multimedia download (pull)** („Delivery for later satisfaction"): ▪ Collector's content, ▪ Video clips, Movies, Songs ▪ Product Information, internal information
Multicast/ Broadcast (Tree-structured-delivery)	**TV and radio services** („Live entertainment"): ▪ TV, interactive TV ▪ Internet Radio ▪ Public viewing	**Multimedia push services** („Pushed Information"): ▪ Local information ▪ Periodicals ▪ Software Upgrade

Fig. 2.3 Virtual service portfolio

Fig. 2.4 Value chain

(see Fig. 2.4) comprises four elementary modules: content, transport, access, and service (see Erner et al. 2007).

A large number of players are involved in the creation of this value chain. Current trends show that the boundaries between the relevant players and supply areas are blurred and thus competition covers the entire value chain. This is making it even more important to determine shares in value added which the various partners can achieve and the share that the company wants to achieve itself.

When developing the business model it becomes clear how interdependent and closely linked the various modules and sub-modules presented in this section are. The business model is based partially on the service portfolio and partially on the analysis of demand, since without a detailed analysis of the demand situation the revenue sources cannot be quantified.

2.4.2.3 Demand Module

After determining the supply, the demand side must be investigated. To this end the potential benefits for individual customer groups are analyzed, which are divided up into segments for the requirements forecast. This process interacts to a large extent with the later supply layout, since identifiable product requirements can be derived from the customer benefits analysis, thus influencing the product design in the long term. The benefits analysis for innovation development generally takes the form of use cases.

The "potential offer" outlines, as shown in the previous section, the leeway for the development of specific offers and thus forms the basis for the first segmentation step – rough segmentation. The aim of segmentation is to determine the needs and usage behavior for the individual products and services still to be specified. Rough segmentation is often done by distinguishing between consumers and business customers.

In the example project, three customer groups, namely consumers, business customers, and wholesale (which is the term used in the telecommunications sector for business between telecommunications operators and service providers) were identified and are distinguished according to further sub-criteria (see Fig. 2.5).

In the next step, these customer groups are transferred to a more "detailed segmentation." In addition to geographical and socio-demographic criteria, behavior-orientated and psychographic features are of great importance (see Meffert 2000, p. 188 et seq.). Sinus Milieus® are widely used in German business practice since they unite the established features in one approach. More recent approaches also include aspects of interaction between people and products and services in so-called usability taxonomies (see Herrmann et al. 2007).

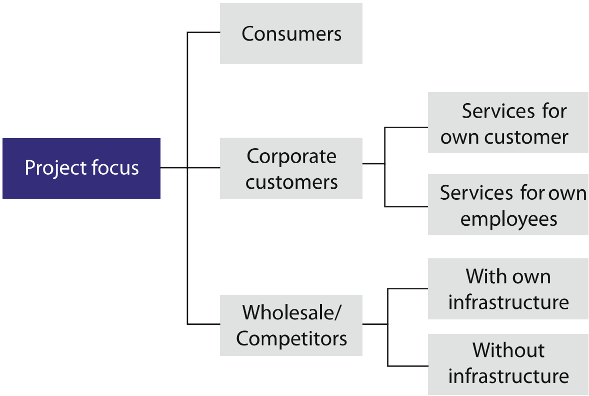

Fig. 2.5 Rough segmentation of target groups

In the example project, the relevant target corridor was determined using Sinus Milieus® and various market research studies. Based on all people living in Germany over 14 years of age and using various telecommunications-specific characteristic filters (broadband users, multimedia affinity, and "open to new services"), the target group was fixed (see Fig. 2.6).

In contrast to consumer segmentation, there is less research interest in business customer segmentation (see Fig. 2.7). In our example, we avoided the widely used segmentation according to revenues, number of employees, or growth rates. Instead,

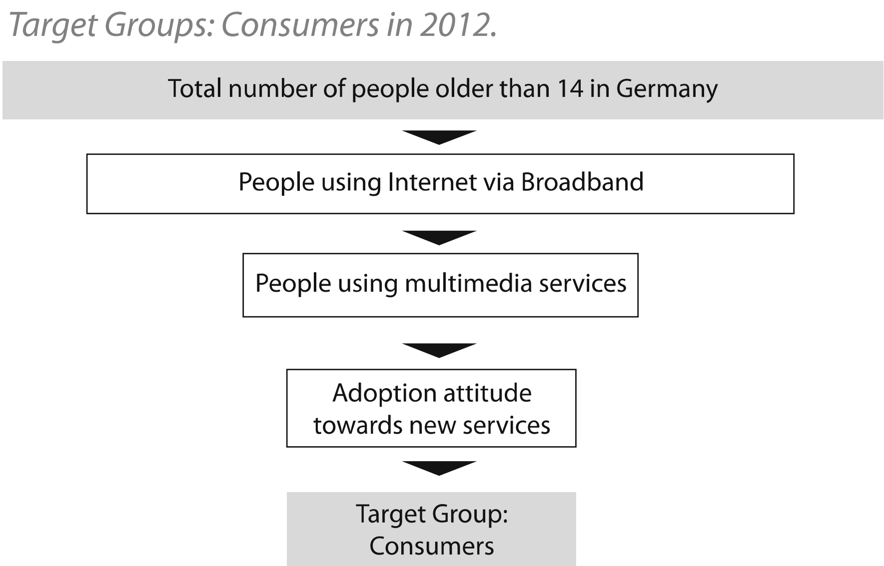

Fig. 2.6 Consumer segmentation

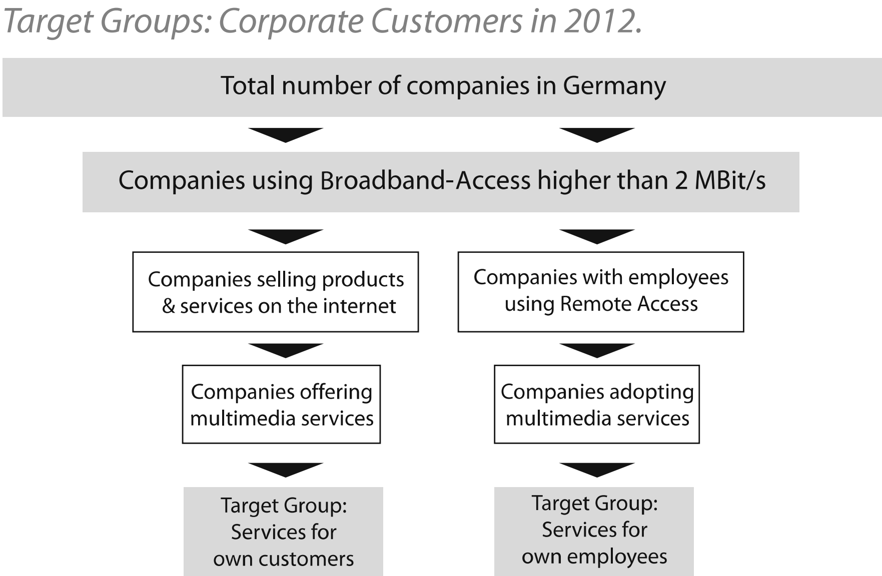

Fig. 2.7 Business customer segmentation

just as for consumer segmentation, two target groups were defined according to telecommunications-specific criteria and characteristic parameters, such as broadband access to the Internet, multimedia affinity, and product portfolio as well as employee services, based on market research studies.

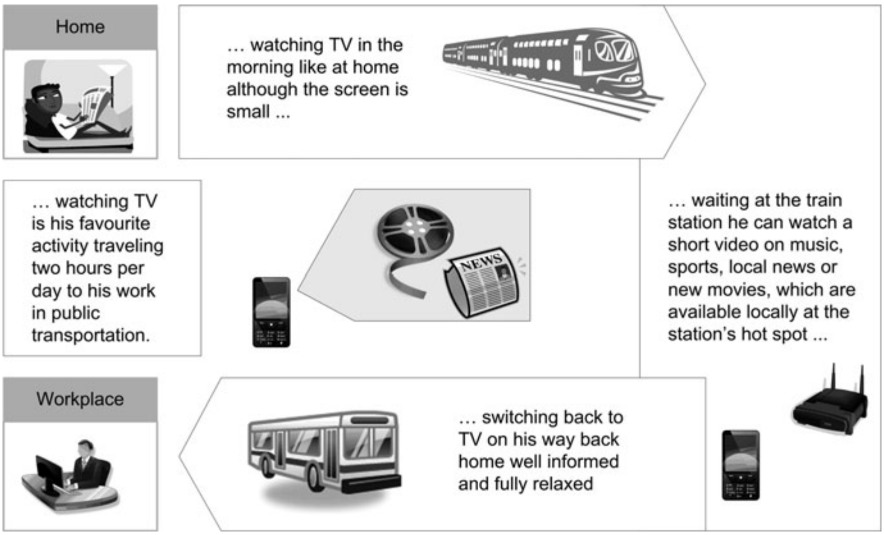

Fig. 2.8 Use case – mobile TV

Use cases examine the use of the potential product by the customers. The question asked is, how and in which situations do the customers use the product or service? Indicators for the frequency and duration of use, which are also particularly relevant for the profitability analysis, are the direct result. This customer-related user assessment also enables direct requirements of product design to be derived. Use cases were developed for all services or product groups of the potential service portfolio. An example of use case for a mobile TV scenario is shown below (see Fig. 2.8).

2.4.2.4 Profitability Analysis

The analysis of the supply module provided information on the relevant market and its development and finally resulted in a potential offer induced by the innovation. Furthermore, the basic business model was determined. In contrast, the target groups and segments were determined on the demand side and use cases were developed. In this context, the task of the profitability analysis is to coordinate and optimize supply and demand from a financial viewpoint. Therefore, the final service offerings are developed, backed up with the revenue models, and finally evaluated in terms of success.

In the supply module, only the virtual service portfolio, in the sense of a potential offer, was developed; the final product offer must be specified in the next step. According to the points made above on the special feature of enabler technologies, it should be noted here that the virtual service portfolio only describes the product room which can be improved or supported by the innovation. The actual services, such as mobile TV, are not originally produced on the basis of the innovation. Service offerings essentially comprise the individual modules and components of the product or enabler which can be traced back to the innovation and which can be implemented as part of a specific value-added chain constellation. Service offerings must be tailored to the target groups identified. In this example the system comprised five components, based on the value chain and influenced in the long term by the innovation, which were offered in three different bundles or product packages for the individual target groups. The "full service package", as the full package encompassing the entire distribution chain, was tailored to consumers in particular, the "technical service package" to business customers who already have their own content management and the "supporting service package" to wholesale customers who play back their own content via their own distribution network. The following method and figures are examples of the "full service package" (see Fig. 2.9), whereby the procedure for the other service offerings is the same.

Alongside the cost model, the market and revenue model is a central component of the business case. The revenue model clarifies the relationships between the innovation, i.e., the product concepts based on it, and the resulting effects on revenue. For this it is necessary to identify the revenue sources and revenue drivers connected with the innovation and to examine their impact on revenue components as regards to the revenue structure.

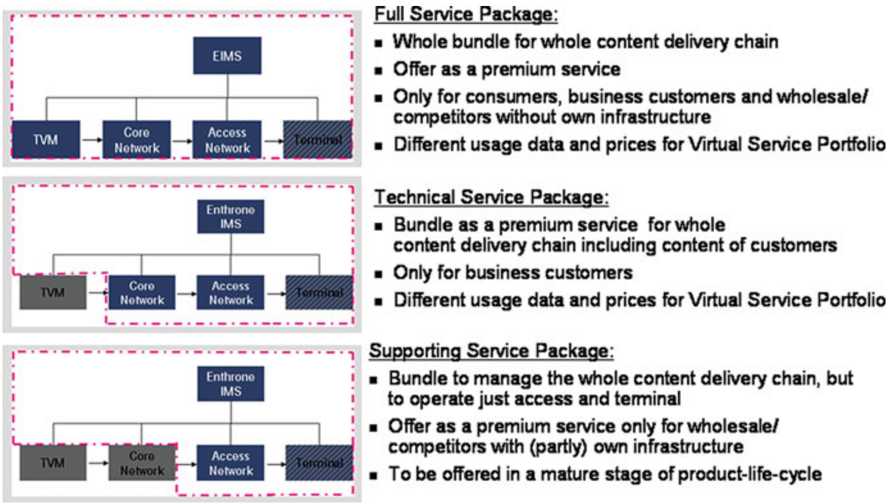

Fig. 2.9 Service offerings

Figure 2.10 shows the potential offer and link to the revenue sources of data traffic, subscription, content per use, service bundles, and advertisements. Based on these sources, together with the revenue drivers, three levers were identified which have a positive impact on revenue. These include more frequent use, a higher number of users, and finally the introduction of additional or premium services.

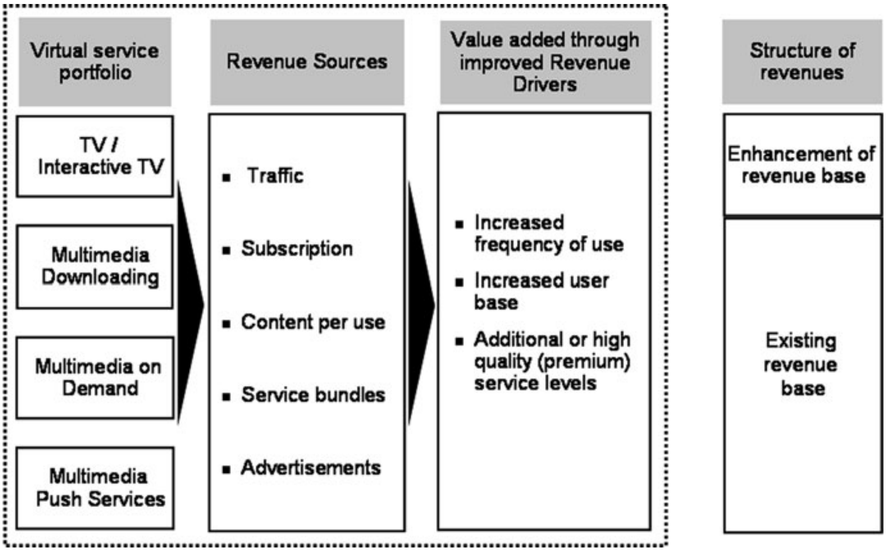

Fig. 2.10 Revenue model

Once the general cause–effect relationships of the revenue model have been identified, the specific influence of the innovation on the revenue drivers now can be determined. Since this innovation concerns an incremental improvement of existing multimedia distribution systems, there is already an existing revenue basis which will simply be improved by the innovation. To evaluate and calculate the financial influence, the impact of the innovation components on the three established revenue drivers will be examined. Here a distinction can be made between four intensity levels, the varying effects of which can be assigned, presented by the various percentage gradings.

Figure 2.11 shows the results of the evaluation in a matrix. By applying these effects to the revenue base, it is possible to calculate the impact on existing revenues via the revenue drivers. Furthermore, when considering the revenue structure it is clear that the innovation, due to its "enabler character", will simply lead to an "enhancement", i.e., to an improvement in the existing revenue.

The revenue development for the coming years can be forecast based on the market size, the dedicated target groups, and the influence of the innovation on revenue drivers and thus the existing offer. By adding in innovation costs (see details in Section 2.3.2), it is possible using the net present value method to calculate a net present value for the innovation and thus the investment over a defined assessment period. This should be considered as the benchmark for measuring innovations.

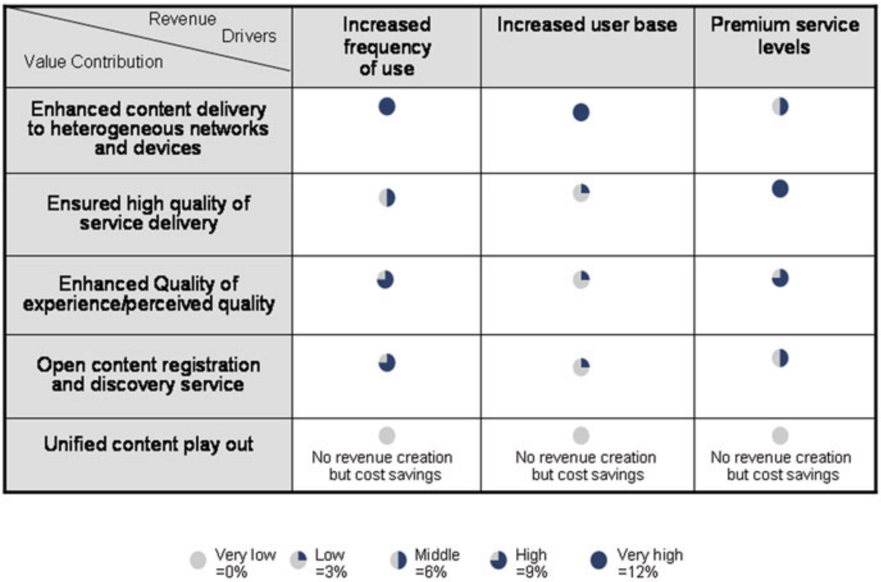

Fig. 2.11 Evaluation of revenue drivers

2.5 Conclusion

The pursuit of companies for value-added growth has become an ambitious target in the age of ever shorter product lifecycles and increasing competition. The successful development and rollout of innovations appears to be at least a key to success in this context. Limited resources and high expectations of new products and services increasingly require the continual quantitative and qualitative evaluation of innovations and innovation projects.

Based on the underlying criteria of accounting systems, we first presented the general possibilities and limitations of the evaluation of innovations, supplemented by an assessment of the specific innovation phases. Based on a requirements analysis, project, future, and success orientation were then identified as decisive guidelines for the evaluation of innovations, although compliance with these guidelines is often insufficiently guaranteed in theory and practice.

On the basis of these guidelines, this article presented a conceptual procedure for evaluating innovations and illustrated the methodology using an example project.

A multi-stage procedure was presented for this which, based on various aspects of supply and demand, finally reconciles these two aspects financially in the business case and determines the value contribution of the innovation.

The central finding of this article and the guideline for the process as a whole is the knowledge that to comprehensively evaluate innovations, it is not sufficient to consider merely cost and project aspects, but rather every phase of the innovation process must involve a continuous market-orientated assessment.

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Chapter 3
Credit Ratings and Assessments as a Form of Innovation Profitability Analysis for Innovative Technology-Oriented (Start-Up) Businesses

Wilhelm Schmeisser

3.1 The Importance to the Economy of Innovative New Business Start-Ups

The role of young technology companies in the USA in creating and further developing individual high-tech industries has caused increased attention to be paid in the Federal Republic of Germany to technology-oriented business start-ups in innovation policy at national and regional level since the beginning of the 1980s and from 1997 to 2001 by the Neuer Markt. Targeted innovation policy has resulted in the creation of invention centres, technology parks and innovation advisory centres with the aim of helping small and medium-sized companies in particular to realise their ideas technically and financially.[1] According to Licht and Nerlinger, the number of companies, employees and start-ups in high-technology industries was actually in decline in the first half of the 1990s. On the basis of this trend and the importance of innovative businesses in the spread of new technologies, special funding programmes were launched and continue to be launched in most of the EU member states with the aim of stimulating start-ups in this area.[2] The development assistance schemes were mediated by the principal bank. However, the application of this principal bank principle meant that the principal bank was liable for all the financial aid granted apart from equity assistance. As a result, start-up projects are selected very carefully and are overseen by the bank.[3]

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W. Schmeisser et al. (eds.), *Innovation Performance Accounting*,
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3.2 The Formation of Innovative Technology Businesses

According to Picot, Laub and Schneider,[4] the distinguishing feature of innovative business start-ups lies in the degree of novelty in problem solution, which influences the entire implementation process. According to this view, the more novel the approach to problem solution, the more difficult it is to evaluate the start-up idea, the founder and the organisation of start-ups. When it comes to valuing the business, it is necessary to know in which phase of the formation process the business currently is.[5] Figure 3.1 outlines the innovation process cycle model. In the literature[6] the growth cycle of an innovative technology business is split into the following investment and financing phases:

Seed financing. During this phase basic research is conducted and prototypes building on this work are created. Financing is largely from one's own resources and public development assistance schemes. The risks here are very high. Thus, for example, only a small percentage of all technically feasible innovations get as far as the market.

Start-up financing. This is the phase in which the innovations are developed to the stage where they are ready for the market and the corresponding marketing concepts are drawn up based on market analyses. It is usually at this point that the start-up is founded.

First stage financing. This phase sees the market launch of the products; production, sales and the organisational framework are built up. In particular, the staff in the development department are a major strategic key to the future of the business.

Second stage financing. This stage sees penetration of the market and the development of distribution channels. During this phase, the need for funding declines due to rising sales.

Third stage financing. In order to be able to exploit the entire market potential, the production and sales apparatus is expanded during this phase.

It follows that the founders of technology-based start-ups are usually in the financing phase of seed financing or second financing when they apply to their principal bank for public funds. In these phases, young technology businesses have a number of special features.

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der Industrieunternehmung. Ein multikontextualer Erklärungsansatz für technische Innovationen. Aachen.

[4] Picot, A., Laub, U. D., Schneider, D. (1989) Innovative Unternehmensgründungen: eine ökonomisch-empirische Analyse, Berlin u.a., pp. 28–55.

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[6] Stedler, H. R. (1987) Venture Capital in der Bundesrepublik Deutschland unter besonderer Berücksichtigung der Rolle des geregelten Freiverkehrs in der Desinvestition, Stuttgart, pp. 42–46; Breuel, B. (1988) Venture Capital. In: Christians, F. W. (ed.) Finanzierungshandbuch, Wiesbaden, pp. 583–584; Servatius, H.-G. (1988) New Venture Management: Erfolgreiche Lösung von Innovationsproblemen für Technologieunternehmen, Wiesbaden, pp. 49–50.

[Profit]

Innovation process phases	I + II	III + IV	V	I II	II+III	III
	Internal innovation process			External innovation process = product life cycle		
phases in the development of a business	Start-up phase			Growth phase		Diversification phase
	Seed stage	Start-up-stage	First stage	Second-stage	Third stage	Disinvestment
Distinguishing features	Start-up idea + development concept + idea evaluation	- Business founded - Product development - Preparations for production - Marketing concepts	- Series production - Market entry - Opening up of market	- First expansion phase - Expansion of distrubution channels	-Breakeven point passed Exploitation of market potential	- Maturity phase - Equity providers released
Structural elements	-Founder person/team -No organisation -No staff -No business location	- Founder person/team - Employees - Location - Production resources	- No of staff increases - Distrubution channels established	- No of staff increases - Distribution - Organisational structure grows - Greater complexity	Expansion of production equipment marketing efforts stepped up	Dependent on product success
Time axis						
Financing	Own resources Grants Loans Venture capital	Further grants Venture capital	Further grants Venture capital	Loans Profits	Increasing profits public capital market -profits	Depentent on further product success
Problems [Loss]	Assessment of ideas and market -Financing	- Time assessment - Financing	- Search for personnel Enterprene urial			

Fig. 3.1 Innovation process cycle model of the formation of businesses
[source: Laub, U. D., Innovationsbewertung, 1991, p. 28]

3.3 Credit Assessment as Part of the Loan Decisions

The granting of loans formally constitutes a decision process that is embedded in the bank's policy objectives. But few action alternatives exist for the loan decision. The possibilities here are approval, approval with reservations (e.g. with conditions, restrictions etc.) or refusal.[7] The choice of action alternatives is determined by the objectives of the bank's loan or risk policies. Here, according to Süchting,[8] profit maximisation combined with adherence to secondary conditions play the critical role in the loan decision.

[7] Staudt, E., Hafkesbrink, J., Lewandowitz, T. (1996), Kompetenz und Kreditwürdigkeit. Bestandsaufnahme der Kreditwürdigkeitsprüfung in Theorie und Praxis bei Existenzgründern und innovativen Klein- und Mittelbetrieben. In: Berichte aus der angewandten Innovationsforschung, hrsg. von Staudt, E., Bochum, p. 21.

[8] Süchting, J. (1992) Bankmanagement, Stuttgart, pp. 313–315.

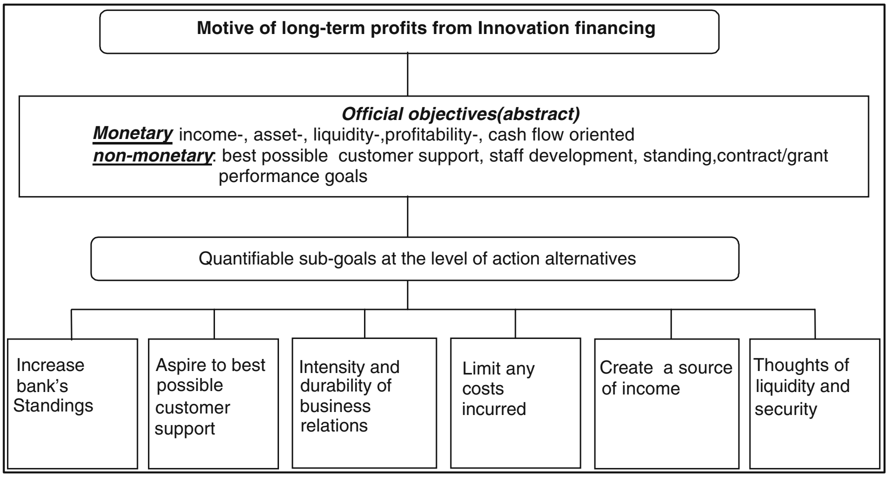

Fig. 3.2 Decision criteria used by banks for innovation financing
[source: Hierl, W., Venture Capitalfinanzierung, 1986, p. 89]

Hierl[9] on the other hand describes loan policy as embedded in a multi-variable objective system. In his view, non-monetary objectives play a role as well as monetary objectives. Figure 3.2 presents the pertinent sub-goals of banking activity in the area of innovation financing. According to this, due to changes in the competition situation, the credit institutions have an interest in standing out from the competition in order thereby to better utilise the potential of their own customers. In the case of young technology businesses in particular, this means stepping up the advice associated with sales. The critical criterion in the competition is the quality of advice.

3.4 Features of Creditworthiness and Indicators of Innovative Technology Businesses

3.4.1 The Areas Assessed During the Assessment of Creditworthiness

The willingness to grant loans depends on the creditworthiness of the borrower. The loan decision is based on an assessment of the borrower's creditworthiness. This assessment entails the selective and weighted bundling of information to enable a

[9] Hierl, W., Banken und Venture Capitalfinanzierung – Determinanten bankbetrieblichen Entscheidungsverhaltens zur situationsgerechteren Beteiligung an einer Venture-Capital-Gesellschaft, Unterföhring 1986, pp. 87–91.

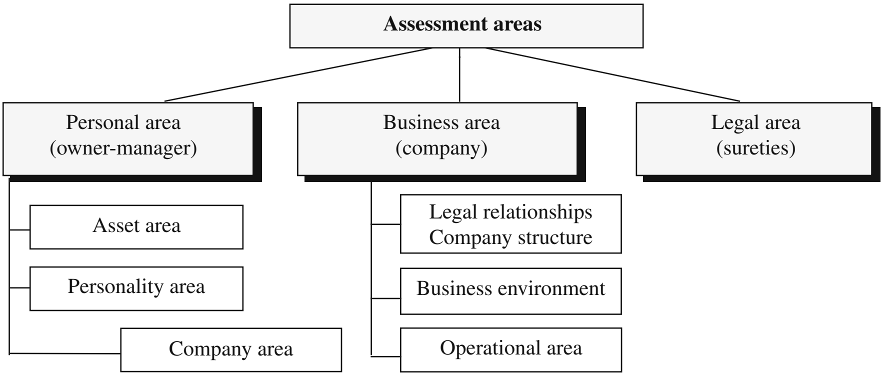

Fig. 3.3 General criteria for the assessment of creditworthiness
[source: Deckers, M., Kreditentscheidung, 1990, p. 87; Schmoll, A., Kreditüberwachung, 1992, pp. 147–148]

decision to be made on whether to approve the request for a loan.[10] To obtain this information for the loan decision, it is first necessary to define the assessment areas. Within these areas in turn, the factors that are critical to creditworthiness have to be identified. To review these, indicators are required.[11] The areas of assessment are summarised in Fig. 3.3

The legal area of assessment is not considered any further below, as normally sureties cannot compensate for the high risk of these start-ups in the case of innovative business start-ups. What is more critical here is the continued existence of the business and the amount of its future earnings. For this reason it is necessary to capture and assess all the factors which determine the success of the company. According to Kirchhoff,[12] this can be done by performing a future-oriented, dynamic assessment of creditworthiness which entails a full analysis of the business.

Laub[13] drew the conclusion from this that it is those factors which go the furthest in determining the success of the innovative business start-up which are essential in the analysis. It follows from this that it is first necessary to capture the central influencing factors to which the overall innovative start-up process can be attributed. In an empirical study, Picot, Laub and Schneider[14] identified the founder, the start-up

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[10] Kronheim, L. (1984) Bonitätseinstufung und -prognose. Die Bank, 4, p. 190.

[11] Rommelfanger, H., Bagus, T., Zerres, B. (1991) Persönliche Kreditwürdigkeit eines mittelständischen Unternehmens. Kreditpraxis 17. Jhg., 5, p. 24.

[12] Kirchhoff, U. (1990) Wachsender Wettbewerb der Kreditwirtschaft um mittelständische Unternehmen. Aktuelle Problemlösungsmöglichkeiten durch Sparkassen und Landesbanken. Sparkasse, 8, p. 359.

[13] Laub, U. D. (1991) Innovationsbewertung. Ein Bewertungskonzept für innovative Unternehmensgründungen. In: Laub, U. D. , Schneider, D. (eds.) Innovation und Unternehmertum. Perspektiven, Erfahrungen, Ergebnisse, Wiesbaden 1991, pp. 36–38.

[14] Picot, A., Laub, U. D., Schneider, D. (1989) Innovative Unternehmensgründungen: eine ökonomisch-empirische Analyse, Berlin u.a., pp. 258–261.

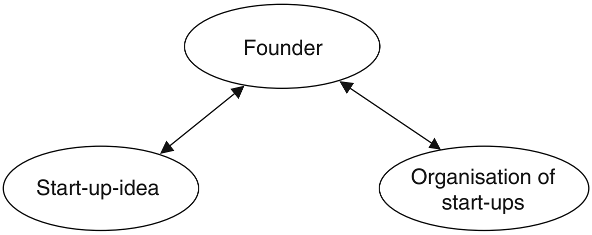

Fig. 3.4 Success factors in innovative company start-ups
[source: Laub, U.D., Innovationsbewertung ("Innovation valuation"), 1991, p. 37]

idea and the organisation of start-ups as the most important determinants of the success of innovative business start-ups. According to Laub,[15] these factors constitute the success factor triangle of innovative company start-ups, which is presented in Fig. 3.4.

These success factors constitute the basis for the way forward. Using the determinants discussed below, it is possible for the credit institutions to value an innovative new business start-up.

3.4.2 The Assessment of Personal Creditworthiness

Given the special importance of the owner–manager for the continued existence of a small or medium-sized enterprise (SME) or young technology business, personal creditworthiness plays a special role in the analysis of creditworthiness, as often the owner is entirely in charge of management of the business. Moreover, studies[16] have shown that personal creditworthiness is particularly important where it is not possible to adequately check the material creditworthiness. This is especially the case where loans for new business start-ups are involved.

If one simplifies the process under which the innovative business comes about, then according to Laub[17] it is apparent that the personality of the founder plays a central role and at the same time constitutes the driving force in a start-up.

The starting point for further economic activities is the start-up idea. The implementation of this idea is affected by many organisational possibilities. Here the founder is the central coordinator of the start-up process. The market constitutes

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15 Laub, U. D. (1991) Innovationsbewertung. Ein Bewertungskonzept für innovative Unternehmensgründungen. In: Laub, U. D. , Schneider, D. (eds.) Innovation und Unternehmertum. Perspektiven, Erfahrungen, Ergebnisse, Wiesbaden, p. 37.

16 Rommelfanger, H., Bagus, T., Himmelsbach, E. (1990) Merkmale der persönichen Kreditwürdigkeit bei Kreditanträgen mittelständischer Unternehmen. Eine empirische Untersuchung. Österreichisches Bankarchiv, 10, p. 796.

17 Laub, U. D. (1991) Innovationsbewertung. Ein Bewertungskonzept für innovative Unternehmensgründungen. In: Laub, U. D., Schneider, D. (eds.) Innovation und Unternehmertum. Perspektiven, Erfahrungen, Ergebnisse, Wiesbaden, p. 30.

the third essential element, which here functions as a source of information and as the ultimate force determining the success of the start-up.[18] It follows from this that personal creditworthiness is rightly of special importance in the assessment of the creditworthiness of innovative business start-ups.

The concept of personal creditworthiness is interpreted in different ways in the literature. Thus, for example, Jährig and Schuck[19] see this as only personal trustworthiness. Others in turn include the qualifications of the entrepreneur, including both the entrepreneur's technical qualifications and also his skill at managing and organising the business.[20] Figure 3.5 summarises the factors determining the assessment of personal creditworthiness.

Although, according to Rommelfanger, Bagus and Himmelsbach,[21] the majority of theoreticians and practitioners agree with the statement that one of the basic preconditions for every credit transaction is that the borrower is trustworthy, there is little in the way of research on either side on personal creditworthiness.

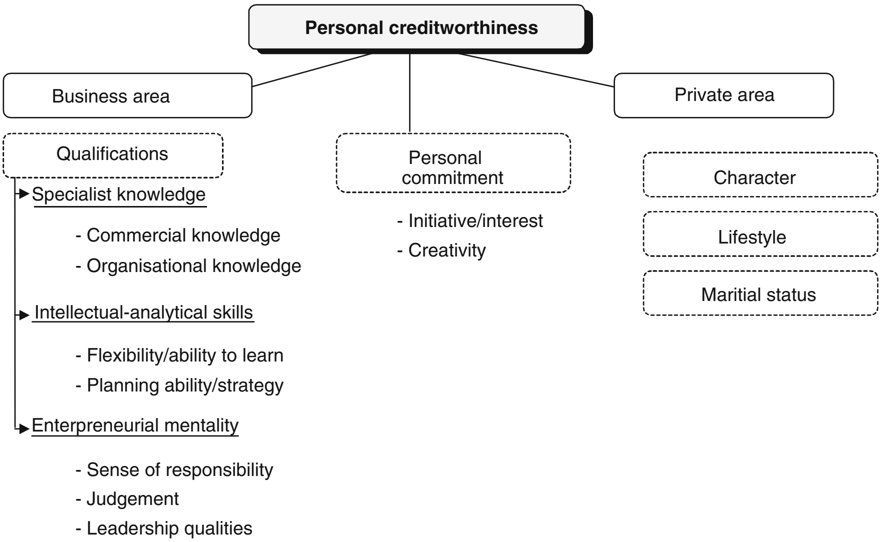

Fig. 3.5 Determinants of personal creditworthiness
[source: Rommelfanger, Bagus & Zerres, Persönliche Kreditwürdigkeit, 1991, p. 25; Schmoll, A., Kreditüberwachung, 1992, p. 147]

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18 Laub, U. D. (1989) Innovative Unternehmensgründungen, pp. 71–72.

19 Jährig, A., Schuck, H. (1990), Handbuch des Kreditgeschäfts, Berlin, p. 336.

20 z.B. Schmoll, A. (1983) Kreditprüfung (I), pp. 94–96; Kreim, E. (1988) Kreditentscheidung, p. 100 ff.

21 Rommelfanger, H., Bagus, T., Himmelsbach, E. (1990) Merkmale der persönichen Kreditwürdigkeit bei Kreditanträgen mittelständischer Unternehmen. Eine empirische Untersuchung. Österreichisches Bankarchiv, 10, p. 786.

3.4.3 Company-Specific Indicators of Creditworthiness

In the specialist literature one finds a few suggested lists of criteria by means of which to determine personal creditworthiness.[22] Insolvency statistics are used to judge the necessary skills, in that it is possible to work out from the reasons for the bankruptcy to what extent shortcomings in qualifications were responsible for the business failure. Taking this line, both Keiser,[23] Reske, Brandenburg and Mortsiefer[24] and Hierl[25] all come to the conclusion that personnel factors are the most important cause of insolvency amongst SMEs. The factors listed in Fig. 3.6 from the personnel area are regarded as increasing the likelihood of insolvency.

It is noteworthy in this connection that the larger business is, the less important character defects and lack of qualification as an entrepreneur become as the cause of

Causes of insolvency	**Overall**	
	Frequency of occurrence as a %	Weighting 1)
Lack of qualification as an entrepreneur	29.9	2.5 2.4
Inadequate level of information	23.6	2.4
Inadequate knowledge of management	21.6	2.4
Character defects	20.5	2.1
Lack of practical experience	14.0	2.3
Poor management style	13.3	2.7
Illness	6.4	2.3
Lacking in entrepreneurial qualities	3.0	
Number of causes expressed as a percentage of businesses	132.3	2.4
1) Role played in bringing about insolvency: 1 = low, 2 = medium, 3 = high		

Fig. 3.6 Business management factors leading to insolvency
[source: Reske, Brandenburg & Mortsiefer, Insolventursachen, 1976, p. 66]

22 z.B. Heigl, A. (1970) Die direkte Prüfung der persönlichen Kreditwürdigkeit. In: Linhardt, H., Penzkofer, P., Scherp, P. (eds.) Dienstleistungen in Theorie und Praxis, Stuttgart; Bellinger, B. (1973) Neue Grundlagen und Verfahren der Kreditwürdigkeitsprüfung. In : Passardi, A. (ed.) Führung von Banken, Bern/ Stuttgart; Hierl, W. (1986) Banken und Venture Capitalfinanzierung Determinanten bankbetrieblichen Entscheidungsverhaltens zur situationsgerechteren Beteiligung an einer Venture-Capital-Gesellschaft, Unterföhring.

23 Keiser, H. (1966) Betriebswirtschaftliche Analyse von Insolvenzen bei mittelständischen Einzelhandlungen, Köln/ Opladen, p. 102.

24 Reske, W., Brandenburg, A., Mortsiefer, H.-J. (1976) Insolvenzursachen mittelständischer Betriebe. Eine empirische Analyse, Göttingen, p. 66.

25 Hierl, W. (1986) Banken und Venture Capitalfinanzierung – Determinanten bankbetrieblichen Entscheidungsverhaltens zur situationsgerechteren Beteiligung an einer Venture-Capital-Gesellschaft, Unterföhring, pp. 196–197.

insolvency. This study likewise supports the view that mistakes in the management area are particularly likely to contribute to the insolvency of young businesses.

Accordingly, the lack of practical experience of the founders of new business start-ups is reflected in this fact. On the other hand, it must be observed that among older companies management defects are still very pronounced as a cause of insolvency, which in turn supports the view that the management of a company plays a central role.[26]

However, in this context Hesselmann and Stefan[27] warn against attributing the onset of a company's woes entirely to the company management. They point out that when one takes a differentiated approach, one comes to the conclusion that fundamental management errors are often confined to individual areas, e.g. short-term planning and control and strategic planning. Jährig and Schuck[28] distinguish the following three main areas of management and business mistakes that are relevant to SMEs.

1. **Lack of or defective transparency of the business situation**
   This is caused by attaching too little importance to the commercial element of business management, with the result that the accounting system is underdeveloped and there is a lack of break-even analysis.
2. **Lack of or defective knowledge of the relevant markets**
   The reasons for this are the failure to monitor the competition, inadequate responsiveness to changes in the market, poor knowledge of the industry situation of the most important customers and existing dependencies on customers or suppliers.
3. **Shortcomings in leadership behaviour**
   The structure of responsibilities, the delineation of responsibility for results, inadequate delegation of tasks, controlling, corporate planning, management and staff and the failure to observe principles of financing are mentioned as examples.

In addition to these business-specific features of creditworthiness, however, the private area also plays a big role in the assessment of personal creditworthiness of SMEs through the close ties between the owner entrepreneur and his business.

3.4.4 Analysis of Technological Rating

According to Heim and Kuhn[29] the valuation of the product or process technologies planned in the business is very important, especially because of the long-term,

[26] Reske, W., Brandenburg, A., Mortsiefer, H.-J. (1976) Insolvenzursachen mittelständischer Betriebe. Eine empirische Analyse, Göttingen, p. 67.

[27] Hesselmann, S., Stefan, U. (1990) Sanierung oder Zerschlagung insolventer Unternehmen: Betriebswirtschaftliche Überlegungen und empirische Ergebnisse, Stuttgart, p. 36.

[28] Jährig, A., Schuck, H. (1990) Handbuch des Kreditgeschäfts, Berlin, pp. 523–526.

[29] Heim, E., Kuhn, W. (1987) Technologiebeurteilung – ein wichtiger Baustein der Kreditwürdigkeitsprüfung. Kreditpraxis, 2, p. 23.

future-related effects of these technologies. As a result, the link between financial and technical expertise is becoming steadily more important for future-oriented loan decisions.

According to Baaken,[30] there are a number of different approaches to the valuation of technology from a business management point of view, among them,

- cost-benefit analysis
- cost-effectiveness analysis
- utility analysis and
- the scoring method.

With regard to the situation of the start-up, however, it should be noted here that all the procedures entail investigating the effect of the introduction of one particular technology in an existing company, i.e. certain framework conditions, facts and structures have to be available for the valuation. When it comes to valuing start-ups, the technology life cycle concept of Ford and Ryan and the technology portfolio analysis of Pfeiffer, in particular, can be used (Fig. 3.7).

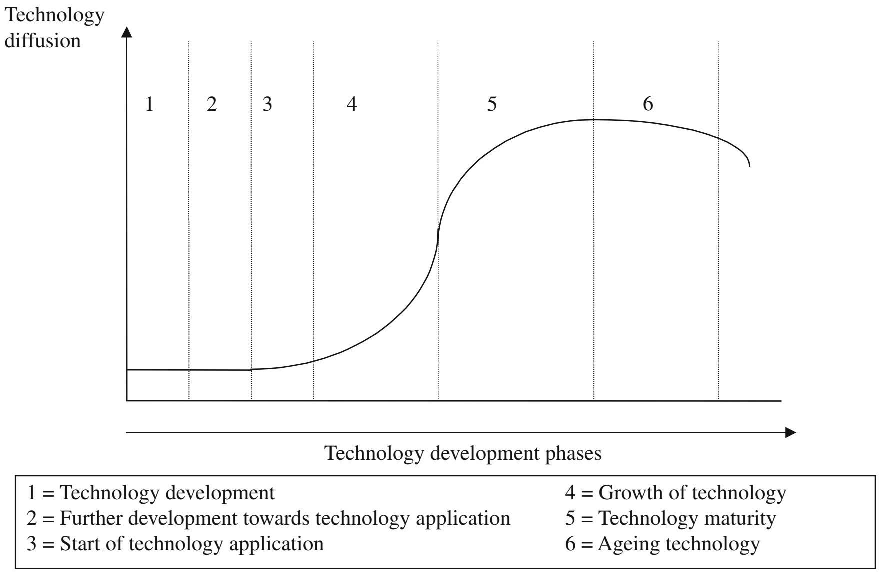

Fig. 3.7 Technology life cycle according to Ford & Ryan
[source: Ford, D. and Ryan, C., Taking Technology to market, 1981, p. 120, cited in Baaken, T., Bewertung technologieorientierte Unternehmensgründungen, 1989, p. 182]

[30] Baaken, T. (1989) Bewertung technologieorientierte Unternehmensgründungen. Kriterien zur Bewertung von Gründerpersönlichkeit, Technologie und Markt für Banken und Venture-Capital-Gesellschaften sowie für die staatliche Wirtschafts- und Technologieförderung, Berlin, pp. 177–184.

With regard to the technology life cycle, there are parallels with the traditional product life cycle. It starts with the "Technology development" phase, in which the basic research has already been conducted and a marketable technology based thereon is under development. In the "Start of technology application" phase, the curve starts to climb, reaching its peak during the "Ageing technology" phase. Although the concept does not work out, for example, when one technology is replaced by a new one and with what measurable variables and indicators the position of a technology can be unambiguously determined, it does provide an indication as to how mature the technology to be assessed is.

During phase 1 the technology is in the initial phase, while in phase 5 and 6 one can assume that there is already a threat of substitute products. Phases 2, 3 and 4 on the other hand suggest that the technology is growing.

According to Kuhn[31] many entrepreneurial difficulties and insolvencies are due to the failure to keep up with developments in the market. However, in most cases signs of a crisis appear in the areas of sales, production and management before the onset of financial problems. The main reasons cited are failures in the technology area. Because R&D cycles are becoming ever longer while at the same time market and product cycles are shortening, it is critically important to apply new technologies as soon as possible. As a result, today entrepreneurial success depends critically on the early recognition of technological developments and the correct assessment of their prospects and risks. Hence the credit institutions need to direct the credit assessment primarily at the future prospects of the company on the market, the technological potential. This implies including patents, licences and general industry know-how in the assessment.

On the other hand, Heim and Kuhn[32] also emphasise that so far little progress has been made in the problem of what criteria the banks should employ to obtain an insight into the technological situation of a business. The concept of the technology portfolio advocated by Pfeiffer,[33] which is presented in Fig. 3.8, is a wide-ranging approach to the strategic capture and valuation of technology.

Under this portfolio analysis, complex interactions between company and markets are reduced to a two-dimensional organisational structure and a statement is made about the future technological trend. Based on the market portfolio concept, the axes of the matrix depict company-external (attractiveness of technology) and

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[31] Kuhn, W. (1992) Zukunftsorientierte Bonitätsanalyse. Den technologischen Stand bewerten. Kreditpraxis, 5, pp. 15–16.

[32] Heim, E., Kuhn, W. (1987) Technologiebeurteilung – ein wichtiger Baustein der Kreditwürdigkeitsprüfung. Kreditpraxis, 2, p. 24.

[33] Pfeiffer, W., Metze, G., Schneider, W., Amler, R. (1992) Technologie-Portfolio zum Management strategischer Zukunftsgeschäftsfelder, Göttingen 1985 zitiert nach Kuhn, W., Zukunftsorientierte Bonitätsanalyse. Den technologischen Stand bewerten. Kreditpraxis, 5, p. 17; Heim, E., Kuhn, W. (1987) Technologiebeurteilung – ein wichtiger Baustein der Kreditwürdigkeitsprüfung. Kreditpraxis, 2, pp. 24–26.

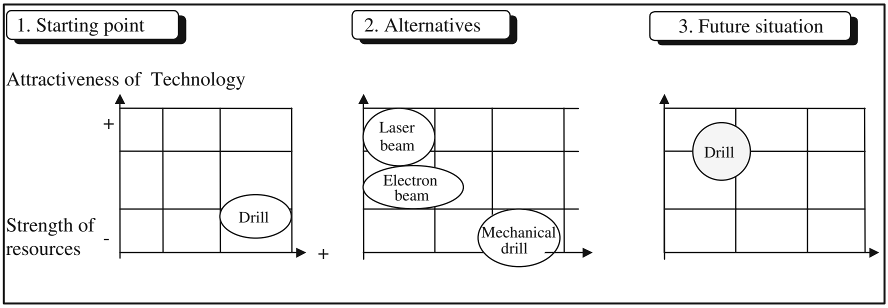

Fig. 3.8 Technology portfolio according to Pfeiffer
[source: Pfeiffer, W., Metze, G., Schneider, W. and Amler, R.: Technologie-Portfolio, 1985, cited in Kuhn, W., Bonitätsanalyse, 1992, p. 17]

company-internal (strength of resources) variables. The variables are assigned to the categories of "low", "medium" or "high" according to their weightings.[34]

The criteria used in this business analysis are the attractiveness of the technology and the strength of resources of the technologies used by the business, which come from a distillation of a number of internal and external factors. The point of departure here is the technology used. The possible alternatives, i.e. future competing technologies, are then included. These alternatives are mostly particularly attractive due to their further development potential. The future position is then put in perspective with reference to the competing technologies. To work out the attractiveness of the technology, both potential-oriented and need-oriented indicators are used. The potential-oriented indicators relate to the scope for further development of the technology and also the time factor, which states the time interval until the next higher stage of technology. The need-oriented indicators consider the possible application areas and volumes and also the course of diffusion of a technology, that is, its speed of penetration as time goes by.[35]

Here the assessments prepared by the relevant specialist institutions for the loan application have to provide the bank with answers to the following questions, amongst others:

1. How will the number of applications change in the future?
2. How will the application volume change?
3. What is the current stage of development of the technology?
4. Are there any substitution technologies?[36]

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[34] Baaken, T. (1989) Bewertung technologieorientierte Unternehmensgründungen. Kriterien zur Bewertung von Gründerpersönlichkeit, Technologie und Markt für Banken und Venture-Capital-Gesellschaften sowie für die staatliche Wirtschafts- und Technologieförderung, Berlin, pp. 185–188.

[35] Heim, E., Kuhn, W. (1987) Technologiebeurteilung – ein wichtiger Baustein der Kreditwürdigkeitsprüfung. Kreditpraxis, 2, p. 24.

[36] Heim, E., Kuhn, W. (1987) Technologiebeurteilung – ein wichtiger Baustein der Kreditwürdigkeitsprüfung. Kreditpraxis, 2, p. 25; Kuhn, W. (1992) Bonitätsanalyse, p. 18.

The strength of resources is calculated with reference to the potential of the company in the financial, staffing, technical and legal areas. The strength of financial resources refers to the level of resources that are currently available or could be got hold of and can therefore be assessed using traditional financial analysis. However, Kuhn stresses that stable income and liquidity figures are necessary for the viability of financing for research and development programmes requiring long-term funding, because with long drawn-out R&D projects no failsafe information is available about capital recovery. The thus ascertained current situation is now applied to the future. The analysis of technical rating thus improves the basis for decisions on the part of the banks, because the results of this forecast show whether there are any opportunities to exploit existing technology potentials and to what extent there is a risk of losing the edge or falling behind.[37]

Endres and Koch[38] expressly mention that the future income prospects of a company can also be assessed through the analysis of technical rating. In this context, technical rating is taken to refer to all the estimates of tangible and intangible assets and prospects that result from those influencing factors that are influenced by technical factors.

These influencing factors consist of factors both internal and external to the business and are based on the following business fields:

Product and market (Attractiveness and risk of the market and technology positions)
Efficiency in production and technological progress (Technology potential, innovation potential, level of organisation, efficiency, speed)
Human resources (Management, staff development, organisation)
Environment (Technology development, location)

Endres and Koch thus base their credit assessment on *qualitative success factors*, on the basis of which the effects of these qualitative factors on quantitative variables like sales, earnings, profitability, equity capital or capacity to meet principal repayments are then separately analysed. These individual judgements are used to form complex value judgments, which are now clarified in assessment tables and representations of portfolios. The above-mentioned fields (*product/market, production efficiency, human resources, environment*) are rated using a scale from 1 (weak) to 5 (strong). Weakness in one field cannot be offset by strength in another field. In this way, technical rating is calculated over four different phases:

1. Preliminary study and analysis of status
2. Estimation of strategic success factors

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[37] Kuhn, W. (1992) Zukunftsorientierte Bonitätsanalyse. Den technologischen Stand bewerten. Kreditpraxis, 5, p. 18.

[38] Endres, D. J., Koch, P. (1994), Technische Bonität – Erfolgsmaß für Unternehmen und Kreditindikator für Banken. Sparkasse, 111. Jhg., 9, pp. 408–411.

3. Concept for working out the strategic success factors
4. Calculation of technical rating.

In order to actually be able to estimate the prospects for success, scenarios that relate to objectively traceable planning calculations have to be developed.

3.4.4.1 Process of Valuation

According to Pleschak and Sabisch,[39] the valuation process is based on the characteristics of the innovation and the initial situation. A distinction can be made between technical, organisational, ergonomic, temporal and economic characteristics. The concrete form of these characteristics then depends on the nature of the innovation. Determination of the targets constitutes one of the most important steps in the valuation. However, from a methods point of view, calculation of the complex overall statement on the degree of target fulfilment is the most difficult.

3.4.4.2 Valuation Procedure

The valuation procedures available are presented in Fig. 3.9.

The quantitative valuation presupposes that measurement rules exist for the characteristics of the object of valuation and that the actual form of the characteristics

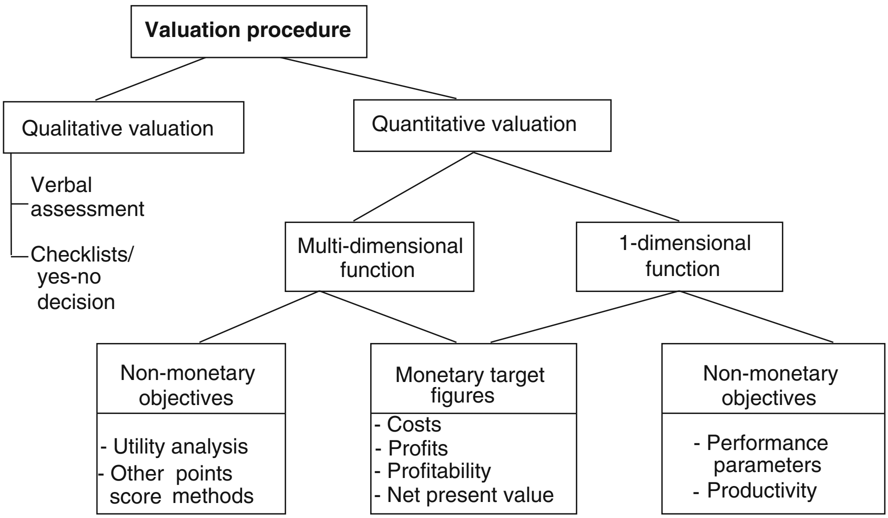

Fig. 3.9 Innovation valuation procedures
[source: Pleschak, F. and Sabisch, H., Innovationsmanagement, 1996, p. 178). For an explanation of multi-dimensional valuation, see Pleschak, F. and Sabisch, H., Innovationsmanagement, 1996, pp. 179–183]

[39] Pleschak, F., Sabisch, H. (1996) Innovationsmanagement, Stuttgart, pp. 175–176.

can be measured. The valuation is always simple if there is only one objective (one-dimensional valuation). But often projects have several competing objectives at the same time (multi-dimensional valuation).

The bigger this number is, the less clear-cut the valuation statement, so that it is sensible to restrict the valuation to valuation characteristics that are relevant to the decision. The criteria of the qualitative valuation are not objectively measurable. The qualitative valuation could, for example, entail the subjective judgements of a representative group of persons. Examples here include surveys of experts and customer surveys.

3.4.5 On the Valuation of Innovative Ideas

Stroetmann and Steinle[40] emphasise that innovations are not just technical phenomena but they have to be valued as complex, market-specific processes. In order for the innovation to be successful, not only must marketable knowledge exist, but a number of external and internal preconditions must also be fulfilled.

As the valuation of ideas is characterised by the fact that very little and only uncertain data is available, Geschka and Laudel[41] recommend proceeding by selecting from several ideas in a series of selections. The first selection stage is performed on the basis of KO criteria which absolutely have to be fulfilled, while in the second selection stage the most promising ideas are selected with the aid of a simple utility analysis. In the third stage the most favourable solution is selected using a refined utility analysis. This selection constitutes the basis for project planning. There are several utility analysis models available for the valuation of ideas.[42] Pleschak and Sabisch[43] recommend using the following criteria:

- Market attractiveness
- Expected sales
- Product superiority

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[40] Stroetmann, K. A., Steinle, W. (1986) Kleine und mittlere Unternehmen als Adressaten staatlicher Forschungs- und Innovationsförderungspolitik. In: Bruder, W. (ed.) Forschungs- und Technologiepolitik in der Bundesrepublik Deutschland, Opladen, p. 308; Schmeisser, W. (1986) Systematische Erfindungsförderung als Unternehmensaufgabe. Wege zur Steigerung der Kreativität und zu erfolgreichen Innovationen, Berlin; Schmeisser, W. (1988) Kreativität praktische Umsetzung: Voraussetzung für Innovation und Erfolg. Gablers Magazin, 6, pp. 25–27.

[41] Geschka, H., Laudel, G. (1992) Die Konzeptionsphase von Innovationsprojekten. In: Gemünden, H. G., Pleschak, F. (eds.) Innovationsmanagement und Wettbewerbsfähigkeit, Wiesbaden, pp. 55–72.

[42] z.B. Brockhoff, K. (1994) Forschung und Entwicklung- Planung und Kontrolle, München/ Wien, p. 250 ff; Eggert-Kipfstuhl, K., Kirchhoff, G. (1994) Bewertung von Produktvorschlägen mit Hilfe einer auf empirischen Kenntnissen beruhenden Software namens PRUV. In: Zahn, E. (ed.) Technologiemanagement, Stuttgart, pp. 427–437.

[43] Pleschak, F., Sabisch, H. (1996) Innovationsmanagement, Stuttgart, p. 184.

- Technological attractiveness
- Degree of novelty of the innovation
- Development effort, development duration

If one values the innovation idea on the basis of the economic valuation of the additional benefit, the valuation can be carried out via the idea-market link.

According to Laub,[44] the valuation of the innovative start-up idea is therefore particularly problematic when the extra benefit added by the product is not obvious or when, although the extra benefit of the idea can be objectively demonstrated, the response of the market participants to it is unknown. In this case the following possibilities exist, for example:

1. The extra benefit does exist, but it is not possible for third parties to appreciate the extent of it;
2. The extra benefit does not match the need structure of the users, were it to be launched on the market;
3. The extra benefit is less than the extra expenditure that has to be borne by the user.

Another difficulty is the fact that in the case of innovative start-up companies (e.g. cutting-edge technology), risk and data certainty normally develop in opposite directions. The "more novel" the start-up idea is, the riskier it is to implement, yet the greater its success potential in the event of success.[45] Accordingly, the criteria shown in Fig. 3.10 are used to value the start-up idea.

The next diagram shows the importance of the individual valuation criteria and the degree of difficulty associated with the valuation.

It is striking here that when one compares the importance and difficulty of the criteria examined, all the criteria are very important to the valuation process and at the same time there are clearly enormous difficulties in obtaining the information. It follows from this that the available instrumental approaches such as cost-benefit analysis, industry and competitor analysis are of little avail if the information needed is not available. It is clear therefore that the time required to gather information is a bottleneck factor for the valuation. With regard to the importance of the criteria, it is striking that problem-solving potential and the alternative problem solutions are viewed as most important. On the other hand, however, there are problems especially in the capture of alternative problems solutions and determination of the growth thresholds. Laub concludes from this that the valuation of innovative problem-solving potential cannot be represented without comparable empirical values from

[44] Laub, U. D. (1991) Innovationsbewertung. Ein Bewertungskonzept für innovative Unternehmensgründungen. In: Laub, U. D., Schneider, D. (eds.) Innovation und Unternehmertum. Perspektiven, Erfahrungen, Ergebnisse, Wiesbaden, pp. 30–38.

[45] Unterkofler, G. (1989) Erfolgfaktoren innovativer Unternehmensgründungen: ein gestaltungsorientierter Lösungsansatz betriebswirtschaftlicher Gründungsprobleme, Frankfurt am Main, p. 121 ff.

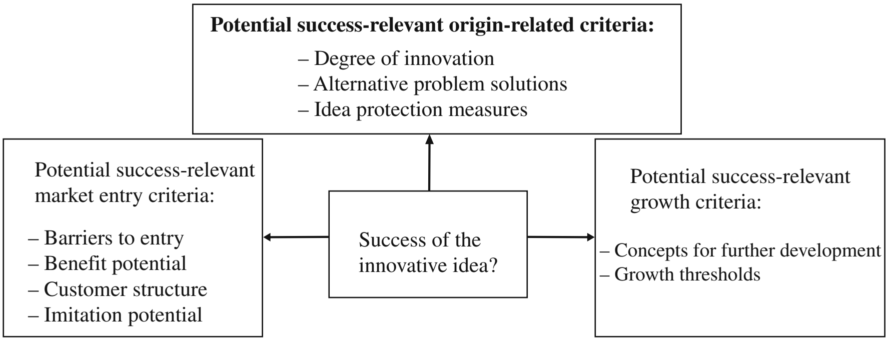

Fig. 3.10 Selected criteria for valuing the start-up idea
[source: Laub, U. D., Innovationsbewertung, 1991, p. 31]

similar product areas. Market analyses carried out in advance can only provide information about what is possible, not about the actual purchasing behaviour of the customers, which in turn reinforces just how uncertain these analyses are. Hence, the experience of the assessors and the quality of research are therefore important if one is to obtain a sound valuation (Fig. 3.11).[46]

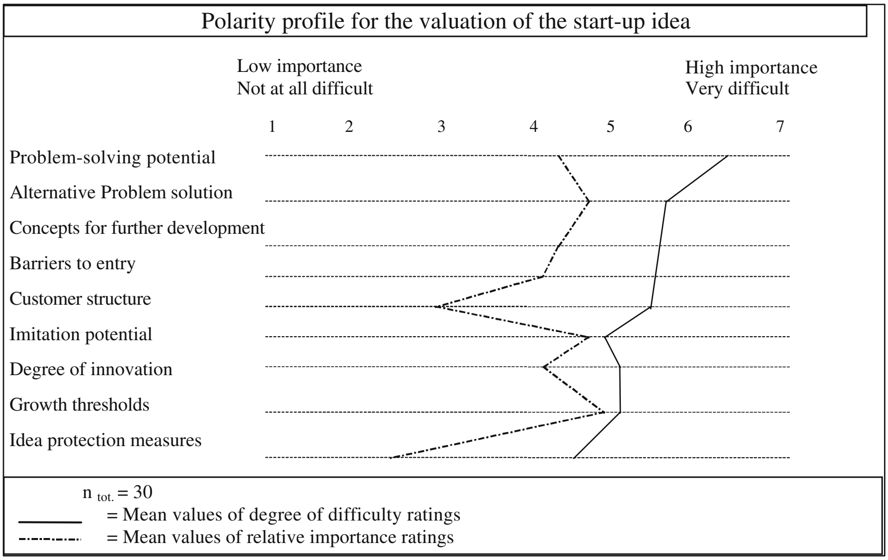

Fig. 3.11 Importance and difficulty of different criteria for the valuation of ideas
[source: Laub, U. D., Innovationsbewertung, 1991, p. 39]

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46 Laub, U. D. (1991) Innovationsbewertung. Ein Bewertungskonzept für innovative Unternehmensgründungen. In: Laub, U. D. , Schneider, D. (eds.) Innovation und Unternehmertum. Perspektiven, Erfahrungen, Ergebnisse, Wiesbaden, pp. 39–40.

In principle it must be emphasised that the start-up idea must always be valued from two points of view. Firstly from the point of view of the supplier: here the question to be considered is whether the idea is financially successful and profitable. And secondly from the point of view of the customer: here the question relates to acceptance of the service offered.[47]

3.4.6 Assessing the Market and Competitive Situation

According to Baaken[48] it is striking just how little significance the German-language literature on start-ups[49] attributes to the problem area of the market. By contrast, the American literature on start-ups considers the start-up product as an element of a product–market combination. Four system elements from the product environment are identified as being relevant to the product here: business, competition, sales market and procurement market.

According to this view, to assess the probability of success of a start-up, a market analysis is required, yet this is beset with difficulties, especially where innovative start-up businesses are concerned (Fig 3.12). According to Baaken,[50] the focus

Founder-specific factors	Innovation-specific factors
Technical orientation of the founder's know-how Lack of empirical values and data in the founder's company Financing constraints Time constraints Lack of acceptance of the founder among experts and customers	Lack of overview of the application areas Lack of knowledge of decision-maker structures Major need to explain the products, yet only vague forecasts produced Danger of imitators

Fig. 3.12 Factors that are problematic in the market analysis of technology-oriented company start-ups
[source: Baaken, T., Bewertung technologieorientierte Unternehmensgründungen, 1989, p. 213]

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[47] Unterkofler G. (1989) Erfolgfaktoren innovativer Unternehmensgründungen: ein gestaltungsorientierter Lösungsansatz betriebswirtschaftlicher Gründungsprobleme, Frankfurt am Main u.a., p. 124.

[48] Baaken, T. (1989) Bewertung technologieorientierte Unternehmensgründungen. Kriterien zur Bewertung von Gründerpersönlichkeit, Technologie und Markt für Banken und Venture-Capital-Gesellschaften sowie für die staatliche Wirtschafts- und Technologieförderung, Berlin, pp. 204–206.

[49] z.B. Szyperski, N., Nathusius, K. (1977) Probleme der Unternehmensgründung: eine betriebswirtschaftliche Analyse unternehmerischer Startbedingungen, Stuttgart.

[50] Baaken, T. (1989) Bewertung technologieorientierte Unternehmensgründungen. Kriterien zur Bewertung von Gründerpersönlichkeit, Technologie und Markt für Banken und Venture-Capital-Gesellschaften sowie für die staatliche Wirtschafts- und Technologieförderung, Berlin, p. 213.

of the market analysis is the sales market. Although innovative products do not have competitors, analysis of the competition and competition trends should not be ignored, as the new product has to hold its own against traditional approaches and, moreover, it is necessary to identify similar development trends amongst other suppliers early on to counter the danger of imitations and substitution products. A realistic assessment of the competitive strength and hence of the prospects of success is not possible until the innovative product and its potential have been compared with the product of the competitor company.

In this connection, the following strategic success factors regarding market experience and market knowledge among the founders have been identified by empirical means:

- Performing a market analysis
- Understanding customers' needs
- Knowledge of purchaser behaviour
- Overview of competition situation
- Knowledge of the potential market[51]

These success factors create the link to the criterion areas of market attractiveness and competitive strength.[52] By conducting a market analysis, the founder obtains information on market growth, sales risk, market size, and the attractiveness of the procurement market. Market analysis produces information about the market which is the prerequisite to a successful launch strategy[53] and the achievement of high market share. On the other hand this argument is weakened by the fact that it is not possible to perform a reliable assessment of market acceptance until the planned products are actually available.[54] Another important factor of competitive strength is the innovative product, the strength of which is determined by price, quality and other competitive advantages.

As far as the business founder is concerned, the market and industry assessment are contained in the company concept. The banks undertake a valuation from a high-level perspective using comparative industry data.

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[51] Baaken, T. (1989) Bewertung technologieorientierte Unternehmensgründungen. Kriterien zur Bewertung von Gründerpersönlichkeit, Technologie und Markt für Banken und Venture-Capital-Gesellschaften sowie für die staatliche Wirtschafts- und Technologieförderung, Berlin, p. 245.

[52] Zum Stellenwert von Produktinnovationen für den Erfolg des Unternehmens Huxold, S. (1990) Marketingforschung und startegische Planung von Produktinnovationen: ein Früherklärungsansatz, Berlin.

[53] Ausführlich zu Marketingkonzepten JTU Baier, W., Pleschak, F. (1996) Marketing und Finanzierung junger Technologieunternehmen, Wiesbaden, pp. 47–97.

[54] Unterkofler G. (1989) Erfolgfaktoren innovativer Unternehmensgründungen: ein gestaltungsorientierter Lösungsansatz betriebswirtschaftlicher Gründungsprobleme, Frankfurt am Main u.a., p. 125.

The tools used for this purpose are industry services and contacts with existing companies. Some banks have constantly updated industry studies available.[55]

3.4.7 Assessment of the Organisation of Start-Ups

According to Laub,[56] assessment of the organisational aspects of idea implementation has received too little attention up to now, since it is only when the resources from procurement, sales, finance and labour markets are successfully integrated that successful implementation of the innovative start-up idea can be ensured.

Figure 3.13 provides an overview of criteria for assessment of the organisation of start-ups which, according to Laub,[57] represent a majority of the characteristic attributes used in organisational assessment, which reflect the current status of academic discussion.

Picot, Laub and Scheider[58] conducted some empirical investigations to clarify the link between organisation of start-ups and start-up success. According to them, the manner in which the process of idea implementation is organised can significantly affect the success of the start-up. Both the contractual tie-in of resources and customers and the organisation of the sales side influence the cost structure of the start-up and the user benefit.

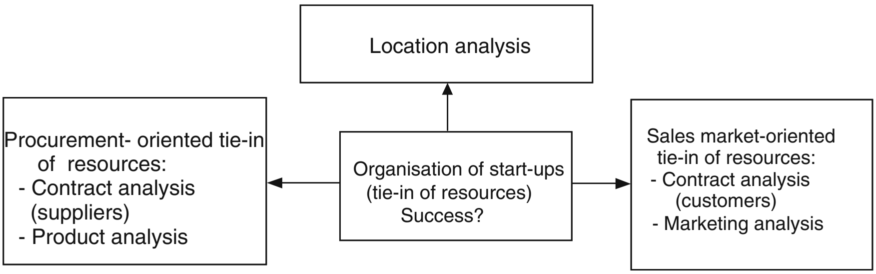

Fig. 3.13 Selected criteria for assessment of the organisation of start-ups [source: Laub, U. D., Innovationsbewertung, 1991, p. 32]

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55 Staudt, E., Hafkesbrink, J., Lewandowitz, T. (1996) Kompetenz und Kreditwürdigkeit. Bestandsaufnahme der Kreditwürdigkeitsprüfung in Theorie und Praxis bei Existenzgründern und innovativen Klein- und Mittelbetrieben. In: Berichte aus der angewandten Innovationsforschung, hrsg. von Staudt, E., Bochum, p. 32.

56 Laub, U. D. (1991), Innovationsbewertung. Ein Bewertungskonzept für innovative Unternehmensgründungen. In: Laub, U. D. , Schneider, D. (eds.) Innovation und Unternehmertum. Perspektiven, Erfahrungen, Ergebnisse, Wiesbaden, p. 42.

57 Laub, U. D. (1991) Innovationsbewertung. Ein Bewertungskonzept für innovative Unternehmensgründungen. In: Laub, U. D. , Schneider, D. (eds.) Innovation und Unternehmertum. Perspektiven, Erfahrungen, Ergebnisse, Wiesbaden, p. 32.

58 Picot, A., Laub, U. D., Schneider, D. (1989) Innovative Unternehmensgründungen: eine ökonomisch-empirische Analyse, Berlin u.a., pp. 49–50.

In this way, according to Picot, Laub and Schneider[59] the manner in which the resources are tied in becomes an important factor that determines the success or failure of an innovative business start-up. The founder therefore faces an organisational problem in realising his innovative idea. It should be noted here that the partial services supplied internally by the business and the internal production processes together have a critical influence on the character of the innovation. As knowledge of partial services provided internally is often available only inside the innovative business itself, the partial services are very complex and moreover there is a high interest in keeping secret any innovation-relevant information,[60] successful innovative start-up companies produce services with high innovative know-how themselves. In the same way, these companies choose forms of tie-in that are closer to the market (external production) for services involving less specific know-how.[61]

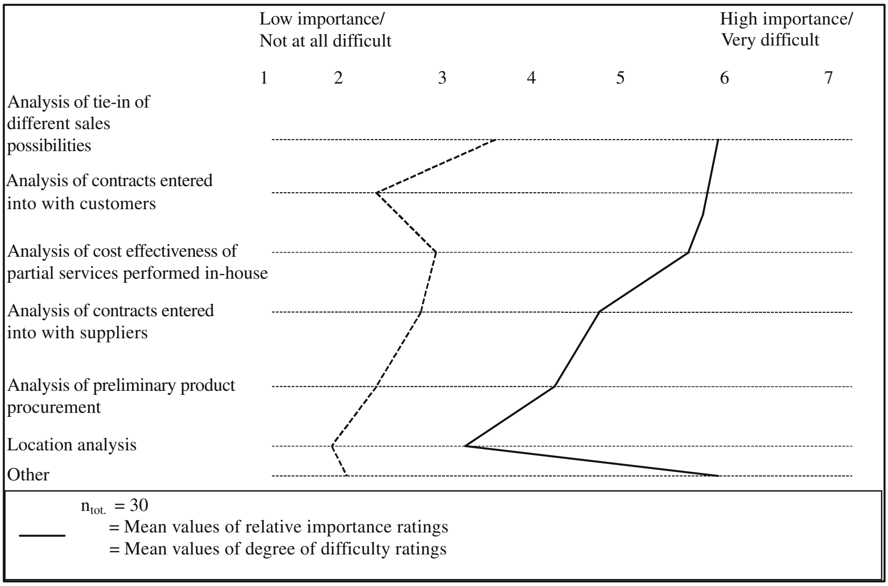

Fig. 3.14 Importance and difficulty of criteria for the assessment of organisations [source: Laub, U. D., Innovationsbewertung ("Innovation valuation"), 1991, p. 44]

[59] Picot, A., Laub, U. D., Schneider, D. (1989) Innovative Unternehmensgründungen: eine ökonomisch-empirische Analyse, Berlin u.a., pp. 186–187.

[60] Picot, A., Laub, U. D., Schneider, D. (1989) Innovative Unternehmensgründungen: eine ökonomisch-empirische Analyse, Berlin u.a., p. 191.

[61] Laub, U. D. (1991) Innovationsbewertung. Ein Bewertungskonzept für innovative Unternehmensgründungen. In: Laub, U. D. , Schneider, D. (eds.) Innovation und Unternehmertum. Perspektiven, Erfahrungen, Ergebnisse, Wiesbaden, p. 43 und Schmeisser, W., Krimphove, D. (eds.) (2001) Vom Gründungsmanagement zum Neuen Markt. Strategien für technologieorientierte kleine und mittlere Unternehmen. Wiesbaden.

In this connection, the procurement market- and sales market-oriented resource tie-in analysis must be assessed as to its importance or difficulty, as presented in Fig. 3.14.

It is clear here that what is of interest in the assessment is predominantly the organisation of sales market relationships. On the other hand, the procurement market side is rated as relatively unimportant, which Laub[62] attributes to the fact that in the start-up phase the number of external procurement market relationships is usually still very limited. The item "Other" covers market-oriented product analysis, future personnel retention strategies and internal operational organisation. The high average value of this item gives an indication of the importance of these points.

Compared with the start-up idea and the founder, the difficulties relating to the assessment of the organisation of start-ups are clearly deemed to be a lot less important. This is because it is easier to obtain information, the information obtained is relatively stable and usable comparative data and empirical values are available.

3.5 Summary

Although for the banks it would be sensible to have a standard valuation method available, especially in view of the rising demand for innovation financing, today only internal valuation guidelines of the nature of a checklist exist. Above all there is a lack of quantitative valuation procedures for the simple calculation of present or future values of innovative start-ups. This shortcoming can be explained by the lack of collaboration between the various valuing institutions and the lack of attention paid to this area by empirical research. The possible contact partners for banks include above all venture capital companies which, unlike the banks, have a lot of experience at valuing innovative start-ups. It follows from this that the valuation of innovative business start-ups has up to now been based solely on the valuation experience of individual bank employees, and as a result there is a lot of uncertainty here.

The central success factors identified in the case of the innovative business start-up were the founder, the start-up idea and the organisation of start-ups. Factors playing an important role here include the expected market potential, the entrepreneurial capabilities of the founder and the economically efficient design of the start-up organisation of start-ups. Having identified the important qualitative success factors, one then has an appropriate basis for assessing innovative founders. If valuation methods were to be developed, this could facilitate the assessment of innovative start-ups in the future and at the same time it would be possible to develop a control instrument for validating external valuations.

62 Ibidem

Chapter 4
Innovation Profitability Analysis in the Assessment of Pharmaceutical R&D Projects

Wilhelm Schmeisser

4.1 Basic Aspects

In management circles, the pharmaceutical industry is referred to as a "high-risk industry", as it takes a very long time to develop a drug and success is difficult to assess.[1] This perception is borne out by practical examples. Thus, for example, the in-house early warning system at pharmaceutical company Bayer was ignored in 2001 in connection with the anticholesterolemic Lipobay, which was associated with 100 deaths. Following the withdrawal of the drug, the company's stock market valuation fell by €5.6 billion on a single day and lawsuits have been filed against it to date in over 14,000 cases.[2] As well as the high risks associated with research and development projects, there are also major opportunities. Huge profits can be made from the successful development and marketing of pharmaceutical products. The American company Amgen achieved sales in excess of 3.5 billion euros within the space of a few years for just two drugs, Epogen and Neupogen.[3]

This suggests that the risk can be defined as the danger of making a poor decision on the basis of which an aspired-to goal is not achieved. A pharmaceutical project conceals many such decision points. Again, when deciding whether to pursue an R&D project or not it is essential to ascertain the risks in advance and take these into account in the assessment. This suggests that one should use decision models to deal with projects and use them as tools for avoiding hazards which could have an impact on the company's value.

The overall analysis of a corporate division like Research and Development presupposes that individual projects are considered in a consistent manner. At the same

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[1]Fischer, M. (2006), p. 1.

[2]Annual report Bayer AG (2004), p. 118, see also Bein, H.-W. (2002), http://www. cbgnetwork.org/952.html, as of 11 December 2006.

[3]Rudolf, M. and Witt, P. (2002), p. 155.

W. Schmeisser et al. (eds.), *Innovation Performance Accounting*,
DOI 10.1007/978-3-642-01353-9_4,

time each R&D project needs to be assessed early on, firstly to establish its significance within the company and secondly to enable specific risks to be identified and monitored appropriately.

For this purpose, business models for assessing alternative actions and their outcomes and the associated uncertainties and resulting risks are analysed and assessed.

4.2 The Pharmaceutical Industry – Background

Pharmaceutical research and development has a long-standing tradition in Germany. "Companies like Schering, Bayer, Boehringer Ingelheim, Merck, [. . .] are among the world's oldest pharmaceutical companies and have been making a valuable contribution to effective and efficient healthcare for over 100 years".[4] Many as yet untreatable illnesses, rising life expectancy and a steadily growing awareness of health issues along with new research and development methods mean that there is a sustained research dynamic in the pharmaceutical industry.[5]

4.2.1 Terminological Definitions: Pharmaceutics

Pharmaceutics is the science that is concerned with the procurement, effect, testing and manufacture of pharmaceutical products and, along with this, is linked to aspects from other sciences, primarily chemistry and biology.[6] Pharmaceutical products are vegetable, animal or synthetic substances that are intended for diagnostic or therapeutic purposes. Pharmaceutical products can be available only on prescription or without prescription and include medicines, vaccines and diagnostics.[7]

4.2.2 Classification of the Pharmaceutical Industry

Essentially the pharmaceutical industry can be broken down into suppliers of innovative original products and suppliers of generic drugs.[8,9] These suppliers are

[4]BCG (2001), p. 1.

[5]BPI (2005a), p. 23.

[6]For further information on this subject, see http://www.gesundheit.de/roche/, as of 11 November 2006.

[7]See. http://www.gesundheit.de/roche/, (11 November 2006). In the literature, the term "pharmaceutical product" is often treated as synonymous with "drug".

[8]Generic drugs are pharmaceutical products with the same active ingredient and same concentration as the original preparation, which can come on to the market at a significantly lower price after the patent protection of the original preparation has elapsed.

[9]The pharmaceutical market distinguishes between prescription-only pharmaceutical products which have to be purchased from a pharmacy, prescription-free / over-the-counter pharmaceutical products and pharmaceutical products that are used in hospitals (see BPI (2001), pp. 11–12.).

subject to different, specific market and competitive conditions that in each case call for a different business strategy that reflects the company's market position and the resources available to it.[10] A provider of innovative original products is referred to as a research pharmaceutical company and its strategy is geared towards the development and marketing of pharmaceutical products. Generic companies are pharmaceutical companies which specialise in the production of generic products and pursue a cost leadership strategy. With their business model, they save the costs and time to go into the research and development of drugs. A pharmaceutical company is deemed to be "fully integrated" if it covers the entire value-added chain, from discovery of the active ingredient, research and development through to production and marketing. Many companies specialise in only a part of this value-added chain. Often these companies are biotechnology companies that develop drugs,[11] and whose core competencies lie in the first two areas.[12] They sell knowledge and findings by developing potential, marketable substances.[13] The value of the company therefore depends heavily on patents, partnerships and/or human capital.[14] If the pharmaceutical and biotechnology companies are direct competitors, to the pharmaceutical company it is strategically attractive to take over the biotechnology company to supplement its own value-added chain.

In addition to this vertical integration there is also the possibility of collaboration. In practice, collaboration is common, especially where the drug in question is still under development. Depending on the type of contract, the biotechnology company receives a percentage of the sales proceeds of the finished drug (royalties), a one-off payment for developing it (milestone payments) or a combination of the two.[15] Whereas pharmaceutical companies finance their R&D activities from the sales of their successful products, biotechnology companies that are developing drugs do not have any profits in the early years.[16]

In this connection the management consultancy firm Deloitte[17] identifies essentially three different business models:

- The **biotechnology industry** (also known as biopharma) comprises companies which use biotechnology methods to develop therapeutic products with "small molecules"[18] or "biological platforms".

[10] Hoffmann, W. et al. (2003), p. 13.

[11] In the biotechnology industry, a distinction is made between three different business models: service providers (i.e. which develop and market technologies), suppliers and product developers (i.e. which develop drugs).

[12] Rudolf, M. and Witt, P. (2002), p. 154 ff

[13] Scheibehenne et al. (2003), p. 668 ff.

[14] Kaufmann, L. and Ridder, Ch.(2003), p. 448.

[15] Rudolf, M. and Witt, P. (2002), p. 155.

[16] Kaufmann, L. and Ridder, Ch.(2003), p. 448.

[17] Deloitte is an audit and management consultancy company which has carried out studies in the biotechnology and pharmaceutical industry on the basis of around 200 leading companies.

[18] "Small molecules" are low-molecular synthetic molecules.

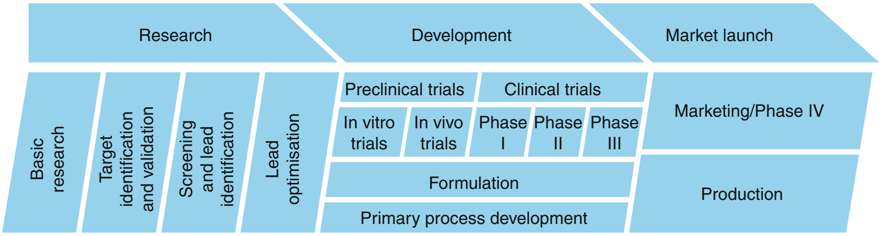

Fig. 4.1 "Fully integrated" value-added chain of pharmaceutical companies [Source: based on Arthur D. Little (1997), p. 71.]

- The **big biopharma industry** comprises companies which have already been profitable for several years and whose product revenues exceed $500 million.
- **Big Pharma** are pharmaceutical companies whose origins lie in the chemical industry. They earn several billion dollars from prescription-only pharmaceutical products.[19]

This classification scheme appears at first glance to be an extreme simplification, but it is practical to use in practice.

4.2.3 Financing

A lot of investment capital is required to finance the development and licensing of new active ingredients.[20] The investments made by large pharmaceutical companies are very different from those of small biotechnology companies. Pharmaceutical companies can finance investment with a long-term time horizon, and/or made high-risk investment with delayed onset of return.[21] Amongst other things they use the proceeds of present-day sales of pharmaceutical products to fund the prolonged and expensive process of developing their future remedies. As far as the industry is concerned, the high prices charged for innovative drugs are necessary to ensure a high return for the investors, one that rewards the risk of investing in pharmaceutical shares. At the same time the prospect of profit is an incentive to develop innovative new pharmaceutical products.[22]

A biotechnology company (biopharma), on the other hand, cannot afford long-term or high-risk investment. To finance the independent discovery and development of pharmaceutical products, it can either licence a product as a means of obtaining

[19] Deloitte (2005), p. 5.
[20] Scheibehenne et al. (2003), p. 668 ff.
[21] Bussey, P. et al. (2005), p. 194.
[22] o. Verf. (2006), pp. 11–13.

milestone payments or royalties, or find alternative financing.[23] As a result, biotechnology companies normally finance themselves using special forms of financing[24] such as private equity financing, whereby equity capital is made available for a fixed period of time by either private individuals or institutional investors.[25] Financing is largely with the aid of venture capital investors (providers of risk capital). Not only are they able to guarantee the company a high flow of liquid resources, but they also place a network with know-how at the disposal of the company.[26]

4.3 Analysis of Pharmaceutical R&D Projects

One of the distinguishing features of the business activities of pharmaceutical companies is the research and development of remedies. This requires a lot of time and know-how. Some 800 individual work steps lie between the initial synthesis and the final pharmaceutical product, each being carried out in a controlled development process. The process of developing a drug takes about 10–15 years altogether, costs on average $800 million and typically has a very low success rate (1:6,000).[27,28]

In order to be able to take better account of the risks of R&D projects, we will first of all explain the typical features of pharmaceutical R&D projects and then consider the ideal course which they typically follow.

4.3.1 Terminological Principles Regarding Research and Development

The aim of researching and developing remedies is to develop new products or processes, and this work is carried out in the form of projects. In the literature, research and development are viewed as independent and in practice are broken down as follows:

- Basic research aimed at uncovering scientific phenomena and interrelations and at trying to explain these without attempting to use the findings directly[29];

[23] Bussey, P. et al. (2005), p. 194.

[24] Private equity, mezzanine financing and sponsored programmes all play an important role in the USA, especially the last of these.

[25] Ehrmann, H. (2005), p. 222 f.

[26] Scheibehenne et al. (2003), p. 668 ff.

[27] This success rate means that out of 6,000 substances researched, only a single substance is eventually successfully licensed. The figures given regarding success rates vary depending on what stage of development/research is taken as the starting point.

[28] BPI (2005a), p. 17.

[29] Pfeiffer, W. and Staudt, E. (1974), Sp. 1523.

- Applied research which solves specific problems as regards materials, procedures or products and is aimed at commercial use[30];
- Development work which adapts existing solutions from applied research to commercial requirements.[31]

Research is strongly oriented towards the strategy of the company. As the strategy is often redefined, its implementation in research constitutes a challenge for management. Ending a research project too early or too late can have far-reaching consequences for the company.[32]

R&D projects in the widest sense are all the projects of a pharmaceutical company, from the active ingredient discovery phase through development to the marketing of a drug.[33] A pharmaceutical R&D project is taken to refer to the development of a new substance, from discovery to synthesisation into a pharmaceutical product and on to its use on humans.

4.3.2 Development Process of a Drug

The process of developing a drug breaks down into several phases. It starts with a research phase (active ingredient discovery phase), during which scientists search for potential new active ingredients. In the next, preclinical stage, the efficacy of the new substance is determined. This is followed by the test phase of clinical research in which the substance is tested on humans in Phases I, II and III. These research and development phases ultimately end with approval for introduction on the market.[34]

4.3.2.1 Research Phase

The process of developing a pharmaceutical product starts with the search for a potential substance, which on average will take 2–4 years. To find a pharmaceutical product, biologists, chemists and pharmacists search for metabolic processes or for molecular structures which play a critical role in a medical condition.[35] With the aid of test systems, known as screenings, a large number of different molecular structures can be tested for their suitability. Promising substances, known as leads, are refined and varied to go through other tests.[36] Methods from "classic" project management can hardly be used during this phase, as content, objectives and costs will vary widely in the course of the project. The research process is characterised by

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[30] Pfeiffer, W. and Staudt, E. (1974), Sp. 1522.
[31] Schätzle, G. (1965), p. 36, quoted by Schmeisser, W. et al. (2006), p. 63.
[32] Weule, H. (2002), p. 201.
[33] Völker, R. (2001), p. 232.
[34] Gorbauch, R. de la Haye (2002), p. 165 ff.
[35] PhRMA (2006), p. 4.
[36] Gorbauch, R. de la Haye (2002), p. 165 ff.

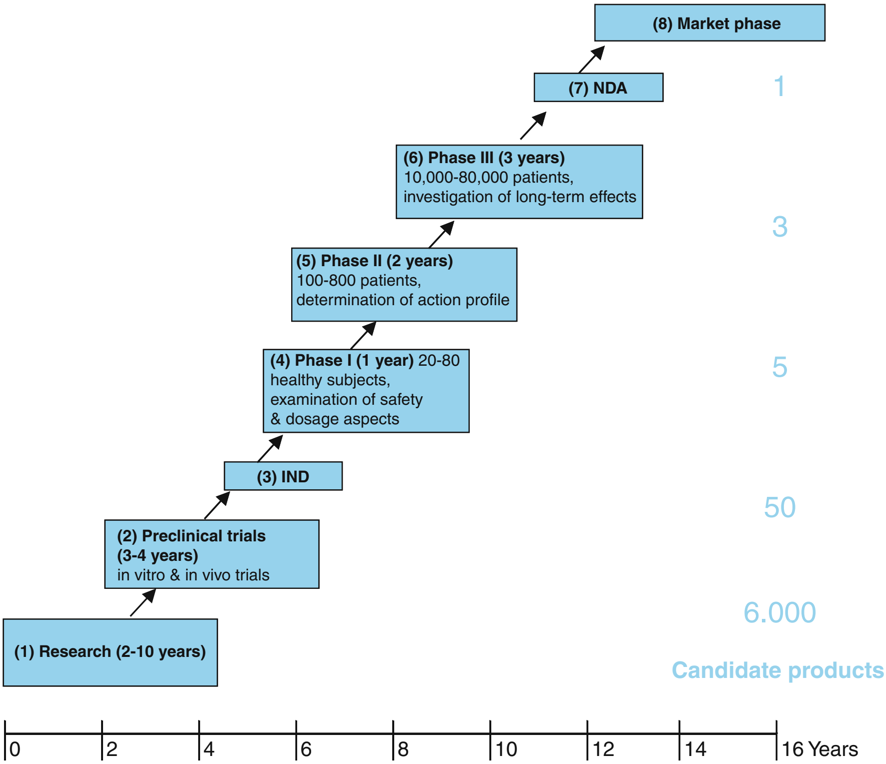

Fig. 4.2 Development process for drugs
[Source: based on Kaufmann, L. and Ridder, Ch. (2003), p. 448]

frequent changes of strategy and chance findings. Weule describes project planning in a simple but telling way: "The more 'fuzzy' the expected project outcome is, the less detailed planning is possible".[37] Too much directing and control would rob the project of its creativity and thus preclude chance or unconventional solutions. However, without control there is the risk that the research is not directed at the needs of the market and the products cannot be sold.[38] With goal-oriented research supported by project management, a considerable number of potential ideas may be lost, but the research is oriented towards the needs of the market.

At the end of this phase the researchers create a candidate active ingredient defined in terms of its key characteristics, the therapeutic area of application, the type of effect that it has (with description of effectiveness and side-effects) and the application profile.

[37] Weule, H. (2002), p. 204.
[38] Weule, H. (2002), p. 204 f.

4.3.2.2 Preclinical Phase

During the preclinical phase, the pharmacological efficacy[39] and toxicological[40] characteristics of the new active ingredient are tested "in vitro" (in the test tube) and "in vivo" (on animals).[41] When it comes to pharmacological efficacy, one learns more about the absorption, distribution, metabolising and elimination (ADME studies) of the substance in the course of this stage. The toxicological examination produces information about unwanted side-effects to do with dose range or long-term use. The aim is to find a dose range which does not have any serious toxicological effects. The risk–benefit assessment is critical. For example, do hypertension drugs have different requirements from cancer drugs?[42] To ensure the quality of this investigation, the licensing authorities insist on adherence to internationally valid regulations such as "Good Laboratory Practice" and directives regarding the species and number of experimental animals to be tested and the duration of the trials.[43]

In practice, the active ingredient is patented at this point and the clock now starts ticking on the patent life of 20 years. In the case of drugs developed to treat medical conditions that are very rare, market exclusivity of up to 7 years in the USA and up to 10 years in the EU from approval can be protected through "orphan drug" status[44]. The cost-effectiveness of a pharmaceutical product is directly related to the size of the market which, in the case of rare diseases, is small. Under normal market conditions it would not be possible to amortise the R&D costs over such small market volumes. Orphan drug status is granted in order to give the pharmaceutical companies an incentive to develop such drugs. As well as the protected market exclusivity, other advantages conferred by this status include support with the licensing procedure, the provision of funding and the possibility of favourable tax treatment.[45]

Project management during the preclinical phase is supportive and coordinating, the aim being to filter out suitable molecular structures.[46] Experience suggests

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[39] Pharmacology is concerned with the interactions between the active ingredients in drugs and the organism.

[40] Toxicology is the study of toxic substances, poisoning and their treatment.

[41] Kaufmann, L. and Ridder, Ch.(2003), p. 449.

[42] Risk-benefit assessments of drugs are carried out during clinical trials and after licensing on the market.

[43] Gorbauch, R. de la Haye (2002), p. 165 ff.

[44] Orphan drug status means that no other approvals are accepted for similar pharmaceutical products for the same therapeutic application area. Similar drugs means similar molecular structure, the same active ingredient mechanism and the same therapeutic application area. When deciding whether to award orphan drugs status, the following criteria are taken into account in the EU: no satisfactory therapy must already exist in the EU and proof must be provided that the new drug will bring significant benefit to the patients affected. At the same time the medical condition must affect fewer than 5 citizens of the EU per 10,000.

[45] BPI (2005b), p. 5 ff.

[46] "New Molecular Entities" (NMEs) or "New Chemical Entities" (NCEs).

that fewer than one project in ten advance from the preclinical phase to the end consumer.[47] This is due not just to the medical termination criteria, but also to the increasing requirements regarding safety, compatibility and the effectiveness of the remedy in the ensuing clinical tests.

4.3.2.3 Clinical Phase

The development process in the clinical phase of a pharmaceutical product resembles a "typical" project more closely than the research work that goes into it. Every substance goes through a development programme ("drug development plan") before it finally reaches the market.[48] Before the clinical test phase can commence, the company requires the approval of the appropriate authority (e.g. the European Agency for the Evaluation of Medicinal Products (EMEA) in Europe or the Federal Drug Administration (FDA) in the USA) in the form of a "Investigational New Drug Application" (IND) and a positive judgement from the ethics commissions. Once approval has been granted, the drug can be tested on human beings, in Phase I on healthy subjects[49] and in Phases II and III on patients. When supplemented by a voluntary phase IV, it is possible to examine the long-term effects or unusual side-effects in more detail.[50]

Before the study gets under way, independent ethics commissions[51] review a risk–benefit assessment, the patient information and their insurance cover. During the study, they monitor its progress. Their ensuing judgement enables the pharmaceutical companies to submit the study to the responsible national authorities.[52] Only after the relevant "reference number" has been granted may clinical trials on real patients begin.[53]

During the clinical trials, the pharmaceutical company already has to ensure that the drug to be tested has been manufactured to the latest standards. The guidelines relating to this are set out in the Good Manufacturing Practice (GMP). The Guideline for Good Clinical Practice (GCP) is an international quality standard which has to be observed when conducting and recording clinical trials that involve the participation of human subjects. To achieve successful licensing, international and national guidelines drawn up by several different institutions[54] exist for virtually

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[47] Stewart, J. J. et al. (2003), p. 814.

[48] Völker, R. (2001), p. 233.

[49] Except in the case of some therapies e.g. cancer therapy, which are treated as exceptions.

[50] Kaufmann, L. and Ridder, Ch.(2003), p. 449.

[51] German ethics commissions are regulated under public law and subject to the federal state law of the Bundesland in question. Their function is to protect the subjects taking part in medical trials.

[52] In Germany such studies can be submitted, for example, to the German Federal Institute for Drugs and Medical Devices (BfArM) or the Paul Ehrlich Institute (PEI).

[53] Gorbauch, R. de la Haye (2002), p. 167 ff.

[54] These include institutions such as the European and American licensing authorities, the International Conference on Harmonization (ICH), the Committee for Proprietary Medicinal Products (CPMP) and the World Health Organization (WHO).

all major indications. Compliance with the guidelines is documented in a development plan for the pharmaceutical product. In summary, this documents the planned studies, their content and sequence. At the same time it forms part of the application for approval to the licensing authorities.[55]

4.3.2.4 Licensing Procedure

Following successful completion of the clinical trials (67% of Phase III candidates), the company applies for approval to the responsible authorities. In the USA this is a "New Drug Application" (NDA) and in the EU it is called a "Market Authorisation Application" (MAA).[56] They examine the documents prepared by the company relating to the pharmaceutical quality, efficacy and safety of pharmaceutical products. For the US market, national approval is granted by the Food and Drug Administration (FDA). In the EU, there are three different licensing procedures. A central Europe-wide procedure is conducted by the European Agency for the Evaluation of Medicinal Products (EMEA) in London. The second procedure leads to reciprocal recognition, such that the approval is recognised by each member state. And finally there is also a purely national licensing procedure, under which approval is granted in only a single EU member state.[57] The strategic orientation of the company will determine to which authority the application should be submitted. However, the authorities decide whether the drug may be marketed for the intended purpose in the country.

4.3.3 Significant Characteristics of Pharmaceutical Projects

Having explained the development process, we shall now examine the typical characteristics of a pharmaceutical project. As well as project-typical features such as quality, cost and duration, the distinguishing features of an R&D project also include uniqueness and novelty in a dynamic environment and limits on time and personnel.[58] According to draft auditing standard no. 5 of the German Institute of Auditors (IDW ES 5 n. F.), the value of an asset is basically determined by its future financial return.[59] In addition, non-financial asset values – intangible asset values – also have to be considered.

4.3.3.1 Financial Return

To ascertain the financial return of an R&D project, it is essential to first assess the size of the market. The market size is determined by the number

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[55] Gorbauch, R. de la Haye (2002), p. 167 ff.
[56] Kaufmann, L. and Ridder, Ch.(2003), p. 449.
[57] BCG, (2001), p. 73.
[58] Brandt, S. M. (2002), p. 123.
[59] IDW ES 5 n. F. (2006), text no. 15.

Phase I

In Phase I of the clinical study, the pharmaceutical product is tried out on humans for the first time, normally between 10 and 100 healthy subjects. The pharmacological and toxicological effects in the human body are tested in ADME (absorption, distribution, metabolising and elimination) studies. Also examined are interactions with other drugs, tolerance limits and dose-effect relationships.

Phase II

In the Phase II clinical trials, which involve a relatively small number of cases – between 50 and 200 patients – the effect of the drug on sick patients is examined, along with the side-effects and optimal dosage. The aim is to obtain data that is not influenced by concomitant disorders or by the peculiarities of individual patients. Using the double-blind procedure*, the drug to be tested is made available to the examining doctor and patient, along with a non-active placebo or a standard therapy.

* "Double-blind" means that neither the doctor nor the patient knows whether the drug or the placebo has been administered.

Phase III

Assuming that the desired effect – an acceptable level of safety and a favourable dose range – has been demonstrated in Phase II, work can now commence on trials with the drug on a larger number of cases – from around 2,000 to over 5,000 patients. The test substance has to be tested under conditions similar to those that will apply in later practice. The effectiveness and tolerance of the test substance are analysed statistically. The trials have to show that administration of the drug had a positive outcome in over 95% of cases. Phase III ends with the creation of the approval dossier** and its submission to the responsible authorities.

** The approval dossier contains all the findings to date in a form that permits a broad judgment to be formed of the mode of action, the pharmacological data, efficacy, dosage, how the pharmaceutical product compares with the previous standard therapy and how well it is tolerated.

Phase IV

Once approval has been granted, the fourth clinical phase, which is no longer part of the clinical trials, begins. Often this phase includes a drug monitoring exercise*** to identify which parameters and risk factors affect the safe use of the pharmaceutical product and any possible interactions which could not be ascertained during the clinical trials.

***This is published through the recommendations of the German Federal Institute for Drugs and Medical Devices (BfArM), as a result of which it has become an increasingly important, strategic tool after licensing for purposes of marketing.

Fig. 4.3 Clinical phases
[Source: based on Gorbauch, R. de la Haye (2002), p. 167 ff.]

of patients with the required daily dose. An epidemiological[60] assessment of the indication enables one to estimate the expected prevalence (morbidity of the medical condition) and incidence (number of new cases) during the period over which the drug to be developed can be expected to be marketed. The epidemiological expectations are developed within a regional framework, so that they can then be generalised to the biggest markets, such as the USA, EU and Japan.[61]

When calculating the sales potential, it is necessary to bear in mind that the bigger the target market is, the greater the likely revenue once the product has been licensed. In order to forecast the revenues in a more understandable faction, ideally a target product profile of the candidate active ingredient is drawn up in consultation with the R&D scientists. This profile is defined in terms of characteristics such as therapeutic use, action profile (with description of efficacy and side-effects), pharmaceutical form and production.[62] At the same time the expenditure associated with the predicted revenue has to be separately estimated. Essentially, this is estimated on the basis of the cost of clinical studies and licensing fees. While the pharmaceutical product is under development, there will be opportunities to consider an alternative solution which could lead to a different target product profile with greater commercial potential or, in the worst case, to termination of the programme.[63] Although the developed target profile will differ from the actual profile of the final pharmaceutical product, it is sensible to forecast the future revenue, firstly in order to work out its significance for the company and at the same time amongst other things to ascertain the value for licensing agreements. On the other hand, this forecast involves assessing the competitive environment and the clinical pictures within this market for which there is as yet no treatment.[64] As R&D projects are developed for one or more indications, the significance of each indication should be considered in the overall assessment.[65]

It must be emphasised that pharmaceutical R&D projects require a lot of time and production factors. In the long term they tie up resources of the company in the pursuit of an objective whose outcome is uncertain. There is no guarantee that the expenses incurred will be recouped later on in the form of revenue. The risk of failure is extremely high over the entire development process and the prospects of a product launch are low.[66]

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[60] Epidemiology examines the distribution and causes of health-related conditions and events.

[61] Bussey, P. et a. (2005), p. 204.

[62] Rudolf, M. and Witt, P. (2002), p. 155.

[63] Bussey, P. et al. (2005), p. 205.

[64] Bussey, P. et al. (2005), p. 205. Cancer therapies need a large sales market, whereas lifestyle preparations like Viagra take less long to launch on the market but have a short marketing phase.

[65] Bussey, P. et al. (2005), p. 204, see also Arnold, K. et al. (2002), p. 1086.

[66] Mansfield, E. (1968), p. 68 ff., cited in Schmeisser, W. et al. (2006), p. 63.

4.3.3.2 Intangible Value

The predictable data outlined above, such as the sales potential, does play an important role in the project assessment, but consideration of non-financial or intangible asset values[67] is lacking.

Based on the prevailing opinion of the business literature, the German Institute of Auditors defines an intangible asset as a business asset used in the business process, whose substance is not physically perceptible, e.g. rights, relationships, know-how or information.[68] When one considers a pharmaceutical R&D project, on the one hand these are assets which relate to patented technologies, active ingredients or receptor molecules and trade secrets regarding formulae or processes. On the other hand, they are intangible assets based on rights, such as licences, management contracts, restraints of competition or non-competitive clauses.[69] It is therefore worth using licensing agreements, for example, to value pharmaceutical projects.[70] When it comes to examining licensing agreements about R&D projects, Arnold et al. show with the results of their study[71] that four other significant factors have a significant influence on the project value: the licence partner, the degree of innovation and stage of development of the drug, the agreed milestone payments and the type of agreement.[72] In view of the high development costs,[73] many biotechnology companies enter into a teaming agreement with a pharmaceutical company for the purposes of obtaining finance. After each phase is successfully completed, the value of a licensing agreement increases by 22%.[74]

The further the drug is along the development process, the more likely it is that the licensing associates will pay more money. The licensing associate itself influences the value of the product to the extent that it lends a bigger reputation as well as making more capital available. The company benefits from the reputation of the pharmaceutical company, since its association with this company draws the attention of venture capitalists, investors or future customers to its product. Major pharmaceutical companies can succeed in doubling the product value by virtue of greater marketing opportunities. They themselves are forced to conclude licences to renew their product pipeline. In this connection Arnold et al. put forward the argument that pharmaceutical companies are not just willing to acquire innovative

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[67] In this connection, Schmeisser, W. et al. (2006), p. 293 ff. discuss in detail the definition and classification of intangible asset values within the framework of "intangibles".

[68] IDW ES 5 n. F. (2006), text no. 3, see also Schmeisser, W. et al. (2006), p. 293 ff.

[69] As defined in IDW ES 5 n. F. (2006), text no. 14.

[70] Bussey, P. et al. (2005), p. 204, also Arnold, K. et al. (2002), p. 1085.

[71] Arnold et al.'s study examined the values of over 100 biotechnology companies which were completed between 1999 and 2001.

[72] Arnold, K. et al. (2002), p. 1085.

[73] The average cost of Phase I studies is $2 million and of Phase II studies $10 million. On top of this there are considerable costs for Phase III studies, so that over the development process as a whole the costs can mount to $800 million (Handen, J. S. (2005), p. 6).

[74] Arnold, K. et al. (2002), p. 1087.

products in order to market them, but they will also buy innovative products without marketing them in order to prevent the competition from gaining access to them.[75]

The value of an R&D project rises significantly if the product possesses a high degree of innovation. Arnold et al. argue that the contract value of a licence is twice as high if a product represents a genuine new development rather than merely a variation on an existing one.[76] But paradoxically, a high degree of innovation tends to be seen as a disadvantage in the industry, as the probability of success is low and development is enormously risky.[77]

The success of the project also depends significantly on the technical competence of the project management and the head of the research team. What is relevant here is the experience of the scientists at successfully getting a candidate product through a development process (Phase I to III studies) and the know-how of the decision makers. Often they have to put off decisions until further information can be obtained about the potential of the drug and its probability of success.[78] The same applies to the decision to pursue alternatives counts here. It must be added that the decisions they make here depend not only on their experience but also on their willingness to accept risk.[79] On top of this they have to be able to actively follow developments in the market and assess to what extent the project can be successfully carried off in the company.[80]

Finally, the value of an R&D project is determined by quite general factors such as the general business strategy, public trust and the opinion of the public and capital markets on biotechnology. Not only the competitive environment, but also the regulatory requirements and legal changes and changes in government policy constantly reshape the environment of the pharmaceutical market.[81]

4.3.4 Summary

The factors discussed which have a significant effect on the value of an R&D project are summarised in the next diagram (Fig. 4.4).

Again, one should not forget the time factor and the external factors.

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[75] Arnold, K. et al. (2002), p. 1086.

[76] Arnold, K. et al. (2002), p. 1087.

[77] It should be added that a market-oriented competition increasingly blurs the boundaries between "actual" and "promised" innovation (see Frerk, V. et al. (1996), cited in Arthur D. Little (1997), p. 77).

[78] Arnold, K. et al. (2002), p. 1088.

[79] Finke, R. (2005), p. 20

[80] Weule, H. (2002), p. 202.

[81] The stock market is quick to criticise changes in policy which affect the pharmaceutical industry. For example the S & P 500 Pharma share index in the USA fell by 4.7% within three days after it became known that the non-pharmaceutical-friendly Democrats had won the election. The reason for this was the reform plans relating to the Medicare state-funded health programme and relaxation of the import regulations governing the import of cheap foreign drugs (Kuchenbuch,

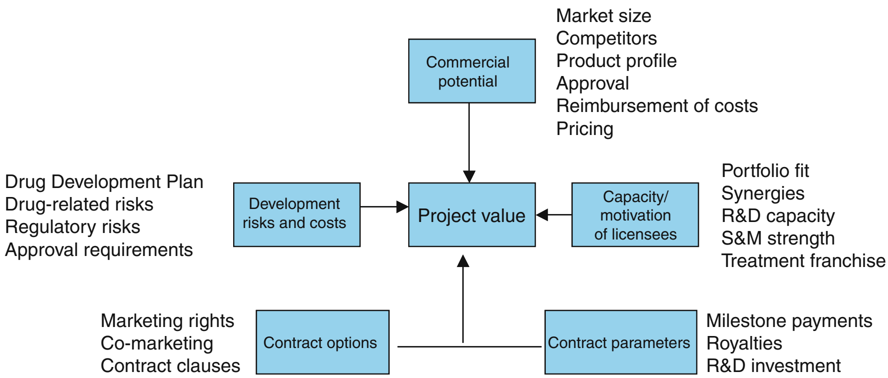

Fig. 4.4 R&D valuation
[Source: based on Bussey, P. et al. (2005), p. 197.]

Finally, the R&D project is bound into a tight timeframe, as only short development times guarantee that a pharmaceutical product will be exclusive on the markets (effective patent term). The uncertainty of the possible product profile, estimation of the probability that marketing will be successful and the consideration of intangible assets pose a major challenge to the company. Ongoing valuation of all projects in progress makes it possible to estimate which products should be developed to achieve the biggest possible commercial success. Given the extreme importance of R&D project valuations, this subject will be considered in more detail in the next section.

4.4 Procedures for Valuing Pharmaceutical R&D Projects

Having explained in more detail in the previous section the sequence of events and the typical features of a pharmaceutical R&D project, we will now consider some valuation procedures. In this context, the main reason for valuing R&D projects and their outcomes is not primarily for accounting or tax purposes but for making decisions on whether to acquire or dispose of them. The aim is to assess a project in a manner that considers the salient features of pharmaceutical projects and also the risks inherent in the R&D process.

4.4.1 The Use of Portfolio Techniques to Value Research Projects

Relatively few pharmaceutical companies value their projects during the research phase using financial valuation analysis. The reason is that due to their non-standard

P. and Kirchgaessner, S. (2006), http://www.ftd.de/ unternehmen/industrie/134041.html, as of 22 November 2006).

components it is impossible to value research projects reliably. Accordingly, the valuation of a research project is not confined to a financial assessment but concentrates on the assessment of its value drivers.[82]

The value drivers[83] in a research project comprise a number of factors of an intangible nature. Some of these are technology-based values, others are assets based on rights, such as licence agreements or patents. The teaming partners, the degree of innovation of the drug and the qualifications of the staff and their know-how are examples of such value drivers.[84]

In order to decide which R&D projects to develop and in which sales markets the company wants to be active in the future, a suitable decision tool is needed.[85] The convention is to use qualitative methods which consider multiple goals and valuation criteria.[86] Purely qualitative methods include checklists, project profiles, portfolio analysis and product life cycle analysis. Checklists are used for the purposes of rapid screening for a project decision.[87] Portfolio analysis produces a differentiated and well-founded value statement. It is the most well-known form of analysis and is often employed in practice. Portfolio techniques serve to link the environment with the corporate strategy. For this purpose a number of models have been developed. These cannot be described in simple terms (source-related or object-related) and also differ as to the variables used to specify the investment fields.[88] Three different approaches will be considered to illustrate the principles: the project portfolio approaches of Loch et al. and Arthur D. Little and the market portfolio.

4.4.1.1 Principles of Portfolio Analysis

Portfolio analysis originates in financial theory and is used to determine the optimum composition of a share portfolio. Essentially two criteria are used to value this portfolio, the expected future returns on capital of the shares and the variance of the standard deviation as a measure of the risk of the securities in question.[89] The concept was developed further in order to consider different factors, for example, whether the project has the same positioning as the competition according to the corporate strategy and the extent of the financial returns expected for each investment.[90] With portfolio analysis it is possible to analyse, condense and present in a discussible form information from the company, its competitors, customers and

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[82] Bussey, P. et al. (2005), p. 211 f.

[83] Value drivers are all the factors which raise the company or project value.

[84] For more detail, see section 3.

[85] A similar argument is advanced by Falter, W. and Michel, U. (2000), p. 473 ff. from the chemical industry.

[86] Specht, G. et al. (2002), p. 216.

[87] Brandt, S. M. (2002), p. 137.

[88] Möhrle, M. G. (1999), p. 10.

[89] Rufo, M. et al. (2006), p. 4.

[90] Bussey, P. et al. (2005), p. 195.

the environment. As a framework for thinking, it enables the results of individual analyses to be combined in a clear way so as to systematically support selection decisions. For this reason, portfolio analysis is often used to generate strategies and for the allocation[91] of scarce financial resources.[92]

The portfolio approach is a useful way of analysing, valuing and organising the entire R&D activity in the company. Möhrle recommends valuing all the R&D projects in the form of an R&D programme portfolio.[93] While considering specific R&D projects, his portfolio considers the criteria of technology push and market pull. Technology push reflects the technological attractiveness of a project, e.g. the type of technology used, the spectrum of applications or the technical standard. The second dimension, market pull, entails considering the criteria of the expected earnings, market and competitive situations.[94] However, the value of pharmaceutical projects depends less on the technology than on available research results, market conditions, existing and future therapy possibilities and their associated risks.[95] We will therefore consider in more detail below portfolios which tend to consider such characteristics.

4.4.1.2 R&D Project Portfolio of Loch et al.

In order to qualitatively assess research projects using a portfolio, Loch et al. employ the criteria of "medical need",[96] product innovation and potential market size.[97]

The assessment of "medical need" is based on the difficulty of treating the medical condition concerned and the efficacy of the available treatments. It is derived from a questionnaire. The assessment of product innovation on the other hand is performed via the analogous comparison of the product profile and the therapeutic concept with existing, successful therapies.[98]

The potential market size is derived from an epidemiological assessment. An epidemiological assessment of the indication enables one to estimate the expected prevalence and incidence during the period over which the drug to be developed can be expected to be marketed. The epidemiological expectations are developed within a regional framework, so that they can then be generalised to the biggest markets, such as the USA, EU and Japan.[99]

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[91] i.e. the allocation of scarce resources to alternative uses.

[92] Rufo, M. et al. (2006), p. 11.

[93] Möhrle, M. G. (1999), pp. 79–82.

[94] Möhrle, M. G. (1999), pp. 82–84. The technology portfolio of Pfeifer et al. and the "Darmstädt" portfolio assess technology development in a similar way (see Specht, G. et al. (2002), p. 95).

[95] Bussey, P. et al. (2005), p. 198. Völker, R. (2001), p. 236 adopts a similar line.

[96] Or, more precisely, "unmet medical need" i.e. clinical picture in respect of which, on current scientific knowledge, there is no adequate treatment.

[97] Loch, C. et al. (1999), p. 3.

[98] Loch, C. et al. (1999), p. 4.

[99] Bussey, P. et al. (2005), p. 204.

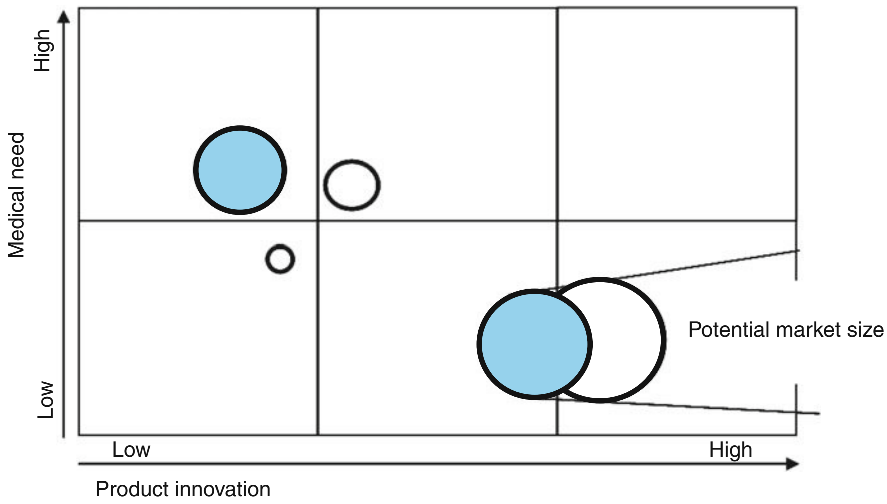

Fig. 4.5 R&D project portfolio of Loch et al.
[Source: based on Loch, C. et al. (1999), p. 4.]

Critically, however, it must be pointed out that to date no statistics have been found which prove that innovative products are also more profitable. On the contrary, experience suggests that many non-innovative products are actually blockbusters. Thus, for example, Bayer was able to successfully extend its product line for the long-established active ingredient, acetylsalicylic acid (ASA), by coming up with a new galenic form, the chewable tablet "Aspirin direct".[100] When one considers the life cycle of a pharmaceutical product, the phases following the expiry of patent protection become increasingly important – in relation to the generic drugs market and the over-the-counter market.[101] The result is that, for the pharmaceutical industry, the search for new active ingredients and modes of action (in this sense, product innovation) are no longer the only success parameters, but innovation quality (product ideas and patient needs) and pace of innovation (the speed of development through to commercial viability) are also important.[102] Or, as in the case of "Aspirin direct", through the relaunch of an old but successful product in a new, creative variation, rather as Zwicky[103] envisioned when he devised the morphological box.

[100]Frerk, V. et al. (1996), cited in Arthur D. Little (1997), p. 77.

[101]OTC products are drugs which can be sold over-the-counter for self-medication without restrictions.

[102]Arthur D. Little (1997), p. 76.

[103]Zwicky, F (1971), p. 88 f.

4.4.1.3 R&D Project Portfolio of Arthur D. Little

The valuation approach employed by management consultants Arthur D. Little qualitatively assesses the opportunities and risks and also the growth and stability of a project by attempting to match the portfolio with the strategic overall concept of the company. This approach to valuation is used to compare several projects with other projects within the framework of benchmarking.[104] Opportunities and risks are assessed in a two-stage valuation process. In the first stage the projects are valued and compared against the two dimensions of risk and attractiveness. The risk dimension is intended to estimate technical and economic uncertainties as well as any possible damage potentials. For the purposes of estimation, expenditure on R&D, the time required to complete the project and possible investment in manufacture and market launch are considered. The second dimension – the attractiveness of R&D projects – is evaluated on the basis of the achievable market, the competitive position, the intensity of competition, the growth potential, the extent to which the project is in line with the corporate strategy, and the achievable innovation edge.[105] If the assessment of the R&D project indicates low risk with high attractiveness, it should be selected from the project portfolio.[106]

During the second stage of the valuation, critical activities within a given process step and project priorities are determined so as to give them the necessary weighting.[107] During the evaluation of the development process of a drug, it is possible to identify the most important process steps and at the same time expose any problem areas.[108,109] The priority of the project is determined by an analysis of strategic effect and outlay, whereby an R&D project with a high strategic effect but low outlay would be assigned a high priority.[110] Starting from this premise, it would not be worthwhile for a pharmaceutical company hoping for success to invest in a niche market. Hence, the legislator has to create incentives to make research and development in such a market attractive, for example by reducing the scope of the clinical studies required. This will make it possible for even a small pharmaceutical company to establish itself on the market with a relatively low outlay.

At the same time a budget size which is proportional to the relevant annual project budget can be represented in the portfolio by means of circle diameters. The staff

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[104] This is an analysis, under which the projects are ranked in relation to processes, products, services etc. in order to identify the best one.

[105] As with Loch et al.'s criterion of "product innovation", a discussion is required here as regards the definition of innovations.

[106] Specht, G. et al. (2002), p. 221 f.

[107] Specht, G. et al. (2002), p. 221 f., see also Weule, H. (2002), p. 282 f.

[108] Critical activities are classified against the criteria of "sub-standard", "acceptable", "advanced" and "world-class", where each of the four evaluation classes has a detailed set of characteristics.

[109] Weule, H. (2002), p. 282 f.

[110] Specht, G. et al. (2002), p. 221 f., see also Weule, H. (2002), p. 282 f.

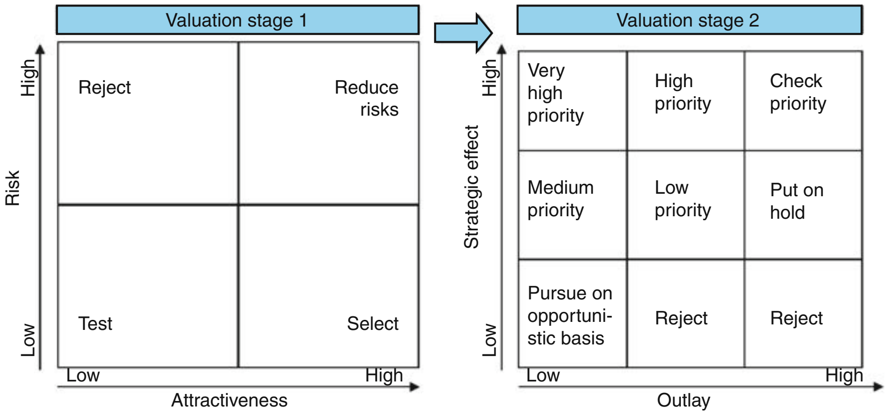

Fig. 4.6 R&D project portfolio of Arthur D. Little
[Source: based on Specht et al. (2002), p. 221.]

of the functional areas concerned, e.g. R&D, production and marketing/sales, create the portfolio, taking into account the financial resources.[111]

4.4.1.4 Market Portfolio

Lastly, we consider the market portfolio approach, under which the value of an R&D project is largely determined by the market and its competitors. For this reason, the market conditions will be analysed using this approach. As in the approach taken by Arthur D. Little, valuation of R&D projects plays a central role in the market portfolio approach, taking into account the corporate objectives and corporate resources.

The market portfolio represents the strategic situation of the R&D project. In a two-dimensional matrix, the situation is classified according to the characteristics of the dimensions of market attractiveness and competitive advantage within four fields. One basic portfolio is the Boston Consulting Group (BCG) portfolio developed by the management consultancy firm after which it is named, with its two dimensions of market growth and relative market share. Underlying the portfolio is the assumption that the higher the relative market share, the lower the market risk.[112] Brandt transfers this idea to an R&D project by considering the variables of market attractiveness and relative competitive advantage.[113,114] The first dimension of the matrix – market attractiveness – is used to assess the profit and growth prospects of the market. Industry-specific criteria such as the market potential, the size of the

[111]Specht, G. et al. (2002), p. 221 f.
[112]Rufo, M. et al. (2006), p. 7.
[113]Vgl. Brandt, S. M. (2002), S. 138.
[114]Brandt, S. M. (2002), p. 138.

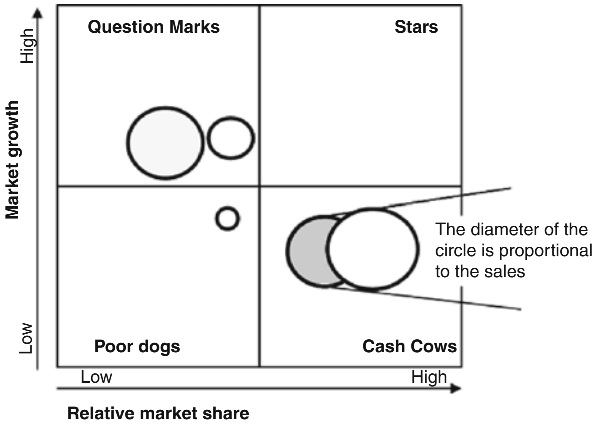

Fig. 4.7 Market portfolio
[Source: based on Brandt, S. M. (2002), p. 138, see also Möhrle, M. G. (1999), p. 87.]

market and market growth or market quality (which is assessed in terms of pricing freedom, patent term or market entry barriers) essentially assist here. One criterion which must not be ignored is the environmental situation, which in the context of pharmaceutical companies in particular is determined by dependence on legislation or on the attitude of the public. The second dimension of the matrix – relative competitive advantage – is assessed using criteria such as the relative market position (market share, size and financial strength of the company), the relative production potential (cost advantages due to modern production conditions, licence relationships, location advantages), the relative R&D potential (status of fundamental and applied research, innovation potential) or the relative qualification of the workforce and managers (quality of management system, professionalism).[115]

Taking into account the above-mentioned criteria, the projects can be assigned to the two dimensions in the matrix. The matrix distinguishes four quadrants: "Poor Dogs", "Cash Cows", "Stars" and "Question Marks". A large pharmaceutical company finances future products with products already on the market. Question Marks are products which exhibit high market growth but in which the company has not yet attained a significant competitive position. Stars are products characterised by high market growth and a dominant relative competitive advantage. A Star normally requires a lot of financial resources to maintain its market position and at least be able to grow with the market. Cash Cows are products with low volume market growth and dominant relative competitive advantage. They are the company's main source of finance and pay for new product developments. Poor Dogs are products with low volume market growth and low relative competitive advantage. Normally, they can only be maintained at the expense of high use of financial resources. Each quadrant in the matrix has an associated action recommendation

[115]Brandt, S. M. (2002), p. 138.

based on one standard strategy.[116] The project can also be assigned a project volume[117] on the basis of the size of the circle.[118] The market portfolio approach links a market analysis (environmental and competitive conditions) with a corporate analysis (relative competitive advantages compared with the strongest competitor). Although this analysis does not result in any direct monetary values, the resulting qualitative assessment enables one to draw conclusions about the market and success potential.[119]

4.4.1.5 Portfolio Analysis as Illustrated by an Example of an Intangible Asset – The Patent

The market-oriented approaches of portfolio theory make it possible to value all the R&D projects in progress in the company. The patent will be considered here as a representative of a typical type of research project. Patents are used to protect intellectual property. A company's own patents protect the company against competitors, whereas third-party patents block the way to the market.[120] As long as patent protection exists, plain imitation is not normally an option for the competition due to the high cost of claims for damages.[121] The patent environment and the valuation of the patent are critical to the success of an R&D product.

Huebner proposes that patents are valued by a "patent due diligence"[122] process. The first part of this valuation, the "scope of protection analysis", is concerned with the strengths and weaknesses of the company's own patent portfolio. It starts by working out as realistic a picture as possible of the development situation in the company in order to ascertain the edge over the competition in terms of time. Furthermore, the analysis concentrates on the content of patents and their breadth and strength in relation to protection claims. The critical measure here is the advantage which the technology[123] confers on the product. Often competitors find an alternative which could be impeded by strategic patent protection. Ultimately the analysis shows how unique the project is and what obstacles competitors would

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[116] The standard strategies are as follows: Question Mark strategy = expand or exit, Star strategy = maintain or expand market share,. Cash Cow strategy = maintain market share without significant further investment,. Poor Dog strategy = relaunch, sell or give up.

[117] Project volumes are determined by total and closing volumes. Under the total volume the project costs are entered and under the closing volume the costs of the project between the time of collecting the data and the project conclusion.

[118] Specht, G. et al. (2002), p. 221 f.

[119] Brandt, S. M. (2002), p. 140 f.

[120] Bussey, P. et al. (2005), p. 197.

[121] Huebner, S. (2005), p. 73 ff.

[122] Due diligence is the term for a detailed audit and valuation of a company, in this context of a patent.

[123] The analysis differentiates between complex and discrete technologies. Complex technologies make use of other patents, whereas discrete technologies can be valued on their own. Here Hübner refers to technologies as "use patents". However, pharmaceutical products are essentially protected through "substance patents" which ensure an absolute marketing protection.

have to overcome or how long they would need to put a comparable product on the market.[124] In the second part of the valuation the danger of being blocked by third-party industrial property rights is estimated through a freedom-to-operate analysis. At the same time it reveals the opportunity associated with an underdeveloped patent environment. Depending on the type of technology or the patented active ingredient, the freedom-to-operate analysis quantifies the danger that the patent environment will obstruct market access. This analysis shows what strategy the company should pursue to reduce the risk and exploit the opportunities. Suitable strategies range from aggressive patenting to the circumvention of technologies belonging to competitors, to the use of licences.[125]

It must be emphasised here that portfolio analysis is particularly useful when it comes to comparing patents. Huebner rightly points out that a "young technology company which has a strong patent portfolio and operates in a favourable patent environment ... has laid important groundwork for its success".[126]

4.4.2 Project Valuation in the Development Process

Having considered in the above sections the valuation of the value drivers of research projects, we will now consider valuation approaches which involve the financial assessment of a project. In order to be able to evaluate R&D projects financially, in practice they are only valued from a particular development stage, i.e. the point at which data proving the pharmacological active profile is available.[127]

The value of a pharmaceutical project depends essentially on its development costs and the probability of successful development (and especially on the time to market launch). The development costs considered are all the costs associated with development, from preclinical phase to Phase I and Phase II through to Phase III of a pharmaceutical product. The probability of successful development is assessed after each development stage. At the same time an estimate is produced of the probability of when it would be better to terminate development of a pharmaceutical product. To assess the probability of success, all the possible risks are considered, including not just the medical risks. The aim is to perform a project assessment which considers the potential of the sales market and also the requirements of doctors and patients within the indication field.[128]

4.4.2.1 Valuation Based on Key Figures

To assess whether the development process is, was and will be efficient or not, a valuation is undertaken using key figures.[129] Thus, the development time through

[124] Huebner, S. (2005), p. 73 ff.
[125] Huebner, S. (2005), p. 73 ff.
[126] Huebner, S. (2005), p. 76.
[127] Völker, R (2001), p. 239.
[128] Bussey, P. et al. (2005), p. 204.
[129] Specht, G. et al. (2002), p. 216, similar arguments are presented in Weule, H. (2002), p. 281.

to market launch can be assessed using the break-even time method. "The break-even time is defined as the time in which research and development investment is amortised".[130] This assessment considers whether market launch was too late and whether the product was successful.[131] Another key figure is the "R&D effectiveness index", which is a measure of the company-wide effectiveness of product developments. This index is based on the ratio[132] between the proportion of sales accounted for by new products and R&D expenditure expressed as a percentage of sales. If the index is bigger than 1, then the return from the new products is greater than the R&D spending required.[133]

For pharmaceutical companies with a large R&D portfolio, these figures can be interesting as they supply clear results for products which are already established on the market. However, in the case of the young pharmaceutical company, the project has not yet reached the stage of market launch. The analysis therefore requires the prediction of success variables and cannot be deduced from direct measures of success. We now consider some forward-looking approaches to the valuation of R&D projects in financial terms. One obvious way of valuing R&D projects in a future-oriented way is using the Discounted Cash Flow (DCF) method.[134] The future (marginal) cash flows can be estimated for a drug under development from the clinical phase. The factors that have to be considered here include the risk, the costs or amounts to be paid out during the development phases, their timing and the probability of success. As well as this traditional method of valuing projects, three other methods are recommended in the literature: value assessment based on comparison of the present project with other, similar projects or "comparable deals",[135] the decision tree model and the option price model.[136] As the DCF approach and the decision tree model are well-established in practice, they will be explained first.

4.4.2.2 Discounted Cash Flow Approach

The valuation of R&D products using the DCF method is based on the principles of company valuation defined by the German Institute of Auditors (IDW ES 1 n.F.).[137]

The DCF approach is one of the methods of value-oriented investment analysis, known as the capital value method.[138] Under this method, the capital value (cash

[130] Weule, H. (2002), p. 280.

[131] Weule, H. (2002), p. 282.

[132] The calculation goes like this: sales revenue from new products x return [profitability + R&D expenditure] in relation to R&D costs.

[133] Weule, H. (2002), p. 282 f.

[134] Wolf, K. (2006), p. 363.

[135] These are compared on the basis of the profits achieved from sale or licensing.

[136] Arnold, K. et al. (2002), p. 1085.

[137] DCF is: "Based on the knowledge that a dollar today is worth less than a dollar tomorrow." (Arnold, K. et al. (2002), S. 1086).

[138] The DCF method distinguishes four different approaches. If payments to shareholders are to be valued, the net method (equity method) is used with a cost of equity rate. To value series of

value) of a future investment is assessed by discounting the series of payments to the present point in time.[139] To work out the capital value, one starts by forecasting financial surpluses (cash flows) over the development process. The cash flow is an absolute index of internal financing which provides information about the financial resources available for investment, dividend payments and the settlement of debts. The basis is the sales surpluses resulting from the difference between incoming earnings/payments and outgoing expenditure/costs.[140] First of all, it is necessary to filter out the project-specific cash flows and deduct from them any additional investment in tangible assets which is necessitated by the project. In R&D projects, the cash manufacturing costs, for example, are derived from the costs of clinical studies and the marketing costs.[141]

Due to the long development times, R&D projects typically have a negative cash flow in the early years.

In order to compare payments that occur at different times, the cash flows are discounted to the present value (cash value) by applying discount rates.

$$\mathrm{CV} = \sum_{t=1}^{n} \frac{E[CF_t]}{(1+r_G)^t}$$

CV = company value (in this case, the value of the R&D project)
$E[CF_t]$ = expected value at time t
r_G = discount factor
t = time

Formula 1 DCF approach [Source: based on Wöhe, G. (2002), p. 660.]

The discount factor takes into account the investment risks in order to represent the expected revenue level. The higher the discount factor is, the lower the estimated revenue level. The factor is derived from the average cost of capital, which is calculated using the Weighted Average Cost of Capital (WACC) model.[142]

$$R_G = r_E \frac{EK}{GK} + r_F\,(1-s)\,\frac{FK}{GK}$$

payments to which shareholders and creditors are entitled, after taking taxation into account the total cash flow (TCF) method or the weighted average cost of capital method (WACC) is used. Here the appropriate cost of capital rate is the overall cost of capital rate. The fourth method is the Adjusted Present Value approach, which works out the "base case" NPV. All these variants work out the value of a project by discounting cash flows. There are differences in the delineation of the cash flows to be discounted, the internal discount rates to be used and the treatment of changes in the capital structure over time (cf IDW ES 1 n. F. (2004), text no. 135).

[139] Perridon, L. and Steiner, M. (2003), p. 61.

[140] Schmeisser, W. (2006), p. 100 f.

[141] Völker, R. (2001), p. 239.

[142] Arnold, K. et al. (2002), p. 1085.

r_{TOT} = weighted average cost of capital (WACC) EC/TC = equity ratio
r_E = cost of equity OC/TC = debt ratio
r_D = cost of debt T = tax rate

Formula 2 Calculation of cost of capital using the WACC model [Source: based on Wöhe, G. (2002), p. 659.]

The model relates to a capital structure which assumes that debt capital is preferable to equity capital (since the interest on borrowed capital is normally tax-deductible). Thus, in the WACC model, the cost of outside capital (OC) and the cost of equity capital (EC) and the related interest are proportional to the market value of the total capital. The cost of outside capital is determined by the average interest costs of the company, taking as the reference point any existing credit agreements. The amount of tax concessions is taken into account in tax rate *T*.[143] As biotechnology companies are largely financed by equity capital, the cost of outside capital is negligibly low.

The cost of equity capital is normally calculated using the Capital Asset Pricing Model (CAPM). This classic model of capital market theory starts from the premise of a complete and perfect capital market in which risk-averse investors expect similar risks and returns from all securities traded on the market. According to this model, the cost of equity capital is calculated assuming a risk-free interest rate and a risk premium. The risk premium consists of a market risk premium combined with a company-specific beta factor.[144] The beta factor reflects the systematic risk of an investment.[145] It is calculated from the covariance between the share yield of the company to be valued or a comparable company and the yield of a share index, divided by the variance of the share index.[146]

$$r_E = r_B + \beta(\mu - r_B)$$

r_E = cost of equity
$\beta(\mu - r_B)$= risk premium
r_B = risk-free reference rate
$\beta(\mu - r_B)$ = general market risk
ß = Beta factor

Formula 3 Calculation of cost of equity capital using the CAPM model [Source: based on Wöhe, G. (2002), p. 659.]

143 Achleitner, A.-K. and Thommen, J.-P. (2006), p. 649.

144 The beta factor relates to the fluctuation of the company's return compared with the return from a market portfolio (e.g. Dax). A risk-free capital investment has a Beta = 0.

145 Perridon, L. and Steiner, M. (2003), p. 119.

146 IDW ES 1 n. F. (2004), text no. 132. In the biotechnology industry a beta factor of 1.5 is assumed, based on the ratio of the NASDAQ Biotech index to the S&P 500 Pharma index.

The discount rates are derived from the cost of outside capital and the cost of equity capital of companies which were coded for anonymity. Experience suggests that the discount factor for biotechnology companies is 20%.[147]

After the cash flow of the expected cash flows has been calculated, the investment payments are deducted. The result is then the capital value of the investment alternative. A positive capital value shows a capital appreciation at time t_0, namely the original capital and the aspired-to minimum return are covered plus an additional profit. This means that one should proceed with the investment.[148]

It must be pointed out that using the DCF approach, it is possible to calculate a risk-adjusted expected value through discounting of the cash flow in a market-oriented way. If the DCF approach is used for R&D projects which are only at an early stage of development, however, the cash flow forecasts may be associated with great uncertainty.[149]

The discount factor takes into account investment risks, but not specific R&D risks.[150] Moreover, under the DCF method the discount rate is determined with the aid of the CAPM, which not only assumes a perfect capital market but also that the company is listed on the stock exchange. In practice this is seldom the case, as indicated by the fact that only 6% of biotechnology companies are listed on the stock market.[151]

For the reasons stated above, both Stewart et al. and Kaufmann and Ridder recommend that one should not use the DCF valuation method for R&D products since a reliable basis for the calculation is lacking.[152] In order to deal more effectively with the special requirements of a pharmaceutical project, we will now take a look at some valuation methods which take into account the probability of success and the high risks of failure in the cost-intensive development process.

4.4.2.3 Decision Tree Model

In order to value an R&D project accurately, an investor must take into account not only the income and expenditure but also the development time to market maturity and the associated risks. The value of an R&D project is essentially reflected in its stage of development. The stage of development indicates whether the product is at the preclinical or clinical phase or has been approved.[153]

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[147] Stewart, J. J. et al. (2001), p 813, also Loderer, C. et al. (2001), p. 250.

[148] Bode, G. (2005), p. 27. If there are any budget constraints, the investment alternatives can be compared with a discounted cash flow rate. The discounted cash flow rate is determined by dividing the net present value by the initial payment.

[149] Bussey, P. et al. (2005), p. 194.

[150] Stewart, J. J. et al. (2003), p. 817.

[151] Ernst & Young (2002), p. 10, quoted in Kaufmann, L. and Ridder, Ch. (2003), p. 448.

[152] Stewart, J. J. et al. (2001), p. 813; Kaufmann, L. and Ridder, Ch. (2003), p. 448 take a similar line.

[153] Völker, R (2001), p. 239.

Stewart et al. recommend valuing R&D projects using the decision tree method as this takes into account the probability of success in the development process. Every phase of the drug development process ends with a decision as to whether to terminate or continue the project, based on progress to date.[154] This decision is presented as a probability of successful development.

Assessing the various probabilities pertaining to successful development is probably the biggest challenge in the valuation. Although a pharmaceutical product might lead to a hugely successful therapy, the probability of successful development may be so low that the investment is not worthwhile. On the other hand, an

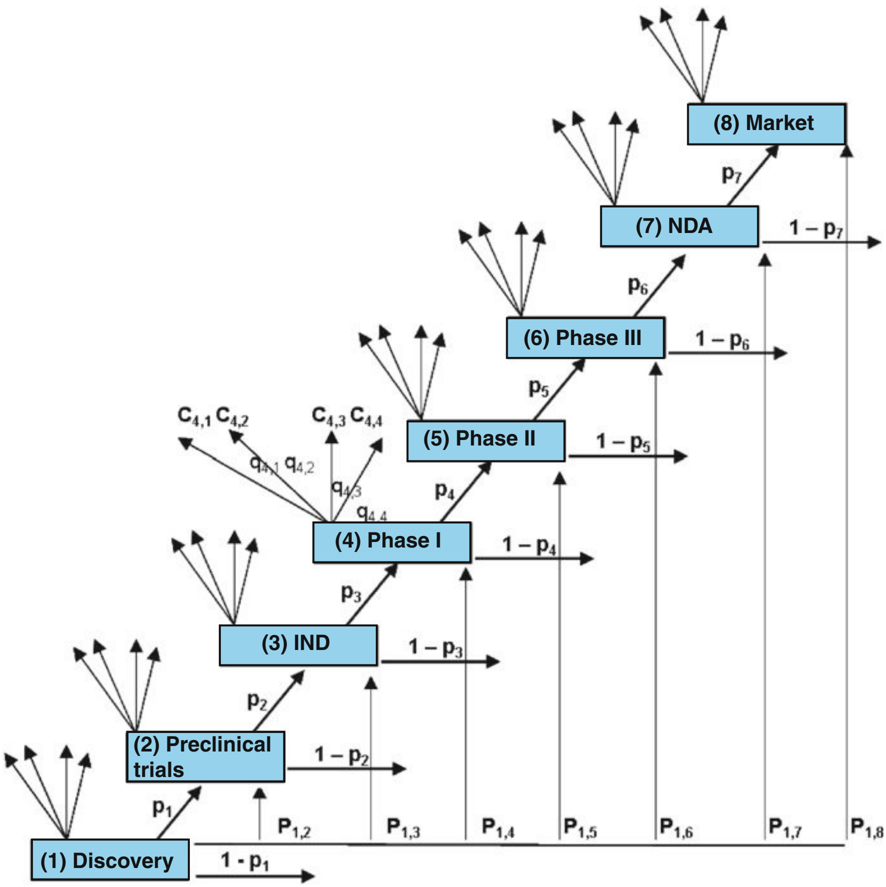

Fig. 4.8 Decision tree model for development of a drug [Source: based on Kaufmann, L. and Ridder, Ch. (2003), p. 450.]

[154]Stewart, J. J. et al. (2001), p. 813; Kaufmann, L. and Ridder, Ch. (2003), p. 448 take a similar line.

R&D investment can turn out to be more valuable than expected if, for example, it is developed for a niche indication on which it has a relatively high probability of success.[155]

In the decision tree model, the probability of success is shown for each individual stage of development. The probability of reaching the next development stage is indicated in the diagram below (Fig. 4.8) by p_i. On the other hand, 1-p_i represents the probability that the drug is aborted.[156]

To derive the decision tree model, Stewart et al. and also Kaufmann and Ridder proceed on the assumption of a risk-adjusted expected value.[157]

For this purpose, the cash flows for a given period, as anticipated at the present time, are calculated in two stages. First the expected value $E(CF_t)$ is calculated, but only when the product under development is at the beginning of period t. Hence, in a further stage (2) the formula is expanded by weighting it with the probability of reaching the relevant period ($p_{t,k}$) as a function of the current stage of development. To illustrate the procedure, the probability of reaching this period $p_{i,k}$ is shown in Fig. 4.8 for the discovery phase. For $p_{t,k}$ one can assume that $p_{1,4} = p_1 \times p_2 \times p_3$.[158] The probabilities of success are based on expected values that depend on the indications and therapeutic goals in question. As a rule of thumb, we can say that $p < 0.15$ for Phase II projects and $0.3 < p < 0.5$ for Phase III projects.[159]

Expected cash flow within a period t, as a weighted average of all the cash flows:

$$E(CF_t) = \sum_{j=1}^{n} q_{t,j} CF_{t,j} \tag{1}$$

Generally speaking, a product that is currently in Phase k may be expected to have the following cash flow in Phase t:

$$E(CF_t) = p_{t,k} \sum_{j=1}^{n} q_{t,j} CF_{t,j} \tag{2}$$

$E(CF_t)$ = expected value of the cash flow within a period t
$CF_{t,j}$ = cash flow in period t
$q_{t,j}$ = probability of a certain cash flow arising in period t
$p_{t,k}$ = probability of success
n = number of possible period cash flows

Formula 4 Calculation of period cash flows [Source: based on Kaufmann, L. and Ridder, Ch. (2003), p. 448.]

[155] Bussey, P. et a. (2005), p. 213.
[156] Kaufmann, L. and Ridder, Ch.(2003), p. 450.
[157] Stewart, J. J. et al. (2003), S. 817, see also Kaufmann, L. and Ridder, Ch. (2003), p. 450.
[158] Kaufmann, L. and Ridder, Ch.(2003), p. 450.
[159] Völker, R (2001), p. 239.

Consideration of Risks in the Decision Tree Model

The probability of development success is the key to the value of a remedy while it is under development. To determine the probability of success of a given development, it is necessary to understand the essential risks at each stage of development. To represent the risks in the different phases of development, it is necessary to analyse the potential revenue and the probability of occurrence in each development stage of each risk. On the basis of the different risk factors during a given development phase, the probability of success can be estimated in two ways. The first of these is to take an overall view of all risks, whereby the probabilities of all the individual risks are summed. The second possibility is risk orientation, under which increases and decreases in the risks are monitored. The result is a quantified probability of success for each development phases which reflects not only the probability of making it successfully to the market, but also the probability that the project is terminated at the various phases of development.[160]

The essential risk factors which influence the probability of success are efficacy, safety, pharmacodynamics,[161] pharmacokinetics,[162] drug administration, inbound deliveries and costs. Although it is unlikely that every risk will be represented, the attempt should be made initially to identify all the specific individual risk factors. Some risks, such as carcinogenicity, could cause an R&D project to be terminated. On the other hand, other risk factors such as in vivo efficacy, although influencing the target profile, do not necessarily have to result in termination of development.[163]

One decision tree-based approach which takes into account the probability of success is the "risk-adjusted Net Present Value approach" (rNPV). Based on the approach of Stewart et al., Kaufmann and Ridder calculate the rNPV,[164] taking into account the costs, risks and time, to obtain a realistic value of an R&D project.[165]

To measure the future financial surpluses with decision alternatives, the cash flows are discounted by a suitable interest rate to a key date, in a fashion similar to the DCF approach. A discount factor that is expected for biotechnology companies is assumed. The period-specific cash flows are weighted with the associated probabilities of success and probabilities of occurrence, with the R&D risks also considered. The cash flows for all the other periods, which grow at a constant rate of growth (g), are included in the remaining part of the rNPV calculation.[166]

[160] Bussey, P. et al. (2005), p. 207.

[161] The study of the effect of drugs on the organism or of the way drugs act on corresponding receptors and their action qualities.

[162] Study of the effect of the organism on the drug, of processes such as absorption, dissemination, protein binding and excretion, which determine changes in the concentration of the drug over time.

[163] Bussey, P. et a. (2005), p. 214.

[164] For original formula, see Annex III.

[165] Stewart, J. J. et al. (2001), p. 816, see also Kaufmann, L. and Ridder, Ch. (2003), p. 452.

[166] Stewart, J. J. et al. (2003), p. 817, see also Kaufmann, L. and Ridder, Ch. (2003), p. 452.

The use of the rNPV can lead to a reasonable value for an R&D project. This clear approach to valuation can support the company in its search for an investor (financing) even at the early stages of research.[167]

$$\text{rNPV} = \sum_{t=0}^{n} \frac{CF_t R_0}{(1+r)^t R_t} + \frac{R_0 CF_{n+1}}{(r-g)(1+r)^n} \tag{3}$$

rNPV = risk-adjusted Net Present Value
CF_t = cash flow in period t
R_0 = the present probability of successfully concluding the development process and as a result of making sales,
R_t = the probability as considered in period t of successfully taking the product to market maturity ($p_{t,8}$ with t>1)
R_0 / R_t = the probability as considered today of generating the cash flows arising in period t, i.e. of reaching period t or attaining this stage of development (corresponds to $p_{1,k}$)
r = discount factor
n = the last period for which costs and revenue are accurately planned
g = growth rate

Formula 5 Risk-adjusted net present value (rNPV) [Source: based on Kaufmann, L. and Ridder, Ch. (2003), p. 448.]

Several criticisms have been levied at rNPV. Stuart et al. do not consider the various cash flows in the product life cycle of an R&D project, which would require the deduction of specific expected value. On the other hand, they use average weightings for the probabilities of success rather than company-specific ones. Again, it would also be possible under a "traditional" DCF approach to modify the cash flows to take into account the probability of success. Consequently, according to Kaufmann and Ridder, the NPV approach would not lead to a more accurate valuation of a company that performed a lot of research than a correctly applied DCF approach.[168]

In order to take into account the specific features of a prospective pharmaceutical company, it might be helpful to amplify the rNPV approach. To this end, the authors Kellogg and Charnes developed the Expected Net Present Value approach (eNPV),[169] which distinguishes between two different cash flows and discount factors. The research and development phase is distinguished from the actual market phase by using a "Discovery Cash Flow" as opposed to a "Commercialisation Cash

[167] Stewart, J. J. et al. (2003), p. 817.

[168] Kaufmann, L. and Ridder, Ch.(2003), p. 448.

[169] Bussey et al. also recommend calculating an eNPV for pharmaceutical projects. Under this approach, the eNPV represents a present average value of the drug over different possible outcomes (see Bussey, P. et al. (2005), p. 208).

Flow". The Discovery Cash Flow stands for the cash flows of the development process that are discounted by a discount factor. If the drug is still under development, this expected value must also be weighted with the relevant probability of occurrence. The Commercialisation Cash Flow stands for the cash flows which occur after marketing of the drug. This is discounted at a rate of interest that is greater than the discount rate for the Discovery Cash Flow.[170] It is also weighted with a probability of occurrence and additionally with a quality factor.[171,172]

The fundamental problem in applying the traditional NPV approach (as also the rNPV and eNPV) lies in the use of average probabilities of success and probabilities of occurrence.[173] The probability of developing a product to the point where it can be launched on the market is much higher when one has a financially strong teaming partner, and this should therefore be considered.[174] It is therefore essential that the probability of success in the development process is modified.

Treatment of Intangible Assets

In order to include not only the probability of failure in pharmaceutical R&D projects but also qualitative information regarding their influence on the valuation, Kaufmann and Ridder developed an Individual Risk-adjusted Net Present Value approach. This approach enables one to take into account the intangible resources of the company, such as human capital, cooperative agreements and patents, as they play a critical role in determining the success of pharmaceutical projects. It also amplifies the rNPV by differentiating between the development phases and the actual market phases.[175]

Compared with the rNPV approach, two additional factors are included. Firstly, the period under consideration is broken down into Phases A, B and C. Phase A covers the entire development period, during which only expenditure[176] arises. Phase B corresponds to the period between the start of production of the product and the end of patent protection. However, only part of the period of patent protection of 20 years is used, as the active ingredient is actually patented during the preclinical development phase so that effective[177] patent protection is limited to 11–12 years. For this Phase B the cash flows are explicitly stated. The third element, referred to

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[170] When it comes to estimating the discount factor, Kellogg & Charnes rely on studies by Myers and Howe (1997), A Life-Cycle Financial Model of Pharmaceutical R&D, Program on the Pharmaceutical Industry, quoted in Kaufmann, L. and Ridder, Ch. (2003), p. 453.

[171] However, in the description of the eNPV approach of Kellogg and Charnes (2000) no details are provided as to how the quality factor should be calculated.

[172] Kellogg and Charnes (2000) quoted in Kaufmann, L. and Ridder, Ch. (2003), pp. 452–453.

[173] Kaufmann, L. and Ridder, Ch.(2003), p. 453.

[174] Arnold, K. et al. (2002), p. 1088.

[175] Kaufmann, L. and Ridder, Ch.(2003), p. 448.

[176] This phase deliberately ignores incoming payments prior to production of the product from possible licensing agreements.

[177] Effective patent protection is taken here to mean patent protection following market launch of the medication.

as Phase C, contains all the other payment flows following the expiry of patent protection. The cash flows for this phase are not planned in detail, but a constant cash flow or a cash flow that changes at a constant rate is used.[178]

The second addition relates to modification of the probability of success as a function of the existence of specific value drivers. This is supposed to take account of the strong influence of intangible resources on the probability of success in the development process. Collaborations or links with research networks are considered in the valuation, depending on their form. Instead of adjusting the amount of the cash flows, the probabilities of success in the development process are adjusted instead.[179]

$$\text{IRA} - \text{NPV} = \underbrace{\sum_{t=0}^{n} \frac{E[CF_t]R_{0,\text{Adj}}}{(1+r)^t R_{t,\text{Adj}}}}_{\text{Phase A}} \underbrace{\sum_{t=n+1}^{m} \frac{E[CF_t]R_{0,\text{Adj}}}{(1+r)^t}}_{\text{Phase B}} + \underbrace{\frac{E[CF_{m+1}]R_{0,\text{Adj}}}{(r-g)(1+r)^m}}_{\text{Phase C}} \quad (5)$$

t = stage of development process
$E[CF_t]$ = expected value of the cash flow within a period t
$R_{0,\text{Adj}}$ = the probability as considered today of successfully concluding the development process and as a result of making sales
$R_{t,\text{Adj}}$ = the probability as considered in period t of successfully taking the product to market maturity
$E[CF_{m+1}]$ = expected cash flows (combined for the remaining value, not detailed for each period)
r = discount factor
n = the last period for which costs/disbursements and revenue/incoming payments are accurately planned
g = growth rate

Formula 6 Risk-adjusted net present value (rNPV) [Source: based on Kaufmann, L. and Ridder, Ch. (2003), p. 453.]

Although this approach does consider the individual phases of the medication, nevertheless there are major uncertainties associated with the forecast cash flows, especially in the second phase. This problem becomes even more acute in the third phase, when patent protection expires and competitors offer generic products.

Conclusions Regarding the Utility of the Decision Tree Model

The decision tree method models possible environmental conditions and optimum decisions. Once the decision tree has been created, it is possible to trace back the optimal decision path. As in the DCF method, the capital value can be calculated

[178] Kaufmann, L. and Ridder, Ch.(2003), p. 453.
[179] Kaufmann, L. and Ridder, Ch.(2003), p. 454.

in the decision tree analysis on the basis of basic assumptions. As well as giving a structure to the decision problem, this approach has the advantage of covering different scenarios. At the same time quantitative success variables (capital values) are presented and later decisions are represented. At the same time the dependence on the first decision and the follow-up decisions that have to be made over time become clear.

However, calculation of the probability of occurrence remains a critical factor as often this entails using average values or estimated values. Thus, for example, in all the NPV approaches apart from the IRA NPV approach, average probabilities of success are employed.[180] The IRA NPV approach avoids this weakness, enabling a project-specific valuation to be undertaken.

Aborting an R&D project is often not the active process that Stewart et al. and Kaufmann & Ridder make it out to be. Often the characteristics of the drug with its associated risks and side-effects determine whether the process has to be terminated or not. Experience suggests that even where the probability of success is low, some R&D projects are not terminated on the basis of a good gut feeling – many blockbuster drugs would otherwise not have been developed.

Another problem lies in calculation of the cost of capital. In principle a different discount rate has to be chosen for every decision point, as the decision "Abort" has a different risk from that of the initial investment. It follows that a loss of liquidity would increase the project risk, as a result of which the cost of capital rate would have to increase.[181] For the sake of simplification, in practice a constant rate of interest which reflects the average risk is assumed over the entire period.

4.4.2.4 Real Options

The weaknesses of the decision tree model as regards capturing the development stage-dependent discount rates could be avoided by using option price theory. The action options considered here are whether to postpone, terminate or increase an investment. Finally there needs to be the possibility of responding to changes in environmental conditions. "The greater the room for manoeuvre that is left open, ceteris paribus the more advantageous an investment object will appear".[182] On the basis of parallels with the room for manoeuvre from financial management, they are described as real options and assessed using an analogous valuation model. This model is called the option price model. It assumes a perfect and complete capital market, in which the payment profile of an option can be duplicated through a suitable mixture of underlying securities and risk-free securities (duplication portfolio). On the assumption that identical goods have the same market price (arbitrage freedom), the value of the option could be deduced from the observed prices of

[180] Kaufmann, L. and Ridder, Ch.(2003), p. 448.
[181] Perridon, L. and Steiner, M. (2003), p. 136.
[182] Perridon, L. and Steiner, M. (2003), p. 134.

other securities (corresponding to the value of the duplication portfolio). The preferences of the investors flow into the market price of the underlying securities. In an unfavourable market situation, a decision-maker would desist from investing. By excluding the risk of loss, a smaller allowance for risk is required than under unconditional implementation. To correctly value the investment prospect, period- and development stage-dependent discount rates that adequately reflect the risk are used.[183]

As in the decision tree model, the project course is considered not rigidly, but as a function of the environmental conditions that will exist later on. Going beyond the original drug development plan, additional opportunities often arise in the course of drug development which could be considered separately. Thus, the development of a new drug may be linked to a new manufacturing method which can be used on later projects.[184] This freedom of manoeuvre would also produce parallels with the above-mentioned options and could be considered in the option price model. However, it is beyond the scope of this contribution to go into the option price model in any more detail. The reader is therefore referred to the literature that considers in detail the subject of valuing R&D projects using real options.[185]

4.4.2.5 Valuation of Intangible Assets in Accordance with IDW ES 5

The next section is concerned with the financial valuation of intangible assets. On this subject, the Committee on Company Valuation and Business Economics of the German Institute of Auditors (IDW) recently (on 25 August 2006) approved a draft of the IDW audit standard, "Principles for the valuation of intangible assets" (IDW ES 5), which will now be examined to see whether it can be used here.

The IDW ES 5 valuation standard can be used in connection with both the acquisition and disposal of intangible assets. For the purposes of financially valuing these, the IDW proposes that one can proceed in a market price-oriented way, a cost-oriented way or a net present value-oriented way.[186]

Market Price-Oriented Method

The market price-oriented method uses either the market price on an active market or the analogy method for the purposes of valuation. The market price is obtained where sufficient comparable assets can be observed.[187] It is only possible to work out prices for comparable pharmaceutical R&D projects if comparable objects

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[183] Perridon, L. and Steiner, M. (2003), p. 134.

[184] Völker, R. (2001), p. 243.

[185] For a detailed account of R&D valuation using the option price model, see Amram, M. and Kulatilaka, N. (1999), p. 163 ff.

[186] IDW ES 5 (2006), text no. 17.

[187] IDW ES 5 (2006), text no. 18.

are available. Moreover, it is questionable whether the drug will be sufficiently successful to warrant conducting any marketing.

Cost-Oriented Method

The second proposed method, the cost-oriented method, draws its data from the past. The financial value is derived from the historical development costs (reproduction cost method) or the costs of developing an equivalent benefit (replacement method).[188] This valuation method is also unsuitable for a project still in the research phase, as high investment is unavoidable at this time. It is possible that it could be used for the purposes of validity testing or to work out the lower price boundaries of R&D projects in a later phase of the life cycle.

Net Present Value-Oriented Method

In the third method, the net present value-oriented method, it is assumed that the intangible asset will contribute towards the company's success in the future. The value of the asset is calculated from the sum of the discounted cash flows (cash values) of the cash flows achievable in the future at the valuation date.[189] Another four methods for performing an isolated valuation of the specific cash flow are available: the surplus profit and residual value methods, the method of direct cash flow forecasting and the method of licence price analogy.[190]

Surplus profit method. Under the surplus profit method, the predicted cash flows are compared with a fictitious object. Here it is assumed that the fictitious object does not possess this intangible value. The difference between the objects indicates the additional cash flow, which is discounted to the valuation day.[191]

Residual value method. Under the residual value method, fictitious amounts paid out for the intangible asset are considered as fictitious user fees. Here it is assumed that the intangible asset is hired or leased from a third party.[192]

Licence price analogy. It is only possible to value the intangible assets using an analogy of licence prices under the precondition that comparable intangible assets are licensed between expert, independent business partners who are prepared to enter into a contract. For the purposes of valuation, the cash flows which arise through licence fees are used. A price is worked out by comparing ownership of this asset with the alternative of licensing a comparison object of equivalent benefit. Fictitious licence payments that would be payable if the asset concerned were owned by a third party are calculated. The licence payments are calculated by using a licence price rate derived from the licence rates for comparable assets. The licence

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[188] IDW ES 5 (2006), text no. 47.
[189] IDW ES 5 (2006), text no. 21 ff.
[190] IDW ES 5 (2006), text no. 27 ff.
[191] IDW ES 5 (2006), text no. 32–35
[192] IDW ES 5 (2006), text no. 36–39

rate is multiplied by the planned sales revenue attributable to the intangible assets to be valued.[193]

Cash Flow forecast. The direct cash flow forecast method is in practice used for R&D projects that are in the development phase (see section 4.2.2, in which cash flow forecasts have already been examined in-depth).

Conclusion Regarding the Methods of the Valuation Standard

IDW ES 5 establishes the principle of asset-by-asset valuation. However, this approach cannot be used if several intangible assets constitute a single entity to be valued or it is not financially sensible to value the single asset on its own.

The methods are future-oriented and cover more than one planning period. The surplus profit method, the residual value method and the licence price analogy all involve comparisons. In the research pharmaceutical industry, however, analogies or comparison objects rarely exist in pharmaceutical patents, so that use is limited to just a few examples. It is possible that these methods might be useful in the market of generic drug suppliers, as in this case there are comparable pharmaceutical products on the market.

4.4.3 Valuation of Biotechnology Companies by Venture Capital Providers

Biotechnology companies and would-be pharmaceutical companies are often financed with equity capital. Since the investors are normally venture capital companies, the assessment criteria that they use to review investment alternatives will be considered more closely in this section.

Whereas large pharmaceutical companies are able to finance their R&D project from current sales, biotechnology companies and would-be pharmaceutical companies have to find alternatives to bank loans as a means of financing. One possibility is to enter into licensing arrangements in order to receive milestone payments and royalties.[194] Another possibility is to obtain funding from the government.[195] However, other financial forms of investment financing such as private equity financing are much more widely used. Here, equity capital is made available for a fixed period of time by either private individuals or institutional investors. This includes venture capital, which is the most common form of financing of biotechnology companies and biopharma.[196]

For venture capital providers, taking a stake in such a company may be lucrative for a variety of reasons. The reason for this is the developmental path of the product

[193] IDW ES 5 (2006), text no. p. 30f

[194] Bussey, P. et al. (2005), p. 194.

[195] BMBF (2005), p. 71.

[196] Ehrmann, H. (2005), p. 222 f.

which enables the venture capital provider to track the process relatively easily as it is clearly structured and characterised by sub-goals. The interim goals enable the venture capital provider to sell his stake in the remaining development cycle or to find additional financiers for the next phases. Moreover, the risk of a biotechnology company becoming insolvent is estimated to be relatively low,[197] since in the event of insolvency the substances and technologies produced represent a value which is retained on insolvency. Hence, it is more likely that the company will be taken over by a competitor before it becomes insolvent.[198]

To estimate the risks and obtain capital, the company value of a pharmaceutical company is calculated on the basis of its R&D projects. The valuation covers the breadth and depth of the development programme, which is determined on the basis of the number of drugs in the development pipeline and their indications. The closer the project is to launch on the market, the earlier it becomes relevant to the company value.[199]

The investors use several criteria to value the R&D project, of which the unique selling point of the product is the most important. Assuming that the R&D projects generate added value for the customer, the unique selling point is the reason for above-average growth and returns. Business ideas, patents, competitors, global market potential and the reputation of the licence partners are all very relevant here.[200]

Also very important to the investors are the criteria of market proximity and time to realisation. Accordingly, the further the drug is along the development process, the more money both licence partners and investors will be prepared to pay.[201]

Depending on the investment phase, the weighting of these criteria will differ slightly. The importance of criteria which convey the potential of a company, such as unique selling point, business idea and global market potential, declines the longer the company has been in existence. On the other hand, the importance of quantitative factors such as patent term and number of products increases.[202]

However, the investment decision is based not just on a valuation of the project but also on the potential of the management. The management criteria[203] are

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[197] On this point Scheibehenne's view requires closer examination and the reasons why biotechnology companies go bankrupt need to be considered.

[198] Scheibehenne et al. (2003), p. 668 ff.

[199] Rudolf, M. and Witt, P. (2002), p. 155.

[200] Scheibehenne, et al. (2003), p. 668 ff.; similar arguments are presented by Arnold, K. et al. (2002), p. 1086 – if the licensed partner is a large pharmaceutical company with a high reputation, then the pharmaceutical business benefits.

[201] Arnold, K. et al. (2002), p. 1086; see also Scheibehenne, et al. (2003), p. 668 ff.

[202] Scheibehenne et al. (2003), p. 668 ff.

[203] When assessing the management, the investors attach a lot of importance to the criteria of academic qualifications and whether the management appears united and confident. Academic qualifications can be inferred from the curriculum vitae, while personal qualifications are inferred on the basis of personal dealings with the management. Criteria such as age, willingness to take risks and internationality appear to be less important for the investors.

broken down into the two category dimensions of personality criteria and track record criteria. Both criteria are highly weighted, which indicates that the expertise available contributes significantly to the decision to invest in a given company in the biotechnology industry. Unusually, two additional criteria, "gut feeling" and the persuasiveness of the company's management, are also important to the venture capital transaction between management and investor. Here the motivation and preparedness of the management for project success are important to the investor.[204]

Finally, Scheibehenne et al. mention the socio-political, scientific and legislative developments in the investment country as the long-term growth potential of the company will depend on these.[205] Accordingly, the success of pharmaceutical company depends on the provisions of the licensing authorities and especially on the legislation.[206]

4.4.4 Summary

The discussion up to now has shown that many different methods exist for valuing R&D projects.

However, the analyses presented at the beginning which were based on key figures give only a limited insight for estimation of the value of a project undergoing research and development.

Since it is frequently the future expected earnings that determine the value of an R&D project, the investment appraisal method is normally used. This can be used as soon as the earnings can be allocated with respect to objectives and time and the amount and timing of payments can be estimated.[207] However, the relationship between the use of resources and the financial return flow is difficult to predict. As the life cycle of R&D projects is associated with many risks, it is a sensible approach to use a multi-stage growth model such as the decision tree model which considers different stages of growth and risk structures. This model also has its limitations, as often it resorts to average values when calculating the probability of success or the discount rates. One should also point out here that it is important to include in the valuation some consideration of intangible assets. Just a small difference compared to the competition, for example, in the application, can be sufficient to achieve a significant market share with a pharmaceutical product and as a consequence to realise considerable revenues.

[204] Scheibehenne et al. (2003), p. 668 ff.

[205] Scheibehenne, et al. (2003), p. 679

[206] The results of a written survey of industrial companies and R&D establishments (70 pharmaceutical companies and 43 R&D establishments assessed the market attractiveness and framework conditions of Germany) show that the health policy framework conditions in Germany are viewed as poorer than the general framework conditions (Nusser, M. and Tischendorf, A. (2005), p. 23).

[207] Specht, G. et al. (2002), p. 216.

The subdivision of probabilities into smaller areas makes it possible to give better answers to estimation questions which in some cases are quite difficult.[208] However, one needs to consider carefully whether this does not simply mean that a larger number of parameters is being considered, but that greater accuracy can be achieved. The data used must be determined with great care to avoid sources of error.

Traditionally, research projects are initially considered under a portfolio approach which captures the general potential of an R&D project. Portfolio analysis enables simple and clear project comparisons to be made by standardising individual projects. To support the implementation of the corporate strategy, the best investments in the portfolio are identified.[209] With the portfolio approach as an instrument of analysis, greater transparency can be created. Handling is very simple and an overall impression is gained quickly.

It is possible to find a compromise between the unambiguity of quantitative approaches and the situation orientation of qualitative valuation methods by combining the two methods and supplementing the qualitative market information with a quantitative decision tree model.

It is important for the valuation of projects to have a structured process in which all the projects under consideration are consistently valued using a single method. Here it is necessary to include in the valuation risk assessments, under which the probabilities of termination are established, development plans and commercial assessments. With the consistent application of valuation methods, it becomes possible to exclude subjective judgements of projects and the associated risk of termination, suspension or the failure of valuable project ideas or projects to materialise.[210]

With representative scenarios it is possible to cover a wide range of possible outcomes at different levels of development. Even if a precise financial valuation is not possible, it is important to obtain information about the value of the investment. Often an estimate in the form of a quantitative approximation will be sufficient as this enables comparisons to be made with other investments. It is recommended using a method that allows comparability to be established and thus to make rational investment and budget decisions.

4.5 Summary and Outlook

The legal reforms are aimed at making company management aware of possible risks and at getting them to take up opportunities aggressively, quantifiably and in a controlled manner.

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[208] Bussey, P. et al. (2005), p. 208.
[209] Bussey, P. et al. (2005), p. 195 f.
[210] Specht, G. et al. (2002), p. 215.

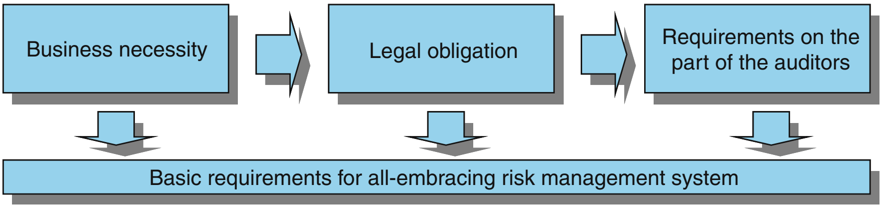

Fig. 4.9 Basic requirements for an all-embracing risk management system
[Source: based on Diederichs, M. (2004), p. 57.]

The legal regulations and provisions allow companies considerable freedom of manoeuvre.[211] This requires considerable efforts on the part of business science and auditors to create closed, business management concepts and standard, binding regulations for innovation profitability analysis.

In the end all the legal regulations and business recommendations demand that risk management should be a reproducible system for every company. All company activities should be explicitly incorporated into a risk process with an appropriate risk culture. Active awareness of risk can secure the viability and continuity of risk management.

[211] Diederichs, M. and Reichmann, T.(2003), p. 232.

Annex I: Addendum on the Risk Management Process

	Tools	Insights
Strategic levels	Scenario analysis	Likely environmental development
	PEST analysis	Extent to which the company is affected by external developments (political, economic, social and technological factors)
	SWOT analysis	Competitive position in central success factors compared with relevant competitors
	Gap analysis	Degree of target achievement and gaps on the basis of the present strength–weakness profile
	Portfolio analysis	Market attractiveness and relative competitive position of strategic business areas
Operative level	Cost accounting	Surplus/shortfall in cost centre budgets, marketability of internal business units (internal transfer prices)
	Cost estimation	Profit margin of services provided on the market
	Break-even analysis	Cost and profit margin structure, extent to which fixed costs are covered, break-even point, safety margin, critical values
	Standard costing	Extent of cost, employment and usage variance (quantity and price deviations), analysis of causes
	Process cost accounting	Marketability of internal service processes, degree of standardisation, need for reorganisation and/or outsourcing
	Key figure analysis / rating	Developments in financial situation (structure, turnover, modernity), finance situation (structure, asset cover, liquidity) and profit situation (structure, sources, profitability)
	Budget balance sheets	Development of balance sheet structure under hypothetical, entrepreneurial decisions
	Investment appraisal	Absolute and relative benefits of planned investments with reference to net present value, internal rate of return
	Financial and liquidity planning	Planned liquidity, receipts and payments structure, degree to which financial equilibrium is maintained, surplus/shortfall
	Cash flow statement	Amount and structure of the cash flow, extent of internal funding, ability to settle debts

Fig. 4.10 Controlling tools aimed at obtaining risk-relevant insights
[Source: based on Bert, U. (2005), p. 9.]

Annex II: Processing of Requests for Joint FDA-EMEA Voluntary Genomic Data Submission

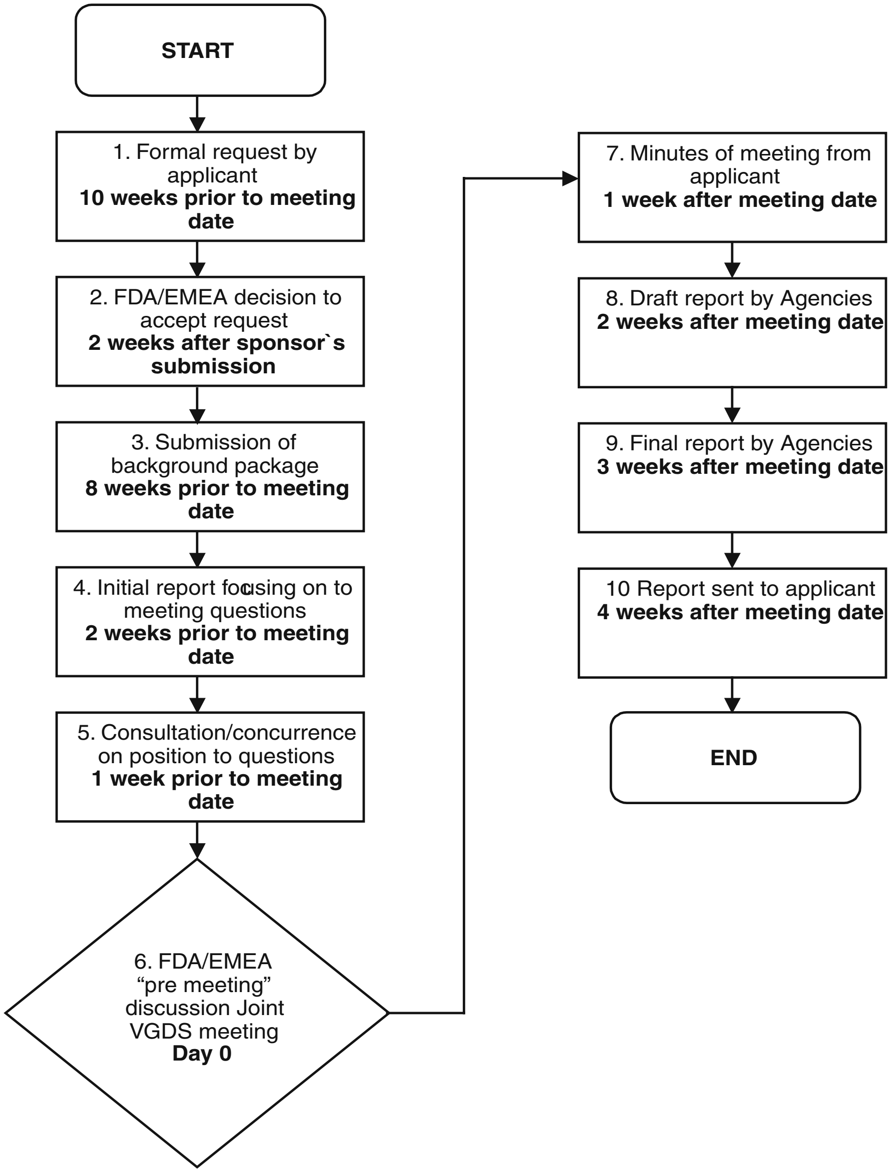

Fig. 4.11 Processing of requests for Joint FDA-EMEA voluntary genomic data submission http://www.emea.europa.eu/pdfs/general/direct/pr/FDAEMEA.pdf

Annex III: Decision Tree Model of Stewart et al.

Stewart et al. assume a “risk-adjusted Value” (rV). In their model, the development that entails a risk is considered by multiplying the payoff with a probability which reflects the successful conclusion of the development process and the generation of sales. The associated costs multiplied by the probability of successful conclusion of the development process are subtracted from this.[212]

$$rV = PR_0 - \sum_{i=0}^{n} C_i R_0 / R_i \tag{1}$$

rV = risk-adjusted Value
P = payoff
R_0 = current risk
C_i = associated costs
R_0/ R_i = the likelihood of having to pay each cost

Formula 7 Risk-adjusted value [Source: based on Stewart, J. J. et al. (2001), p. 815.]

The risk-adjusted NPV (rNPV) is accordingly calculated as follows:Formula 8

$$rV = PR_0 - \sum_{i=0}^{n} C_i R_0 / R_i \tag{2}$$

rNPV = is the NPV of the risk adjusted payoff minus the sum of the NPV of the risk-adjusted costs
NPVPR_0 = the NPV of the risk adjusted payoff
R_0 = current risk
NPV$C_i R_0/R_i$ = sum of NPV of the risk-adjusted costs

Formula 8 Risk-adjusted net present value [Source: based on Stewart, J. J. et al. (2001), p. 816.]

[212]Stewart, J. J. et al. (2003), p. 817.

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Part II
Innovation as Patent Evaluation and Accounting Problem

Chapter 5
Fundamental Principles in the Valuation of Intangible Assets, Taking the Valuation of Technologies Protected by Patents as an Example

Ulrich Moser and Heinz Goddar

5.1 Introduction

The valuation of intangible assets is playing an ever greater role in valuation practice nowadays. One of the main reasons for this are the fundamental changes that have occurred in important accounting standards, particularly those concerning the treatment of business combinations (especially IFRS 3) and the impairment of assets (especially IAS 36).

Intangible assets can be divided into various categories.[1] In this context – in addition to other assets, such as trade marks and the customer relationship – patented technologies in particular are also of great importance.

In this study, we shall be discussing both the theoretical principles involved in the valuation of patents and also the way in which they are implemented in a specific valuation case. First of all, we shall briefly consider some of the basic principles of valuation – independently of the valuation of patents – in so far as they are relevant for the purposes of this study (Section 5.2). This will be followed by an analysis of patents – or more precisely: of patented technologies – from the point of view of valuation (Section 5.3). Then those aspects of the income approach which are relevant to the valuation of patents will be discussed (Section 5.4), and their practical application explained by means of an illustrative example (Section 5.5).

The comments will not, however, be restricted *a priori* to a consideration of the valuation of patents for accounting purposes. The only special feature of that case is the fact that the valuation model is characterised by specific assumptions which are laid down by the Accounting Standards or their interpretation. This will only be discussed in passing in the study.

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[1] See, for example, IFRS 3 Illustrative examples A–E, SFAS 141 A. 14.

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5.2 Valuation Principles

5.2.1 Outline

A precondition for any valuation – in addition to a thorough understanding of the valuation methodology to be applied – is a clear and unambiguous delimitation of the object to be valued and a knowledge of the reason for the valuation. In the following, we shall present the aspects involved here in so far as they are relevant to the valuation of patents (Section 5.2.2–5.2.4).

5.2.2 Basic Valuation Approaches

5.2.2.1 Initial Considerations

The value of an object, e.g. a patent or even an entire company, is derived from the benefit which it brings its owner.[2] In order to measure this benefit, it is in principle possible to refer to three categories:

- the income which the asset to be valued is likely to generate in future
- the existing market prices for the object concerned or for comparable objects
- the cost of obtaining a comparable object.[3]

Accordingly, a distinction is made between three fundamental valuation approaches[4] (Fig. 5.1)[5]:

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[2] As one example among many, see *Smith/Parr*, Valuation of Intellectual Property and Intangible Assets, 3rd ed., New York, *inter alia*, 2000, pp. 152, 163 .

[3] See, for example, *Smith/Parr*, loc. cit. .(fn. 2), pp. 164 ff.

[4] The Real Options Aproach will not be considered in the context of this study. For more on this approach cf. *Copeland/Antikarov*, Real Options. A Practitioner`s Guide, New York 2001; *Mum*, Real Options Analysis, Hoboken/New Jersey 2002; Ernst/Moser, in: Ernst/Häcker/Moser/Auge-Dickhut (eds.), Praxis der Unternehmensbewertung und Akquisitionsfinanzierung. On the application of this approach in the valuation of patents or technologies, see in particular Khoury, Valuing Intangibles? Consider the Technology Factor Method, in: les Nouvelles 2001 pp. 87–90; Kidder/Mody, Are Patents Really Options, in: les Nouvelles 2003 pp. 190–192; Kossovsky/Arrow, TRRU Metrics: Measuring the Value and Risk of Intangible Assets, in: les Nouvelles 2002 pp. 139–142; Pries/Astebro/Obeidi, Economic Analysis of R & D Projects: Real Options vs. NPV Valuation Revisited, in: les Nouvelles 2003 pp. 184–186; *Razgaitis*, Valuation and Pricing of Technology-Based Intellectual Property, Hoboken/New Jersey 1999, pp. 223 ff.

[5] See, for example, *Smith/Parr*, loc. cit. (fn. 2), 163 f. In connection with the valuation of patents, cf. also Goddar, Die wirtschaftliche Bewertung gewerblicher Schutzrechte beim Erwerb technologieorientierter Unternehmen, in: Mitteilungen der deutschen Patentanwälte 1995 pp. 357–366. Khoury/Lukeman, Valuation Of BioPharm Intellectual Property: Focus On Research Tools And Platform Technology, in: les Nouvelles 2002 p. 50, and more recently Drews, Patent Valuation Techniques, in: les Nouvelles 2007 pp. 365 ff.

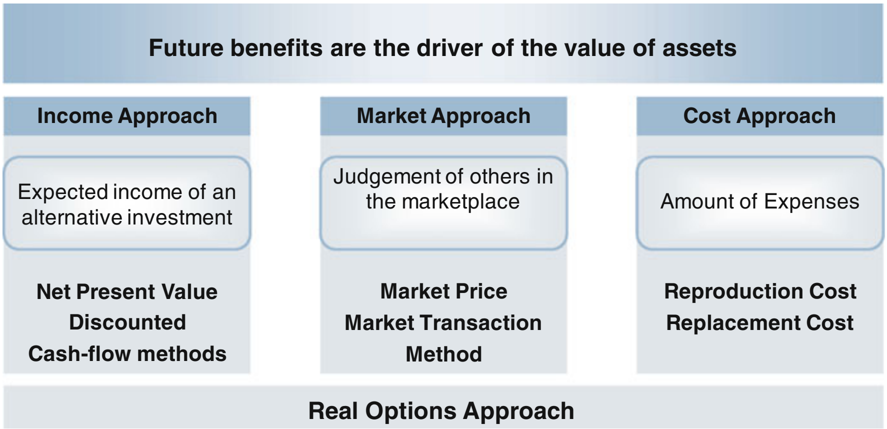

Fig. 5.1 Basic valuation concepts

- Income approach,
- Market approach or
- Cost approach.

In the practice of valuation, especially the valuation of intellectual assets, these approaches have taken on different forms. In this context, the "hybrid approaches" deserve particular emphasis since they combine elements of two of the basic valuation approaches, specifically the market and the income approaches.[6]

In addition, a number of articles can be found in the literature which claim to have developed further valuation methods in addition to the three basic concepts.[7] An analysis of these approaches, however, reveals that they are only adaptations of the basic concepts, especially of the income approach, and accordingly do not have any individual significance.[8]

In the following, the three basic valuation approaches will be explained briefly.

5.2.2.2 Income Approach

As already mentioned, the income approach takes as its point of departure the income which can probably be expected in future from the asset to be valued. In the case of a patent to which licences have been granted, for example, this is derived from the future royalty payments to its proprietor, and in the case of a company it is

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[6] Cf. Khoury/Daniele/Germeraad, Selection and Application of Intellectual Property Valuation Methods in Portfolio Management and Value Extraction, in: les Nouvelles 2001 p. 81.

[7] Examples are Anson/Martin, Accurate IP valuation in multiple environments, in: Intellectual Asset Management, February/March 2004 pp. 7–10; Poredda/Wildschütz, Patent Valuation – A Controlled Market Share Approach, in: les Nouvelles 2004 pp. 77–85.

[8] See also *Smith/Parr*, loc. cit. (fn. 2) pp. 163 f., Khoury/Daniele/Germeraad (fn. 6), p. 79.

the future dividends paid to the shareholders, or the payments to all investors. The point of departure for the valuation approach is therefore the ability of the asset to be valued to generate future income.[9] "Income" for the purposes of the income approach also includes savings of notional royalties which the patent proprietor would have to pay to a third party if the patent concerned, which is in fact exploited economically by the patent proprietor, were the property not of the patent proprietor, but of a third party. The value of the asset to be valued then corresponds to the amount that would have to be invested in order to obtain the alternative investment.

This comparison of alternatives is performed by discounting the future flows of income from the asset to be valued. In this case, the discount rate embodies the alternative investment. The resulting value of the asset to be valued can accordingly be defined as the present value of the future income payments that can be expected.

The valuation methods used in the income approach are the discounted cash flow methods.

5.2.2.3 Market Approach

The market approach,[10] which, according to IFRS 3 is to be preferred in the valuation of intangible assets, works on the premise that the valuation of an object should be based on an estimation of the benefits to the market participants. The approach is based on the idea that, in competitive markets – provided other conditions are met – market prices will develop as a matter of principle for the objects traded there.[11]

If the asset to be valued is itself traded on an active market,[12] its market price provide the most reliable estimate of the value of the asset. If this is not the case, comparable assets should be used as a guide, and their market prices transferred to the asset to be valued (guideline method).

When the guideline method is used, the first step is to calculate a multiple for the relationship between the market price of the comparable asset and a reference parameter. In order to determine the value of the asset to be valued, this multiple must then be applied to the reference parameter of the asset to be valued. In the case of the valuation of a patent for example, the known market price of a comparable patent can be based on the current annual sales (reference parameter) of the product protected by the comparable patent. Applying the multiple determined in this way to the current annual sales of the product protected by the patent to be valued leads to the patent value sought.

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[9] Cf. *Smith/Parr*, loc. cit. (fn. 2), pp. 164 ff..

[10] For one analysis of the market approach among many, see Moser/Auge-Dickhut, Unternehmensbewertung: Marktpreisabschätzungen mit Vergleichsverfahren, in: FB 2003 pp. 10 ff.; id., Unternehmensbewertung: Zusammenhang zwischen Vergleichs- und DCF-Verfahren, in: FB 2003 pp. 213 ff.

[11] Cf., for example, *Smith/Parr*, loc. cit. (fn. 2), pp. 170–173, *Reilly/Schweihs*, Valuing Intangible Assets, New York et al. 1998, pp. 101 f.

[12] For the strict requirements of an active market: e.g. IAS 38.8, *Smith/Parr*, loc. cit. (fn. 2), pp. 170–173.

When the asset to be valued is not traded on an active market but the market approach is still to be applied, it is necessary for there to be an asset available which is comparable to the asset to be valued and whose market price is known. If a comparable asset is not traded on an active market, comparable transactions must be referred to in order to calculate market prices. If corresponding transactions can be identified, a precise analysis is needed, especially of the detailed terms of the transactions and the circumstances under which they came about (e.g. changes in the market conditions that might have occurred in the meantime, influence of motives specific to that particular buyer).

In view of these preconditions for applying this method, it is immediately apparent that the scope of application of the market approach for valuing intellectual assets, especially patents, is very limited.[13]

5.2.2.4 Cost Approach

With the cost approach,[14] the value of the asset to be valued is determined by the amount needed in order to acquire an asset that enables the owner to obtain the benefit which the asset to be valued gives him. It is therefore the amount which the owner must spend in order to substitute the asset to be valued with an equivalent. The principle on which the approach is based is that of substitution.[15]

One consequence of the principle of substitution is that the cost approach establishes an upper limit for the value: an investor acting rationally will pay no more for an asset – even if its value would be higher when adopting the income approach – than the amount which he would have to spend in order to acquire another object from which he could obtain the corresponding benefit.

The cost approach exists in various forms:

One basic form proceeds from the identical reproduction of the asset to be valued – an "exact duplicate", which is the reproduction cost. The other main variant is based on the procurement or production of an object with an equivalent benefit; this is the replacement cost.[16]

Unlike the reproduction cost, the replacement cost disregards elements which the asset to be valued possesses but which do not provide any benefit at the time of the valuation. The converse applies to technological advances, which are only reflected in the replacement cost. The asset on which the calculation of the replacement cost is based can accordingly differ significantly from the asset to be valued.

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[13] See also Khoury (fn. 4) p. 88, Khoury/Daniele/Germeraad (fn. 6) pp. 77–86, *Woodward*, in: Wild (ed.), Building and enforcing intellectual property value. An international guide for the boardroom 2003, London 2002, pp. 49 f.

[14] For details on the cost approach, see *Smith/Parr*, loc. cit. (fn. 2), esp. pp. 197 ff., *Reilly/Schweihs*, loc. cit. (fn. 11), esp. pp. 118 ff.

[15] On this and the following, cf., for example, *Reilly/Schweihs*, loc. cit. (fn. 11), pp. 96 f., *Smith/Parr*, loc. cit. (fn. 2), p. 164.

[16] The historical costs incurred in procuring or producing the asset to be valued are not taken into account separately in the cost approach.

When calculating the value according to the cost approach, it may be necessary, where appropriate, also to take physical deterioration and technical and economic obsolescence into account.

The scope of application of the cost approach is, however, limited, because the fact that costs have been incurred in producing an object does not necessarily make it possible to draw conclusions about any future benefit that may result from it. One can think of the development of new technologies, for example, in which vast amounts may be invested, but whose benefit may be very minor in a specific case.[17] The cost approach is used above all if – as has already been explained – it establishes the upper limit of the value.

The cost approach also includes the asset-based approach.

5.2.2.5 Dependencies Between Income, Market and Cost Approaches

The income and cost approaches are based on the amount needed in order to obtain an asset that provides the same benefit. With the income approach, the measurement of this benefit is specified by the income associated with the asset to be valued. The connection with the market approach exists whenever market prices are referrd to in order to calculate the "costs".

5.2.3 Asset to Be Valued

The asset to be valued may consist of individual assets, e.g. machines, patents or trademarks, but also entities, e.g. patent portfolios or entire enterprises (Fig. 5.2). In this study, the asset to be valued is already defined by the subject. There is therefore no need to consider other assets to be valued.[18]

However, one reason why it is crucial to delimit the asset to be valued is that this defines some essential parameters of the valuation approach[19]: applying the income approach it establishes the future income which is taken into account in the net present value calculation. The market approach presupposes that there is at least an asset available which is comparable to the asset to be valued. That is why the nature of the asset to be valued is decisive when choosing the comparable asset. With the cost approach, the asset to be produced or replaced is orientated towards the asset to be valued.

In the valuation process – especially in the case of individual assets – any possible dependencies between the asset to be valued and other objects must also be taken into consideration. In particular, it is necessary to take account of the fact that the asset to be valued may be part of a larger entity, e.g. a patent in a patent portfolio, and the latter must be allocated to an enterprise. This becomes very clear with the

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[17] Cf. Khoury/Daniele/Germeraad (fn. 6) p. 80; Khoury (fn. 4) p. 88; Woodward (fn. 13) p. 50.

[18] For the different types of intellectual property, see Goddar (fn. 5) pp. 357–360.

[19] Similarly also *Smith/Parr*, loc. cit. (fn. 2), pp. 155.

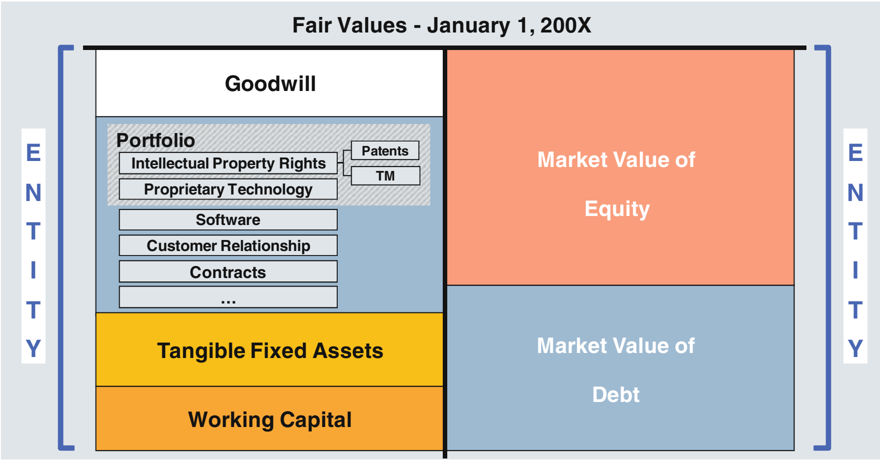

Fig. 5.2 Assets to be valued

income approach, for example: all the assets listed in Fig. 5.2 interact to earn the income of the enterprise or business unit.That is, an individual asset is typically not capable of generating income without the assistance of other assets. If – in a simple example – a patent protects major components of a product, income generation will in particular require the production and sale of the product; in most cases, for example, manufacturing facilities, a work force with the appropriate level of skills, working capital, a corresponding sales force etc. will be required. In order to value an individual asset, i.e. the patent in this example, its contribution to the total income of the entity must be isolated, or carved out.[20]

5.2.4 Reason for the Valuation

5.2.4.1 Transaction-Based Valuations

Valuations of patents are often connected with transactions. These transactions may involve entire enterprises, individual assets (i.e. patents) and also a wide variety of bundles of different assets (e.g. patent or trademark portfolios). In addition, patent valuations are carried out in connection with financing transactions, such as when calculating the collateral value of a patent (Fig. 5.3).

Transactions can be carried out in a variety of ways, depending on the subject of the transaction and the underlying purpose. They may, for example, take the form of selling or purchasing the asset concerned, of entering strategic partnerships or taking

[20] See, for example, *Smith/Parr*, loc. cit. (fn. 2), pp. 55 ff., 333 ff.; Kidder/Mody (fn. 4), p. 190, and, for a fundamental consideration, *Sullivan/Edvinsson*, A Model for Managing Intellectual Capital, in: Parr/Sullivan (eds.), Technology Licensing. Corporate Strategies for Maximizing Value, New York, 1996, pp. 249 ff.

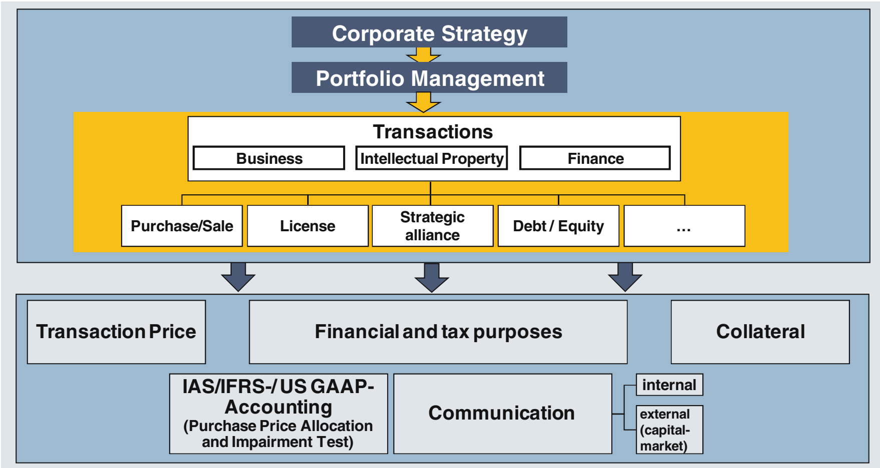

Fig. 5.3 Purpose of valuation

out or issuing licences to intellectual assets. Financing transactions encompass a wide variety of forms of equity and debt financing.

In the case of business and intellectual asset transactions, the purpose of the valuation can be to calculate maximum/minimum price limits for the buyer or vendor in preparation for the purchase price negotiations. In addition, in the case of business transactions, considerable importance must also be attached to the allocation of the purchase price to the individual assets acquired, for accounting purposes – purchase price allocation especially in accordance with IFRS 3 or SFAS 141.

Intellectual asset transactions are often also carried out by means of company law arrangements, such as in the form of capital contributions. In cases of this kind, there are various regulations which require that the value of the asset transfered should be assessed. Intellectual asset transactions in connection with restructuring for tax purposes usually have to be conducted on an arm's length basis. The assessment of this requirement is for its part based on the value of the asset transfered.

One example of financing transactions is when patents or trademarks are used as collateral in order to finance a loan. In such cases, the collateral value has to be calculated, which has already been referred to above.

5.2.4.2 Portfolio Management

The reasons for a valuation that have been described are bound up to a greater or lesser extent with the corporate strategy of an enterprise[21]: an enterprise's strategic planning will determine the composition of its strategic business unit portfolio,

[21] On the following, see also *Bea/Haas*, Strategisches Management, 2nd ed., Stuttgart 1997, pp. 154 ff.

the development of the individual strategic business units and the development and exploitation of the potentials for implementing the strategies. In this way, the technology strategy of an enterprise can, for example, be derived from the corporate strategy.[22] This may indicate, e.g. with regard to a particular necessary technology, that the technology should not be developed in the company, but should rather be procured externally by means of a transaction, such as by acquiring a patent portfolio protecting a technology, taking over another company, or entering into a strategic partnership.

Strategic planning in this sense is a complex form of portfolio management, which comprises the business unit portfolio and also the enterprise's asset portfolios, e.g. the patent portfolio. If the enterprise has adopted the principle of shareholder value management, the portfolio management is also based on value considerations. In this case, the valuation of patents is the appropiate tool for managing the patent portfolio.

In this context, attention should also be drawn to those cases in which patent valuations are performed for communications purposes. First of all, it is a question of describing value generation within the enterprise, such as by the research and development sector, for the benefit of the management, or by the management for the benefit of the supervisory board. Secondly, it is also a question of communicating the value generation to addressees outside the enterprise, especially to the capital market.

5.2.4.3 Impact of the Reason for the Valuation

The impact of the reason for conducting the valuation for the result of the valuation can be illustrated by referring to some simple examples.

The calculation of an upper price limit for a potential acquirer for forthcoming purchase price negotiations, taking into account his subjective assessment of the basic facts of the situation, can lead to values which deviate from the fair value that has to be calculated in the case of a business combination in accordance with the requirements of IFRS 3 and IAS 38. If that asset to be valued is contributed to an incorporated enterprise by way of a capital contribution according to German regulations, the debt coverage potential has to be established in the course of calculating the lasting value. The value calculated in this way can for its part deviate from the maximum price limit and from the fair value in the sense described.

A banking institution deciding on whether to grant a loan needs to know the collateral value of the asset provided as security. This covers the situation in which the borrower might no longer be able to fulfil his obligations, so that the asset provided

[22] For the connection between corporate strategy , research and development strategy and patent strategy, see Wijk, Measuring the Effectiveness of a Company's Patent Assets, in: les Nouvelles 2001, pp. 25–33. Some fundamental reflections on the subject can be found in Germeraad/Harrison/Lucas, IP Tactics In Support Of The Business Strategy, in: les Nouvelles 2003, pp. 120–127.

as security would therefore have to be realised. The break-up value of the asset to be valued can differ considerably from the going-concern value – especially as a function of the market situation prevailing at the time of realisation.

5.3 Patents as Assets to Be Valued

5.3.1 Outline

In order to value patents, it is first necessary to study the fundamental conditions which are responsible for patents' generating value (Section 5.3.2). It is clear in this context that it is necessary to distinguish between the IPR, on the one hand, and the technology on which it is based, on the other (Section 5.3.3). In addition, it is necessary to decide how to proceed when integrating patents in portfolios (Section 5.3.4).

5.3.2 Factors Influencing the Value of a Patent

5.3.2.1 Value Generation by Means of Patents

The relevant characteristics for valuing a patent are summed up in Fig. 5.4:

One precondition among others for the grant of a patent is an invention, i.e. the solution to a technical problem. The solution may find expression above all in a

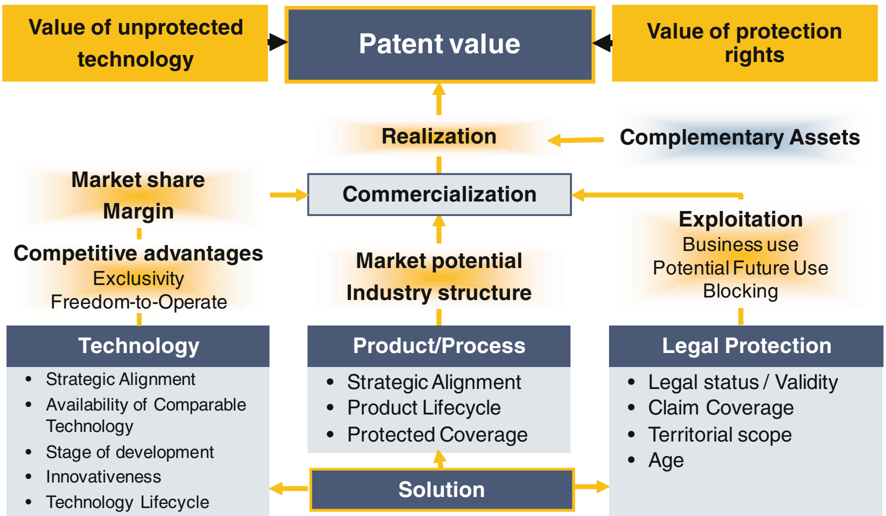

Fig. 5.4 Value drivers of patented technologies

product or a component of a product or in a process used in the manufacture of a product.[23] It has a technical element,[24] which becomes particularly clear above all in those cases in which it embodies a technology[25] or part of a technology. In order to simplify the following considerations, it will be assumed that the solution is a technology.

A technology can be exploited in particular by means of the products in which it is implemented, or which are manufactured on the basis of that technology. The success of the exploitation is determined principally by its attractiveness to the market, and especially its market potential (market volume and market growth), the structure of the industry concerned,[26] and the positioning of the products in comparison to those of the competition.

The technology can influence the positioning of the products in a variety of ways: it may, for example, enable its user to differentiate his product from the products of the competition and in this way to obtain higher prices from the customers in comparison to those of his competitors. The benefits of a technology may, however, also consist in the fact that its use leads to a reduction in the manufacturing costs, which enables the user of the technology to achieve higher sales by cutting prices, thus capturing market share from his competitors.

This illustrates the connection between an enterprise's technologies and competition strategies[27]: the benefit of a technology results in principle from the competitive advantage it procures for its user.

There is, however, no competitive advantage resulting from a technology if it is also possible for competitors to use the same technology. This is in principle the case whenever it is not possible to keep it secret, such as when anyone can gain an understanding of the technology by analysing the product. This is where the protective effect of the patent comes in: a patent is a monopoly right which enables the proprietor to prohibit third parties from using the patented invention.

A further precondition for exploiting a technology – as has already been stated under Section 5.2.3 – is its interaction with other assets.

[23] In order to simplify the terminology here, uses and business processes will be disregarded. It goes without saying that the comments also apply to claims of that kind.

[24] On this subject, see also the other conditions for grant, viz. novelty and the inventive step (PatG – German Patent Act sections 1 para. 1, 3 para. 1, 4) and their reference to the state of the art.

[25] For a definition of the term "technology", see, for example, Boer, The Valuation of Technology, Business and Financial Issues in R & D, New York 1999, pp. 4 ff.: "Technology is the application of knowledge to useful objectives. It is usually built on previous technology by adding new technology input or new scientific knowledge".

[26] See, for example, *Bea/Haas*, loc. cit. (fn. 21) pp. 79 ff.

[27] For competition strategies, see, for example, *Bea/Haas*, loc. cit. (fn. 21) pp. 167 ff.

5.3.2.2 Factors Enhancing the Value of Patents

Creating Legal Protection

Ways of Exploiting Patents

The legal protection created makes it possible to exploit a technology in a variety of ways, or it may favour particular ways. The first possible approach is to exploit it via the products in which the technology concerned is used, or on the basis of which they are produced. The points discussed so far are based on this idea.

This way of exploitation can also be performed by one or more third parties, especially by granting the third parties a licence to the protected technology.

Patents may, however, still benefit their proprietors, even if they do not actively influence an enterprise's production of goods and services and are not exploited in the manner described above. An enterprise may, for example, manufacture products on the basis of a patented technology. In addition, it may possess patents which protect a different technology, which could be used as an alternative basis for manufacturing the products, but which is not used by the enterprise for that purpose. Thanks to those patents, the enterprise is in a position to exclude potential competitors from manufacturing and marketing products of this kind, thus protecting its own sales. Patents which are only filed and renewed in order to prevent a competitor from exploiting the invention and in this way benefit the patent proprietor's own on-going or pending production are referred to as "blocking patents".

In connection with patented technologies which are intended for commercialisation in the near future, we may speak of "patents currently withheld from reduction to practice". These are defined as "patents for inventions which are not exploited or are not yet ready for exploitation at the time when the patent is granted, but which can be expected to be exploited or to be ready for exploitation at a later stage". If they merely relate to improving existing patents, they are referred to as "patents of improvement currently withheld from reduction to practice".

Legal Factors of Influence

Creating legal protection includes in particular the following parameters which are relevant to any valuation:

- Legal status (existence/maintenance of the patent application or the granted patent)
- Current status (status of the patent application in the grant procedure; granted patent subject of opposition or nullity proceedings, including status of the proceedings)
- Validity (legal validity of the patent in comparison to the state of the art)
- Scope of protection
- Exploitation of the patent dependent on third-party intellectual property rights (freedom to operate?)
- Territorial field of application

- Age of the patent (remaining term)
- Involvement in litigation (subject of infringement actions, parties suing or being sued under the patent? Status of the litigation?)
- Agreements with third parties relating to patents (licences granted or taken out? Toleration agreements? Non-aggression agreements?)

Technology

Benefit of Technologies

As just explained, protected technologies can procure a competitive advantage for an enterprise if they make it possible to differentiate its products over those of a competitor or if they lead to cost benefits over the competition. This can result in a more or less unique position for the user of the technology compared to his competitors (exclusiveness).

Protected technologies are not only important in the above-mentioned cases, in which they lead directly to competitive advantages. Patent protection can also be necessary in order to protect an enterprise's freedom for manoeuvre or to provide protection against the monopoly position of third parties (freedom to operate). When a company has patents of its own, they constitute an important – and in some cases the only accepted! – "currency" which can be used for cross-licensing purposes to pay for licences to third-party patents which are useful when putting the company's own technologies into practice.

Technology-Related Factors of Influence

The importance of a technology for an enterprise is determined by more than its benefit, i.e. whether it procures an exclusive position for its user or merely freedom to operate. It has already been explained under Section 5.2.4 that an enterprise's technological strategy can be derived from its corporate strategy. This may, for example, lead to define core fields of technology – linking up with the core competences of the enterprise. Technologies that can be classified among the core technology fields then take on an importance which is fundamentally different from that of mere "marginal technologies". The strategic relevance of a technology accordingly represents a basic driver of value.

Other important characteristics of technologies are their degree of innovation, the life cycle of the technology on which they are based, sometimes called as the innovation cycle, and their state of development. This latter aspect relates, *inter alia*, to the question of whether the technology is already in the commercialisation phase or whether that is still to come.[28] This gives rise to a whole series of very specific questions for the valuation of patents, which go beyond the scope of this study.

[28] The latter are also referred to as early-stage technologies, cf. *Smith/Parr*, loc. cit. (fn. 2), pp. 495 ff.

In the context with which we are concerned here, it merely has to be borne in mind that the life cycle (innovation cycle) of a technology constitutes an absolute limit on the possibilities of using it. If that comes to an end before the expiry of the remaining legal term of the patent, it determines the useful life of the patented technology, i.e. the fact that the legal term of the patent is longer then becomes irrelevant.

Product or Process

The importance of a product for an enterprise, and thus also the importance of the components or processes used for producing it, is determined by the corporate strategy – just like the importance of technologies (strategic relevance of the products). The key point here is the product/market strategy of the enterprise, "which proceeds from the question of what is to be offered (product) and to whom it is to be offered (market)".[29]

Other major factors influencing the value of a patent are

- the product life cycle and the
- protected coverage of product, i.e. share of the patent in the product or a component in the product.

Empirical studies have shown that the sales of products usually follow a typical curve, the product life cycle.[30] This is described by the introductory, growth, maturity and degeneration phases. The importance of this concept results above all from the awareness that products have a limited useful life. Rather like the technological life cycle, the product life cycle can limit the useful life of the patented technology. In principle, this is the case whenever the useful life of the product comes to an end before the remaining legal term of the patent. Unlike the technological life cycle, it must be borne in mind here that it might conceivably be possible to continue exploiting the patented technology by means of successor products or different products.

In the case of product patents, the technology on which they are based may cover the entire product or only a part of it. In other cases, the technology relates to one component of the product, which in turn relates to one part of the product, or merely to a part of the component. The importance of the share of a patent in the product or a component of a product becomes particularly clear in the case of licence agreements. In this case, it is frequently taken as the basis for calculating the royalty payments.

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[29] Bea/Hass (fn 21) 155.

[30] For the concept of the product life cycle, cf. *Bea/Haas*, loc. cit. (fn. 21), pp. 112 ff.

Determining the Useful Life of a Patent

The ideas presented so far have shown that the useful life of a patent depends on the remaining legal term of the patent, the technological life cycle (innovation cycle) and the product life cycles of all the products manufactured on the basis of or by means of the technology. It is interesting to note in this context that the remaining average duration of the period during which a patent is maintained can be a good criterion for determining its likely residual useful life at the time when the patent is valued.[31] According to the statistics which are regularly published by the German Patent and Trade Mark Office (DPMA) at the beginning of a year, the average period for which German patents are maintained is currently approx. 14 years.

5.3.3 Distinction Between a Patent and the Underlying Technology

As has been shown under Section 5.3.2, patents are characterised in particular by the underlying technology and the legal protective effect procured by it. This in principle gives rise to two different approaches on which the valuation can be based.

There are a number of articles expressing the opinion that the value of a patent results from the difference in the profit earned when patent protection exists and what would be earned if there were no patent protection.[32] This opinion, for which no reasoning is provided however, is thus directed towards the value of the legal protective effect of a patent.

Other articles,[33] though these likewise do not offer any reasons for their opinion, link the valuation of a patent – as in the case of valuing trade secrets – to the underlying technology; in other words, they treat that as the asset to be valued. Accordingly, they work on the basis of the income that can be attributed to the technology.

In order to clarify the question of which approach should be adopted, it is necessary to take the reason for the valuation into account. In the vast majority of cases, the various reasons for the valuation are concerned with determining transaction prices – even if they might only be hypothetical – in the sense of upper or lower price limits (limit prices) for purchasers or vendors.[34]

One consequence of disposing of a patented technology might, for example, be that the vendor will in future no longer be permitted to manufacture and market the products concerned. I.e. he is thus renouncing the future income associated with

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[31] On this complex of problems, cf. again Goddar (fn. 5).

[32] Examples are Pitkethly, The Valuation of Patents, A review of patent valuation methods with consideration of option based methods and the potential for further research, Oxford 1997, p. 2; Poredda/Wildschütz (fn. 7) p. 77.

[33] See, for example, *Reilly/Schweihs*, loc. cit. (fn. 11), pp. 434 ff., *Smith/Parr*, loc. cit. (fn. 2), pp. 215 ff.

[34] Cf. Section 5.2.4.1

manufacturing and marketing the products.[35] The only situation in which this does not cause the enterprise to impair its own wealth position – i.e. there is no reduction in the value of the enterprise – is if the selling price obtained at least matches this loss of future income (vendor's lower price limit).

Corresponding considerations apply when calculating the purchaser's upper price limit.

As a consequence any calculation of the lower price limit or the upper price limit for the sale or purchase of the patents concerned must be based on the underlying patented technology and not on the legal protective effect.

The value of the legal protective effect conferred by patents is the difference between the value of the patented technology and that of technology which is not protected. That value may be relevant if, for example, it is necessary to decide whether to patent a technology or to treat it as a trade secret.

The connection between the two approaches is thus clear (Fig. 5.5): the value of the patented technology is the value of the unprotected technology plus the value of the legal protection. This means that the two approaches produce the same result whenever either the technology or the legal protection does not have any intrinsic value of their own, i.e. the value of one of these components is zero.

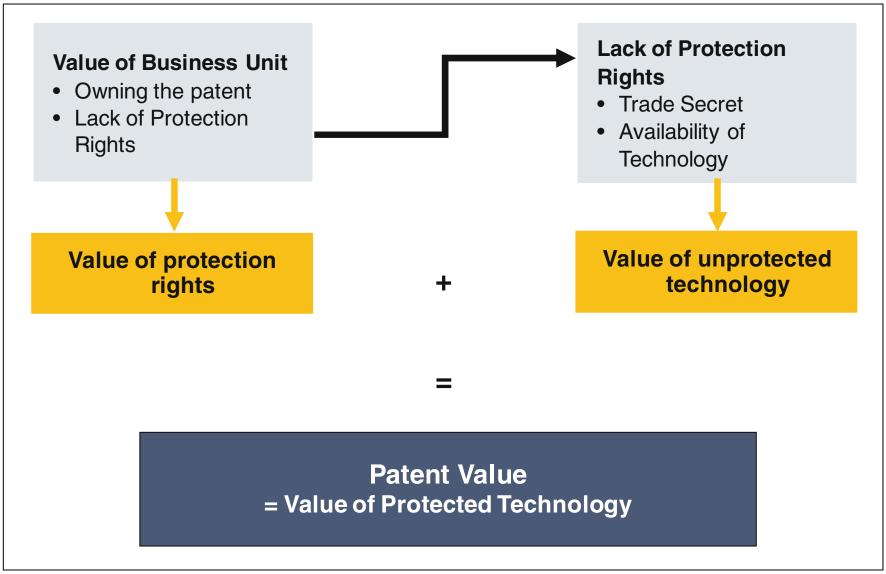

Fig. 5.5 Value of protected technology

[35] When calculating this future income, the consequential effects for other assets which are necessary in order to exploit the technology ("complementary business assets") also have to be taken into consideration.

5.3.4 Integration of Patents in Patent Portfolios

The comments under Sections 5.3.2 and 5.3.3 have already made it clear that often even simple technologies cannot be protected by a single patent, but rather require a patent portfolio – even if it is only a small one (Fig. 5.6).

For example, by manufacturing and marketing products on the basis of a technology which is protected by a basic patent and other patents relating to improvements and features, an enterprise obtains sales and income. The level of those sales and income may, however, also be dependent on blocking patents: "complementary protection" patents[36] prevent or restrict competitors from achieving sales and profits with competing products.

There are, however, also cases in which a single patent can protect a technology or a product. This can be seen in the pharmaceutical industry, for example, in the case of drugs.

In connection with delimiting the asset to be valued, it is accordingly usually necessary also to establish whether the individual patent, part of a portfolio or indeed the entire portfolio has to be valued. In order to answer this question, it is again necessary to refer to the reason for the valuation.

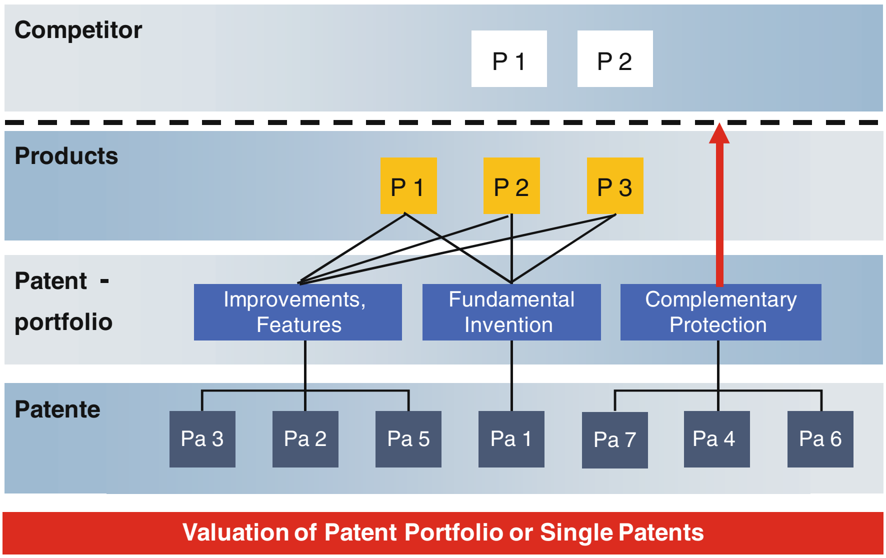

Fig. 5.6 Technology protection based on a patent portfolio

[36] *Sullivan/Daniele*, in: Parr/Sullivan (fn. 20), p. 35; cf. also section "Ways of Exploiting Patents".

5.4 Valuation of Patented Technologies on the Basis of the Income Approach

5.4.1 Outline

As already explained, the income approach bases its valuation on the income which the asset to be valued is likely to generate in future. If the asset to be valued is an individual asset, such as a patented technology, it should be borne in mind that the future income can usually only be obtained by means of its interaction with other assets, e.g. manufacturing facilities, working capital and a work force. Valuing an asset of this kind therefore regularly requires that its contribution to the total income of all the assets involved be determined.

In the following, we shall first analyse the contribution of the asset to be valued, i.e. in this case the patented technology, to the future total income from all the assets involved (Section 5.4.2). That will then provide the basis on which we shall provide a survey of the various valuation approaches, in the course of which we shall point out their key assumptions (Section 5.4.3). In order to determine the value of the asset to be valued, the future income derived from the asset to be valued, calculated in this way, has to be compared with an alternative investment possibility, which is reflected in the discount rate. The basis for the determination of the discount rate will then be described (Section 5.4.4). The calculation of the value is also influenced by tax considerations, which will be dealt with in Section 5.4.5.

5.4.2 Analysis of the Contribution of Patented Technologies to Income

Investigating the contribution of the patented technology to the income of the enterprise or business unit[37] to which it can be attributed first of all presupposes a very precise definition of income. The obvious answer here is to refer to the free cash flow.[38]

It has already been explained under Section 5.3.2.1 that the benefit of technologies for their users results in particular from the fact that they procure competitive advantages – in the form of differentiation advantages or cost advantages. In the following, we shall accordingly provide an exemplary illustration of the influence of differentiation or cost advantages associated with patented technologies on the elements of the free cash flow (Fig. 5.7).

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[37] To simplify the wording, we shall merely speak of business units in the following. The comments nevertheless also apply without restriction to entire enterprises.

[38] As is also suggested by *Smith/Parr*, loc. cit. (fn. 2), pp. 356 f., though they speak of the "debt free net income".

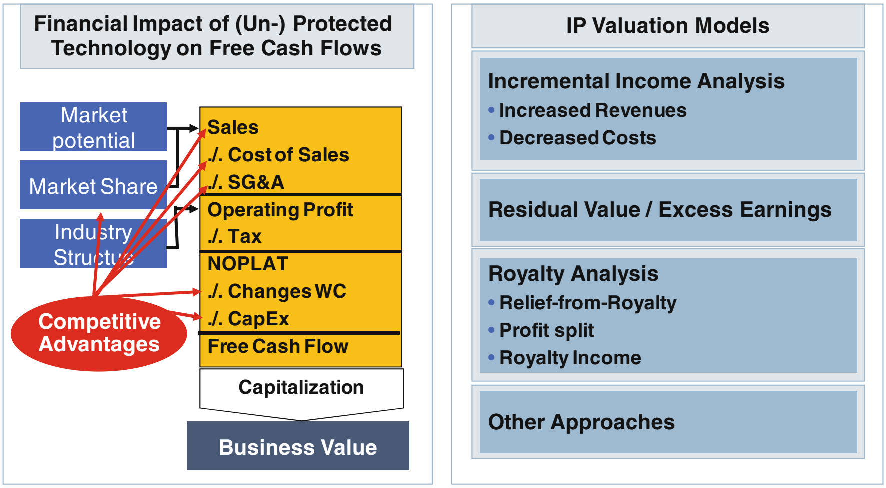

Fig. 5.7 Analysis of free cash flows of a business unit

A patented technology can lead to an increase in the revenues of the business unit concerned if, for example, it makes it possible to obtain higher sales prices and/or greater volumes.

Higher sales prices may be a consequence of differentiation advantages. One example is when price mark-ups in the pharmaceutical sector can be identified by comparing the prices of patented drugs with those of generic products. The same often also applies to products that possess features which appeal to users and which are not present in the competitors' products; this can be seen with cameras, for example.

One way in which an increase in the volume can be achieved is if a product with a differentiation advantage is offered at the same price as competitors' products. Technology-induced advantages which reduce the cost of sales may result in larger sales volumes, such as by passing on a lower price to the customers. If the margin per unit remains unchanged, there will be a proportional increase in the gross profit. Cost benefits of this kind are often involved where process patents are concerned, which lead to savings in material and/or manpower.

Increases in the free cash flow on the basis of patented technologies may also result from reductions in the selling general & administrative expenses (SG&A), the working capital required and the capital expenditure needed (CapEx). Reductions in the selling general & administrative expenses and the working capital are frequently achieved via improved business processes, which can be protected by business process patents. Value-enhancing effects in capital expenditure are not limited to reducing the amount required, but can also result from shifting expenditure to later fiscal years.

These influences of patented technologies on the free cash flow of the business unit concerned may also be accompanied by other effects on the elements of the free cash flow.

Additional features in a product, for example, will regularly lead to an increase in the cost of sales, which may also be reflected in an increase in the working capital[39] because of the higher manufacturing costs. It is conceivable that manufacturing the product with this additional feature might even require further capital expenditure. In addition, price mark-ups connected with the differentiation may also affect such aspects as the marketing expenditure and thus the selling general and administrative expenses, though this could take the form of an increase or equally well of a reduction.

Increases in volumes – to mention a further example – of course raise the cost of sales simply because of the need to manufacture the additional volumes. It will regularly be the case that additional quantities will also lead to additional stock and accounts receivable, resulting in an increase in the working capital. As far as the available capacities are concerned, it is conceivable both that economies of scale could be achieved, and that there could be a need for further capital expenditure.

5.4.3 Valuation Approaches for Patented Technologies on the Basis of the Income Approach

5.4.3.1 Incremental-Income Analysis

The incremental-income analysis[40] takes as its point of departure an analysis of the influence of the asset to be valued, i.e. in this case the patented technology, on the future free cash flow[41] of the business unit concerned, which has been discussed under Section 5.4.2. The value of the asset to be valued can be calculated – taking taxes into account – as the present value of the increases in the future free cash flow isolated in this way. Since this approach takes as its point of departure the changes in the free cash flow which can be attributed directly to the asset to be valued, the approach is also referred to as the "direct technique".[42]

A typical example of where this valuation approach is applied is the case of technologies which result in identifiable cost savings (cost savings approach[43]). In this context – as has just been explained (Section 5.4.2) – one might think in particular of process patents which make it possible to reduce the cost of materials and/or manpower costs.

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[39] An increase in the working capital may also come about as a result of higher levels of accounts receivable which may be a consequence of the higher prices involved in the differentiation.

[40] As is also discussed in *Reilly/Schweihs*, loc. cit. (fn. 11), pp. 159 ff. The terminology is not uniform in the literature. Some authors also speak of the incremental cash flow method or incremental revenue analysis.

[41] The decisive point is that income is understood in the sense of the free cash flow. Not clear in AICPA, Practice Aid Series: Assets Acquired in a Business Combination to Be Used in Research and Development Activities: A Focus on Software, Electronic Devices, and Pharmaceutical Industries, 2001, 2.1.10.

[42] In particular *Smith/Parr*, loc. cit. (fn. 2), pp. 215 ff.

[43] Cf. AICPA (fn. 41), 2.2.10; Woodward (fn. 15) p. 49; *Smith/Parr*, loc. cit. (fn. 2), p. 218.

However, because of the need to isolate the incremental income attributable to the asset to be valued, this approach has a limited scope of application. In some cases, such as products which, thanks to some special feature, can be sold for a higher price than the competitor's products, the price mark-up may possibly also be influenced by other assets of the business unit concerned, e.g. by a trade mark. Beyond this, it is in many cases simply impossible to make any statements about the influence of the technology to be valued on sales prices and/or volumes.

The reason for the limited scope of application is connected with the key assumption of the approach: the "incremental income" can only be isolated by considering the different components of the free cash flow determined by use of the patented technology to be valued, and comparing them with the components of free cash flow that would result without using the technology concerned. I.e. a comparable business unit is needed to reflect the situation that would exist if the business unit under consideration did not possess the technology to be valued. It is obvious that such a comparable asset is only available in exceptional cases.

As a consequence of the limited scope of application of the incremental-income approach, it is usually necessary, in order to value patented technologies, to have recourse to valuation approaches which can be subsumed under the "indirect techniques".[44] An outline of approaches of this kind is provided in Sections 5.4.3.2 and 5.4.3.3.

5.4.3.2 Residual-Value Approach

The residual-value approach[45] calculates the value of the asset to be valued by deducting from the entity value of the business unit concerned the values of all the other assets to be attributed to it. This means that if this approach is to be adopted, it is necessary both to determine the entity value of the business unit, and also to value the other assets which belong to it (Fig. 5.8). The residual-value method therefore entails all the valuation problems of all the other methods.

From the technical point of view, the usual procedure is to deduct from the income of the business unit concerned the contributions of all the assets to the income with the exception of the asset to be valued. The remaining "excess earnings" are regarded as being attributable to the asset to be valued. Its value can then be calculated – taking taxes into account – as its present value. For this reason, this approach is also referred to as the excess-earnings or multi-period excess-earnings method (Fig. 5.8).[46]

The approach is based on the fundamental idea that the business unit under review has the technology to be valued at its disposal and also uses it. It does not, however, need to own the other assets which are involved in generating the income. These may therefore be procured in some other way, e.g. by leasing.

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[44] Cf. *Smith/Parr*, loc. cit. (fn. 2), pp. 222 ff.

[45] Cf. Khoury/Daniele/Germeraad (fn. 6) pp. 82 ff.

[46] E.g. by AICPA (fn. 41), 2.1.10 and 16.

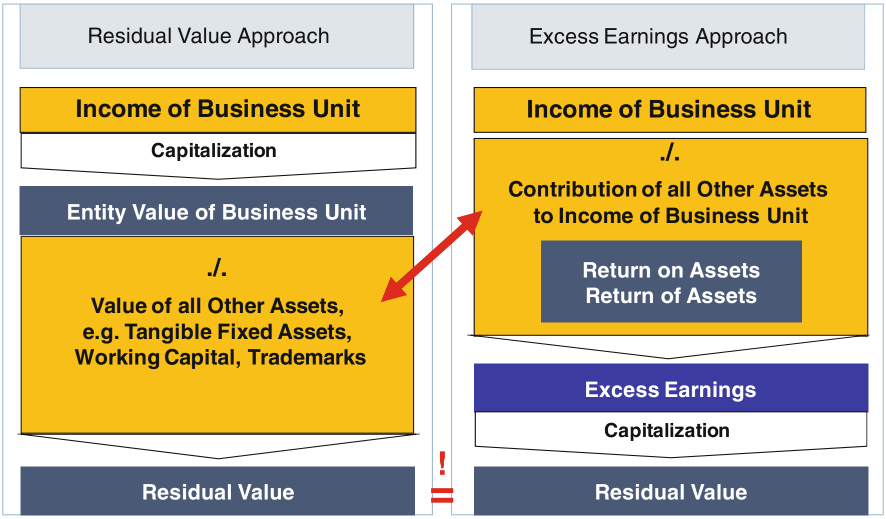

Fig. 5.8 Approaches to calculate residual value

The principal requirements for adopting this approach are as follows:

- It must be possible to provide reasons why the "excess earnings" should be attributed to the asset to be valued. This is usually assumed in cases in which the asset to be valued is the leading asset of the business unit concerned.
- All the other assets must be identifiable and susceptible to valuation. This means in particular that it must be possible to establish their contribution to the total income of the business unit.

A detailed discussion of the first requirement in particular would go beyond the scope of this study. We would merely point out that the residual-value approach tends to increase the risk of overvaluing the asset to be valued: first of all, possible synergy effects resulting from the interaction of all the assets in generating the income of the business unit are attributed in full to the asset valued under this approach. I.e. a major element of goodwill is assigned to the value of the asset to be valued.[47] Secondly, there are also cases in which not all the assets of the business unit can be identified and valued. Their value is then likewise reflected in that of the asset to be valued.

[47] For the allocation of this synergy effect to the goodwill, see *Reilly/Schweihs*, loc. cit. (fn. 11), pp. 381 f.; *Smith/Parr*, loc. cit. (fn. 2), pp. 24–27.

5.4.3.3 Royalty Analysis

Relief-from-Royalty Method

A further "indirect technique" for determining the value of patented technologies is the relief-from-royalty approach.[48] This is based on the idea that an enterprise which is the owner of the asset to be valued, i.e. the technology in this case,[49] does not need to acquire a licence to it from a third party. If it had to obtain a licence, it would have to pay royalties to the third party, whereas these are not incurred as things stand – because of the enterprise's position as the owner (so that the enterprise is "relieved" of them). The payments saved in this way are attributed as income to the asset to be valued; the value of the latter is consequently derived as its present value – taking taxes into account.[50]

If the royalty payments saved in the manner described are to be estimated, it presupposes that it is possible to calculate royalty rates. For this purpose, reference is made to licence agreements for assets which are comparable to the asset to be valued. The basis for the assessment of the royalty payments is usually calculated with reference to the projected financial information of the business unit concerned, though the terms of the comparable transactions must also be taken into account.

The approach works on the assumption that the business unit actually uses the technology to be valued but is not its proprietor. For this reason, the technology has to be procured elsewhere – by taking out a licence to it.

The principal conditions for using this approach are thus clear:

- One basic condition for calculating royalty rates from market transactions is the requirement that assets which are comparable to the asset to be valued are the subject of licence agreements at all.
- In order to assess the comparability of possible market transactions, to calculate the royalty rates and to define the basis for the assessment, it is additionally necessary to know the details of the agreements, especially the terms, underlying the transactions.

If the first condition mentioned is met, the scope of application of the relief-from-royalty method is usually relatively broad. In order to identify comparable transactions and to determine the contents of the agreements, not only the case law

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[48] Cf. *Smith/Parr*, loc. cit. (fn. 2), pp. 215 ff.

[49] The approach is also applied in particular in the valuation of trade marks.

[50] See, for example, *Anson/Suchy*, Intellectual Property Valuation. A Primer For Identifying and Determing Value, Chicago 2005, pp. 35 f.

and publications in text books[51] are important, but to an increasing extent also data base providers.[52]

Conceptually, the relief-from-royalty approach is an income approach. Because of the reference to market transactions, however, it is also influenced by the market approach. The relief-from-royalty approach is accordingly also described as a hybrid approach,[53] and in some cases even subsumed under the market approach.[54]

In this context, we must also consider the case of granting licences from the point of view of the licensor. He receives royalty income which is attributable to the asset. If that differs from what would result for comparable transactions, applying market terms, it is necessary to examine whether an advantageous or disadvantageous contract exists side by side with that asset.[55]

Profit-Split Analysis

Practical "rules of thumb"[56] are applied in a number of industries and attempt to divide up the income of a business unit under consideration between the licensee and licensor (profit split). The "25% rule"[57] is particularly worth mentioning here, which says that 25% of the income should go to the owner of the intellectual property, i.e. the licensor, and 75% to the producer, i.e. the licensee. The justification given is the distribution of risk between the two parties, according to which the producing enterprise should receive the lion's share of the income because of the investment risk assumed.

The 25% rule is applied in connection with mechanical engineering, for example. It is worth noting that in industries in which the 25% rule is generally applied, it can regularly be seen that royalty rates agreed in licence agreements, especially also licences based on turnover, are also guided by this rule.[58]

The profit-split analysis is accordingly very suitable for a direct calculation of royalty payments which play a role in the relief-from-royalty analysis. A more important application, however, is its use in establishing the plausibility of valuation

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[51] On this subject, see, for example, Hellebrand/Kaube, Leitsätze für technische Erfindungen, 2nd ed., Cologne et al. 2001; IPRA, Inc., Royalty Rates for Technology, 3rd ed.; id., Royalty Rates for Pharmaceuticals & Biotechnology, 5th ed.

[52] E.g. Royalty Source (www.royaltysource.com).

[53] As by Khoury/Daniele/Germeraad (fn. 6), p. 81; *Anson/Suchy*, loc. cit. (fn. 50), p. 35.

[54] Cf. *Reilly/Schweihs*, loc. cit. (fn. 11), pp. 441 f.

[55] Cf. also *Smith/Parr*, loc. cit. (fn. 2), p. 339.

[56] Critical comments on "rules of thumb" can be found in *Smith/Parr*, loc. cit. (fn. 2), pp. 366–368, who state: "Rules of thumb cannot be dismissed summarily, but their use must be viewed with caution ..."

[57] A detailed presentation of this rule can be found in Goldscheider/Jarosz/Mulhern, Use of the 25% Rule in Valuing IP, in: les Nouvelles 2002, pp. 123 ff.; criticism expressed by *Smith/Parr*, loc. cit. (fn. 2), pp. 366–368.

[58] *Smith/Parr*, loc. cit. (fn. 2), p. 366, speak of "self-fulfilling prophecies" in this context.

parameters and results, such as royalty rates, which are determined in accordance with the approach described under section “Relief-from-Royalty Method”.[59]

5.4.4 Discount Rate

5.4.4.1 Outline

In order to determine the value of the asset to be valued, it is then necessary to compare the future income attributed to it with an alternative investment. Technically, this is done by means of discounting.

This requires that an alternative investment which is comparable to the asset to be valued has to be defined. Particular attention should be paid to the fact that it should have a corresponding term and risk, i.e. the alternative investment should be equivalent to the asset to be valued as far as the term and the risk are concerned. The discount rate which satisfies this condition will be referred to in the following as the asset-specific rate of return.

When calculating the asset-specific rate of return, it is possible to take the cost of capital of the enterprise as the point of departure. It is, however, necessary to take the useful life of the asset to be valued into account when establishing the term (term equivalence) (Section 5.4.4.2). In addition, it has to be adapted in accordance with the asset-specific risk of the asset to be valued (risk equivalence) (Section 5.4.4.3). Finally, we shall briefly consider the practicality of this approach (Section 5.4.4.4).

5.4.4.2 Calculating the Term-Equivalent Cost of Capital

The weighted average cost of capital of an enterprise (abbreviated as WACC) is composed of the cost of equity (r_E) and the cost of debt (r_F), which are weighted according to their share of the entity value (Fig. 5.9). The entity value in this case is the sum of the market value of the equity (E) and the market value of the debt (D). In the case of the cost of debt, it is also necessary to take into account the possibility of setting it off as an expense for tax purposes by means of the tax shield (1–t).

The usual method of calculating the cost of equity is to apply the capital asset pricing model (CAPM). In this, the cost of equity is composed of the risk free rate (r_f) and a risk premium. The risk free rate here must be derived in a term-equivalent manner, i.e. in accordance with the useful life of the asset to be valued. The risk premium is determined by multiplying the market risk premium ($r_M - r_f$) by the β factor (Fig. 5.9).[60] When calculating the cost of debt, the term and risk equivalence must be taken into account appropriately.

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[59] It is presumably in this latter respect that *Smith/Parr*, loc. cit. (fn. 2), p. 368, also see its most important field of application.

[60] The β factor of a security i is defined as the covariance between the expected return on that security and that of the market portfolio divided by the variance of the return on the market portfolio.

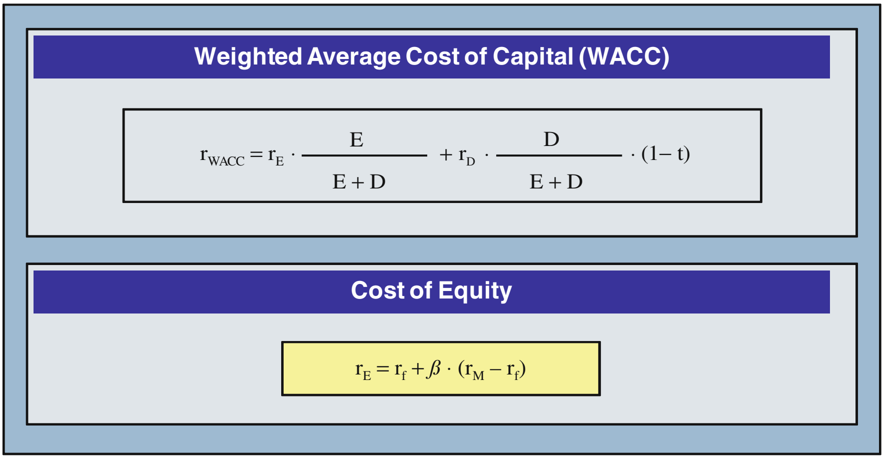

Fig. 5.9 Determination of cost of capital

The parameters of the cost of capital just described may be calculated from the point of view of the enterprise, where the asset to be valued contributes to achieving its total income in conjunction with other assets. They may, however, also be determined separately from it, with reference to comparable companies (peer group). The latter means, for example, that the weighting of the cost of equity and cost of debt is not determined by the share of the market value of the equity and the share of the market value of the debt in the entity value of the enterprise concerned, but is instead based on the capital structure of the peer group.

One argument in favour of applying the second approach is that when the asset to be valued is an individual asset, it can usually only generate income in collaboration with other assets, so that its value is accordingly part of the value of the unit earning the income. The valuations of the individual assets may thus be regarded as sub-calculations related to the value of the unit earning the income. The approach to be applied in defining the parameters of the cost of capital should, however, be determined in accordance with the context of the specific valuation case, especially bearing in mind the reason for the valuation.

5.4.4.3 Allowing for the Asset-Specific Risk

The risk inherent in assets can be measured by the volatility of the income associated with them.[61] In an enterprise or business unit, which should be regarded as a bundle of assets, those assets interact in order to create the total income of the entity. Each of these assets is characterised by the fact that the contribution to the total income

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[61] See Moser/Schieszl, Unternehmenswertanalysen auf der Basis von Simulationsrechnungen am Beispiel eines Biotech-Unternehmens, in: FB 2001 pp. 530–541.

attributable to it can possess its own individual volatility and thus its individual, i.e. asset-specific, risk.[62]

The development of a new technology can, for example, make an existing technology totally obsolete, but it might still be possible to put the existing machinery to good use, such as to manufacture the products based on the new technology. In this case, the contribution to the total income attributable to the technology may in some cases exhibit higher volatility and thus involve a higher asset-specific risk than the machinery.

The basic idea in calculating asset-specific adjustments is that the rate of return generated by the bundle of all assets should correspond to the rate of return demanded by all the investors in the enterprise. I.e. the weighted average rate of return on all assets should be equal to the weighted average cost of capital (Fig. 5.10).[63]

Figure 5.11 contains a very simplified example to illustrate this situation: the business unit under consideration uses a technology, tangible fixed assets, working capital and other, unspecified assets, which are reflected in the goodwill. The useful life of all the assets mentioned should be identical and amount to 10 years. The weighted average cost of capital was calculated at about 6.08% on the basis of a term of 10 years.

The asset-specific risk adjustments to the term-equivalent cost of capital (risk mark-ups or mark-downs) were determined iteratively in such a way that the following conditions were met[64]:

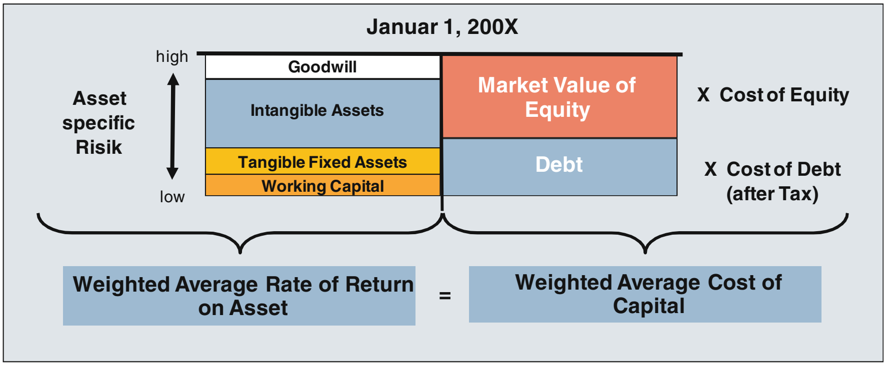

Fig. 5.10 Determination of asset specific rate of return

[62] For a fundamental consideration, see *Smith/Parr*, loc. cit. (fn. 2), pp. 227–236, 356–362, 558–562.

[63] See ibid.

[64] A description of how to determine the risk-specific interest rate and the problems involved will be provided in the context of the illustrative example (see section "Calculating the Asset-Specific Rate of Return").

Assumptions
- **Useful life of all assets** **10 years**
- **Weighted Average Cost of Capital** **6,08%**

Asset	Fair Value	Risk mark up/down	asset spec. rate return	weighted rate return
Goodwill	15	2,92%	9,00%	0,56%
Technology	50	2,42%	8,50%	1,77%
Tangible Assets	75	–0,08%	6,00%	1,88%
Working Capital	100	–1,58%	4,50%	1,88%
	240			6,08%

Fig. 5.11 Example – calculation of asset specific rate of return

- The asset-specific rate of return, which appears as the sum of the risk mark-up / mark-down and the term-equivalent cost of capital, expresses the different risks inherent in the individual assets in relation to one another. In the example, this means that the risk to the goodwill is greater than that to the technology, while risk to the technology is greater than that to the tangible fixed assets; and the working capital is subject to the least risk.
- The sum of the weighted asset-specific rates of return of the individual assets (weighted average rate of return on all assets) is equal to the weighted average cost of capital.

5.4.4.4 Practicality of Calculating the Asset-Specific Rate of Return

The comments so far have shown that calculating the asset-specific rate of return requires a valuation both of the entire business unit whose income is generated with the aid of the asset to be valued, and also of all the assets attributable to it. In those cases in which all these valuations have to be made in any case – such as when carrying out a purchase price allocation in accordance with IFRS 3 – this approach does not usually require any additional effort.

There are other cases, however, in which – in an extreme situation – only a single asset, such as a patent, has to be valued; here, calculating the asset-specific rate of return also requires that the entire business unit to which the asset to be valued is attributable must be valued, as must all the other assets belonging to it. As a result, the valuation of an individual asset would usually involve a relatively great amount of effort. In such cases, it is worth considering whether a lump-sum estimate of the asset-specific risk mark-up on the term-equivalent cost of capital is sufficient.

5.4.5 *Allowing for Taxation in the Valuation of Intangible Assets*

5.4.5.1 Relevant Issues for Tax Purposes

When intangible assets are valued according to the income approach, tax effects may be important in two ways:

- Inclusion of tax in the valuation calculation
- Allowing for the tax amortisation benefit

5.4.5.2 Inclusion of Tax in the Valuation Calculation

When the income approach is adopted in the valuation of assets – in the same way as with a business valuation – corporate taxes have to be taken into consideration. The income attributable to the asset to be valued accordingly has to be reduced by deducting corporate taxes on earnings. With the incremental-income and residual-value approach, this is immediately apparent. With the relief-from-royalty approach, the consideration of taxes results from the fact that the royalty payments saved are business expenses which can be set off against tax, and which reduce the licensee's corporate taxes. For this reason, when royalty payments are no longer applicable, this only reduces the royalty payments by their amount after deducting the corporate taxes. The need to take corporate taxes on earnings into consideration with regard to the discount rate depends on whether the latter is a pre-tax or after-tax parameter.

5.4.5.3 Tax Amortisation Benefit

When an intangible asset, such as a patent, is acquired separately, the purchaser is entitled, according to the tax laws of most countries, to spread the acquisition costs out over its useful life by means of amortisation with a tax effect. This results in a reduction in the annual tax burden incurred by applying the purchaser's tax rate to the annual amortisation amount. The tax amortisation benefit (TAB) is then the sum of the present values of those annual tax benefits.

From the point of view of the purchaser, it is necessary to calculate the maximum price he can pay for the acquisition of an asset without impairing his wealth position in comparison to refraining from making the acquisition (upper price limit). This means that the tax amortisation benefit must always be taken into account when calculating this amount, whenever the conditions for realising it are met.

When calculating the tax amortisation benefit, a circularity problem consequently occurs (Fig. 5.12): on the one hand, the upper price limit includes the tax amortisation benefit, but on the other hand, it also represents the basis on which that benefit is calculated. The resolution of this circularity problem is illustrated in Fig. 5.13.

Fig. 5.12 Tax amortisation benefit – basics

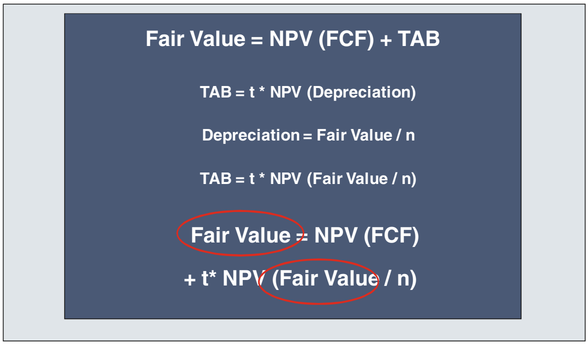

Fig. 5.13 Tax amortisation benefit – calculation

$$V = NPV + \sum_{t=1}^{n} \frac{V}{n} \cdot s \cdot q^{-t} \quad (1) \qquad V = NPV + s \cdot \frac{V}{n} \sum_{t=1}^{n} q^{-t} \quad (2)$$

$$\text{with} \quad \sum_{t=1}^{n} q^{-t} = \frac{q^n - 1}{q^n \cdot (q-1)} \quad (3) \qquad V = \frac{NPV}{1 - \frac{s}{n} \cdot \frac{q^n - 1}{q^n \cdot (q-1)}} \quad (4)$$

$$StepUp = \frac{1}{1 - \frac{s}{n} \cdot \frac{q^n - 1}{q^n \cdot (q-1)}}$$

Applying the tax amortisation benefit, especially taking it into account when calculating the fair value, involves a number of (unanswered) questions, which it is not possible to discuss within the scope of this study.

5.5 Illustrative Example

5.5.1 Outline

In the following, a simple numerical example will be provided to illustrate the basic principles involved in applying the different forms of the income approach described to the valuation of patented technologies. For this purpose, the comments will be based on various assumptions regarding the scope of application and importance of the asset to be valued and the availability of comparable technologies (Sections 5.5.3–5.5.5). Finally, the results obtained will be compared (Section 5.5.6). Before that, the initial data of the illustrative example will be summed up (Section 5.5.2)

5.5.2 Initial Data

Example Ltd. is the proprietor of a patented technology. It is used by the company itself in the Special Problems (SP) business unit. In the context of an extensive restructuring project, it is necessary to value the technology as of 1st January, 2007.

The product range of the SP business unit consists merely of a single product type, which is manufactured in a number of different variants. The patented technology to be valued is relevant for the production, or for the production and marketing of the entire product range of the SP business unit. On the basis of past experience, the management of the SP business unit believes that the technology has a remaining useful life of 8 years.

The technology is protected on the basis of a number of granted patents with remaining terms of 10–12 years.[65] According to current assessments, the resulting protection of the technology is judged to be high. The entire product range of the SP business unit can be protected effectively against any kind of imitation by competitors by deploying the patents. The assessment took particular account of the validity, the scope of protection and the territorial field of application.

Table 5.1 contains the profit & loss projections of the SP business unit. The business unit's tangible fixed assets and working capital were revaluated as of the valuation date. Their fair values are EUR 100,000 and EUR 75,000 respectively. The tax rate of the business unit is 40%. The weighted cost of capital of the SP business unit was calculated at 7.08% (Table 5.2).

In order to simplify the assessment, it was decided not to apply the midyear convention.[66] The results arrived at by applying it can be calculated by compounding the values derived in the following for 6 months by the discount rate applied in each case.

Table 5.1 Business plan of business unit SL

Mio. EUR		2007	2008	2009
Sales		360	389	404
Cost of sales		−241	−259	−270
Gross profit		119	130	134
SG&A		−61	−67	−68
EBIT		58	63	66
Tax	40%	−23	−25	−26
NOPLAT		35	38	39

65 This makes it possible to calculate the useful life of the asset to be valued: since the terms of the patents exceed the useful life of the technology, the latter determines their useful life. That is thus 8 years.

66 See *Reilly/Schweihs*, loc. cit. (fn. 11), p. 188.

Table 5.2 Calculation of WACC of business unit SL

						Weighting
Cost of equity				**9.40%**	**60%**	**5.64%**
Risk free rate (term equivalent)			4.00%			
Risk premium			5.40%			
Market risk premium		4.50%				
ß-Factor		1.2				
Cost of debt				**3.60%**	**40%**	**1.44%**
Cost of debt pre tax (term and risk equivalent)		6.00%				
Tax	40%	2.40%				
Weighted average cost of capital						**7.08%**

5.5.3 Incremental Income Analysis

5.5.3.1 Selecting the Valuation Method to Be Applied

In the following, it will be assumed that the patented technology to be valued is a process which results in a reduced materials usage per unit produced in manufacturing the SP business unit's products. Because of the positioning of the business unit's products compared to those of its competitors, the company sees no need to lower its prices in order to pass on to its customers the cost benefits achieved in this way. It assumes that this advantageous situation will not change in the remaining years during which this technology is used.

Under these conditions, the technology to be valued has no influence on the volume and price structure of the SP business unit. I.e. the number and price of the products manufactured and sold by the business unit when using the technology is not different from what could be achieved without using the technology. The only difference between these two constellations is consequently the level of the cost of materials and the margin per unit produced. This means that the conditions for isolating the contribution of the technology to be valued to the future income of the business unit under consideration, i.e. the incremental income, are met: the future annual cost savings result from the savings in the cost of materials per item and the number of products manufactured in the individual years of the remaining useful life of the technology.

On this basis, it is possible to establish the value of the patented technology according to the incremental-income analysis. It describes the present value of the future cost savings associated with it and also takes the tax effects into account.

In order to calculate the value of the asset to be valued (Section 5.5.3.5), the annual cost savings associated with it for its remaining useful life (Section 5.5.3.2), the asset-specific rate of return (Section 5.5.3.3) and – provided the conditions for applying it are met – the tax amortisation benefit (Section 5.5.3.4) have to be determined. In order to simplify the assessment, it will be assumed in the following that, in order to realise the cost savings, no additional capital expenditure will be needed. In addition, it will be assumed that it is possible to disregard influences on the working capital as being of minor significance.

5.5.3.2 Calculating the Future Cost Savings

An analysis of the influence of the technology to be valued on the materials usage for the various models in the product range of the business unit under consideration revealed that the materials savings per unit produced depends on the model. When calculating the savings in the cost of materials, it must also be borne in mind that materials of different qualities are used in the various models, with corresponding differences in the purchase prices. The annual cost savings are accordingly determined not only by the number of products manufactured in that period and the savings in the materials usage per unit which can be achieved in the process, but also by the product mix.

In order to simplify the approach when using the incremental-income analysis, Example Ltd. has calculated the improvement in its margin resulting from the savings in the cost of materials for each year of the projection period as a percentage of sales. For the time after the projection period until the end of the useful life of the technology, the management of the SP business unit assumes that the product mix of the last year of the plan will be representative of the entire period. The improvements in margins are summed up in Table 5.3.

Finally, calculating the annual savings in the cost of materials requires a projection of the sales until the end of the useful life of the asset to be valued. Because of the technology life cycle and the state of development of the relevant market, the company assumes that the revenues of the last year of the business plan can be extrapolated at the expected market growth rate of 2%. At the end of the useful life of the technology, its substitution by the successor technology must be taken into consideration – building on past experience. The sales projections derived in this way and the corresponding cost savings are shown in Table 5.3.

Table 5.3 Sales projections and improvement of margin

Mio. EUR	proj. 2007	proj. 2008	proj. 2009	2010	2011	2012	2013	2014
Sales	360	389	404	412	421	429	438	365
Growth rate	20.0%	8.0%	4.0%	2.0%	2.0%	2.0%	2.0%	−20.0%
Improvement of margin	3.5	3.8	4.1	4.2	4.3	4.4	4.5	3.7
as percentage of sales	0.98%	0.99%	1.02%	1.02%	1.02%	1.02%	1.02%	1.02%

5.5.3.3 Calculating the Asset-Specific Rate of Return

The point of departure in calculating the asset-specific rate of return is the term-equivalent weighted cost of capital of the SP business unit. This has to be adjusted by allowing for the asset-specific risk. The approach explained under Section 5.4.4.3 must in principle be adopted here.[67]

In those cases in which it is not possible to identify and value all the assets of the business unit under consideration – e.g. because of the effort involved – the only possibility left is an overall assessment of the asset-specific risk. For this reason, when valuing the patented process technology, an estimated mark-up of 2% for the asset-specific risk is added to the term-equivalent weighted cost of capital (7.08%). The asset-specific rate of return for the asset to be valued thus amounts to 9.08%.

5.5.3.4 Calculating the Tax Amortisation Benefits

The planned restructuring project at Example Ltd. will lead to a transfer of the asset to be valued with tax effect. The value of the patented technology which needs to be determined accordingly entails amortisation for tax purposes. The conditions for adopting the tax amortisation benefits approach thus apply.

The tax amortisation benefit can be calculated by applying the step-up factor from Fig. 5.13. Applying this to the present value of the income to be attributed to the asset to be valued leads to the value including the tax amortisation benefit. In order to calculate the tax amortisation benefit separately, it is therefore necessary to deduct the present value of the income from the entire value.

The application of the step-up factor from Fig. 5.13 for the SP business unit's patented technology to be valued is shown in Table 5.4.

5.5.3.5 Calculation of the Value of the Patented Technology

The value of the patented technology is arrived at by discounting the annual cost savings which result from using the process technology. Since these improvements in margins are in principle subject to the corporate taxes on earnings at Example Ltd., the additional tax burdens must be deducted. In line with the comments under Section 5.5.3.4, the tax amortisation benefit has to be added to the present value of the future cost savings. The calculation of the value of the patented technology can be seen in Table 5.5. It amounts to EUR 18.5 million.

[67] The approach is explained under section "Calculating the Asset-Specific Rate of Return".

Table 5.4 Calculation of tax amortization benefit

Depreciation method				straight line
Tax amortization period				8
Cost of capital				9.08%
Year	Month	Present value factor	Amortization factor	Present value amortization factor
1	12	0.9168	0.1250	0.1146
2	24	0.8404	0.1250	0.1051
3	36	0.7705	0.1250	0.0963
4	48	0.7063	0.1250	0.0883
5	60	0.6476	0.1250	0.0809
6	72	0.5936	0.1250	0.0742
7	84	0.5442	0.1250	0.0680
8	96	0.4989	0.1250	0.0624
9	108	0.4574	0.0000	0.0000
10	120	0.4193	0.0000	0.0000
11	132	0.3844	0.0000	0.0000
12	144	0.3524	0.0000	0.0000
13	156	0.3231	0.0000	0.0000
14	168	0.2962	0.0000	0.0000
15	180	0.2715	0.0000	0.0000
Total sum of present value amortization factors				0.6898
Total corporate tax rate				40.0%
Total tax savings percentage				0.2759
Converted into a step up (1/1-total tax savings %)				1.3811

Table 5.5 Valuation of patented technology applying incremental income method

Mio. EUR		Proj. 2007	Proj. 2008	Proj. 2009	2010	2011	2012	2013	2014
Sales		360	389	404	412	421	429	438	365
Incremental income		3.5	3.8	4.1	4.2	4.3	4.4	4.5	3.7
Tax	40%	−1.4	−1.5	−1.6	−1.7	−1.7	−1.8	−1.8	−1.5
Royalty savings after tax		2.1	2.3	2.5	2.5	2.6	2.6	2.7	2.2
Present value factor		0.9168	0.8404	0.7705	0.7063	0.6476	0.5936	0.5442	0.4989
Present value		1.9	1.9	1.9	1.8	1.7	1.6	1.5	1.1
Net present value		**13.4**							
TAB	1.3811	5.1							
Fair value		**18.5**							

5.5.4 Relief-from-Royalty Method

5.5.4.1 Selecting the Valuation Method to Be Applied

The following comments are based on the assumption that technologies which are in principle comparable to the one to be valued will typically be the subject of licensing transactions. This satisfies the basic requirement for applying the relief-from-royalty method.

The value of the patented technology to be valued can thus be defined – taking the tax effects into account – as the present value of the (notional) royalty payments which the enterprise saves because of its position as the proprietor of the asset to be valued. To calculate the value (Section 5.5.4.3), it is first necessary to determine the future royalty payments which have been saved. For this purpose, it is possible to refer to comparable transactions (see section "Calculating the Royalty Payments from Comparable Transactions") or to apply a profit-split factor (see section "Calculating the Royalty Payments by Means of the Profit Split"). The way in which the asset-specific rate of return and the step-up factor are established in order to calculate the tax amortisation benefit has already been described under Sections 5.5.3.3 and 5.5.3.4. At this point, the reader may be referred to those comments.

5.5.4.2 Calculating the Royalty Payments Saved

Calculating the Royalty Payments from Comparable Transactions

Royalty payments are usually determined by applying a royalty rate to an assessment basis, e.g. the revenues earned on the basis of the licensed technology. In addition, it is often the case that further payment components are agreed, such as up-front and milestone payments or minimum royalty agreements. In order to calculate the future royalty payments saved, the first step is to identify licensing transactions based on technologies which are comparable to the asset to be valued. Then the terms of the licence agreed in the comparable transactions must be applied to the situation applicable to the asset to be valued – for the years of the remaining useful life.

A research of data bases containing details of licence transactions has revealed that the licensing of patented technologies comparable to the asset to be valued is typically concluded on the basis of the following agreements: the assessment basis for the royalty payments are the sales, where the definition of sales used in the comparable transactions is the same as the delimitation of sales on which the projected financial information of the SP business unit of Example Ltd. is based. In the vast majority of cases, the royalty rate is approximately 4%. No importance should be attached to any other agreements that might be relevant to royalty payments.

In order to calculate the royalty payments saved in future, it is thus necessary to apply a royalty rate of 4% to the projected sales up to the end of the useful life of the technology to be valued. The projected sales of the SP business unit's products manufactured and sold on the basis of the asset to be valued have already been discussed in the context of the incremental-income analysis (Section 5.5.3.2) (Table 5.3). The savings of royalty payments calculated in this way are shown in Table 5.6.

Table 5.6 Valuation of patented technology applying relief-from-royalty method

Mio. EUR		Proj. 2007	Proj. 2008	Proj. 2009	LC 2010	LC 2011	LC 2012	LC 2013	LC 2014
Sales		360	389	404	412	421	429	438	365
Royalty payments									
Royalites based on sales	4%	14.4	15.6	16.2	16.5	16.8	17.2	17.5	14.6
Minimum royalties									
Maximum		14.4	15.6	16.2	16.5	16.8	17.2	17.5	14.6
Upfront payments		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Adjustment		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Royalty savings		14.4	15.6	16.2	16.5	16.8	17.2	17.5	14.6
Tax	40%	−5.8	−6.2	−6.5	−6.6	−6.7	−6.9	−7.0	−5.8
Royalty savings after tax		8.6	9.3	9.7	9.9	10.1	10.3	10.5	8.8
Present value factor		0.9168	0.8404	0.7705	0.7063	0.6476	0.5936	0.5442	0.4989
Present value		7.9	7.8	7.5	7.0	6.5	6.1	5.7	4.4
Net present value		**53.0**							
TAB	1.3811	20.2							
Fair value		**73.2**							

Calculating the Royalty Payments by Means of the Profit Split

Royalty payments are often determined by applying rules of thumb specific to the industry concerned, e.g. the 25% rule. Here, the profit which is earned with a contribution from the patented technology to be valued is split between the licensor and licensee in accordance with the respective rule. Before calculating the royalty payments saved in future, it is necessary to establish whether such a rule of thumb can be applied at all in the specific case. If it is to be applied, it is then necessary to establish how the profit to be distributed should be calculated (definition of profit), and to forecast it up to the expected end of the useful life of the asset to be valued.

An analysis of licensing in practice has revealed that it is customary in the industry to apply the 25% rule in order to determine the royalty rate for the patented technology to be valued. In the vast majority of cases, the earnings before interest and tax (EBIT) are taken as the definition of the profit.

In order to forecast the EBIT of the SP business unit, the first step was to analyze in detail the profit & loss statements and the corresponding balance sheets from the last three fiscal years, and also the profit & loss projections and balance sheet projections. It was found that for the projection period, the EBIT of the business unit's projections could be taken over without modification. In addition, it was established that the EBIT margin in the last year of the projection period was representative of the subsequent years of the remaining useful life of the asset to be valued. By applying it to the projected sales which were already derived in the incremental-income analysis (Section 5.5.3.2), it is possible to calculate the EBIT until the end of the useful life. The future royalty payments saved thus amount to 25% of the EBIT calculated in this way (Table 5.7).

Table 5.7 Valuation of patented technology applying profit split-method

Mio. EUR		Proj. 2007	Proj. 2008	Proj. 2009	2010	2011	2012	2013	2014
Sales		360	389	404	412	421	429	438	365
Cost of sales		−241	−259	−270					
Gross profit		119	130	134					
SG&A		−61	−67	−68					
EBIT		57.6	63.2	65.6	66.9	68.2	69.6	71.0	59.1
Profit split	25%	14.4	15.8	16.4	16.7	17.1	17.4	17.7	14.8
Tax	40%	−5.8	−6.3	−6.6	−6.7	−6.8	−7.0	−7.1	−5.9
Net cash flow		8.6	9.5	9.8	10.0	10.2	10.4	10.6	8.9
Discount factor		0.9168	0.8404	0.7705	0.7063	0.6476	0.5936	0.5442	0.4989
Present value		7.9	8.0	7.6	7.1	6.6	6.2	5.8	4.4
Net present value		**53.6**							
TAB	1.381063	20.4							
Fair value		**74.0**							

5.5.4.3 Calculation of the Value of the Patented Technology

The value of the patented technology is obtained by discounting the future royalty payments calculated under sections “Calculating the Royalty Payments from Comparable Transactions” or “Calculating the Royalty Payments by Means of the Profit Split” which are saved because of the SP business unit’s position as the proprietor of the asset to be valued. Since any royalty payments which Example Ltd. had to pay would in principle be deductible as business expenses when calculating the taxes on its earnings, the reduction effect is only the amount left after deducting the corporate taxes on royalty savings. In line with the comments under Section 5.5.3.4, it is also necessary to add the tax amortisation benefit to the present value of the future cost savings. The calculation of the value of the patented technology can be seen from Tables 5.6 and 5.7. When the royalty rate is calculated on the basis of licensing transactions, this results in a value of EUR 73.2 million, and when the profit split method is used, the figure is EUR 74.0 million.

In cases in which the use of a profit split is customary in the industry concerned, the occurrence of a (major) difference between the value calculated on the basis of licensing transactions and the one using the profit split should be seen as a reason for re-examining the values calculated. This is particularly true when the royalty rate is calculated from comparable transactions and when the relevant sales and profits have to be defined. Otherwise, if no (major) difference arises between the value calculated on the basis of licensing transactions and the one when using the profit split, as can be seen from Tables 5.6 and 5.7 in the illustrative example dealt with here, it quite simply means that the royalty rate of 4% observed on the market in accordance with section “Calculating the Royalty Payments from Comparable Transactions” does actually correspond to the 25% rule. If that is the case, then it is a straightforward matter of definition that identical values are obtained, when, on the one hand, the royalty payments saved are calculated on the basis of an observed royalty rate applied in comparable transactions (as in section “Calculating the Royalty Payments from Comparable Transactions”) and, on the other hand, the royalty payments are determined by means of the profit split (as in section “Calculating the Royalty Payments by Means of the Profit Split”).

In addition, it may be noted that the value resulting from section “Calculating the Royalty Payments from Comparable Transactions” corresponds to the value of the invention generally arrived at as a lump sum when calculating the remuneration for employee inventions in the form of lump-sum payments according to the Remuneration Guidelines for Employee Inventions, namely by applying the licence analogy.[68]

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[68] See Goddar (fn. 5).

5.5.5 Residual-Value Approach

5.5.5.1 Selecting the Valuation Method to Be Applied

The observations in the last part of the example are based on the assumption that the patented technology to be valued constitutes the leading asset of the SP business unit. All the business unit's other assets are merely regarded as supporting assets.[69] It is accordingly a logical step to apply the residual-value approach.

The residual value can either be calculated directly as the difference between the value of the business unit and the values of all the supporting assets (Section 5.5.5.2) or as the present value of the "excess earnings" (Section 5.5.5.3). Since the two approaches can lead to different results, it is finally necessary to analyse and interpret the reasons responsible for this (Section 5.5.5.4). In order to simplify the illustrations, it will be assumed in the following investigations that the SP business unit merely requires three assets – in addition to the technology to be valued, these are the working capital and the tangible fixed assets.[70]

5.5.5.2 Calculating the Residual Value Directly

Procedure

In view of the simplified assumptions of the example, there is no difficulty in calculating the residual value directly: in the first step, the value of the SP business unit has to be determined (see section "Calculating the Value of the SP Business Unit"). Then, all the other assets which, together with the asset to be valued, play a role in earning the income of the business unit concerned must be identified and valued. Since those assets and their values are already known, this step is not necessary for the illustrative example. Finally, the values of those supporting assets, i.e. in this case the fair values of the tangible fixed assets and of the working capital, must be deducted from the value of the SP business unit (see section "Calculating the Residual Value").

Calculating the Value of the SP Business Unit

The value of the business unit, which represents the point of departure for calculating the residual value, must include the values of all the associated assets. This must accordingly be understood as the entity value and not as the equity value, which is arrived at by deducting the value of the debt from the entity value (Fig. 5.2). Since the discounted cash flow method in the form of the WACC approach is aimed directly at determining the entity value, an obvious step is to use this approach in order to determine the value of the SP business unit.

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[69] In order to simplify the comments, these assets will be referred to in the following as "supporting assets".

[70] We shall therefore disregard the fact that, in addition to other intangible assets, it is usually also necessary to have a work force (cf. 2.3).

In the WACC approach, the free cash flow of the entity to be valued has to be discounted by the term-equivalent and risk-equivalent weighted average cost of capital. The free cash flow of the SP business unit for the period of the useful life of the technology to be valued has to be forecast and discounted by its weighted average cost of capital.

The free cash flow is obtained by deducting the following from the EBIT: corporate taxes on earnings, changes in the working capital and net capital expenditure, i.e. capital expenditure less depreciation and amortisation. The EBIT of the SP business unit for the remaining useful life of the asset to be valued has already been calculated in connection with the application of the profit split approach (see section "Calculating the Royalty Payments by Means of the Profit Split"). With the WACC approach, the corporate taxes have to be calculated on the basis of the EBIT, i.e. by applying the corporate tax rate applicable to the business unit – on the basis of the facts, this is 40% – to that figure. The changes in the working capital and the net capital expenditure, which appear here as a divestment, were projected separately by the management of the business unit up to the end of the useful life of the technology to be valued. The calculation of the free cash flow of the SP business unit is summed up in Table 5.8.

The term-equivalent and risk-equivalent weighted cost of capital of the SP business unit have already been calculated at 7.08% in the course of presenting the initial data of the example (Section 5.5.2).

On the basis of these data, an entity value of EUR 335.95 million results for the SP business unit (Table 5.8).

Table 5.8 Calculation of enterprise value of business unit SL

Mio. EUR			Proj. 2007	Proj. 2008	Proj. 2009	2010	2011	2012	2013	2014
Sales			360	389	404	412	421	429	438	365
Cost of sales			−241	−259	−270					
Gross profit			119	130	134					
SG&A			−61	−67	−68					
EBIT			57.6	63.2	65.6	66.9	68.2	69.6	71.0	59.1
Tax	40%		−23.0	−25.3	−26.2	−26.7	−27.3	−27.8	−28.4	−23.7
NOPLAT			34.6	37.9	39.3	40.1	40.9	41.7	42.6	35.5
Changes WC			−15.0	−5.3	−1.8	−1.9	−2.0	−2.0	−2.1	105.0
Net CapEx			11.0	1.0	13.0	1.0	15.0	15.0	15.0	29.0
Net cash flow			30.6	33.7	50.5	39.2	53.9	54.7	55.5	169.5
Discount factor		7.08%	0.9339	0.8721	0.8145	0.7606	0.7103	0.6634	0.6195	0.5785
Present value			28.5	29.4	41.2	29.8	38.3	36.3	34.4	98.1
Net present value			**335.95**							

Calculating the Residual Value

The value of the patented technology to be valued is arrived at – as already explained – by deducting the value of the tangible fixed assets (EUR 100 million) and the value of the working capital (EUR 75 million) from the value of the business unit as just established (EUR 335.95 million). Excluding the tax amortisation benefit, it amounts to EUR 160.95 million. If the tax amortisation benefit is calculated in accordance with the procedure described under Section 5.5.3.4, using the weighted average cost of capital of the SP business unit as the discount rate,[71] we arrive at a value of the asset to be valued of EUR 229.16 million.

In determining the value of the SP business unit (see section "Calculating the Value of the SP Business Unit"), the amortisation of the asset to be valued was not taken into consideration when calculating the corporate taxes. In order to verify the value of the patented technology just arrived at, including the tax amortisation benefit, the value of the business unit is therefore determined in Table 5.9 including its amortisation. This assumes straight-line amortisation of the asset for the remaining useful life. After deducting the value of the tangible fixed assets and the value of the working capital from the value of the business unit just arrived at, the result is – as was to be expected – again the value of the asset to be valued, including the tax amortisation benefit, amounting to EUR 229.16 million.

5.5.5.3 Calculating the Residual Value as the Present Value of the "Excess Earnings"

Procedure

Calculating the residual value by means of the excess-earnings approach begins by determining the contributions of the supporting assets to earnings (see section "Calculating the Contributions of the Supporting Assets to Earnings"). In order to determine the excess earnings attributable to the asset to be valued, they have to be deducted from the income of the business unit (see section "Calculating the Excess Earnings"). The value of the asset to be valued is then arrived at by discounting the excess earnings by their asset-specific rate of return (see section "Calculating the Asset-Specific Rate of Return").

Applying the excess-earnings approach involves a number of questions which have been the subject of discussions. In the following, the procedure will therefore merely be sketched briefly. Details will be presented in a separate article.

Calculating the Contributions of the Supporting Assets to Earnings

The contributions of the supporting assets to earnings, which are also referred to as "contributory asset charges",[72] consist of two components: the

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[71] In this case, a step-up factor of 1.4238 results.
[72] Cf. AICPA (fn. 41), 5.3.54 ff.

Table 5.9 Calculation of enterprise value of business unit SL taking into account amortization of patented technology

Mio. EUR				Proj. 2007	Proj. 2008	Proj. 2009	2010	2011	2012	2013	2014
Sales				360	389	404	412	421	429	438	365
Cost of sales				−241	−259	−270					
Gross profit				119	130	134					
SG&A				−61	−67	−68					
EBIT				58	63	66	67	68	70	71	59
Amortization		229.16	8	−29	−29	−29	−29	−29	−29	−29	−29
EBIT after amortization				29	35	37	38	40	41	42	30
Tax	40%			−12	−14	−15	−15	−16	−16	−17	−12
NOPLAT				17	21	22	23	24	25	25	18
Changes WC				−15	−5	−2	−2	−2	−2	−2	105
Amortization				29	29	29	29	29	29	29	29
Net CapEx				11.0	1.0	13.0	1.0	15.0	15.0	15.0	29.0
Net cash flow				42.0	45.1	62.0	50.6	65.4	66.2	67.0	181.0
Discount factor		7.08%		0.9339	0.8721	0.8145	0.7606	0.7103	0.6634	0.6195	0.5785
Present value				39.2	39.4	50.5	38.5	46.5	43.9	41.5	104.7
Net present value				**404.16**							
Fair value working capital				−75.00							
Fair value fixed assets				−100.00							
Fair value				**229.16**							

- return of the invested capital and the
- return on the invested capital.[73]

In order to calculate the capital invested in a supporting asset, it is valued at the fair value obtaining at the time of valuation. In the subsequent periods, the invested capital is reduced by the consumption of the value of the asset, which can be measured in the case of a tangible fixed asset, for example, by the depreciation; it is increased if any further capital expenditure should be required. The annual return of the capital invested in an asset appears as the balance of these changes.

The return on the capital invested in a supporting asset is determined by its level at the beginning of the period and the asset-specific rate of return. The latter has to be established – in accordance with Section 5.4.4 – taking the useful life and the asset-specific risk of the asset concerned into account.

The calculation of the return of and the return on the capital invested in the tangible fixed assets of the SP business unit is summed up in Table 5.10. This is based on the detailed projections of the development of the tangible fixed assets for the remaining useful life of the asset to be valued, which has already been discussed under section "Calculating the Value of the SP Business Unit". The return of and return on the capital invested are determined in an analogous manner for the working capital (Table 5.11).

Table 5.10 Valuation of tangible fixed assets

Year		2007	2008	2009	2010	2011	2012	2013	2014
Return on capital invested*)	7.00%	7.0	6.2	6.2	5.3	5.2	4.1	3.1	2.0
Return of capital invested		11.0	11.0	13.0	13.0	15.0	15.0	15.0	13.0
Liquidation									16.0
CapEx			−10.0		−12.0				
Return of capital invested less CapEx		11.0	1.0	13.0	1.0	15.0	15.0	15.0	29.0
Cash flow		18.0	7.2	19.2	6.3	20.2	19.1	18.1	31.0
Present value factor	7.00%	0.9346	0.8734	0.8163	0.7629	0.7130	0.6663	0.6227	0.5820
Present value	100.0	16.8	6.3	15.6	4.8	14.4	12.7	11.3	18.1
Capital invested	100.0	89.0	88.0	75.0	74.0	59.0	44.0	29.0	0.0

*After corporate taxes

[73] Cf. *Reilly/Schweihs*, loc. cit. (fn. 11), pp. 176 ff.

Table 5.11 Valuation of working capital

Year		2007	2008	2009	2010	2011	2012	2013	2014
Return on capital invested*	3.00%	2.3	2.7	2.9	2.9	3.0	3.0	3.1	3.2
Liquidation									87.5
Changes in working capital		−15.0	−5.3	−1.8	−1.9	−2.0	−2.0	−2.06	17.51
Return on capital invested less changes WC		−15.0	−5.3	−1.8	−1.9	−2.0	−2.0	−2.1	105.0
Cash flow		−12.8	−2.6	1.1	1.0	1.0	1.0	1.0	108.2
Present value factor	3.00%	0.9709	0.9426	0.9151	0.8885	0.8626	0.8375	0.8131	0.7894
Present value	75.0	−12.4	−2.4	1.0	0.9	0.9	0.8	0.8	85.4
Capital invested	75.0	90.0	95.3	97.0	99.0	101.0	103.0	105.0	0.0

*After corporate taxes

The supporting assets' contributions to income can be determined in the manner shown as returns of and returns on the capital invested in the supporting assets for specific periods. It is, however, also possible to work on the assumption that the supporting assets are not the property of the business unit but are used on the basis of a leasing agreement. The contributions to income then appear as notional leasing payments, which have to be calculated as the annuity on the amounts assigned to specific periods.

Calculating the Excess Earnings

It has already been explained under section "Calculating the Value of the SP Business Unit" that the business unit's income should be understood as the free cash flow. This means that, in order to calculate the excess earnings, it is necessary to deduct from this amount the contributions of the supporting assets to income, which were calculated under section "Calculating the Contributions of the Supporting Assets to Earnings".

The calculation of the excess earnings is, however, simplified by the following considerations: the free cash flow is arrived at by deducting the changes in the working capital and the net capital expenditure (capital expenditure less depreciation) on the tangible fixed assets, i.e. the changes in the tangible fixed assets, from the net operating profit less adjusted tax (NOPLAT) (see section "Calculating the Value of the SP Business Unit"). Since – in line with the comments under section "Calculating the Contributions of the Supporting Assets to Earnings" – the return of the capital invested in the working capital and the tangible fixed assets result in a change in those assets, deducting the return of the capital invested in the working capital and the tangible fixed assets from the free cash flow leads in turn to the NOPLAT. It is therefore possible to calculate the excess earnings proceeding from the NOPLAT by deducting the return on the capital invested in the working capital and the tangible fixed assets.

In this case, when determining the return on the invested capital, it must be borne in mind that it has to be calculated after corporate taxes. On the other hand, if a pre-tax figure is taken as the starting point, it either has to be reduced by corporate taxes or deducted from the EBIT instead of the NOPLAT.

For the SP business unit's patented technology to be valued, this approach is illustrated in Table 5.12.

In practice, the contributions of the supporting assets to income are often modelled on the basis of notional leasing instalments – adopting the approach already discussed under section "Calculating the Contributions of the Supporting Assets to Earnings". In order to avoid recording income contributions twice, especially the consumption of the value of the supporting assets, the starting parameter chosen, from which the leasing instalments have to be deducted, is typically the EBITDA (earnings before interest, tax, depreciation and amortisation).

Since the EBIT is obtained by deducting amortisation from the EBITDA, the notional leasing instalments have to be established – in line with the above considerations – as an annuity, obtained by financial mathematical calculations, based on

Table 5.12 Valuation patented technology applying excess earnings method

Mio. EUR		Proj. 2007	Proj. 2008	Proj. 2009	2010	2011	2012	2013	2014
Sales		360	389	404	412	421	429	438	365
Cost of sales		−241	−259	−270					
Gross profit		119	130	134					
SG&A		−61	−67	−68					
EBIT		58	63	66	67	68	70	71	59
Tax	40%	−23	−25	−26	−27	−27	−28	−28	−24
NOPLAT		35	38	39	40	41	42	43	35
Return on capital invested									
Working capital		−2	−3	−3	−3	−3	−3	−3	−3
Tangible fixed assets		−7	−6	−6	−5	−5	−4	−3	−2
Net cash flow		25	29	30	32	33	35	36	30
Present value factor	8.37%	0.9228	0.8515	0.7857	0.7250	0.6690	0.6174	0.5697	0.5257
Present value		23	25	24	23	22	21	21	16
Net present value		**174.98**							
TAB	1.3954	69.18							
Fair value		**244.15**							

return on the capital invested and the consumption of value recorded in the amortisation. I.e. the calculation of the leasing instalments usually only needs to include the return on the capital invested in the case of the working capital; whereas in the case of the tangible fixed assets, depreciation also have to be taken into consideration. In addition, it must be borne in mind that the leasing instalments have to be calculated before deducting corporate taxes. The notional leasing instalments can, on the other hand, be derived from the fair values of the assets concerned. In this case, however, they have to be deducted from the free cash flow.

The leasing instalments for the SP business unit's patented technology can be seen from Table 5.13.

Calculating the Asset-Specific Rate of Return

The asset-specific rate of return has to be calculated on a term-equivalent and risk-equivalent basis. The first aspect requires that the asset-specific rate of return is determined taking the useful life of the asset to be valued into account. The second aspect is in practice usually taken into account by applying an asset-specific risk mark-up/mark-down[74] in accordance with the procedure explained under Section 5.4.4.3.

The point of departure in calculating the asset-specific risk mark-up is the idea that the weighted average rate of return covering all assets should be identical to the weighted average cost of capital (WACC) (Fig. 5.10). The weighted average rate of return must be calculated from the asset-specific rates of return on all the assets

Table 5.13 Calculation of lease payments

Year		2007	2008	2009	2010	2011	2012	2013	2014
Tangible fixed assets									
Return on and of capital invested									
Pre tax		22.7	21.4	23.3	21.8	23.6	21.9	20.1	16.4
Present value	117.43	20.7	17.8	17.7	15.1	15.0	12.7	10.6	7.9
Annuity		−21.7	−21.7	−21.7	−21.7	−21.7	−21.7	−21.7	−21.7
Working capital									
Return on capital invested									
Pre tax		3.8	4.5	4.8	4.9	4.9	5.0	5.1	5.3
Present value	25.46	3.4	3.7	3.6	3.4	3.1	2.9	2.7	2.5
Annuity		−4.7	−4.7	−4.7	−4.7	−4.7	−4.7	−4.7	−4.7

[74] In order to simplify matters, the following comments will merely speak of risk mark-ups. The comments of course also apply to those cases in which a risk mark-down has to be made.

Table 5.14 Calculation of asset specific risk mark-up

	Fair value	Rate of return	Weighted
Tangible fixed assets	100.00	7.00%	1.67%
Working capital	75.00	3.00%	0.54%
Patent	244.15	8.37%	4.88%
Total	419.15		7.08%

which contribute to achieving the income of the business unit concerned, i.e. the asset to be valued and the supporting assets. The weighting is made with the fair value of each asset included.

With this approach, the difficulty nevertheless arises that the asset-specific risk mark-up on the term-equivalent cost of capital is not known for the asset to be valued. For this reason, it first has to be defined provisionally – and with it also the asset-specific rate of return. The excess earnings calculated under section "Calculating the Excess Earnings" are then discounted by that (provisional) discount rate according to the valuation model of Table 5.12. When the tax amortisation benefits are included, one arrives at a provisional fair value for the patented technology to be valued.

On this basis – taking into account the fair values and asset-specific rates of return for the working capital and the tangible fixed assets, which are already known – the weighted average rate of return is calculated, covering all the assets of the SP business unit (Table 5.14). If this weighted asset-specific rate of return differs from the weighted cost of capital, the asset-specific risk of the asset to be valued has to be adjusted iteratively until this relationship is achieved. The result of this procedure is summed up in Tables 5.12 and 5.14. It shows that an asset-specific rate of return of 8.37% results for the patented technology to be valued, with a corresponding fair value (including the tax amortisation benefit) of EUR 244.15 million. Table 5.15 shows that using the leasing model leads to the same result.

5.5.5.4 Comparison of the Two Procedures for Calculating the Residual Value

Under Section 5.5.5.3, a residual value of EUR 244.15 million (including the tax amortisation benefit) with an asset-specific rate of return of 8.37% has just been calculated. In contrast to this, the direct calculation of the residual value under Section 5.5.5.2 produced a value of EUR 229.16 million. The corresponding asset-specific rate of return is 9.56%. It was calculated iteratively with the excess-earnings model. Table 5.16 shows the result of the calculation of the asset-specific rate of return based on the contributions of the supporting assets to income for specific periods, while Table 5.17 shows the result when it is calculated via leasing instalments.[75]

[75] The tax amortisation benefit was calculated on the basis of this asset-specific rate of return. If, on the other hand, the calculation of the tax amortisation benefit is based on the weighted

Table 5.15 Excess earnings approach applying leasing model

Mio. EUR		Proj. 2007	Proj. 2008	Proj. 2009	2010	2011	2012	2013	2014
Sales		360	389	404	412	421	429	438	365
Cost of sales		−241	−259	−270					
Gross profit		119	130	134					
SG&A		−61	−67	−68					
Operating profit		58	63	66	67	68	70	71	59
Depreciation		11	11	13	13	15	15	15	13
EBITDA		69	74	79	80	83	85	86	72
Lease payment tangible fixed assets		−21.6	−21.6	−21.6	−21.6	−21.6	−21.6	−21.6	−21.6
Lease payment working capital		−4.7	−4.7	−4.7	−4.7	−4.7	−4.7	−4.7	−4.7
EBIT		42.3	47.9	52.2	53.5	56.9	58.2	59.6	46
Tax	40%	−16.9	−19.1	−20.9	−21.4	−22.7	−23.3	−23.8	−18
Net cash flow		25.4	28.7	31.3	32.1	34.1	34.9	35.8	27
Present value factor	8.3700%	0.9228	0.8515	0.7857	0.7250	0.6690	0.6174	0.5697	0.5257
Present value		23.4	24.5	24.6	23.3	22.8	21.6	20.4	14.4
Net present value		**174.98**	60.65	**114.33**					
TAB	1.3953637	69.18	23.11						
Fair value		**244.15**	83.76						

Table 5.16 Calculation of asset specific rate of return based on residual-value model

Mio. EUR		Proj. 2007	Proj. 2008	Proj. 2009	2010	2011	2012	2013	2014
Sales		360	389	404	412	421	429	438	365
Cost of sales		−241	−259	−270					
Gross profit		119	130	134					
SG&A		−61	−67	−68					
Operating profit		58	63	66	67	68	70	71	59
Tax	40%	−23	−25	−26	−27	−27	−28	−28	−24
Net operating profit		35	38	39	40	41	42	43	35
Charges		−9.3	−8.9	−9.0	−8.2	−8.1	−7.2	−6.2	−5.2
Net cash flow		25.3	29.0	30.3	32.0	32.8	34.6	36.4	30.3
Present value factor	9.5613%	0.9127	0.8331	0.7604	0.6940	0.6335	0.5782	0.5277	0.4817
Present value		23.1	24.1	23.1	22.2	20.8	20.0	19.2	14.6
Net present value		**167.0**							
TAB	1.3719	62.12							
Fair value		**229.16**							

Calculated in this way, the weighted average rate of return across all the assets of the SP business unit is 7.71% and is clearly different from the weighted average cost of capital (7.08%) (Table 5.18). This raises the question as to what has caused this difference of EUR 14.99 million[76] – which is approx. 6.5% based on the value calculated under Section 5.5.5.2 – and which of the two approaches should ultimately be adopted.

With the calculation of the asset-specific rate of return described under Section 5.5.5.3, the share of the fair values of all the assets in the entity value of the business unit is extrapolated unchanged over the entire useful life of the asset to be valued. This approach is therefore based on a static assessment. However, if the capital invested in the individual assets is calculated over that period – this calculation will not be discussed in the context of this study –, it becomes clear that this requirement is not met. The capital invested in the individual assets changes from year to year.

The assessment of the asset-specific rate of return must therefore be based on a dynamic approach, i.e. the calculation of the asset-specific rate of return must be carried out on the basis of the share of the fair values of all the assets involved which are applicable in each period of the useful life of the asset to be valued. In each period, this approach leads to the periodic-specific rate of return. This means

cost of capital, a figure of EUR 160.95 million before tax amortisation benefit is arrived at – that is the same as the directly calculated residual value before tax amortisation benefit – with an asset-specific rate of return of 10.54 %.

[76] This is precisely the amount by which the sum of the fair values of all the assets according to Table 5.14 exceeds the total value of the business unit according to Table 5.9.

Table 5.17 Calculation of asset specific rate of return based on leasing model

Mio. EUR		Proj. 2007	Proj. 2008	Proj. 2009	2010	2011	2012	2013	2014
Sales		360	389	404	412	421	429	438	365
Cost of sales		−241	−259	−270					
Gross profit		119	130	134					
SG&A		−61	−67	−68					
Operating profit		58	63	66	67	68	70	71	59
Depreciation		11	11	13	13	15	15	15	13
EBITDA		69	74	79	80	83	85	86	72
Lease payment tangible fixed assets		−21.7	−21.7	−21.7	−21.7	−21.7	−21.7	−21.7	−21.7
Lease payment working capital		−4.7	−4.7	−4.7	−4.7	−4.7	−4.7	−4.7	−4.7
EBIT		42.2	47.8	52.2	53.5	56.8	58.2	59.6	46
Tax	40%	−16.9	−19.1	−20.9	−21.4	−22.7	−23.3	−23.8	−18
Net cash flow		25.3	28.7	31.3	32.1	34.1	34.9	35.8	27
Present value factor	9.5613%	0.9127	0.8331	0.7604	0.6940	0.6335	0.5782	0.5277	0.4817
Present value		23.1	23.9	23.8	22.3	21.6	20.2	18.9	13.2
Net present value		**167.04**							
TAB	1.3718558	62.12							
Fair value		**229.16**							

Table 5.18 Calculation of weighted average rate of return

	Fair value	Rate of return	Weighted
Tangible fixed assets	100.00	7.00%	1.73%
Working capital	75.00	3.00%	0.56%
Patent	229.16	9.56%	5.42%
Total	404.16		7.71%

that the condition that the weighted average rate of return should be equal to the weighted cost of capital is met in each period.

It can therefore be stated that both when the residual value of the asset to be valued is calculated directly and when it is determined by means of the excess-earnings method, the result is basically the same. It is irrelevant in this connection whether the contributions of the supporting assets to income are attributed to specific periods or whether they are taken into consideration in the form of notional leasing instalments. One precondition, however, is that the use of the excess-earnings method should be based on calculating the asset-specific rate of return dynamically. If the static consideration is adopted, the result can at best be seen as a more or less rough approximation.

5.5.6 Summary of the Results of the Illustrative Example

Table 5.19 sums up the values arrived at for the patented technology to be valued when the different forms of the income approach are adopted. Since each of the valuation approaches described involves its specific application requirements, these results are not comparable to one another, or are only comparable to a very limited extent. It does, however, become clear what influence the choice of valuation approach can have on the result of the valuation. It must accordingly be ensured in this context that above all the basic assumptions of the method used are complied with in the underlying facts of the valuation.

Table 5.19 Sum up of results

	Fair value	
Valuation approach	Excl. TAB	Incl. TAB
Incremental income	13.37	18.46
Relief-from-royalty		
Transaction based	52.97	73.15
Profit split	53.59	74.01
Residual value		
Dynamic	160.95	229.16
Static	174.98	244.15

5.6 Summary

This study first explained the fundamentals of valuing intangible assets. In that part, the basic valuation approaches – income, market and cost approaches –, the need to delimit the asset to be valued and possible reasons for the valuation of intangible assets were outlined briefly.

Then patents were examined as assets to be valued. It became clear that the key factor which determines their value is the competitive advantage associated with a patent. Specifically, the value of a patent is influenced by the legal protection it provides, the underlying technology and the products which form the basis of its exploitation. It was shown in this context that the value of a patent – depending on the reason for the valuation – is usually understood as the value of the patented technology, which is composed of the value of the unprotected technology and the value of the legal protective effect. In addition, when delimiting the asset to be valued, it must be borne in mind that a technology is often protected not by a single patent, but by a patent portfolio.

Building on these considerations, the next step was to explain the valuation of patented technologies by means of the income approach. The point of departure was to examine the contribution of a patented technology to the total income of all the assets involved. On this basis, the various types of the income approach in the valuation of intangible assets were considered. In the process, the following key aspects, *inter alia*, were elaborated:

- The incremental-income analysis has a limited scope of application, since in many cases the basic requirement of isolating the incremental income attributable to an asset to be valued cannot be met.
- The scope of application of the relief-from-royalty method, on the other hand, is considerably broader. It is applicable if assets which are comparable to the asset to be valued are the subject of licence agreements and the data needed to calculate the royalty payments saved are available.
- Applying the residual-value method presupposes that the asset to be valued is the leading asset for income generation. In addition, it is necessary for all the supporting assets to be identified and valued. The problematic aspect with this approach is that all the synergy effects resulting from the interaction of the assets involved are allocated to the asset to be valued.

The subject of the last part of the study was an illustrative example to demonstrate the practical application of the different forms of the income approach which had been presented. In this context, it became apparent, *inter alia*, that, with the residual-value method in the form of the excess-earnings approach, particular importance should be attached to determining the contributions of the supporting assets to income and to calculating the asset-specific rate of return of the asset to be valued. Important questions arising in this connection were elaborated. A detailed study of these must, however, be reserved for a separate article.

Chapter 6
Reporting R&D Activities in Accordance with IFRS

Ulrich Moser

6.1 Fundamental Principles

IFRS/IAS[1] do not contain any specific regulations for the accounting treatment of R&D activities. Instead, the general regulations relating to reporting intangible assets are to be applied in this case.

The ways of reporting intangible assets are dealt with in particular[2] in the following standards:

- IAS 38 Intangible assets
- IFRS 3 Business combinations
- IAS 36 Impairment of assets

When reporting them in balance sheets – according to general accounting principles[3] – a clear distinction has to be made between

- recognition of the asset value (Section 6.3) and its
- measurement (Section 6.4).

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[1] The following comments do not take the treatment of patents in accordance with the German Commercial Code (HGB) and US GAAP into consideration; refer in this connection to, for example, Esser/Hackenberger, Bilanzierung immaterieller Vermögenswerte des Anlagevermögens nach IFRS und US-GAAP (Valuation of Intangible Assets under Fixed Assets in Accordance with IFRS and US GAAP), in: KoR 2004, 402–414.

[2] For further standards which regulate the valuation of intangible assets in special cases, see IAS 38.2–7 and Heyd/Lutz-Ingold, Immaterieller Vermögenswerte und Goodwill nach IFRS (Intangible Assets and Goodwill in Accordance with IFRS), Munich 2005, 29–30.

[3] For details, refer, for example, to Ruhnke, Rechnungslegung nach IFRS und HGB (Accounting in Accordance with IFRS and HGB), Stuttgart 2005, 260 ff., Kirsch, Einführung in die Internationale Rechnungslegung (Introduction to International Accounting in Accordance with IAS/IFRS), Herne/Berlin 2003, 30 ff.

W. Schmeisser et al. (eds.), *Innovation Performance Accounting*,
DOI 10.1007/978-3-642-01353-9_6,

In approaching the subject, the aim is to establish whether an item can or must be included on the asset side of the balance sheet or as equity or debt on the liability side or rather has to be shown as an expense or income in the profit and loss statement. This has to be determined independently of the allocation of a value to the item. This allocation then follows in a separate step, the measurment.

The following remarks are restricted to an outline of the treatment of R&D activities for accountancy purposes. As regards details of the valuation of intangible assets reference is made to the extensive literature.[4] In the following, firstly the fundamental alternatives for the balance sheet treatment of R&D activities are illustrated on the basis of a simple example (Section 6.2).

6.2 Introductory Example

In the current year, RD Ltd. has incurred expenses amounting to EUR 8.7 million attributable to the field of R&D. This is composed of human resources expense, external services (e.g. fees paid to external research institutions as well as to external patent lawyers) and various other expenditure (e.g. materials consumed, depreciation of laboratory equipment). They are focussed on the development of new technology intended to serve as the basis for a completely new product generation. These products will probably be launched onto the market in the next financial year. The expected technology lifetime is estimated to be 5 years.

RD Ltd.'s pro-forma balance sheet and P&L account are illustrated in Fig. 6.1. Up to the present, all R&D expenditure has been shown in full in the P&L account in the corresponding item, designated accordingly. The balance sheet does not show that RD Ltd. possesses the technology mentioned, which will probably be an essential basis for the company's success over the next 5 years.

In Fig. 6.2, the company's balance sheet and the P&L account have been drawn up based on the assumption that 40% of the R&D expenditure for the current financial year qualifies for inclusion as an intangible asset in the balance sheet. Therefore, technology amounting to EUR 3.5 million is shown in the balance sheet. At the same time the R&D expenditure shown in the P&L account is reduced by these EUR 3.5 million, which in turn results in an increase in the pre-tax earnings in the same amount. Taking income tax into consideration, the net income for the years amounts to EUR 2.2 million.

As a result of including technology on the asset side of the company's balance sheet, the former therefore has to be amortised over the next 5 years – because of its limited lifetime. Applying linear amortisation, this results in additional expenditure of EUR 0.7 million over the next 5 years and consequently a reduction in the annual earnings (post income tax) of EUR 0.5 million per annum.

[4] Cf. e.g. Heyd/Lutz-Ingold (fn 2), Esser/Hackenberger (fn 1).

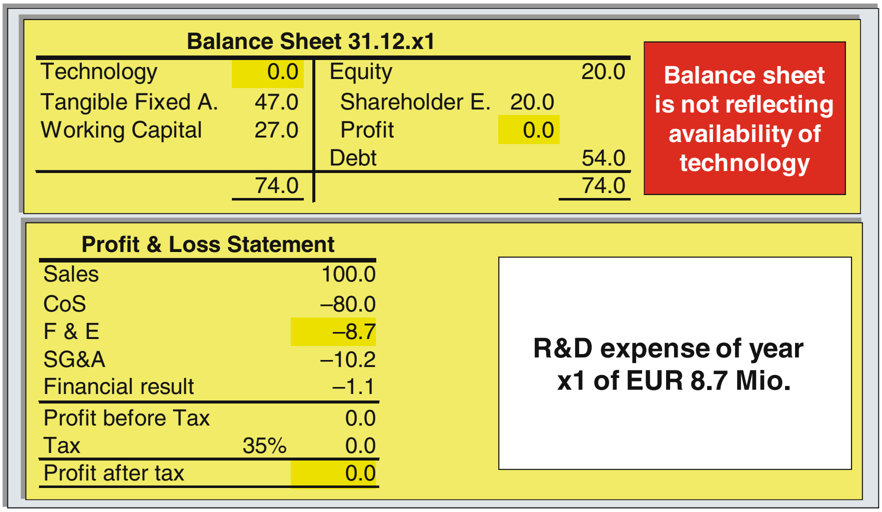

Fig. 6.1 FE GmbH – draft of financial statement

RD Ltd.'s earnings trend in the current financial year and the following 5 years is included in Fig. 6.3 with simplifying projections: it is assumed that R&D expenditure occurs only in the current financial year, but not in the following 5 years. The earnings prior to the deduction of R&D expenses and also before the deduction of the amortisation of technology included on the asset side of the balance sheet, where applicable, for the financial year and the 5 following years should amount to EUR 8.7 million per annum.

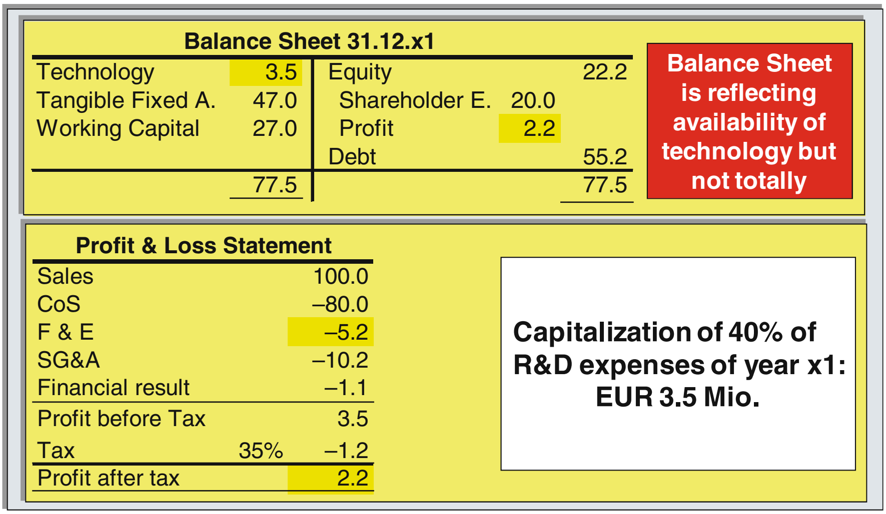

Fig. 6.2 FE GmbH – capitalization of R&D expenses

	x1	x2	x3	x4	x5	x6	Sum
Profit before R&D	8.7	8.7	8.7	8.7	8.7	8.7	52.4
R&D	–8.7						–8.7
Amortization							0.0
Technology							0.0
Profit before tax	0.0	8.7	8.7	8.7	8.7	8.7	43.7
Tax	0.0	–3.1	–3.1	–3.1	–3.1	–3.1	–15.3
Profit after tax	0.0	5.7	5.7	5.7	5.7	5.7	28.4

Capitalization	**x1**	**x2**	**x3**	**x4**	**x5**	**x6**	**Sum**
Profit before R&D	8.7	8.7	8.7	8.7	8.7	8.7	52.4
R&D	–5.2						–5.2
Amortization							0.0
Technology		–0.7	–0.7	–0.7	–0.7	–0.7	–3.5
Profit before tax	3.5	8.0	8.0	8.0	8.0	8.0	43.7
Tax	–1.2	–2.8	–2.8	–2.8	–2.8	–2.8	–15.3
Profit after tax	2.3	5.2	5.2	5.2	5.2	5.2	28.4

Fig. 6.3 FE GmbH – profit year ×1 – ×6

If technology is not reported on the asset side of the balance sheet, the company shows final earnings for the current financial year of EUR 0, but EUR 8.7 million in the following years. Taking the inclusion of technology worth EUR 3.5 million on the asset side of the balance sheet into consideration, this results in an annual profit for the current financial year of EUR 2.5 million. Annual profit for the following years will be influenced by the annual amortisation of EUR 0.7 million and subsequently amounts to EUR 5.2 million per annum. It has to be noted that the sum of the earnings for the current financial year together with those of the following 5 years is not influenced by the differences in the treatment of R&D expenditure for accountancy purposes. This amounts in both cases to EUR 43.7 million before tax and EUR 28.4 million after tax.

6.3 Recognition

6.3.1 Overview

If, but only if, the conditions for recognition are fulfilled, intangible assets have to be accounted for (IAS 38.1). These conditions are listed in IAS 38.18: the entity must prove that the appropriate item

- meets the definition of an intangible asset and
- the criteria for recognition are met.

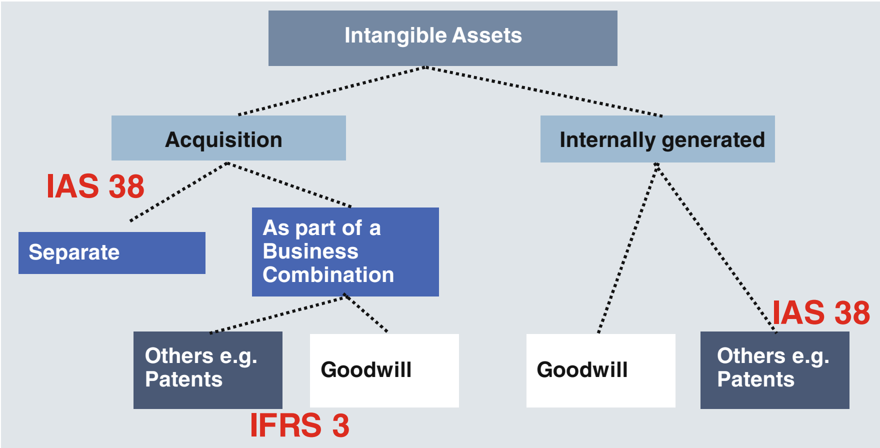

Fig. 6.4 Recognition of intangible assets under IFRS/IAS

In addition, IAS 38 and IFRS 3 include regulations which deal with the application of recognition criteria in certain cases. To this end, they distinguish between in-house production ("self-generation") and the acquisition of intangible assets. In the case of acquisition, there is a further distinction between the instance of separate acquisition and acquisition in the context of a business combination (Fig. 6.4).[5] Finally IAS 38 includes prohibitions on recognition certain intangible assets (Fig. 6.5).

In the following, the definition and recognition criteria will first be reviewed (3.2). Then the self-created intangible assets, the case of separate acquisition

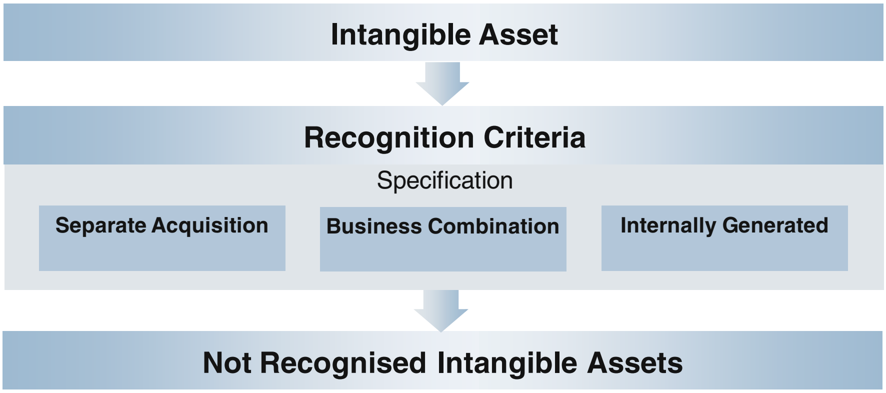

Fig. 6.5 Recognition of intangible assets – overview (IAS 38.18)

[5] IAS 38.44–47 also include cases of acquisition through a government grant and the exchange of assets. These two cases will not be expanded upon in the following remarks.

and finally acquisition through a business combination will be expanded upon (Sections 6.3.3.1–6.3.3.3). In conclusion, prohibitions on recognition will be discussed briefly (Section 6.3.4).

6.3.2 Definition and Recognition Criteria for All Intangible Assets

Recognition of an intangible asset in accordance with IAS 38.18 presupposes – as has just been explained – that the item meets the definition of an intangible asset and satisfies the recognition criteria in accordance with IAS 38.21.

The term "intangible asset" is defined in IAS 38.8 as "an identifiable non-monetary asset without physical substance". Because of the reference to assets, the definition of that term, which is similarly included in IAS 38.8, also has to be taken into consideration: it is "a resource

(a) which is controlled by an entity as a result of past events; and
(b) from which economic benefits are expected to flow in future".

The existence of an intangible asset therefore presupposes – apart from its lack of substance and its non-monetary nature – the possibility of identifying and controlling it and also the expected future economic benefit (Fig. 6.6).

The recognition criteria which have to be met, in addition to the existence of an intangible asset as a precondition for recognising it on the asset side of the balance sheet in accordance with IAS 38.21, aim to show that

(a) it is probable that the expected future economic benefits that are attributable to the asset will flow to the entity; and

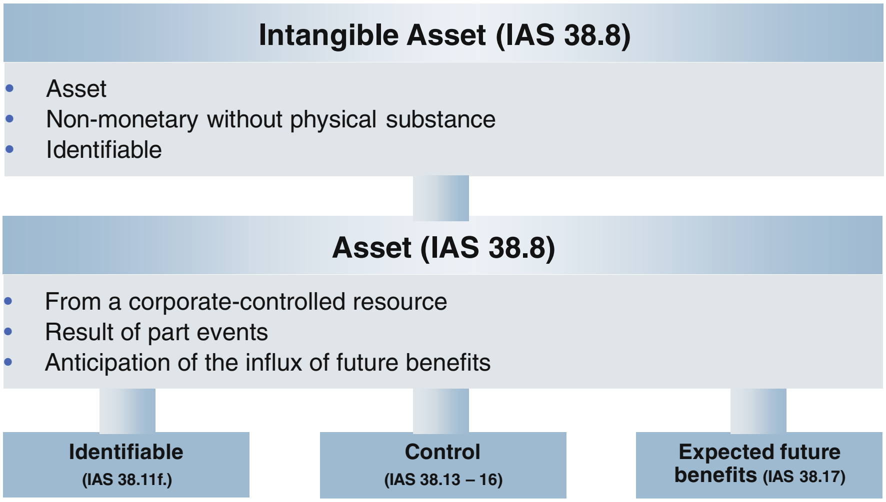

Fig. 6.6 Definitions

(b) the cost of acquiring or producing the asset can be measured reliably.

This being said the recognition of an intangible asset presupposes the existence of the following criteria:

- identifiability
- non-monetary nature
- lack of substance
- control
- future economic benefits
- probability of expected future economic benefit flow
- reliable valuability

Identifiability aims to show that an intangible asset has to be distinguishable from goodwill in the form of a business or company value. In accordance with IAS 38.12 this is true in two cases:

- when the asset is "separable" – "it is capable of being separated or divided from the entity and sold, transferred, licensed, rented or exchanged". It is sufficient in such a case if this can be achieved with a contract, an asset or debt (separability criterion).
- The asset arises "from contractual or other legal rights". This does not depend on whether these rights are transferable or can be separated from the entity or from other rights or obligations (contractual legal criterion).

In the case of patents as rights, for example, identifiability does not therefore create any special problems.

The criterion *non-monetary nature* is only applied indirectly, when IAS 38.8 defines the expression "monetary assets". According to this definition, monetary assets are "money held and assets to be received in fixed or determinable amounts of money".[6]

In the case of the balance sheet presentation of patents, for example, this criterion is of no significance.

The question of *lack of substance* arises in the case of intangible assets contained in or on a physical substance. A typical example here is computer software on a compact disc. In determining whether an asset that incorporates both tangible and intangible elements should be treated under IAS 16 or as an intangible asset under IAS 38, the entity, using its own judgement, has to apply IAS 38.4 to assess which element is more significant.[7]

In the case of patents, for example, this criterion is basically of no significance. However, in the case of research and development projects, an item of a material nature can indeed occur in the form of a prototype for example (IAS 38.5).

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[6] On this and other details, cf. Heyd/Lutz-Ingold (fn 2), 35

[7] For an in-depth treatment of this issue, see Heyd/Lutz-Ingold (fn 2), 1–7

The element of *control* of an intangible asset is present if "the entity has the power to obtain the future economic benefits flowing from the underlying resource and to restrict the access of others to those benefits" (IAS 38.13). This precondition does not create any problems in the case of legally enforceable claims. Control may however also exist without legal enforceability.

This precondition is particularly important in assessing the relevance of an entity's assembled workforce as well as other values[8] connected to human resources or those of a client portfolio, which is not based on contractual relations (IAS 38.15f).[9]

This criterion is of no concern in the case of patents, for example, because of the inherent legal position.

With regard to the *future economic benefits* of an intangible asset, IAS 38.17 explains that this can include: "revenue from the sale of products or services, cost savings, or other benefits resulting from the use of the entity".[10]

The assessment of the *degree of certainty attached to the flow of future economic benefits*[11] has to be based on "reasonable and supportable" assumptions that represent the "management's best estimate" (IAS 38.22). External rather than internal evidence is of greater importance in this connection (IAS 38.23).

The evaluation of this criterion will not as a rule cause any problem with patents, whose technology is already incorporated into products or is used for their manufacture. This criterion is, however, of greater importance in early-stage technologies.

The assessment of the criterion of *reliable valuation* depends above all on whether the intangible asset was acquired separately or in the context of a business combination or was self-created. This will be expanded upon in the following (Section 6.3.3).

The definition and recognition criteria illustrated are summarised once more in Fig. 6.7.

6.3.3 Specification of Recognition Criteria in Certain Cases

6.3.3.1 Internally Generated Intangible Assets

Initial Considerations

In the case of internally generated intangible assets IAS 38.51 recognises difficulties in assessing whether the recognition criteria laid down in IAS 38.21 actually exist when

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8 On this subject, see e.g. Heyd/Lutz-Ingold (fn 2), 48 f., Esser/Hackenberger (fn 1), 402 ff., 404 f.

9 On this subject, see e.g. Heyd/Lutz-Ingold (fn 2), 48 f.,

10 On this subject, see also e.g. IASB Framework 1989, F. 53 ff.

11 On the redundancy of this criterion, cf. Heyd/Lutz-Ingold (fn 2), 28

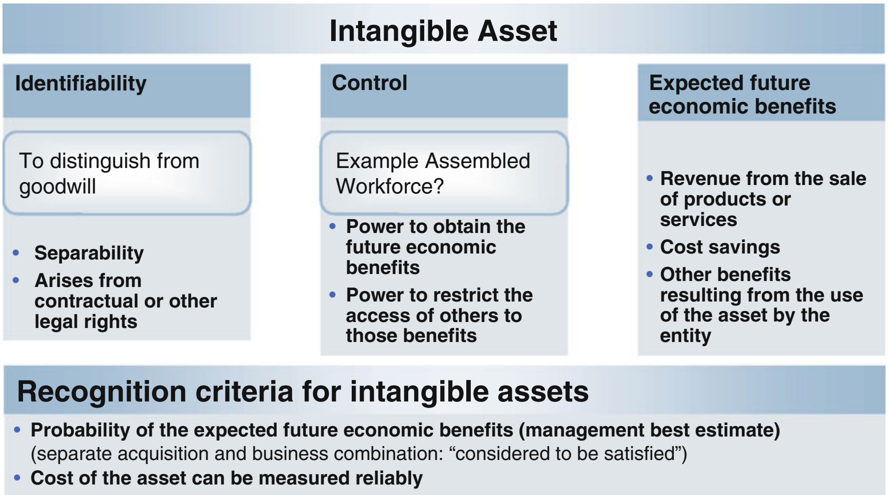

Fig. 6.7 Recognition of intangible assets – details

- identifying whether and when there is an identifiable asset that will generate expected future economic benefits and
- reliably determining the cost of the asset.

This will become particularly clear when we look at internally created products or the development of a client portfolio. This can cause enormous expense, with no guarantee that the measures taken will be successful or that it will be possible to attribute the success achieved to the measures taken. The same is of course also the case with the development of technologies.

To assess operationally whether the recognition criteria have been met, IAS 38.52 classifies the asset generation process into

- a research phase and
- a development phase

and lays down special regulations or criteria for them.

The definitions of the terms “research” and “development” in accordance with IAS 38.8 are summarised in Fig. 6.8. The examples which IAS 38.56 quotes for research activities and IAS 38.5 9 for development activities are set forth in Fig. 6.9.

The compilation process on which IAS 38 is based is designed – through the reference to research and development – especially for the development of technologies. Since this model does not necessarily suit the generation of all other categories of intangible assets, the expressions “research phase” and “development phase” in accordance with IAS 38.52 have a broader meaning and may, where suitable, be

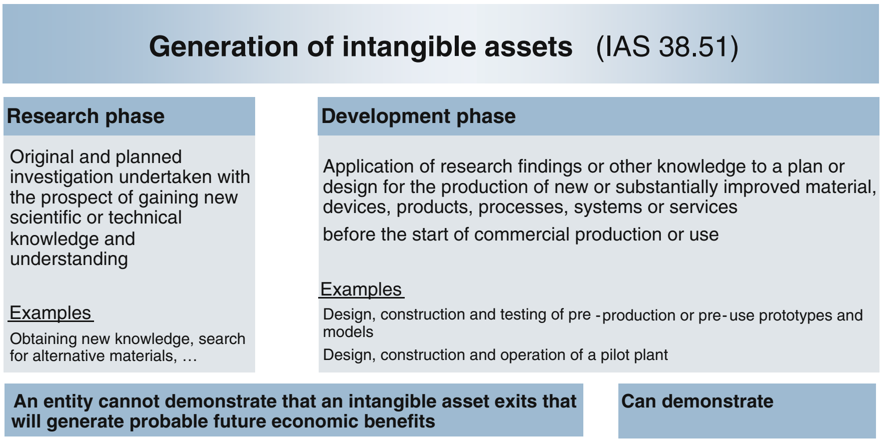

Fig. 6.8 Assessment of the recognition criteria regarding internally generated intangible assets

Fig. 6.9 Examples of research and development activities

applied to other types of intangible assets.[12] As the question of the recognition of self-generated R&D activities is the subject of our examination here, the following remarks are restricted to a consideration of the development of technologies.

[12] On this subject, cf. Heyd/Lutz-Ingold (fn 2), 40

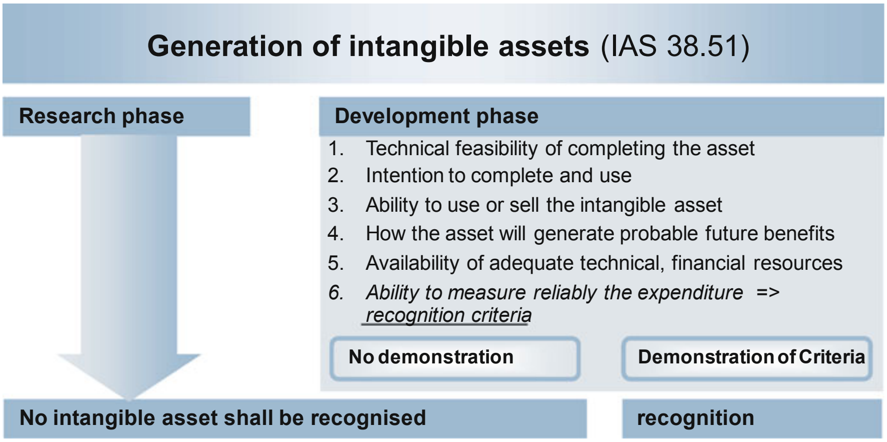

Fig. 6.10 Recognition criteria regarding internally gemerated intangible assets

Treatment of Expenditure in the Research and Development Phase

In a project's *research phase* the recognition of an intangible asset is not permitted (IAS 38.54). IAS 38.55 states that no proof of the existence of an intangible asset capable of generating probable future economic benefits can be demonstrated. Research expenditure therefore has to be treated as an expense when it is incurred.

In a project's *development phase*, on the other hand, the recognition of an intangible asset is obligatory if the entity can prove the fulfilment of all 6 further criteria listed in Fig. 6.10 (IAS 38.57). Otherwise, development expenditure has to be treated as an expense when it is incurred.

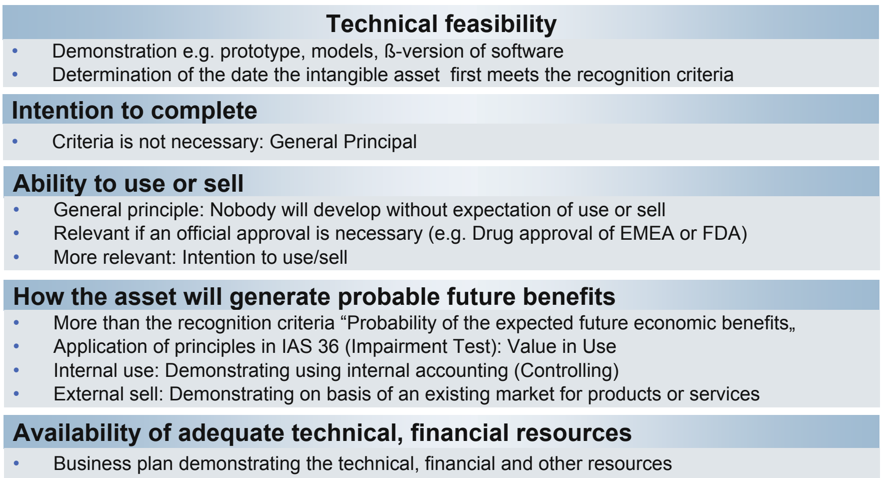

Fig. 6.11 Summary of criteria

Criteria (1)–(5) substantiate the recognition criterion "degree of certainty attached to the flow of future economic benefits", whereas criterion (6) merely transfers the recognition criterion of "reliable valuability" to the development phase of intangible assets.[13] Comments on criteria (1)–(5) are summarised in Fig. 6.11.

Overall, it can be stated that the criteria illustrated offer the accountant considerable scope for interpretation and discretion. Heyd/Lutz-Ingold[14] therefore point out that the *requirement to report* self-generated intangible assets effectively becomes a *reporting option*.

When assessing the reporting of patents issued to the entity itself, it is necessary to take into consideration the fact that results of R&D activity are technologies, which can, but do not have to, be protected by patents. Consequently it is worth assessing the criteria mentioned for R&D activities irrespective of whether they have been patented or not. A separate examination of patents is therefore not necessary.

Practical Procedure

For research-intensive entities, the balance sheet treatment of development expenditure can be of considerable importance.[15] This can include a proportionate amount of administrative expenses. In order to contain this, it is particularly important to recognise the point in time at which development expenditure has to be accounted for and therefore listed separately without a specific examination of the individual case in question, in other words more or less on an automatic basis.

The point in time for the initial recognition of development expenditure is – as just explained – typically determined by proof of the technical feasibility of the intangible asset's completion. The R&D process can help to provide this proof. The process is often characterised by various phases, whose successful completion is documented by milestones. It therefore has to be decided whether the necessary proof of technical feasibility can be linked to existing milestones. If this cannot be done, the possibility of modifying processes, including the milestone model, should be examined (Fig. 6.12).

6.3.3.2 Separate Acquisition of Intangible Assets

IAS 38 (Fig. 6.13) assumes that in the case of the separate acquisition of an intangible asset, the recognition criterion of the probability of expected future economic benefit flow is always satisfied (IAS 38.25), while that of reliable valuation is normally met (IAS 38.26).

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[13] Heyd/Lutz-Ingold (fn 2), 41, regard this as an "avoidable redundancy".

[14] Fn 2, 46

[15] With regard to the financial accounting of R&D activities in various industries, see Leibfried/Pfanzelt, Praxis der Bilanzierung von Forschungs- und Entwicklungskosten gemäss IAS/IFRS, in: KoR 2004, 491–497 (Financial Accounting for Research and Development Costs in Accordance with IAS/IFRS)

- **We should not focus on patents – the focus should be on R&D Expenditures**
- **Structuring the R&D Process:**

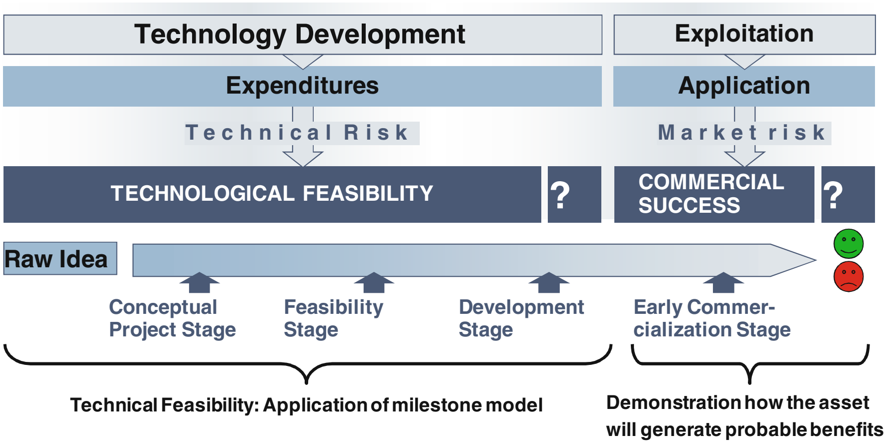

Fig. 6.12 Technical feasibility

By way of justification of the first recognition criterion, the regulation points out that the price paid on acquisition normally reflects the expectations of the probability that the prospective future benefit will flow. The second criterion results from acquisition costs actually incurred.

There are no special considerations with regard to R&D activities.

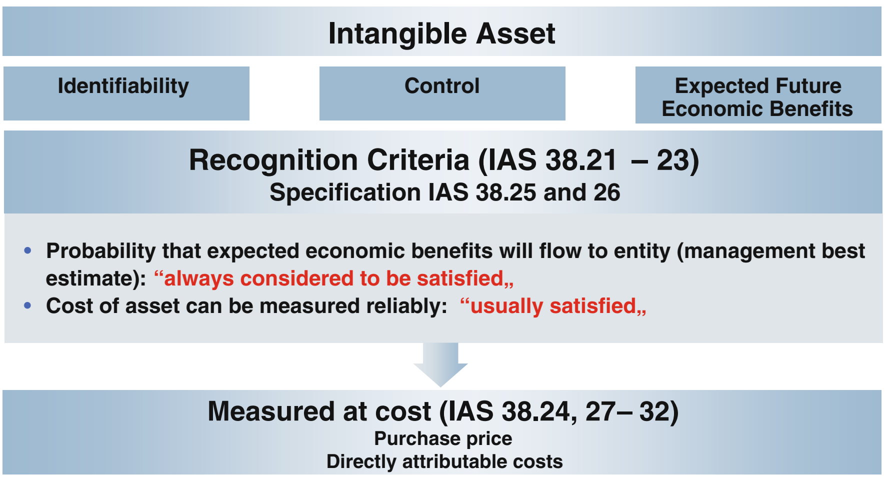

Fig. 6.13 Separate acquisition of an intangible asset

6.3.3.3 Acquisition of Intangible Assets Through Business Combinations

Treatment of Business Combinations in Accordance with IFRS 3

In Appendix A, IFRS 3 defines a business combination[16] as "the bringing together of separate entities or businesses into one reporting entity". Typical examples of business combinations are

- the acquisition of a majority of voting shares (share deal),
- the acquisition of assets and the assumption of debt (asset deal) or
- the inclusion of several entities into a newly established company.

The scope of application of IFRS 3[17] does not, however, include all business combinations. The regulations do not apply, for example, to the combination of separate entities to form a joint venture (IFRS 3.3a).

IFRS 3 specifies that business combinations should be accounted for by applying the purchase method. The business combination is seen from the acquirer's point of view: the acquirer "purchases net assets and recognises the assets acquired and liabilities and contingent liabilities" (IFRS 3.15). In doing so, all the identifiable assets, liabilities and contingent liabilities of the acquired entity that satisfy the recognition criteria are included (IFRS 3.36), irrespective of whether they were applied by the acquired entity before the business combination (IAS 38.34).

These assets, liabilities and contingent liabilities are accounted for by their fair value at the acquisition date.[18] This results in the closing balance of the acquired entity being transformed into a revaluation balance (fair value status).[19]

Goodwill applies in cases where the acquisition costs paid by the acquiring entity[20] exceed the net assets[21] in the revaluation balance of the acquired entity. Goodwill is measured as the acquisition costs amounting to the excess stated above (IFRS 3.51).

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[16] Further details on business combinations and their treatment in accordance with IFRS 3 can be found, for example, in Heyd/Lutz-Ingold (fn 2) 131 ff., Küting/Wirth, Bilanzierung von Unternehmenszusammenschlüssen nach IFRS 3 (Financial Accounting of Business Combinations in Accordance with IFRS 3), in: KoR 2004, 167–177, Brücks/Wiederhold, IFRS Business Combinations, in KoR 2004, 177–185, Zeiger, Purchase Price Allocation in Accordance with IFRS and US GAAP, in Ballwieser/Beyer/Zeige (eds.), Unternehmenskauf nach IFRS und US GAAP (Business Purchase in Accordance with IFRS and US-GAAP), Stuttgart 2005, 141 ff.

[17] On this subject see IFRS 3.2–13.

[18] In accordance with IFRS 3, Appendix A, this is "the date on which the acquirer effectively obtains control of the acquiree".

[19] Cf. Heyd/Lutz-Ingold (fn 2), 139 and HFA 16 Sub-section 41.

[20] Details on the calculation of acquisition costs of a business combination are given in IFRS 3.24–35.

[21] If the acquirer does not take over the acquiree completely, but only partially, the proportionate amount of the net assets must be taken as the basis.

Example

On July 1st x1 (acquisition date), Example Ltd. acquired all the shares of Packing Solution Ltd. The acquisition costs for the purposes of IFRS 3.24–25 amount to EUR 55 million. Packing Solution Ltd. issued interim accounts as at June 30th x1, applying previously valid accounting principles, i.e. on the basis of book values. The balance sheet is shown in Fig. 6.14.

Fixed assets were revalued as at July 1st x1. This resulted in a fair value of EUR 60 million. Neither working capital nor debt needed to be revalued. The book values represent fair values.

The analysis of the entity resulted in the identification of 2 classes of intangible assets: technologies and trade marks. Their fair values were given as EUR 10 million and EUR 5 million respectively.

On this basis, a revaluation balance for Packing Solution Ltd. has been drawn up as at the acquisition date and as illustrated in Fig. 6.14.

The goodwill achieved through this business combination results by deducting net assets in the revaluation balance from the acquisition costs of EUR 55 million. The latter results from deducting the applicable fair value of debt (EUR 54 million) from the total of all the applicable fair values of all assets (EUR 102 million) and amounts to EUR 48 million. This results in goodwill amounting to EUR 7 million.

The revaluation balance sheet of Packing Solution Ltd. as at the acquisition date, including goodwill, is shown in Fig. 6.14.

The procedure for establishing the purchase price allocation in accordance with IFRS 3 is summarised in Fig. 6.15.

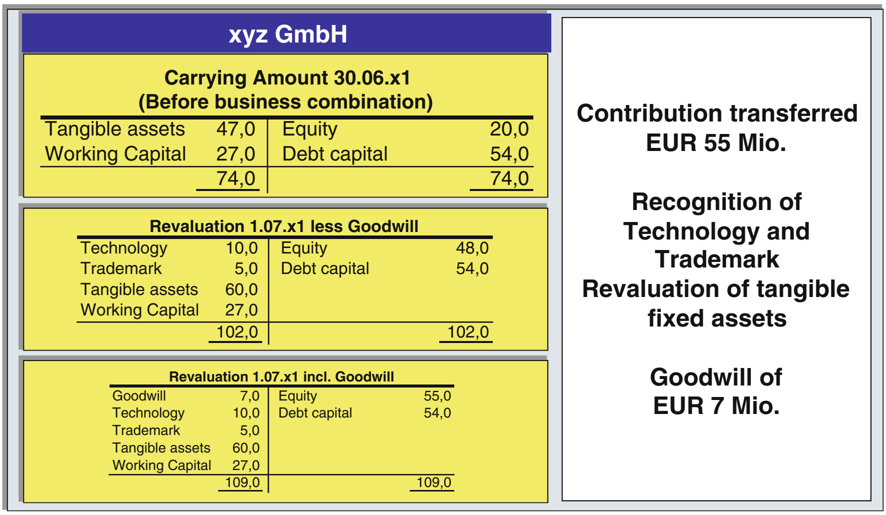

Fig. 6.14 Takeover of xyz GmbH

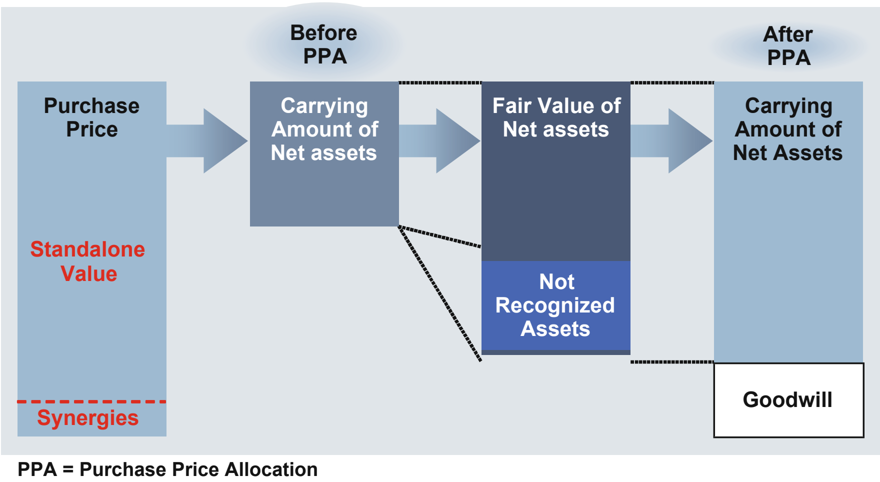

Fig. 6.15 Treatment of a business combination

Recognition Criteria for Intangible Assets in Business Combinations

The recognition criteria laid down in IAS 38.21 require special treatment in the case of business combinations (Fig. 6.16):

- the probability that expected future economic benefits will flow (IAS 38.21a) is always considered to be satisfied (IAS 38.33).
- with regard to the reliable measurement of acquisition or manufacturing costs (IAS 38.21b), IAS 38.35 assumes that the fair value of intangible assets can

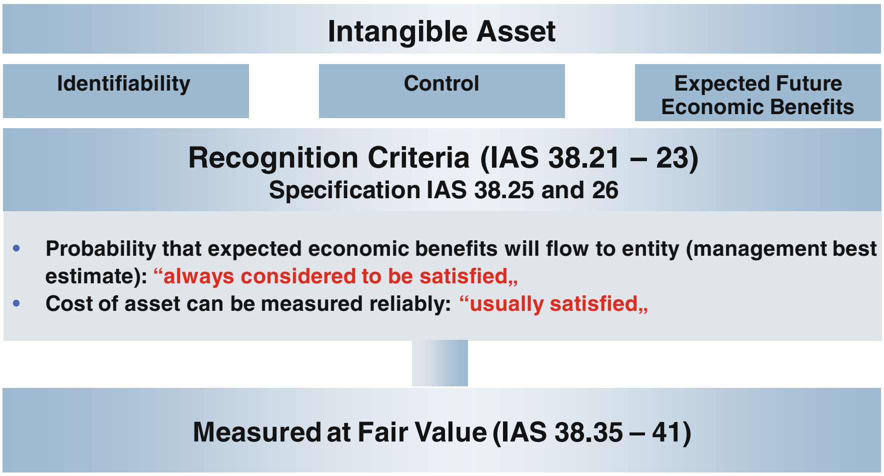

Fig. 6.16 Business combination

"normally be measured with sufficient reliability"; in the case of intangible assets with a finite useful life, there is a rebuttable assumption that its fair value can be measured reliably.[22]

In justifying the satisfaction of the first recognition criterion, IAS 38.33 states that the fair value of an intangible asset reflects "market expectations about the probability that the future economic benefits .... will flow". IAS 38.35 justifies the relativisation of the second recognition criterion by stating that the uncertainty in measuring the asset's fair value arising out of a range of possible outcomes is included in the measurement of fair value rather than demonstrating an inability to measure fair value reliably.

To that effect, an intangible asset can only be accounted for separately in accordance with IFRS 3.37c[23] if

- the asset corresponds to the definition of an intangible asset defined in IAS 38 – IFRS 3.46 explains this and also the identifiability criteria once again – and
- the fair value can be reliably measured, which – as just explained – is normally the case in accordance with IAS 38.35.

It can therefore be stated that, in the case of business combinations, in recognising intangible assets it is only the identifiability criterion that has to be examined in addition to the definition attributes, particularly that of control.

Basically, no particular difficulties are expected in the assessment of recognition criteria for patents acquired through business combinations.

In-Process Research and Development Projects (IP R&D)

The requirements listed in section "Recognition Criteria for Intangible Assets in Business Combinations" for the recognition of intangible assets also have to be applied to in-process research and development projects as part of a business combination.[24] This is the case irrespective of how they were treated by the acquired entity prior to the business combination. A decision regarding their compulsory recognition therefore depends on the definition attributes of intangible assets and the reliable valuation of the fair value.

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[22] Further details on this are to be found in IAS 38.36–38.

[23] See also IFRS 3.45

[24] Cf. IFRS 3.45 and IAS 38.34. For the treatment of IP R&D refer above all to Lüdenbach/Prusacyk, Bilanzierung von "In-Process Research and Development" beim Unternehmenserwerb nach IFRS und US-GAAP (In-Process Research and Development Accounting for Business Acquisitions in Accordance with IFRS and US-GAAP) in: KoR 2004, 415–422, AICPA, Practice Aid Series: Assets Acquired in a Business Combination to be Used in Research and Development Activities: A Focus on Software, Electronic Devices, and Pharmaceutical Industries, 2001, and Heyd/Lutz-Ingold, (fn 2) 53.

If the acquirer incurs research and development expense after the acquisition of a research and development project, this has to be treated in accordance with the principles of the recognition of self-generated intangible assets (Section 6.3.3.1).[25]

6.3.4 Prohibition of the Recognition of Intangible Assets

Prohibitions of the recognition of intangible assets arise from the application of the IAS 38 recognition criteria. In this context, reference is made to the observations in Sections 6.3.1 and 6.3.2. Additionally, IAS 38 includes a number of instances of prohibitions of recognition.[26] These include in particular

- internally generated goodwill (IAS 38.48–50)
- internally generated brands, mastheads, publishing titles, customer lists and items similar in substance (IAS 38.63 f.) including subsequent expenditures for such items (IAS 38.20)
- start-up costs (IAS 38.69 (a))
- expenditure on training activities (IAS 38.69 (b))
- expenditure on advertising and promotional activities (IAS 38.69 (c))
- expenditure on relocating or reorganising part or all of an entity (IAS 38.69 (d)).

6.4 Measurement of Intangible Assets

6.4.1 Overview

When measuring assets and liabilities, there has to be a distinction between the measurement at the time of the initial recognition of the item, i.e. on initial entry (initial measurement; Section 6.4.2) and the measurement in subsequent financial years (subsequent measurement; Section 6.4.3).[27]

6.4.2 Initial Measurement

6.4.2.1 Basic Principle

IAS 38.24 states the general principle that “an intangible asset shall be measured initially at cost”. This is defined according to IAS 38.8 as “the amount of cash or cash equivalents paid or the fair value of other consideration given to acquire an asset at the time of its acquisition or construction . . .”

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[25] IAS 38.42 f. The same practice applies to separately acquired research and development projects.
[26] Cf. Heyd/Lutz-Ingold (fn 2), 46.
[27] On this differentiation, cf. also IAS 38.18–71 on the one hand, and IAS 38.72–111 on the other.

6.4.2.2 Internally Generated Intangible Assets

Internally generated intangible assets are measured by their construction costs. As to their accrual, IAS 38.65 refers to the date on which the recognition criteria as defined in Section 6.3.3.1 are met (Fig. 6.17). Construction costs amount to the total costs incurred from that date on. Costs recorded as expenses prior to that date may not be recognised as an asset at a later date (prohibition of past expenses being recognised as an asset in accordance with IAS 38.71).

In accordance with IAS 38.66, the construction costs of intangible assets comprise "all directly attributable costs necessary to create, produce and prepare the asset to be capable of operating in the manner intended by the management". IAS 38.66 lists the individual items attributable to construction costs, IAS 38.67 lists items which are not cost components (Fig. 6.18). The components listed do,

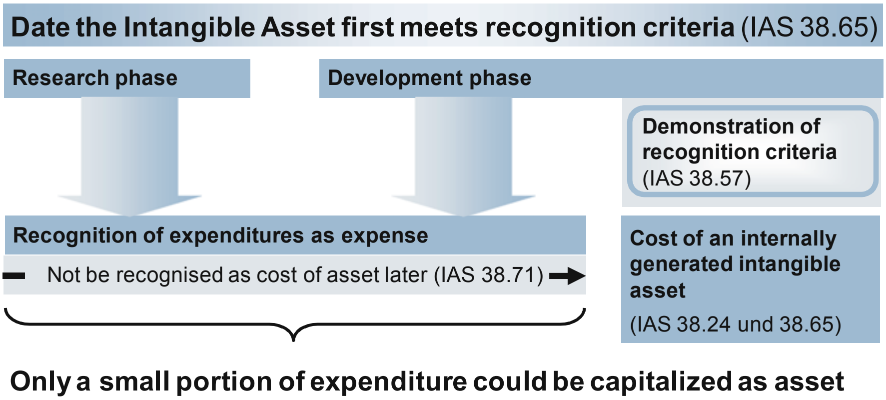

Fig. 6.17 Measurement of internally generated intangible assets

- Cost of an internally generated intangible asset comprises
  - All directly attributable costs necessary to create, produce and prepare the asset
  - To be capable of operating
  - In the manner intended by management
- Components (IAS 38.66)
  - Cost of materials and services or consumed in generating the asset
  - Cost of employee benefits arising from the generation of the asset
  - Fees to register a legal right
  - Amortisation of patents and licenses that are used to generate the asset
  - Borrowing costs (allowed – not obligatory)
- Following are not components of cost (IAS 38.67)
  - Selling, administrative and other general overhead expenditure unless it could be directly attributed to preparing the asset for use
  - Identified inefficiencies and initial operating losses
  - Expenditure on training staff to operate the asset

Fig. 6.18 Cost of an internally generated intangible asset (IAS 38.66 f.)

however, include not only "directly attributable costs", i.e. individual costs, but also production-related general expenses.[28]

6.4.2.3 Separate Acquisition of Intangible Assets

Separately acquired intangible assets are to be valued at their cost of acquisition (Fig. 6.19). This comprises the purchase price and other supplementary acquisition costs (e.g. import duties, non-refundable purchase taxes) after deduction of trade discounts, rebates and allowances (IAS 38.27). The inclusion of interest resulting from the utilisation of a deferred payment period is in line with the principles of IAS 23 (IAS 38.32).

Supplementary acquisition costs include above all "costs directly attributable to preparing the asset for its intended use". As examples of this, IAS 38.28 lists

- Costs of employment benefits
- Professional fees
- Costs of testing whether the asset is functioning properly.

The acquisition process is completed when the asset is in the condition necessary for it to be capable of operating in the manner intended by the management. Costs incurred after this date may not therefore be included in the acquisition costs (IAS 38.30).

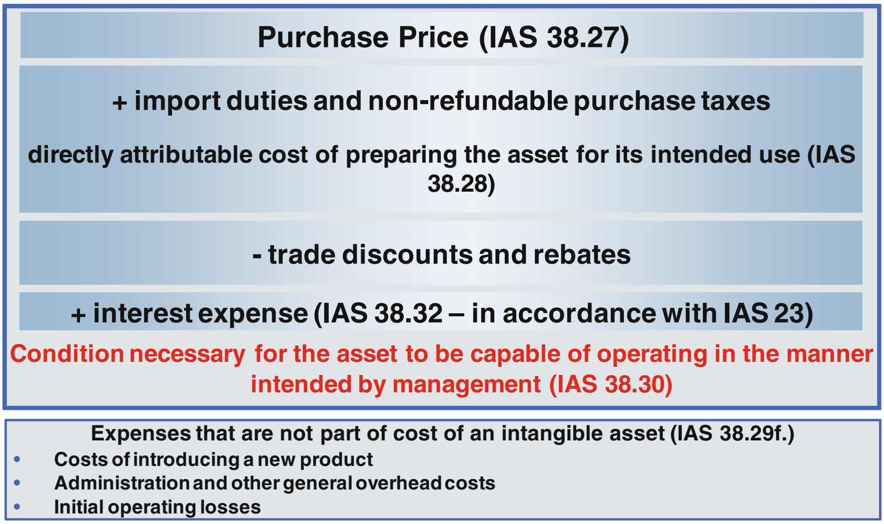

Fig. 6.19 Separate acquisition of an intangible asset

[28] Cf. Heyd/Lutz-Ingold (fn 2), 63 f.

Examples of expenditures which are not part of the cost of an intangible asset are the costs of introducing a new product, administrative and other general overhead expenses, and start-up losses (IAS 38.29 f.).

6.4.2.4 Business Combinations

Intangible assets are – as already mentioned (Section 6.4.1) – to be measured initially at cost (IAS 38.24). A business combination is, however, characterised by the fact that costs[29] are incurred for the combination itself but not for the individual assets, liabilities or contingent liabilities acquired. IFRS 3.36 consequently states that these items – and therefore also intangible assets – are to be measured at their fair value, provided that they have to be included at all in accordance with the observations under Section 6.3.3.3.[30] IAS 38.33 goes on to remark that the acquisition costs of intangible assets amount to their respective fair value.

The expression "fair value" is defined in Appendix A of IFRS 3 as "the amount for which an asset could be exchanged, or a liability settled, between knowledgeable, willing parties in an arm's length transaction". In determining the fair value, it is the perspective of a hypothetical and not that of an actual acquirer: the intention for use of the actual acquirer is subordinate to the opinion of the hypothetical acquirer.[31] The fair value reflects "the knowledge and the expectations of the market participants".[32]

Appendix B16 of IFRS 3 expands on measures to be treated as fair value. In the case of intangible assets (IFRS 3 Appendix B16 g), reference is firstly made to an active market,[33] whereas IAS 38.78 assumes that such a market does not normally exist for intangible assets. In accordance with IAS 38.39, the current bid price is the appropriate market price or – if this is not available – the price of the most recent similar transaction may provide a basis, provided that there has not been any significant change in economic circumstances in the meantime.

If no active market exists, the fair value is determined on a basis which reflects the amounts the acquirer would have paid for the assets in arm's length transactions between knowledgeable, willing and independent parties (IFRS 3 Appendix B16 g), whereby "recent transactions ...... for similar assets have to be taken

[29] Cf. IFRS 3.24–35 for the calculation of acquisition costs of a business combination.

[30] Refer also to Heyd/Lutz-Ingold, 54, who emphasise that no individual acquisition costs are available.

[31] IDW comment on financial accounting (IDW RS HFA 16), in: FN 2005, 721–738, Sub-section 7.

[32] Ibidem.

[33] IAS 38.8 defines the existence of an active market when items traded are homogeneous, willing buyers and sellers can normally be found at any time, and prices are available to the public.

into consideration" (IAS 38.40). IAS 38.41, finally, refers to multipliers, the relief-from-royalty method and the discounting of future net cash flows.[34]

6.4.3 Measurement After Recognition

6.4.3.1 Overview

IAS 38.72 allows in principle 2 possible accounting and measurement methods for measurement after recognition(Section 6.4.3.2):

- the cost model and
- the revaluation model.

In applying either model, impairment losses (4.3.3) and depreciation charges (4.3.4) have, if necessary, to be taken into consideration. This results in the carrying amount which IAS 38.8 defines as "the amount at which an asset is recognised in the balance sheet after deducting any accumulated amortisation and accumulated impairment losses thereon". Figure 6.20 illustrates procedures for measurement after recognition.

Cost Model	**Acquisition or construction** **./. Accumulated depreciation** **./. Accumulated impairment losses**	
Revaluation Model	**Revalued amount (IAS 38.75)** **FV determined by reference to an active market** **less any subsequent accumulated amortization** **less any subsequent accumulated impairment loss**	**It is uncommon for an active market … to exist for an intangible asset (IAS 38.78)**
Amortization	**Definite useful life (IAS 38.88ff.)** **Amortization method (IAS 38.97ff.)** **Residual value is zero unless … (IAS 38.100ff.)**	**Review of amortization period and amortization method (IAS 38.102, 104ff.)**
Impairment Loss	**Determination whether an intangible asset is impaired (IAS 38.111, IAS 36)**	

Fig. 6.20 Measurement after recognition

[34] For details on the measurement of intangible assets – also in the case of business combinations – refer in particular to Moser/Goddar, Grundlagen der Bewertung immaterieller Vermögenswerte am Beispiel der Bewertung patentgeschützter Technologien (Fundamental Principles in the Valuation of Intangible Assets, Taking the Valuation of Technologies Protected by Patents as an Example), in: FB 2007, 594–609, and IDW RS HFA 16 (Fn 31), sub-sections 19–60).

6.4.3.2 Cost and Revaluation Model

According to the cost model, acquisition costs are deducted from an intangible asset in order to measure accumulated amortisation and accumulated impairment losses (IAS 38.74).

The revaluation model assumes that the asset will be carried forward at the revalued amount. This is the result of the fair value at the date of revaluation less any accumulated amortisation and accumulated impairment losses, where fair value is to be determined by reference to an active market (IAS 38.75).

In view of the requirements which have to be met for the existence of an active market,[35] there are considerable restrictions on the application of the revaluation model. This is what IAS 38.78 also assumes: "under normal circumstances .... there is no active market for an intangible asset", patents, brands and trade marks, inter alia,[36] being listed as examples of these.[37]

The application of the revaluation model also requires that this is in principle also applied to all other assets "of a similar nature and use within an entity". IAS 38.73 also describes such a grouping of assets as a class of intangible assets.[38]

The revaluation model is not permitted on initial recognition, which – as explained above (Section 6.4.2) – has to take place for acquisition or construction costs, (IAS 38.76 (b)). In the case of self-generated intangible assets, it therefore has to be noted that, on initial recognition, and as a result of the recognition criteria, there is in principle a cap on construction costs (Section 6.4.2.1); however, on measurement after recognition "the revaluation model can be applied to the total asset value" (IAS 38.77). Heyd/Lutz-Ingold[39] point out that this must be regarded as a breach of the prohibition of past expenses being recognised at a later date as stated in IAS 38.71: expenditure immediately recognised as costs is included as assets within the terms of the revaluation.

Revaluations have to be carried out regularly, although an annual review is not obligatory. Rather, the guiding principle is that "the carrying amount of the asset does not differ materially from its fair value" (IAS 38.75 and IAS 38.79).

Further individual questions on the application of the revaluation model – such as procedures to be adopted upon the discontinuation of an active market, the treatment of increases or decreases in the carrying amount either as a profit or loss as a result of revaluation[40] and the treatment of the provision for revaluation – are explained in IAS 38.81–87.

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[35] See fn 32 for the definition of the expression "active market" in accordance with IAS 38.8

[36] In the German translation of IAS 38 (revised 2004), in addition to terminological inexactitudes, it was obviously not noticed that the term "Warenzeichen" (trade marks) in the German Trade Mark Act has been replaced by the term "Marken" (brands)

[37] IAS 38.78 does, however, also cite examples of cases in which there is an active market: transferable taxi licences, fishing licences, production quotas

[38] Examples of separate classes are to be found in IAS 38.119, such as "computer software" or "copyrights, patents and other industrial property rights, service and operating rights".

[39] Fn 2, 78 f.

[40] Refer in this case also to the example quoted in Heyd/Lutz-Ingold (fn 2), 81 f.

6.4.3.3 Amortisation

Finite and Indefinite Useful Life

In the measurement after recognition of intangible assets, IAS 38 distinguishes between those having a finite useful life and those having an indefinite[41] one. In the case of a finite useful life, the asset has to be amortised (systematically), but not in the other case (IAS 38.89). Under these circumstances and in accordance with IAS 38.88, it is necessary to examine which of the two cases applies.

An indefinite useful life is to be assumed, "if, based on an analysis of all the relevant factors, there is no foreseeable limit to the period over which the asset is expected to generate net cash flows for the entity" (IAS 38.88). IAS 38.91 emphasises that this expression differs from the expression "infinite".

IAS 38.90 lists various factors which have to be considered in determining the useful life.

A further significant factor in determining the useful life is the level of future maintenance expenditure. This has to be measured at the level necessary to maintain the asset at its standard of performance assessed at the time of estimating the asset's useful life. A conclusion that the useful life is indefinite should not depend on planned future expenditure in excess of this level (IAS 38.91).

The useful life of intangible assets resulting from contractual or other legal rights can be determined by economic and legal factors. The former determine the period of the flow of future economic benefits, the latter determine the period over which the entity controls access to these benefits. The useful life of these intangible assets is consequently limited by the legal background (IAS 38.94 f.).

In determining the useful life of patents, their legal limitation to 20 years has to be taken into consideration.

A possible extension of the legal rights can be considered in determining the useful life if the entity can demonstrate that an extension can be achieved without significant costs (IAS 38.94). In delivering this proof, various factors can be relied upon, such as experience or evidence that the legal requirements for a renewal to be granted will be met, as well as the fact that the extension costs will not differ significantly from the flow of future economic benefits. Should the renewal depend on consent from third parties, such evidence is also required (IAS 38.96).

In the case of patents a renewal of the legal period can only be considered in exceptional cases, for example when granting "orphan drug status".

Intangible Assets with Finite Useful Lives

As already stated in section "Finite and Indefinite Useful Life", intangible assets with finite useful lives have to be amortised. This means that the depreciable amount

[41] The German translation of IAS 38.88 ff. uses the expression "unbegrenzt" (unlimited)

is "to be allocated on a systematic basis over its useful life" (IAS 38.97).[42] This happens on the basis of an amortisation method. The depreciable amount is defined in IAS 38.8 as "the difference between the cost of an asset, or other amount substituted for cost, less its residual value".

The depreciable amount is therefore determined on the basis of the following factors:

- Cost of an asset or revaluation amount
- Useful life
- Amortisation method
- Residual value

As the first two factors have already been discussed at length (Sections 6.4.2 and "Finite and Indefinite Useful Life"), the following comments are restricted to the treatment of the two remaining factors.

The choice of *amortisation method* must reflect the pattern in which the asset's future economic benefits are expected to be consumed by the entity (IAS 38.97) and is in principle to be applied consistently from period to period (IAS 38.98). In accordance with IAS 38.98 the straight-line and declining balance method as well as the unit of production method are possible, the straight-line method always being applied if the amortisation pattern cannot be determined reliably (IAS 38.97). In addition, IAS 38.98 assumes that there is very rarely persuasive evidence to support an amortisation method that results in a lower amount of accumulated amortisation than under the straight-line method.

A *residual value* greater than zero can only be applied under exceptional circumstances. This is the case (IAS 38.100) when

- there is a commitment by a third party to purchase the asset at the end of its useful life or
- when the residual value, on the assumption that there is an active market (IAS 38.8), can be determined and it is probable that the active market will exist at the end of the asset's useful life.[43]

The amortisation period, the amortisation method and the residual value must be reviewed at least at the end of each financial year (IAS 38.102 and 38.104). If necessary, the appropriate modifications have to be made.

In the case ofintangible assets with finite useful lives, IAS 36 has to be applied to determine whether they are impaired, if there is appropriate evidence (IAS 38.111).[44]

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[42] IAS 38.8 correspondingly defines amortisation as "the systematic allocation of the depreciable amount of an intangible asset over its useful life."

[43] For the determination of residual value, cf. IAS 38.102.

[44] For details of the review of impairments see Section 6.4.3.4.

Intangible Assets with Indefinite Useful Lives

As already stated (see section "Finite and Indefinite Useful Life"), intangible assets with indefinite useful lives cannot be amortised systematically (IAS 38.107). They in fact have to be tested annually or whenever there is an appropriate indication of impairment (IAS 38.108).[45]

The assessment of the useful life of an intangible asset as "indeterminable" has to be reviewed in each reporting period (IAS 38.109). Should a change in the classification to intangible assets with finite useful lives take place, an impairment test has to be carried out (IAS 38.110).

6.4.3.4 Impairment Losses

Overview

In the measurement after recognition of intangible assets, impairment losses have to be taken into consideration – as already explained (Fig. 6.21). The relevant directives are to be found not in IAS 38 and IFRS 3 but in IAS 36.

The scope of application of these directives is not restricted to the treatment of impairment of intangible assets (IAS 38.111). Rather, IAS 36 can in principle be applied to all assets, though IAS 36.2 defines important exceptions. Accordingly, the financial accounting of impairments in the case of inventories, for example (IAS 2), of assets arising from construction contracts (IAS 11) and of deferred tax assets (IAS 12) is not regulated under IAS 36. The scope of application of the directives does,

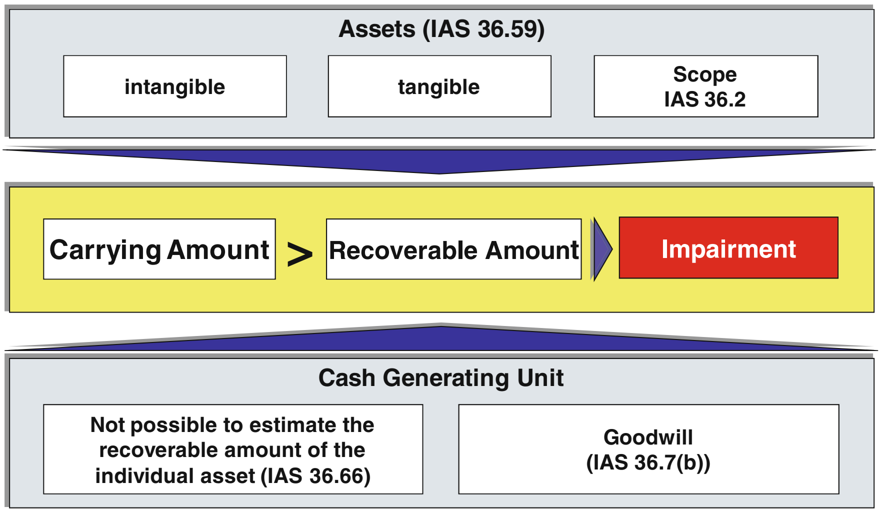

Fig. 6.21 Impairment loss – overview

[45] For details of the review of impairments see Section 6.4.3.4.

however, include fixed assets (IAS 16). IAS 36 also has to be applied to goodwill, which cannot be amortised systematically (IFRS 3.55).

An asset is amortised in accordance with IAS 36 if the recoverable amount is less than the carrying amount. On this condition, the asset's carrying amount has to be exceptionally amortised, i.e. has to be reduced to its recoverable amount (IAS 36.1, 8, 59). In those cases in which the recoverable amount for an individual asset cannot be assessed, the so-called cash-generating units have to be used as a basis for determining the impairment loss on classes of assets in accordance with IAS 36.66. This procedure also applies to impairments on goodwill (IAS 36.7 (b)).

IAS 36 also regulates the extent to which, in those cases where an impairment loss recorded in an earlier financial period no longer exists in part or in full, a reversal has to take place.

In the following there will firstly be an explanation of the treatment of impairments on individual assets (see section "Treatment of Impairments on Individual Assets"). After that, the procedure for cash-generating units will be examined (see section "Treatment of Impairments at the Cash-Generating Unit Level"). Finally, the conditions for the reversal practice will be illustrated (see section "Timing of Impairment Tests"). First of all, the identification of the existence of an impairment and the determination of the recoverable amount will be described (see sections "Identification of Assets with Impairment Potential" and "Measurement of the Recoverable Amount").

Identification of Assets with Impairment Potential

As a matter of principle, an assessment has to be made at each reporting date as to whether there are any apparent indications of an impairment (Fig. 6.22). If any such indication exists, the recoverable amount of the asset has to be estimated (IAS 36.9).

In special cases, and irrespective of possible indications of this kind, an annual impairment test has to be carried out (IAS 36.10). This applies

- to intangible assets with indefinite useful lives
- to intangible assets not yet available for use (IAS 36.11) and
- to goodwill acquired through a business combination.

These principles not only apply to individual assets. They are similarly valid for cash-generating units with or without allocated goodwill (IAS 36.7, 36.88–90).[46]

Evidence indicating an impairment is listed in IAS 36.12 in the form of examples, i.e. not exhaustively (IAS 36.13). In this case, the directive allocates these to internal and external sources of information (Fig. 6.23). Furthermore, it has to be noted that

[46] Cf. also Graumann, Die Durchführung des Wertminderungstests auf zahlungsmittelgenerierende Einheiten nach IAS 36 (The Implementation of Impairment Tests in Cash-Generating Units in Accordance with IAS 36), in: UM 2004, 370 ff., 373

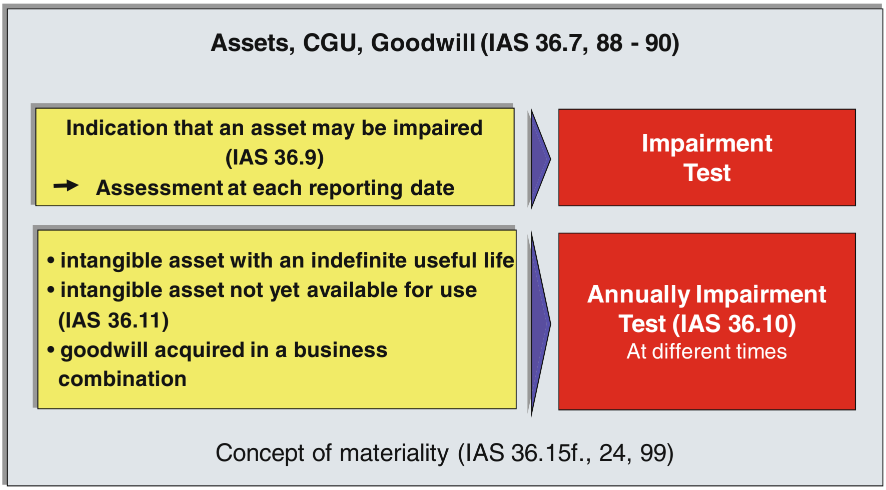

Fig. 6.22 Identifying an asset that may be impaired

this evidence – independently of impairment registration – serves as an indication that the remaining useful life, the depreciation/amortisation method and residual value of depreciable assets need to be reviewed (IAS 36.17).

Further indications of impairments on intangible assets are given in IAS 38:

- In the case of the application of the revaluation model for subsequent measurement (Section 6.4.3.2), the fact that an active market no longer exists for a revalued intangible asset is such an indication (IAS 38.83).

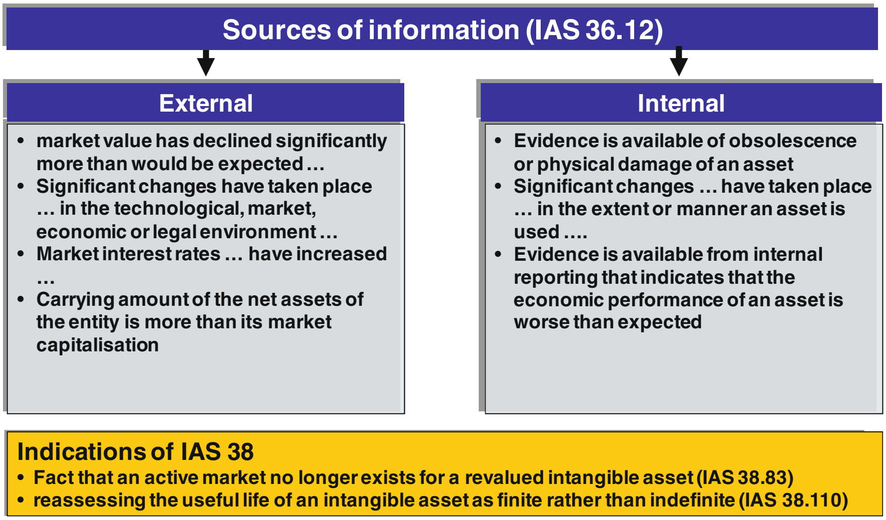

Fig. 6.23 Indication that an asset may be impaired

- The same applies to the reassessment of the useful life of an intangible asset as finite rather than indefinite (IAS 38.110).[47]

In reviewing recoverability, the concept of materiality has to be applied (IAS 36.15 f.). In this context, the recoverable amount does not have to be re-calculated especially if in previous calculations the recoverable amount was significantly higher than the carrying amount and no events have occurred that would eliminate this difference. These criteria are specified further in IAS 36.24 and 36.99 for intangible assets with indefinite useful lives, whose amortisation can only be reviewed in conjunction with a cash-generating unit, and for goodwill.[48]

Measurement of the Recoverable Amount

Basis

An asset or a cash-generating unit is impaired – as already explained – if its carrying amount exceeds the recoverable amount. On this basis therefore, the asset's or the cash-generating unit's carrying amount has to be assessed in those cases in which, according to section "Identification of Assets with Impairment Potential", the existence of an impairment has to be examined.

The recoverable amount of an asset or a cash-generating unit (Fig. 6.24) is defined in IAS 36.6 as "the higher of its fair value less costs to sell and its value in use" (IAS 36.18, 36.74).[49]

According to IAS 36.19, it is not always necessary to determine both the fair value less costs to sell and the value in use. This is the case if either of the amounts exceeds the carrying amount. In other cases, if it is not possible to determine fair value less costs to sell, the value in use corresponds to the recoverable amount (IAS 36.20). Fair value less costs to sell can ultimately be regarded as the recoverable amount if there is no obvious reason for assuming that the value in use considerably exceeds fair value (IAS 36.21).

The requirements for measuring the recoverable amount, specified in IAS 36.19–57, are applicable to individual assets as well as to cash-generating units (IAS 36.18 and IAS 36.7a and IAS 36.74).

Fair Value Less Costs to Sell

Fair value less costs to sell is defined as the "amount obtainable from the sale of an asset or cash-generating unit in an arm's length transaction between knowledgeable, willing parties less the costs of disposal" (IAS 36.6).

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[47] Cf. section "Intangible Assets with Indefinite Useful Lives".

[48] Heyd/Lutz-Ingold (fn 2), 94 f., assume that the conditions for these exceptional circumstances will in practice only rarely be met.

[49] See Heyd/Lutz-Ingold (fn 2), 90 for the assumption of the rational dealing involved in this.

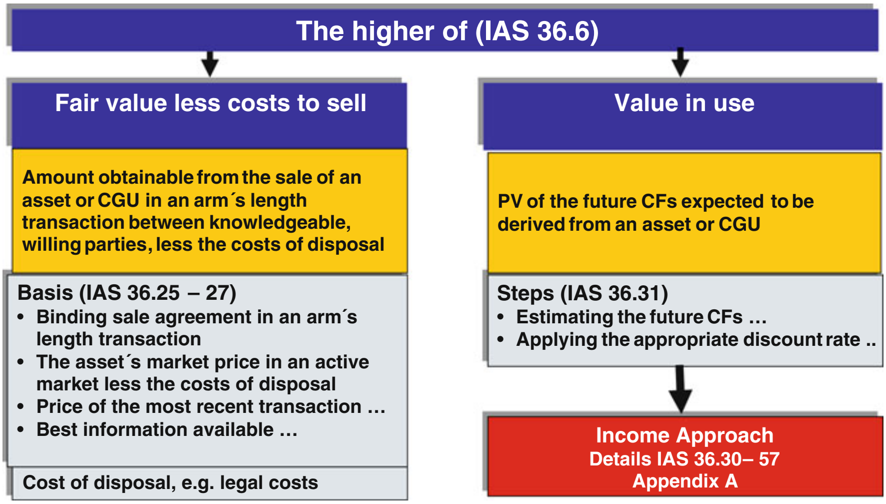

Fig. 6.24 Asessment of recoverable amount of an asset or CGU

IAS 36.25 presumes that fair value less costs to sell is best expressed as a "price in a binding sale in an arm's length transaction" – adjusted for incremental costs directly attributable to the disposal of the asset. If such a contract is not available, then the market price (less costs of disposal) in an active market should serve as a basis, where the current bid price is usually suitable. If this is also unavailable, the price of the most recent transaction may provide a basis from which to estimate fair value, provided that there has not been a significant change in economic circumstances in the meantime (IAS 36.26). Finally, IAS 36.27 refers to "the best information available to reflect the amount that an entity could obtain, at the balance sheet date, from the disposal of the asset in an arm's length transaction between knowledgeable, willing parties acting independently of each other after deducting the costs of disposal". In doing so, the outcomes of other comparable transactions are to be considered.

Costs of disposal are defined as "incremental costs directly attributable to the disposal of an asset or a cash-generating unit, excluding financial costs and income tax expense" (IAS 36.6). IAS 36.28 cites the following examples: legal costs, stamp duty and similar transaction costs, costs of removing the asset and direct incremental costs to bring the asset into the appropriate condition for sale.

Value in Use

Value in use is defined in IAS 36.6 as "the present value of the future cash flows expected to be derived from an asset or a cash-generating unit".

In accordance with IAS 36.31 value is determined in two steps:

- estimating the future cash flows of the asset or the cash-generating unit
- applying the appropriate discount rate to those future cash flows.

IAS 36.30 lists the following elements to be included in the calculation of an asset's value in use[50]:

- an estimate of the future cash flows the entity expects to derive from the asset or cash-generating unit
- expectations concerning variations in the amount or the timing structure of future cash flows
- the current market risk-free rate of interest
- the price for bearing the risk inherent in the asset or cash-generating unit
- other factors, for which IAS 36.30(e) cites as examples: "the illiquidity that market participants would reflect in pricing the future cash flows the entity expects to derive from the asset".

IAS 36.33–57 and Appendix A of IAS 36 expand in detail on the calculation of the value in use.

Treatment of Impairments on Individual Assets

The treatment of impairment costs – this meaning the amount by which the carrying amount of an asset .... exceeds its recoverable amount (IAS 36.6)[51] – depends on whether subsequent accounting is based on the cost or revaluation model (Section 6.4.3.2). In the first instance, the cost has to be carried immediately and in full at fair value through income; in the second instance, on the other hand, only in as much as it cannot be set off against the revaluation surplus.

IAS 36 offers no basis for the recognition of a liability in those cases in which the impairment costs exceed the carrying amount of the asset. However, this can be required by other standards (IAS 36.62).

Adjustments ultimately arise in the depreciation/amortisation charges for the asset concerned in future periods (IAS 36.63) and, if applicable, in any deferred taxes in accordance with IAS 12 (IAS 36.64).

Treatment of Impairments at the Cash-Generating Unit Level

Identification of Cash-Generating Units

As already explained, in accordance with IAS 36.66 the recoverable amount of the cash-generating unit has to be determined if this is not possible for an individual asset. The latter is the case if

- "the value in use of the asset cannot be estimated to be close to its fair value less costs to sell . . . and
- the asset does not generate any cash inflows that are largely independent of those from other assets" (IAS 36.67).

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[50] Similarly Appendix A1 to IAS 36

[51] Cf. also IAS 38.8

These conditions apply in particular under the following circumstances: typically, assets only generate cash flows in conjunction with other assets.[52] If the contribution of one particular asset to this joint cash flow of all participating assets cannot be isolated, its value in use cannot be determined. However, the asset can, on the one hand, be of particular importance in generating joint cash flow but, on the other hand, only be disposable at a very low scrap value. Under this assumption, it cannot be ruled out or even has to be assumed that the fair value less disposal costs does not reflect the value in use of the asset. If as a result of the low scrap value it is less than the carrying amount, it indicates an impairment, even though the unit as a whole may be completely recoverable.

This group of assets, to which cash flow can be allocated, forms a cash-generating unit (Fig. 6.25) if it is "the smallest identifiable group of assets generating cash inflows, which are largely independent of the cash inflows from other assets or other groups of assets" (IAS 36.6, 68).

A cash-generating unit is therefore characterised by

- the complementarity of the individual assets with regard to cash flow generation and
- the independence of the cash flow from other assets or other groups of assets.[53]

When identifying cash-generating units in accordance with IAS 36.69, various factors have to be considered. Among other things, the supervision of the entity's

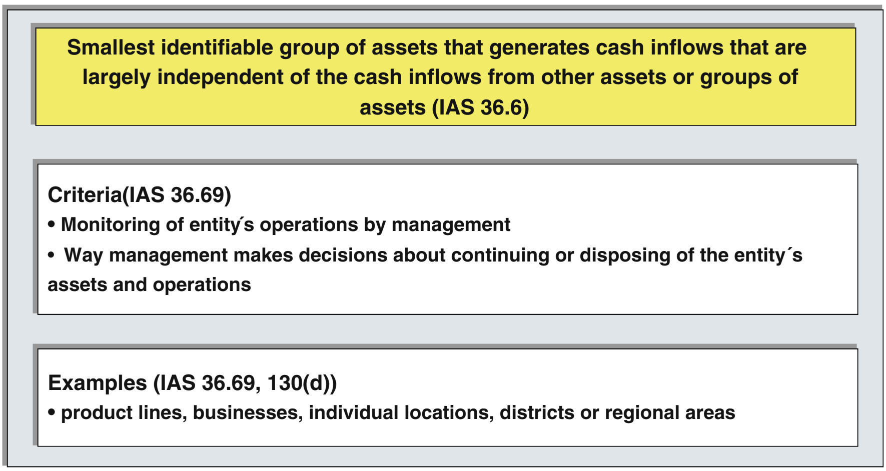

Fig. 6.25 Cash generating units

[52] On this subject, see e.g. Moser/Goddar (fn 34), esp. 597 f.

[53] Cf. Heyd/Lutz-Ingold (fn 2), 102

activities by the management and decisions made on the continuation or suspension of corporate activities are of primary importance. It could, for example, be a question of product lines, business areas, individual locations, districts or regional zones.[54] Further details such as procedures for vertical integration are explained in IAS 36.70 f.

Cash-generating units have to be identified consistently from period to period (IAS 36.72).

Determining the Carrying Amount of Cash-Generating Units

The impairment cost of a cash-generating unit results from a comparison of its recoverable amount with its carrying amount. The determination of the coverable amount of a cash-generating unit has already been described (see section “Measurement of the Recoverable Amount”), the determination of the carrying amount is explained in greater detail in IAS 36.75–79.

In accordance with IAS 36.75 the carrying amount of cash-generating units has to be determined on a basis consistent with the determination of the recoverable amount. In doing so, the following assets have to be considered:

- assets directly attributable to a cash-generating unit (IAS 36.76 (a)) and
- assets attributable to a cash-generating unit on a reasonable and consistent basis – e.g. by means of key sizes (IAS 36.76 (a)).

The last aspect mentioned refers to corporate assets. IAS 36.6 defines these as “assets other than goodwill that contribute to the future cash flows of both the cash-generating unit under review and other cash-generating units”. These are consequently characterised by the fact that they do not generate cash flows independently of other assets or groups of assets and that they cannot be fully allocated to a cash-generating unit. Examples of such are buildings of a headquarters or of a business division, EDP equipment or research centres (IAS 36.100).[55]

In those cases in which a corporate asset of a cash-generating unit cannot be allocated on a reasonable and consistent basis (IAS 36.77), the following procedure has to be adopted (IAS 36.102):

- the unit is examined from the point of view of recoverability excluding the corporate asset.
- the recoverable amount is examined at the level of the smallest group of cash-generating units to which part of the corporate assets can be allocated on a reasonable and consistent basis.

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[54] Similarly IAS 36.130 (d)

[55] For a review of corporate assets for impairment see IAS 36.101.

A similar procedure is adopted in the case of goodwill acquired by a business combination (IAS 36.77). This does not generate any cash flows independently of other assets or groups of assets; rather, it contributes regularly to the cash inflows of several cash-generating units (IAS 36.81). As a result, goodwill is to be allocated to the cash-generating units or groups of cash-generating units which are expected to benefit from the synergies of the combination, "irrespective of whether other assets or liabilities of the acquiring entity have already been assigned to those units or groups of units" (IAS 36.80). In this case, allocation occurs at the lowest level within an entity at which goodwill is monitored for internal management purposes. This unit or group of units may not exceed a segment determined in accordance with IAS 14 (IAS 36.80).[56]

Liabilities and provisions cannot as a matter of principle be included in the carrying amount of the cash-generating unit. On an exceptional basis, they can be recognised if, without their consideration, the recoverable amount of the cash-generating unit cannot be determined (IAS 36.76 (b)). IAS 36.78 quotes the example of restoration commitments with mines in this context.

IAS 36.79 allows simplifications for practical reasons.

Allocation of Impairment Losses

The impairment loss for a cash-generating unit or for the smallest group of cash-generating units to which a corporate asset or goodwill has been allocated (Fig. 6.26), firstly reduces the goodwill allocated. Any remaining impairment loss has to be set off proportionately from other assets of the unit or group of units (IAS 36.104). However, an asset's carrying amount may not be reduced below the highest of the following:

- its fair value less costs to sell (if determinable)
- its value in use (if determinable)
- zero.

An impairment loss that would otherwise have been allocated to the asset shall be allocated *pro rata* to the other assets of the unit or group of units (IAS 36.105).

According to the treatment of impairment losses on individual assets, IAS 36 does not offer any basis for the recognition of a liability incurred for any remaining impairment loss after application of the previously mentioned regulations. This can however be required by other standards (IAS 36.108).

If, in accordance with IAS 36.107, the appropriate cash-generating unit is not impaired, no recognition of impairment takes place on an asset whose recoverable amount cannot be determined.

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[56] Further details, particularly on the allocation of goodwill to cash-generating units or on the treatment of minority interests, are set out in IAS 36.80–99. Refer also to Heyd/Lutz-Ingold (fn 2), 172–176, Hachmeister, Impairment Test in Accordance with IFRS and US GAAP, in: Ballwieser/Beyer/Zelger (fn 16), 191 ff., 202–207.

	Carrying value	Recoverable amount	Reduction goodwill	Pro rata	Not below	Pro rata	Expense
Goodwill	20.0		0.0	0.0	0.0	0.0	20.0
Trademark	10.0		10.0	7.1	7.1	5.6	4.4
Patent portfolio	20.0		20.0	14.3	14.3	11.1	8.9
Finished goods	50.0	50.0	50.0	35.7	50.0	50.0	0.0
Raw materials	20.0		20.0	14.3	14.3	11.1	8.9
Tangible fixed assets	40.0		40.0	28.6	28.6	22.2	17.8
Total	160.0		140.0	100.0	114.3	100.0	60.0
Recoverable amount	100.0		100.0	100.0	100.0	100.0	
Impairment loss	60.0		40.0	0.0	14.3	0.0	60.0

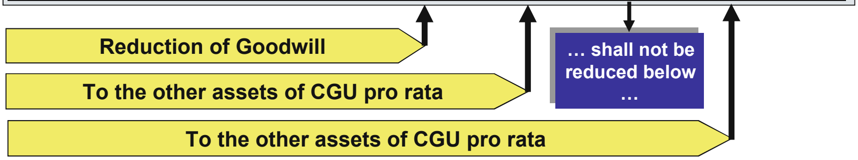

Fig. 6.26 Impairment loss for a CGU

Timing of Impairment Tests

The annual impairment test on intangible assets with an indefinite useful life, on assets not yet available for use (IAS 36.10 (a)) and for cash-generating units with allocated goodwill (IAS 36.96) may be performed at any time during an annual period provided the test is performed at the same time every year. Furthermore, the test can be performed for various assets of this kind as well as for cash-generating units at various times.

On testing the recoverable amount

- for assets belonging to a cash-generating unit with goodwill at the same time as those for that unit or
- for cash-generating units belonging to a group of cash-generating units with goodwill at the same time as those for this group,

the assets in question or rather the individual units have to be tested first then followed by the greater units (IAS 36.97).

6.4.3.5 Reversing an Impairment Loss

An impairment loss recognised in prior periods for an asset has in principle to be reversed in accordance with IAS 36.114 and its carrying amount increased[57] to the recoverable amount "if there has been a change in the estimates used to determine the asset's recoverable amount since the last impairment loss was recognised"

[57] It has to be pointed out that in accordance with IAS 36.117, the carrying amount after reversal of an impairment loss "may not exceed the carrying amount which would have been determined (net of amortisation and depreciation) if in prior years no impairment loss had been recognised".

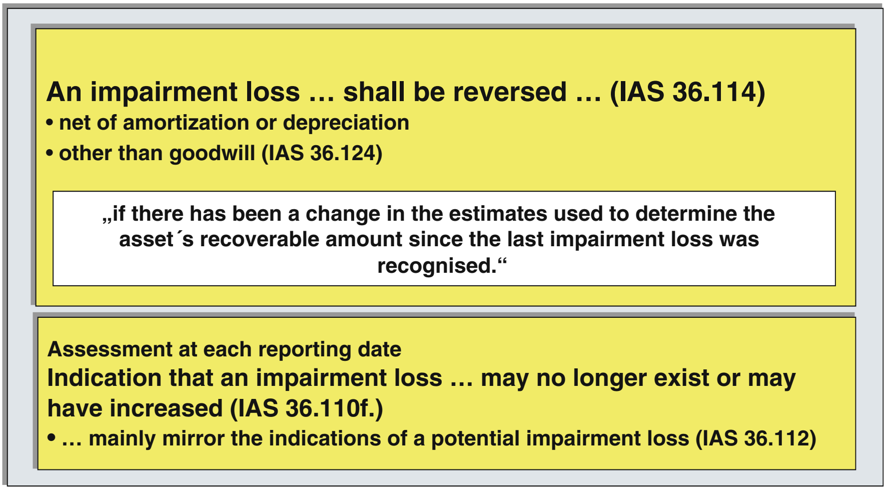

Fig. 6.27 Reversing an impairment loss

(Fig. 6.27). This does not apply to goodwill. In this case, a reversal of an impairment loss is not permitted (IAS 36.124).

To establish whether there is a requirement for the reversal of an impairment loss on an asset, there has to be an assessment whether there is any indication that an impairment loss may no longer exist or may have decreased (IAS 36.110). IAS 36.111 lists a minimum of such indications which have to be tested. These correspond to a great extent to those which in accordance with IAS 36.12 suggest the existence of an impairment loss (IAS 112).[58]

Further details on the treatment of reversals of impairment losses on individual assets as well as on cash-generating units are explained in IAS 34.109–125.

6.5 Notes

Included in the notes are a range of details on intangible assets. These arise primarily from IAS 38.118–128. Details on business combinations result from IFRS 3.66–77, on asset impairments and reversal of impairment losses from IAS 36.126–137. Given the scope available here, a recital of these disclosure requirements has been dispensed with.

[58] If such evidence exists, this is an indication that, in accordance with IAS 36.113, the remaining useful life, the depreciation/amortisation method and the residual value may need to be reviewed, irrespective of an impairment loss being reversed.

Part III
Intellectual Property Management/Patentmanagement

Chapter 7
Strategic IP Management for the Protection of Innovations

Hermann Mohnkopf

7.1 Introduction to Innovation Management

7.1.1 Germany as a Centre of Innovation

Germany needs to return to higher growth and rising employment in the future through greater value creation. The German government's High-Tech Strategy is the signal for a new innovation policy in Germany. The central plank of this strategy is a partnership between academia and industry. Individual strategies are to be developed for 17 cutting-edge fields of the future. Research funding and framework conditions such as regulation, standardisation and the protection of intellectual property are to be tied into a unified strategic innovation policy. Competitive advantages and, along with them, opportunities for growth depend on new ideas, products and system solutions. The result will be to create jobs and secure living standards both in today's society and for future generations.

The aim is to develop lead markets in Germany, to attract investors and researchers alike, so that new products, processes and services that can be sold around the world can evolve. The process of translating new research results into products should be quick and simple. State-driven funding of technology is passé; instead, what is required is a performance-oriented research landscape in which good ideas flourish. The German government is improving the framework conditions for inventors, researchers and innovative companies in Germany, the biggest economy in Europe.

Such was the vision pronounced by Federal Chancellor Angela Merkel at the European Patents Forum 2007 in Munich, in which she stressed the importance of patents for Europe's innovation capability and future viability. "The promotion of innovation and patent protection are two central challenges for the future of the Continent", said Merkel.

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W. Schmeisser et al. (eds.), *Innovation Performance Accounting*,
DOI 10.1007/978-3-642-01353-9_7,

She added that the protection of innovations played a critical role in creating the willingness to invest in research and development. As an export region for high-valued technology goods, Europe especially is highly dependent on systems for the protection of intellectual property that function efficiently.

To reliably guide innovations along from idea through to implementation in a product, management needs a regulatory environment. This includes the efficient protection and exploitation of intellectual property rights such as patents, trademarks, copyrights and designs. Patent protection gives a company the time it needs to recover on the market the investment in research and development out of which the patented invention evolved. Without protection of intellectual property and hence what is effectively monopoly rights in a specific region for a reasonable period of time, a company will not be adequately motivated to invest in innovative products.

Many factors play a role in determining corporate strategy: the useful life of the product, the in-house research and development base, the needs of the company's customers, the support of its suppliers, potential exploitation in its own products or through the granting of licences, and the competition in the relevant sector of the economy.

In the applied technologies such as automotive, environmental and mechanical engineering, Germany continues to be one of the biggest innovators and biggest generators of patents in the world. For example, German manufacturers are among the world leaders in all the main areas of car manufacture, such as propulsion, control systems, vehicle stabilisation, materials and safety. Again, in aerospace technology the number of patent applications grew by 7% between 2000 and 2004.

An applied example from the field of aerospace technology is used below to illustrate the rapid innovative response to a problem which led from analysis of the problem to the idea, implementation and finally to the product. In addition to the customer requirements and time targets, designers, materials specialists, new production technologies, suppliers and mechanics all played a part in the timely development of the product. The chain of events involved in the development of an innovation, how one ascertains the value of the innovation from process phases and how one demonstrates the value added in the value-added chain can be illustrated with the aid of the innovation process performance calculation, as per the Berlin Balanced Scorecard (BBS) approach, through translation of objectives, the strategic initiatives, into measurable criteria and requirements (see contributions of Schmeisser et al. in Chapter 4).

7.1.2 Terminology

7.1.2.1 Intellectual Property (IP)

According to Hilgers (2003, p. 1), "intellectual property" refers to the industrial property rights which are protected by the law of copyright and by related protection rights such as the legal protection of industrial property. In other words, intellectual property should be viewed as a kind of generic term for patents, utility models, designs and copyrights. The term comes from the legal protection of industrial property and recently from a new term commonly employed: the intangible property right. This right is used to refer to an exclusive right to intangible property such as ideas, concepts, technical inventions, works and information. No one but the owner of the right is entitled to use, imitate or use the intangible property without permission. If innovation and creative work are to be encouraged, if competitiveness is to improve, if the economy is to grow and technical progress is to create jobs for all, protection of intellectual property is essential.

7.1.2.2 Innovation Management

Innovation management is all about taking over and guiding the key phases from initial idea through to product launch, combined with the patent life cycle, in the company. In key phase 1 the idea is formulated, an analysis of the state of the art is conducted and the disadvantages of the current technical solution are apportioned, i.e. the process of developing a potential innovation gets under way. In key phase 2 the process of protecting the innovation begins with the preparation of a description of the problem solution and the filing of an industrial property rights application. Key phase 3 covers enforcement of the patent through to defence and preservation of the industrial property right. Key phase 4 covers the implementation, launch and application of the innovation and the patent which has been granted.

7.1.2.3 Legal Protection of Industrial Property

At this point reference will be made to Hilgers's definition of the legal protection of industrial property: "The legal protection of industrial property covers those regulations which serve to protect the intellectual work in the industrial area. These include patent law, the law governing models, designs and trademarks and competition law. Patent law grants an exclusive exploitation right for inventions. The law on registered designs confers only the right to copy designs and models that have an aesthetic value. Trademark law entitles the owner to launch a product or service on the market for the first time and to use the trademark to protect it against competitors. Finally, competition law is intended to prevent dishonest competitive practices".

7.1.2.4 Patent System, Patent Management and Innovation Management

It is quite difficult to draw the line between the terms patent system and patent management as they are frequently used together in the literature.

"The patent system is concerned with legal protection of the commercial exploitation of technical knowledge. The following are technical knowledge: inventions, new technical resources and means and procedures for satisfying human needs" (Huch 1997, p. 2). Here Huch defines commercial exploitation as "the use of economic resources (capital and work) in a company with the aim of recouping the resources used through the application of the technical knowledge and of making a profit on top of this". Huch rationalises the legal protection with the creation of a privileged position up to the point where the resources used are recovered.

Patent management on the other hand attempts to exert an influence on technology management through patent information gained. Ernst defines patent management as follows: "Patent management supports technology management in its central function of planning and directing the process of internal and external technology acquisition, storage and exploitation so as to best fulfil the corporate goals".[1] Harhoff too assigns patent management to the technological knowledge areas and classifies it under innovation management. According to Harhoff, innovation management can be defined as the attempt to systematically shape and influence innovation processes in the company in such a way that the company obtains an optimal return from the creation and marketing of new products, services and processes. In this context industrial property rights such as patents, utility models and copyright constitute instruments of innovation management. Here a company's patent management determines strategies, processes and structures aimed at optimising the value of its intellectual property.[2]

7.1.2.5 Invention, Innovation and Diffusion[3]

In research, "invention" is normally taken to refer primarily to the "invention or discovery of new problem-solving potentials",[4] the "... intellectual anticipation of a possible problem solution".[5] As well as the feature of (objective) novelty, another characteristic sometimes mentioned as required is a certain "anticipated usefulness".[6] In this way "innovation" includes the actual action with which the idea representing the novelty is implemented, i.e. launch on the market as a marketable product. Such a distinction underlies the analysis of innovation processes.

On the other hand, Fischer prefers a more final interpretation of the terms invention and innovation. Invention, he argues, covers an act of imagination such as the creation or manufacture of the novelty as a tangible or intangible product, whereas innovation is understood as a higher-level process geared towards the launch and transformation of this new product.[7] Invention and innovation both contain thinking and action aspects, but they are geared towards different intentions.

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[1] Ernst (2002), p. 3

[2] Harhoff (2005), p. 177

[3] Schmeisser, Kantner, Geburtig and Schindler (2006), pp. 11–12

[4] Pfeiffer & Staudt (1975), column (1943)

[5] Cited in Fischer (1982), p. 30

[6] Mansfield. p. 50 ff.

[7] Fischer (1982), p. 30 ff; cf. Scherer (1984)

Whereas under the first interpretation invention and innovation are in an equal relationship or, in the process sequence, the invention clearly precedes the innovation, the second interpretation is based on a relationship of subordination which allows interdependencies and two-way flows between invention and innovation.[8] The delineation between innovation and diffusion seems to be clearer: the diffusion process, which Mansfield essentially characterises as a “learning process”,[9] applies at that point in time when the new “product”, the innovation, is first launched on the market. In diffusion research, statistically the first 2.5% of the users of innovations in the diffusion process are often referred to as innovators, and succeeding users as imitators.[10] However, such a subdivision makes little sense as far as the business is concerned, as the important issue is not the objective novelty of an innovation but the subjective novelty for the business concerned.

7.1.2.6 Employee Invention Act

The Employee Invention Act is a law that only applies nationally in Germany. This law covers inventions and technical improvement proposals from employees in the private and public sector, from officials and personnel in the armed forces.

7.1.2.7 Service Inventions

Service inventions are inventions made either during the term of employment or shortly afterwards which arise either from the activity owed to the employer in the business or through suggestion from the field of activity of the business, i.e. all inventions which affect the field of activity in the wider meaning.

7.1.2.8 Own Industrial Property Rights

Own industrial property rights are commercial technical industrial property rights, i.e. patents or utility models owned by the business.

7.1.2.9 Third-Party Industrial Property Rights

Third-party industrial property rights are rights owned by third parties, notably by competitors.

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[8] Fischer (1982) p. 36; cf Grefermann & Sprenger (1977), p. 23

[9] Mansfield (1968), p. 132

[10] Pfeiffer & Staudt (1975); Kiefer (1967). According to Mansfield, the diffusion rate of innovations depends on the following four factors: a) the extent of the economic advantage of the innovation over older methods and products, b) the degree of uncertainty when the innovation is first applied, c) the cost of first-time testing of the innovation and d) the extent of uncertainty reduction (Mansfield (1968), pp 133 ff.).

7.1.3 Problem Statement and Aims of Strategic Innovation Management

Technical advances increasingly play a critical role in determining profitable growth in companies. Innovation activity, that is, above all technical ideas through patent and trademark protection to the initiation of production, plays an important role here.

Hence IP management, which makes use of the legal protection of industrial property, has come to be highly important in the company. For this part of company management, it is normal practice today to adopt a strategic approach in the daily business which is not just intended to save companies high costs. But the procedures necessary for this which need to be observed in the company not only concern scientific–technical processes in production but also necessitate organisational changes and essentially social processes.

Technical developments with their positive and negative consequences call for a change in employee attitudes towards technological development, which has an impact on the effective enforcement of innovations.

Employee ideas, as the offer of problem solutions and new know-how based on technological changes and new production methods, are extremely important to companies both to survive and grow and also as a means of gaining competitive advantage. They give companies security in planning, customer satisfaction, product stability and internal cooperation at a time of highly competitive pressure due to globalisation. Products are becoming ever more short-lived and are taken off the shelves more quickly then ever before. Any company hoping to hold its own needs effective ideas management. In particular, it is essential to respond quickly to customer needs and come up with targeted problem solution proposals in the product. Especially as regards the use and application of the product, short response times and prompt product launch conditions are required.

However, all these parameters can only be asserted if well functioning processes and procedures support this. Organisational structure also plays a role here. Figure 7.1 gives a practical example.

The strategic approach with effective innovation management has become indispensable. If customer requirements are to be implemented quickly and purposefully, the outstanding feature in both new designs and technical changes and modification of components and whole systems must be protected from the patent side.

It must be the aim of an industrial enterprise to increase the proportion of successful new products in the portfolio even during economic downturns and under tougher competitive conditions. Strategic innovation management requires that new ideas are generated in the company and tested for marketability and marketable products which address customer requirements are developed, all in the shortest possible time (see Example in Fig. 7.2). This requires on the one hand the right tools and methods which can be used purposefully and effectively for the project. At the same time the innovation managers have to motivate all the employees to "be

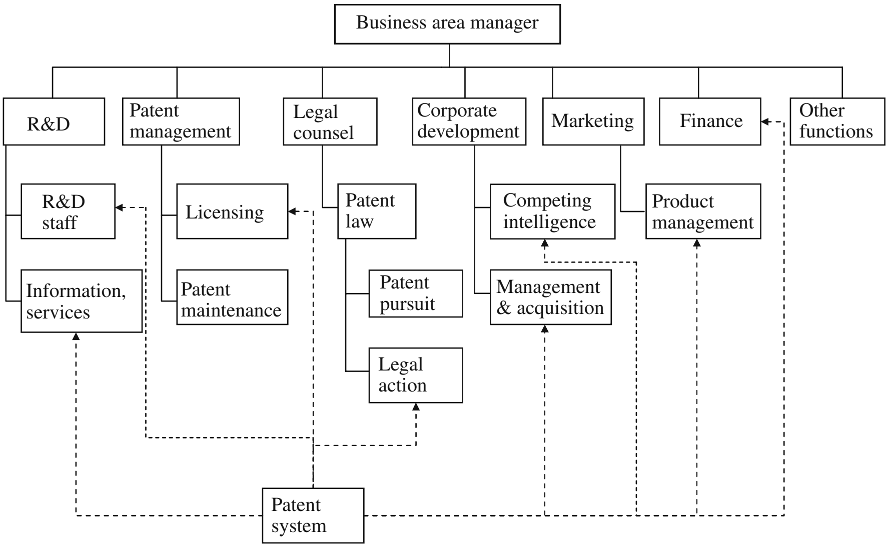

Fig. 7.1 Example of an organisational structure

creative" in a team, from preliminary design for a new product to further development and the necessary testing to market maturity, to enthuse them for new ideas and resolve conflicts in the team.

Company analyses in R&D are also an important milestone within the product innovation cycle. As a first step they require individual examination of projects and specifically of R&D projects. While the analysis should emphasise the importance of the project in the corporate strategy, at the same time specific risks must be identified and accepted fairly by every department in order to be able to respond promptly.

For this purpose business models, calculation methods and analyses for evaluating action possibilities have been drawn up in order to make the resulting success criteria available for other applications in the company.

7.1.4 Operational Structure and Strategic IP Organisation

In a multinational company, as well as the supplier-related internal project organisation, it is also very important to control the line structure for the areas of research and development, business area development, financial controlling, contracts, sales, aftermarket, law and IP management in an innovation-oriented manner.

As presented in the next section, IP lies at the centre of every activity in the company. Whether we are talking about preliminary design, redesign, product development, production, business development or financial controlling, all of these have

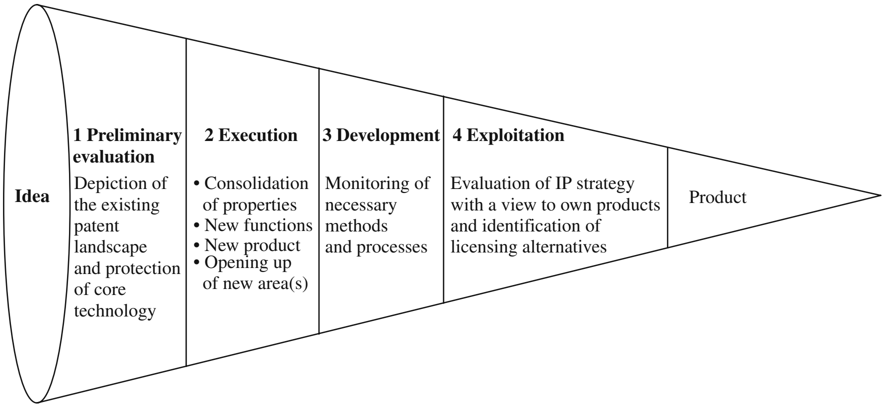

Fig. 7.2 Example of idea through to product launch

a function related to cost management and budgeting. In addition, supplier relationships and external cooperation are integrated into the company's IP process through the purchasing, law and IP departments as regards protection of intellectual property.

Line and project organisations can be structured differently, but must always have the aforementioned as the base and also follow from the requirements of the company, the corporate culture and the business model and be oriented towards the product innovation cycle.

Within the company, the intellectual property managers (IPM) also always rely on close cooperation through a coordination function through their deployment in the business areas.

The aim is to ensure through liaison meetings or ongoing patent discussions and training of the IP representatives in the disciplines and their coordination of innovations with product development, production and technology management, that all aspects involved in protecting the new technology are considered.

7.2 The Integrated Innovation Process as a Corporate Strategy

7.2.1 Corporate Strategy as a Strategic Competitive Advantage

At the centre of a functioning corporate strategy lies the business area strategy, which includes a technology strategy over all the technology fields and also the relevant product strategy. Figure 7.4 shows the influence of the corporate strategy on the patent strategy in the company.

All these aspects which influence the patent strategy of the company (see Fig 7.3) are the basis of all innovations in the company and must be protected along with locking up of the know-how and trade secrets. Trademarks and copyright are additional tasks in IP.

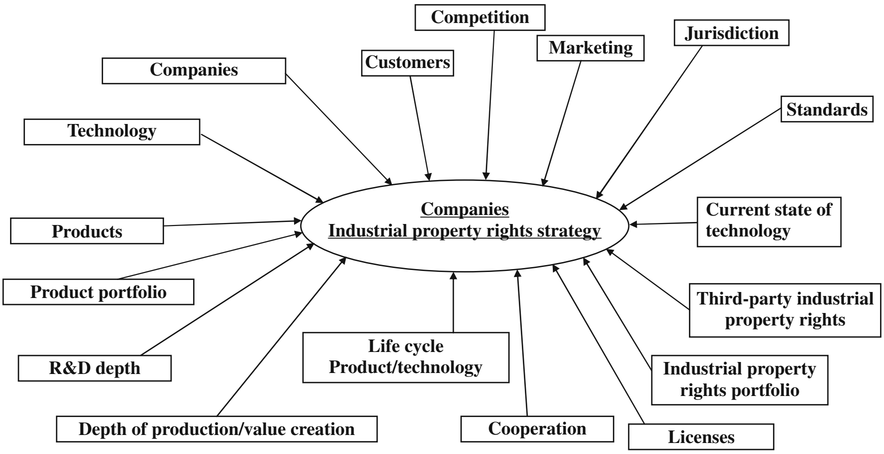

Fig. 7.3 Factors influencing company's industrial property rights strategy

The product innovation cycle, which is made up of nine essential features, follows from the corporate strategy – see Fig. 7.5.

Through early integration of all the participants in the R&D process, that is, designers, materials specialists, production engineers, buyers and suppliers, the foundations are laid for all the innovations in a given project. Here, strategic internal and external points of emphasis for the new product or modifications are laid down and overseen by all the project managers. Support for IP-relevant subjects, such as patent protection, trademark protection, copyright etc., is provided in predefined milestones in the project plan or through reviews and patent checks at fixed dates.

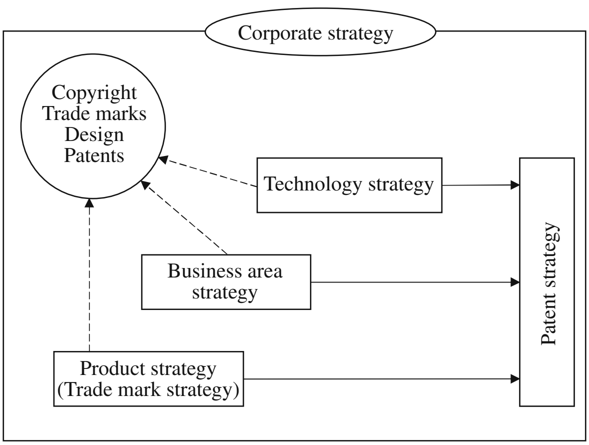

Fig. 7.4 Influence of corporate strategy on patent strategy

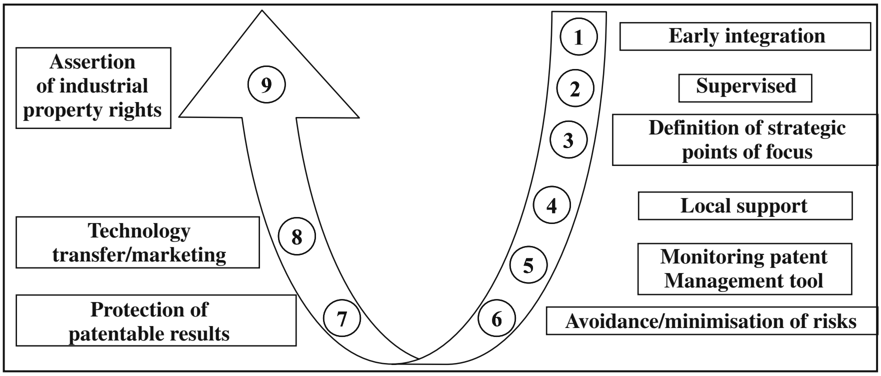

Fig. 7.5 Features of the product innovation cycle

The IPMs advise the design and production engineers, note down any new, patentable ideas, perform selective patent searches and specify any recurring searches on commonly specified subject areas to be conducted at fixed intervals.

They track IP campaigns, plan and create patent application texts, which they secure on the basis of the invention disclosure form and direct discussion with the project engineers. Section 7.3.7 presents a system for organising the monitoring of industrial property rights in the company and explains the tasks of the R&D staff and IPMs involved.

Industrial property rights information and monitoring of industrial property rights are also important information factors, as are the protection of intellectual property and making the information available in the company's internal process chain (Mohnkopf 2007, p. 37ff).

Throughout the innovation path, from idea to the start of series production, it is constantly necessary to identify, avoid or minimise specific risks through problem analysis.

Protection of patentable results is maintained throughout the innovation process, as it is necessary to keep performing patent reviews, i.e. comparison of current state of the art with the new devices and procedures, not only in design but also in test, materials research and production.

In particular, the IPMs maintain close contact with those responsible from R&D, technology transfer management and the licence specialists, in order to comply with company regulations regarding technology acquisition and technology marketing.

Through the analysis of industrial property rights, from first filing through to granting of the patent specifically with regard to use in one's own product, to the exercise of blocking action against competitors to licensing, an ongoing basis for decisions is developed for the body which makes the decisions regarding the handling of industrial property rights internally and externally for further action.

Assertion of the company's industrial property rights, their defence and preservation are the job of the IPMs, coordinating closely with the technical departments. Here too, the involvement of the project participants or, in the case of industrial property rights outside one particular project, the inventors and the experience of the technical departmental management, is very useful to the assessment and exploitation initiatives.

Naturally, if innovations are to bring the company success, it is also necessary to analyse the customer requirements, maintain ongoing contact with the customer's technical representatives and analyse the customer-manufacturer interfaces in the application of the products.

Watching the market segment in which the company is active, literature and patent searches on the competition and discussions with one's own colleagues and inventors in the various departments are just as important as it is to determine the project and process strategies, define and monitor the corporate goals and their realisation.

The patent strategies derived from the corporate and technology strategies are a target for all those involved in the process and contribute towards determining the approach to business policy and also the approach towards protecting the intellectual property, namely, patent portfolio management, environment analysis, dataflow and patent application parameters (see Fig. 7.6). A clean and reliable database is essential for working out patent goals and a downstream patent strategy in the entire R&D process. Project-oriented patent work presupposes that the fine details of the strategic action requirement for the relevant core technology field have been worked out, so that the initial phase of the project can be completed in as short an interval as possible. Here it is important to clarify the patent situation in one's own company, feed in the existing industrial property rights and create a subject-related strategy plan before the project start. In this connection, IP is always part of the project, as it may occasionally be necessary to adapt the company's patent strategy paper here. One important element of the project goal is that the project staff should be trained by the IPM on industrial property rights, industrial property rights searches, monitoring and infringement criteria.

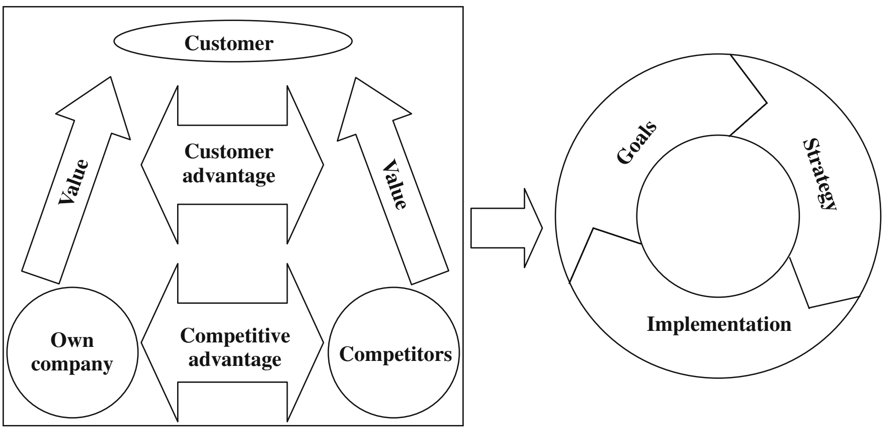

Fig. 7.6 Interactions between goals, strategy and their realisation

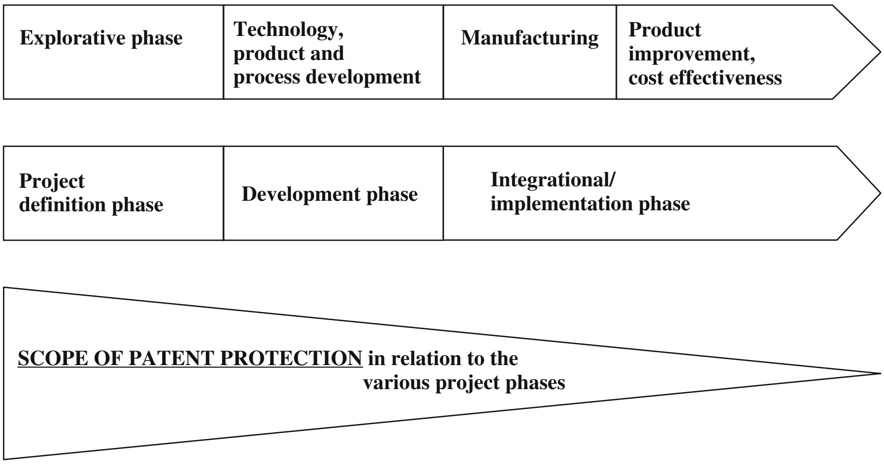

Fig. 7.7 Phases for project-integrated strategic patent work

Figures 7.7, 7.8 and 7.9 illustrate portfolio maintenance during the various phases of the project. Portfolio maintenance over the course of the project and the evaluation and action parameters at the conclusion of the project are important milestones in the interplay of the disciplines, from market requirement across company departments to industrial property rights maintenance and technology marketing. The protective scope of a patent in relation to the project and project phases,

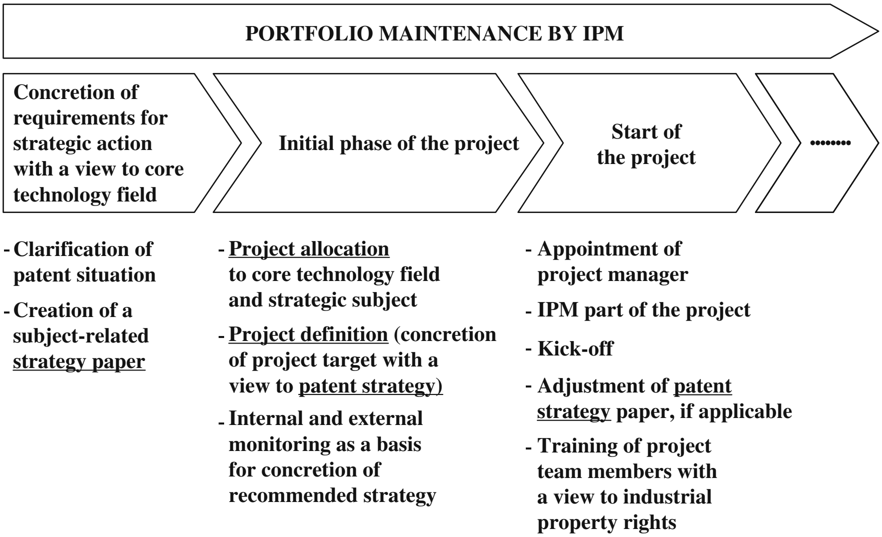

Fig. 7.8 Portfolio maintenance during the initial and start phases of the project

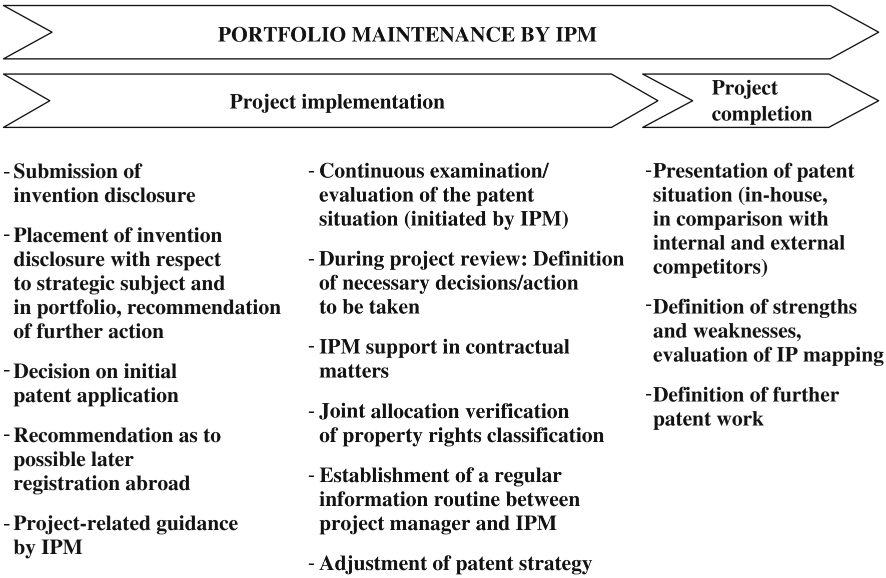

Fig. 7.9 Portfolio maintenance during the implementation and final phases of the project

the pre-development phase, product development, production, product improvement and cost reduction is essentially determined by the development results.

The project definition, development and integration/implementation phases determine how successful the project will be.

The following influencing factors are particularly important for the development of the corporate industrial property rights strategy:

- Corporate structure and company requirements
- Customers and suppliers
- Competitors
- Marketing requirements
- Laws and directives
- Standards
- State of the art
- Third-party industrial property rights
- Company’s own industrial property rights portfolio
- Licences
- Cooperative agreements with partners and competitors over R&D
- Life cycles of products and technologies
- Depth of production
- Value-added chain in the company
- Company’s product portfolio
- Technology and materials availability

7.2.2 Research and Technology Project Organisation

The technology acquisition process in an international technology company is marked by stringent organisation in its course and close cooperation between individual disciplines.

The aim of the process can only be to ensure the provision of technologies for the project plans specified in the master plan.

As a result of this process newly acquired technologies which will be used in new projects in future or have already flown into existing products are available to the company.

The process-leading organisational unit gives the process participants directions as to how submission of applications, planning, coordination and implementation are to be carried out.

Information and services, internal and external, are summarised and prepared for the project managers and offered to them.

Interfaces with other areas must be defined in order to ensure that everything flows smoothly within the project. This can be routinely accomplished through organisational and procedural instructions. Amongst other things these will cover research and technology acquisition, technology selection, process of methods software, acquisition of production technologies and confidentiality, IP protection and security both inwards and outwards. The process-leading organisational unit is in charge of integration, implementation and support for strategies and technology acquisition programmes. This leads to detailed tasks such as definition and coordination of the technology acquisition strategy and the technology programme for the relevant product definition plus the right of ownership to particular processes for evaluation, implementation and management of the technology programme. The project-oriented detailed tasks and milestones also include planning and tracking of the annual budget and the relevant budget plan over several years.

Moreover, IP-relevant activities are necessary at this point, namely, controlling and tracking the exchange of technology programmes and intellectual property rights within the company. Monitoring of these activities with partners outside the company is effected through a coordination office in consultation with IP and the legal department, especially contracts.

Again, the protection of suitable contractual provisions for joint projects with partners and provisions for the protection of intellectual property, pre-existing IP rights and provisions covering jointly developed IP rights must be regulated in advance, especially where national regulations and export control regulations exist. The project manager will keep an eye on both technical and administrative developments and, in so doing, monitor and adhere to deadlines for funded projects for which different reporting and billing obligations apply.

In their role of supporting the project manager, those in charge of technology are responsible for monitoring the project, representing the technical interests in the development team for parts and subassemblies, are involved in the analysis of competitor activities, coordinate actions and serve as contact persons for the IPMs in the company for the technical evaluation of ideas and inventions. Financial controlling is another important partner of the project, supporting the project team with financial forecast planning, internal and external billing over the course of the project and cost monitoring. Financial controlling prepares cost rates for estimation of the costs of making the application, approves and modifies requirements within the framework of the project and updates the overall preliminary costing, taking into account the elapsed time between phases payment flow.

The purchasing manager also plays an indispensable role on the project. He supports the selection of future suppliers and plays a part in developing the supplier strategy in the technology acquisition process. Here, the company-wide purchasing strategy serves as the basis; it is always implemented within the project by the purchasing manager unless deviations are globally agreed in advance.

As a member of the project, the IPM advises the project manager on all issues of IP management, especially as regards the industrial property rights strategy on applications, enforcement and preservation, both before the project gets under way and also on an ongoing basis.

Patents provide protection for new products and procedures and through the monopoly right conferred they offer the company a competitive edge. But patents benefit not only the business but also the employee as inventors. Industrial property rights constitute important documents from which the state of the art can be determined. They also provide information on the specialist areas and subjects in which the competition is conducting research or development work. Through targeted patent searches, employees and engineers obtain important information which often saves them from having to duplicate work or indicates the state of the art. Under the Employee Invention Act employers in Germany remunerate employee inventors for their inventions if the industrial property right is applied in production. All in all, it is therefore well worthwhile, and not just for the project work, having a good overview of the patent system and using the possibilities that it offers deliberately to improve global competitiveness and the development of technical improvements. At this stage it should be pointed out that it is a very good idea to draw up a separate procedural instruction for innovation management in the company and to make clear the sequence of steps from the inventive idea to the granting of the patent and volume launch of the product by means of a flowchart.

During the project pre-selection phase, all the proposed projects are compared with the ascertained state of the art so that the degree of novelty can be assessed, and how these projects relate to the corporate strategy and products is established. The various project proposals are prioritised and proposals for funded projects identified.

The project manager arranges for a patent search to be carried out even before project descriptions of the selected projects have been prepared and calls in the IPM to assess the results and appoint the members of the project team.

After that, in a technology selection process, a suitable technology is selected to be the subject of a project while the product strategy of the company, its affiliates and the future technology goals are specified. The acquisition strategies also enter into the process. In this connection, the ability of the regional business units of the technology providers to supply the capabilities needed has to be considered.

The prioritised projects are assessed as regards the benefit to the future business of each unit and examined as regards financial investment, funding possibilities through external programs and self-financing.

In this connection, use will subsequently be made of the criteria used in the innovation process success calculation, as described in further detail in Chapter 12.

7.2.3 National and International Research and Technology Trends

Investing in research and technology is a key element of economic policy in the company. The resulting innovations have the effect of bringing steady growth in the global competition, from their origination through to product launch. Every analysis of international trends in research reflects the influence of the research funds invested on the American market. Between 1998 and 2000, over $200 billion was invested each year in the United States of America – more than in the United Kingdom, France and Germany combined.

Yet it is not just the amounts invested in research and technology but also the number of resulting industrial property rights that is so striking in this context.

Three different trends can be discerned in the global context:

1. More and more global collaborative agreements are being concluded with external partners and greater value is being placed on licensing and collaboration on projects sponsored by foreign governments.
2. Corporate management appears to be focusing strongly on achieving corporate goals, especially in research and development. "Management by objectives" has become an established element of corporate strategy.
3. Research projects are increasingly geared specifically towards corporate strategy and business results, a trend in which changes in the conditions under which sponsors operate and dwindling availability of funds are becoming increasingly important factors.

It is therefore all the more important to develop models for the evaluation of R&D projects and to use these directly in the decision process. An example here is the way the Rolls-Royce Group collaborates with global partners in industry and academia to develop new engines.

7.2.4 Innovation Example from Problem Through to Product Maturity

Modern civil engines are subject to ever tougher demands as regards efficiency, environmental compatibility and low-cost production. These objectives require the use of modern materials and technologies. Fibre composite materials demonstrate great potential for engine applications due to their high specific strength and tailored production.

The example of a component made from fibre composite materials for an aircraft engine will be used to illustrate how new approaches to a design solution that take into account modern production methods can be developed in a relatively short time, thanks to purposeful project organisation. On this project, the research & development and technology management departments and the suppliers all worked together in a highly cost-effective way, especially in relation to the conditions and requirements imposed by the aviation authorities and customers.

In a problem analysis aimed at identifying the disadvantages of the present component and determining the development goals of changing the component, first of all information was gathered and an analysis of the current configuration was carried out. The small project group consisting of two development engineers, design and materials specialists, a representative from Purchasing and another representative from Sales, who summarised the customer requirements, was supplemented by an IPM who defined the framework for a literature and patent search together with the project members.

The impetus to change the component, which is located in the engine intake and has the function of conducting the incoming air into the compressor, arose in the course of a cost reduction programme. In addition, the materials specialist suggested that, if possible, the part should be manufactured from a single component and using the "filament winding" method, an automatable wrapping process used for components made from fibre composite materials.

This would mean departing from the normally used prepreg method, which entails manual bondings at a particular location, and would thus eliminate a source of defects and minimise or eradicate quality fluctuations.

The aim was to reduce costs caused by premature failure of the component, i.e. at odds with the planned life cycle.

The solution needed to specifically take into account the problem of penetration by foreign objects such as hail, stone impact and ice – foreign object damage – and also the desirability of reducing the number of components through the use of function-integrative design methods.

The project group also examined what form future customer requirements regarding this component might take and defined these in the form of a project requirement. Maintainability, life cycle costs, better handling capability and cost savings are always the top priorities.

Also on the list of development goals were better surface moulding of the component, weight reduction, quality improvement and reduced noise and toxic emissions. On top of this, it was hoped that greater rigidity and aerodynamic optimisation of the external contour would improve the rotor dynamics and incident flow.

With regard to manufacture of the component, as already mentioned, it was also important to develop a production process that could be automated so as to minimise quality fluctuations and thus achieve the objectives that had been set. In this connection, the chosen automated manufacturing process should make it possible to significantly reduce the cost of the component despite using more expensive materials.

A requirements analysis for the design change was prepared by all the departments. This was carried out using the standard TRIZ process of inventive problem solving, a unique, knowledge-based approach to the solution of innovative problems. Ideality is defined in terms of the main function of the product. In his book, "The systematic path to problem-solving", Zobel presents not only TRIZ tools but also supplementary methods and practical examples (Expert Verlag 2007).

To explain the principle of ideality, let us take the example of a computer keyboard whose main function is to transfer information from the user to the computer.

The ideal system must satisfy the following requirements:

- eliminate the disadvantages of the original system
- retain the positive characteristics of the original system
- not be any more complicated
- not introduce any additional disadvantages
- fulfil the function *without being physically present* (space, mechanics, maintenance...)

Based on these requirements, an ideal computer keyboard transfers the information from the user to the computer without actually being there.

This extreme illustration concentrates product development on the main functions of the system and serves as a model. The closer a product comes to this model, the better.

The ideality principle can best be illustrated using a formula:

$$\text{Ideality} = \frac{\sum \text{useful effects}}{\sum \text{costs} + \sum \text{harmful effects}}$$

The bigger the resulting quotient, the greater the ideality of the product.

TRIZ is based on the idea that many fundamental technical requirements have already been solved once. Unlike conventional approaches, which often make compromises, TRIZ looks for design contradictions and tries to eliminate or solve them. TRIZ is based on the analysis of comparable technical problems and offers a systematic approach to the development of new, innovative products.

The next stage after the requirements analysis was to develop the concept proposals in the project. Once the literature and patent search results were available, further project discussions were initiated with the aim of assessing them in the team.

Determining the state of the art inside and outside the company and externally as revealed by the patent situation indicated that different approaches existed towards technology acquisition: hybrid composite metal solutions and also a metal-sheet variant of the nose cone.

However, the new solution needed to satisfy the requirements described above and also take into account the customer requirements.

These requirements – adaptation of the composite component to the subassembly, automated process involving the use of filament winding, simpler manufacture including at the supplier's (design-to-make) and single piece component – were to be first summarised in a dissertation and later discussed individually in the project, if necessary, with external manufacturers. In addition it was important to define other project constraints, such as reduced manufacturing costs, improved aerodynamic characteristics and weight reduction on the component as a whole.

Similarly, the mechanical loading criteria, such as bird strike, hail, ice, the influence of temperature and temperature fluctuations, were identified and a technology assessment prepared.

Again, the production potentials, such as a reduction in the number of steps involved in manufacture, fabrication method, winding technology and resin injection instead of bonding, automatable blank production and use of novel textile techniques, were all considered in the initial phase of the project.

All this was achieved by specifying so-called review gates, i.e. monitoring and check mechanisms over the course of the project. Here, in particular, the design, manufacture, manufacturing route, modelling, cost plan and schedule were examined. A risk analysis, under which categorisation of the risks not yet eliminated was undertaken and captured for recurring use, was also incorporated into the review milestones. Similarly, interviews with the designers and production engineers, during which the IPMs compared the state of the art in the new design and the new process and, if necessary, would apply for patent protection in respect of any new patentable know-how, were built in throughout the course of the project with the aim of in this way protecting the innovations for the company, securing a competitive advantage and achieving a monopoly position. The summary and drawing which follow are cited as an example from the patent application.

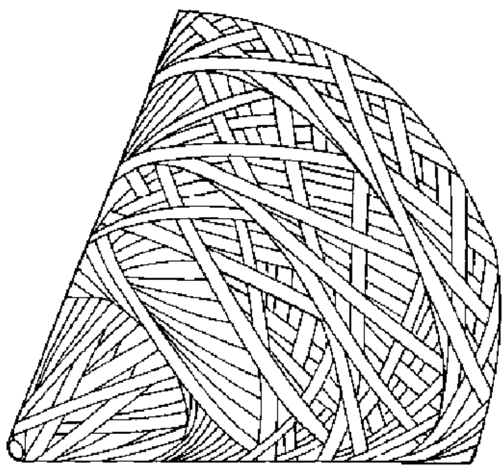

Fig. 7.10 Fibre composite nose cone – "the composite component"

"In an existing nose cone for a gas turbine engine constructed out of fibre composite materials, the cone element, the attachment element and the protective cover element are fabricated as a single unit from a large number of winding strips superimposed across each other by the method of filament winding technology in such a way as to form a wickerwork (Fig 7.10). The winding strips consist of fibre optic strings running in parallel and adjoining each other in alternating fashion and carbon fibre strings of equal strength. The resulting single-piece nose cone can be manufactured and mounted in a simple way and its distinguishing features are elasticity, rigidity and impact resistance".

Since this is a part used for an aircraft, special proof also had to be supplied, and certification by the aviation authorities is required. This required strength verification calculations, proof of service life, vibration and dynamic tests, exposure modelling and computational simulation of a bird strike, which if necessary, had to be recorded throughout the monitoring process with individual measuring points.

As well as the company-internal release of the new design and presentation to the customers with regard to maintainability, repairability and implementation plans, further tests of the engine – airframe interface were necessary before implementation could be planned.

Before this prototypes naturally had to be built and components tested, while materials investigations and certification processes had to be conducted in the company and at the supplier's.

The design of tools, special tools and transport equipment and their manufacture must not be overlooked in the project process, as failure to do so could lead later on to unpredictable delays on the project.

Following the decision by the customer, who had already been involved early on in the development and production process, an implementation plan could be drawn up. This had been preceded both at the supplier's and in the company by the special processes and certification processes which were recorded in a separate process specification.

There then followed assembly tests and the start of serial production through to acceptance and quality testing prior to delivery to the customer.

The description of this example in the process illustrated followed the approach with the previously explained research and technology project organisation in the company. Company-internal technical departments, customers, suppliers, external partners and higher educational establishments were involved as development partners.

The project described took less than 2 years from problem analysis through to installation at the customer's, including quality and operational checks. This example serves to demonstrate practical support and process steps in order to make clear what measures were necessary in the initial phase of the project, the development phase, the implementation phase and the product launch phase. It is also an example of collaboration with external organisation and academia. Important milestones in

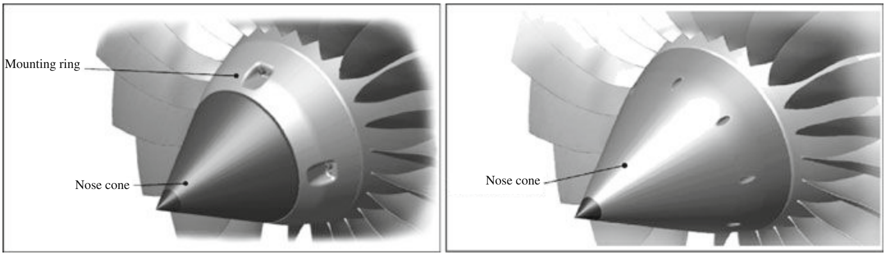

Fig. 7.11 (a) Original nose cone, constructed out of several components. (b) New, single-part nose cone

the partnership with higher educational establishments are listed in Section 7.4. Figure 7.11 illustrate the old and new nose cone designs.

7.3 Value-Added Chain

The IP value-added chain runs from problem analysis to idea and patent, to implementation in the product.

7.3.1 Ideas Management

The securing and strengthening of international competitiveness in the company requires that the workforce is actively involved in innovation management.

To this end, there are a number of institutions in an international company which invite the individual cooperation of employees, manage their intellectual property in accordance with the applicable regulations and protect it for the company. In this way the ideas are rendered usable and steps are taken to ensure that they can be implemented in a manner that is fair to the originator of the ideas.

The company suggestion scheme is mainly aimed at cost reduction, quality improvement, efficiency enhancement and measures to promote health and safety.

The ideas pool, also known as the ideas board, is intended to promote the team spirit of the staff, utilise hitherto unused employee potential, increase job satisfaction and motivation and also raise quality awareness.

The patent system, the submission of invention disclosure forms as the third pillar in ideas management, helps employees with their work in a specialist area, increases competence, provides the motivation to produce further patentable ideas and holds up the promise of compensation if the industrial property rights should be applied in production.

Figure 7.12 illustrates a typical example from practice of a workflow.

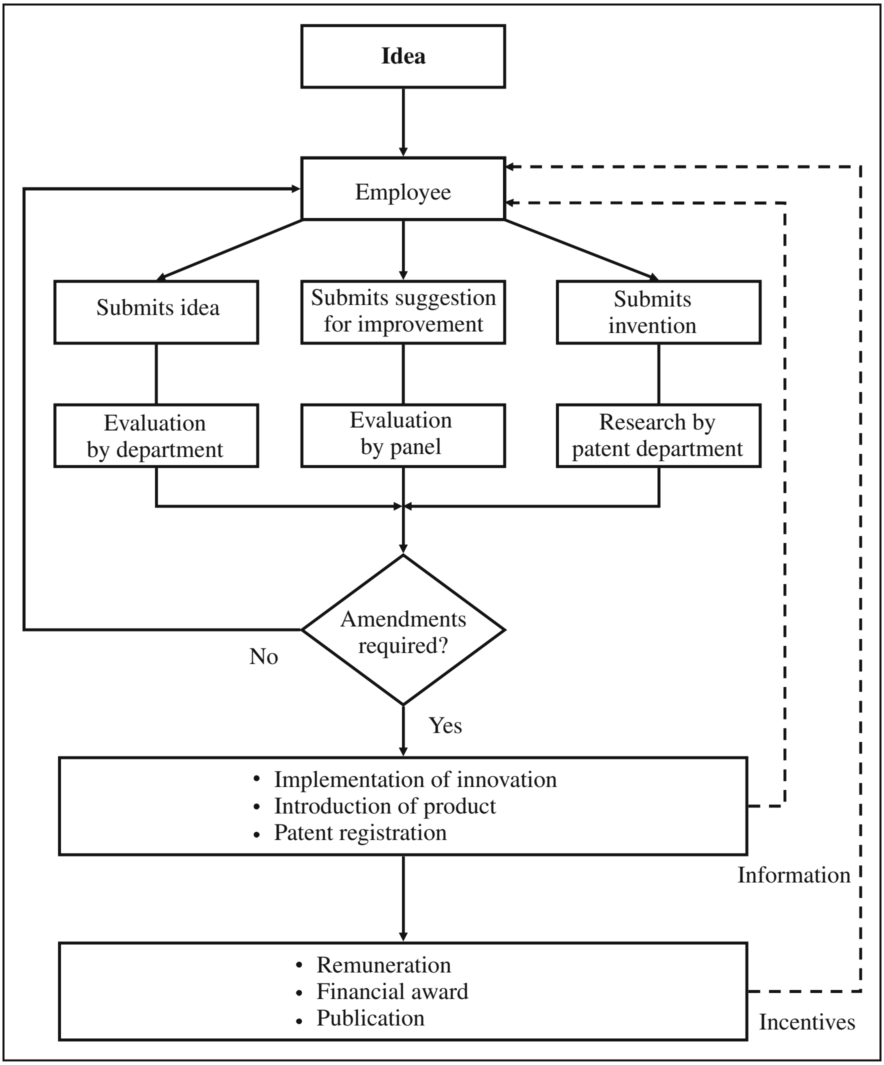

Fig. 7.12 Flowchart from idea to compensation

7.3.2 Patent Protection as a Strategic Tool for Investment, Innovation, Patent Monitoring, Evaluation and Exploitation

7.3.2.1 Importance of Patent System and Infrastructure

From an economic point of view, patents are granted by the state to encourage inventors, authors etc. to disclose their insights so that general benefits can be drawn from them. In return for the disclosure of inventions, the patent offers the inventor the prospect of an industrial property right for a defined period during which the inventor is named and possesses the exclusive rights to the invention. This means he can refuse to allow the use of his idea, he can market it or grant licences for its exploitation and earn money from it. This has the effect of encouraging the inventive spirit, which brings benefits to industry and technical progress. The prospect of acquiring an industrial property right and public disclosure of his name as the inventor are supposed to spur the inventor on to ever more and better accomplishments. These accomplishments add to the technical knowledge in the public domain through publication of the invention and in this way promote general benefits through steady progress in the technology area.

From a business point of view, the patent system/patent management makes an increasingly important contribution to corporate revenue. To this end the idea is to try to use the characteristics and functions of patents (offensive, protective, motivational, reputation, financial and information functions) strategically.

Patents have a positive impact on competitive position and on company start-ups. For small and young companies especially, patents offer a means of penetrating existing markets and of holding their own against larger companies. For many companies, especially technology-oriented companies, patents even constitute the biggest, protected part of the company's value.[11] On the other hand, large conglomerates such as Texas Instruments or IBM, which operate highly aggressive patent management, can draw licence fees of several million US dollars in a few years.[12]

Several studies have investigated the effect of patent management on company success. These are summarised in Table 7.1.

These studies have confirmed the positive economic effects of patents on business success, although the time lag between patent application and effect should be noted. Moreover, the quality of the patents and patent portfolios plays a critical role in success.

The increasing importance of the patent system is also reflected in the global increase in numbers of patent applications.

Another important aspect is the dissemination of knowledge through patents, i.e. the patent documents are used intensively to obtain technical information. Some 80% of technical knowledge available worldwide is only published in patent specifications.

Again, in Germany every individual employee gains from his industrial property rights in the form of additional compensation when his inventions are applied in the company.

Some 1.25 million patent applications are handled in the world's patent offices every year. Today over four million patents are in force globally, and every year over

[11] Gassmann (2006), p. 23.

[12] Ernst (2002a), p. 96

Table 7.1 Effect of patent protection of success [13]

Authors	Example	Main findings
Austin (1993, 1995)	20 American biotechnology companies	The granting of a patent has a positive impact on the market value, key patents have greater influence
Lerner (1994)	535 Rounds of financing 173 venture capital financed biotechnology companies	Patents with technologically wide patent claims enhance the value of the company
Ernst (1996)	50 Mechanical engineering companies in Germany	Companies with an active, systematic patent strategy are significantly more successful than companies with inactive, unsystematic patenting behaviour
Deng, Lev & Narin (1999)	380 Companies (pharmaceutical, chemical, electronics)	Frequently cited patents have positive influence on market value
Hall, Jaffe & Trajtenberg (1999)	4,000 American companies from the goods-producing industry	Frequently cited patents have positive influence on market value
Ernst (2001)	50 Mechanical engineering companies	Patent applications lead to significant increases in sales with a time lag of 2-3 years. Effect is even more pronounced for qualitatively higher patents.
Shane (2001)	1,397 Patents awarded to the Massachusetts Institute of Technology (USA)	The existence of qualitatively high-value patents (broad technological claims, frequently cited) improves the commercialisation prospects (in the form of company start-ups or licence agreements)

a million patent specifications are published.[14] Eighty four percent of patents originate from the patent offices of the European Patent Convention (EPC), the Japanese Patent Office (JPO) and the US Patent and Trademark Office (USPTO).[15] For over 20 years the patent offices of the USA and Japan and the European Patent Office have been working together and trying, with some success, to bring about reciprocal agreements and harmonisation in the area of patent protection with a view to setting benchmarks for every country in the world.

[13] Ernst (2002a), p. 98

[14] Annual report of the European Patent Office (2006)

[15] Schramm (2005a), p. 7

7.3.2.2 Patent Application and Procedure for the Granting of Patents

In Europe companies have several ways of submitting a patent application. Patent protection can be sought through national registration of the invention in the relevant country, as an application for a European patent or a globally recognised Patent Cooperation Treaty (PCT) application.

In Germany, the patent granting procedure is governed by Sections 34–64 of the Patent Act and starts with the application for a patent. An application is only legally valid when an invention is disclosed, an application is submitted for the granting of a patent and the party applying for the patent is visible. Following the submission of a legally valid application, the applicant receives confirmation of receipt from the German Patent and Trademark Office (GPTO). This contains an official reference number and an official filing date. The fee for applying for the patent falls due on this date.

After the patent application has been submitted, the GPTO conducts an examination as to whether there are any obvious substantial defects, such as failure to comply with the required form and consistency.

If the submission by its nature constitutes an invention, is it commercially utilisable, is it a state secret, are there grounds for excluding it (contrary to public policy or morality etc.) etc.? The inventors have to be named within 15 months, and 18 months after the filing date the application is published as a non-examined patent application. From this time forth the applicant acquires the right to compensation from users of his invention.[16] One now has the option of submitting a patent search request to the GPTO according to Section 43 Patent Act, in which case the GPTO performs a patent check to identify all the publications which need to be taken into consideration in assessing the patentability of the invention in respect of which the application. Third parties may also submit search requests. The results of the search are delivered to the applicant within the priority year.[17,18]

The examination procedure ends with either grant of the patent or rejection of the patent application. Under Section 47 Patent Act, the GPTO is obliged to give the grounds for rejecting a patent application. If the patent is granted, the patent specification is now published. After this date third parties, notably competitors, have 3 months to appeal against the granting of the patent. Appeals were submitted against about 7% of all German patents granted in the year 2000. Another peculiarity of the patent-granting process is the so-called priority rule, which Schramm describes in his lecture series on patents as conferring on a person who "files an earlier application in a convention country a priority

[16] Section 33 Patent Act.

[17] Refers to the first year from the date of submission of the application.

[18] Schlagwein (2005), p. 86

right for 1 year from the earlier application. The priority right allows subsequent applications filed abroad within this period (priority year) to be treated in such a way as if they had been submitted on the priority date (date of earlier application)..."[19]

Although a lot of effort has gone into the harmonisation of patent law, individual national patent granting procedures still differ greatly. Up to now national patents have been valid only for the relevant country. Attempts to implement an EU-wide Community patent that would be valid in all EU states have come to nothing. However, a major advance was achieved when the application phase was simplified. The most important conventions here are the European Patent Convention (EPC) and the Patent Cooperation Treaty (PCT) application as well as agreements such as the Community Patent Convention (CPC), the Eurasian Patent Convention (EAPC) and the African Intellectual Property Organization (OAPI), amongst others.

For European patent applications, a single application to the European Patent Office composed in German, English or French confers patent protection in all Member States [20] of the European Patent Organisation under the EPC. If a patent is granted, then the patent disintegrates into many national patents and essential rights are transferred to the treaty states.[21]

7.3.2.3 Patent Strategies, Functions and Success Factors for Implementation

Patents fulfil several different functions. From a historic point of view, the main function of patents was to exclude the competitor from exploiting the invention or even to bar him from a certain market. However, patents seldom create the basis for a monopoly situation, as there is nothing to stop competitors offering technical alternatives in order to have products to offer.[22]

Patent strategy has a positive influence on one's competitive position. The aim of a patent strategy is to orient one's own inventory of industrial property rights to the success factors of the business.[23] It is an element of the corporate strategy.

A patent strategy is implemented with the aid of patent functions. As mentioned already, the main function is to retain the exclusive rights to an invention. The following functions of patents are derived from this: offensive function, protection function, motivation function, reputation function and financial function.[24]

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[19] Schramm (2005a), p. 56

[20] Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Liechtenstein, Luxemburg, Monaco, Holland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, Latvia, Lithuania and Poland. (status 2007)

[21] Schramm (2005c), p. 78

[22] Ibid. p. 182

[23] Mohnkopf (2006) p. 6

[24] Schramm (2005b), p. 144

Where the company actively uses patents against competitors, they serve the offensive function. In this way it is possible to exclude competitors from exploiting a particular invention. The owner of the patent can himself use the patented object to obtain a return on the investment he has put into developing the invention. On the other hand, patent protection can also have the effect of enabling the owner of the patent to protect a technology which represents an alternative to the technology in use. Such a substitute patent would not be actively used but simply serve the purpose of protecting an earlier patent.[25]

Another procedure is licensing for the purpose of obtaining an income from royalties. The owners of the patent license the industrial property rights to other players in the market. The licences in question can be either exclusive or non-exclusive and, as such, differ as to their marketing rights. Licensing is particularly attractive where the cost of developing a market would be high.

Patents are actively used in order to obtain market share or even to establish links between the patent and a standard, resulting in the international standardisation of one's own patent solutions (e.g. the VHS standard for video recorders from the JVC company).[26]

The "protective function" is where companies build up a patent network which protects its own basic patents against patents whose purpose is to circumvent them, and protects future application areas. Another effect of such patent networks is that they deny competitors technological freedom of movement. On the other hand a patent network can be built up by several companies at the same time. These "patent pools" enable the shared use of patents and avoid patent disputes.

The financial function covers the possible financial revenue to be had from an active licence policy, while at the same time patents constitute an important means of helping young companies especially to obtain finance capital. For example, patents can be used as collateral for loans raised from outside parties.[27]

The reputation function occurs where the volume of patents projects an image of technical superiority to the outside world while also promoting a positive research and development atmosphere within the company. It can also be used for marketing purposes, it strengthens the creditworthiness of the company and enhances the company's reputation when there is a successful patent trademark combination.[28]

Patents can have a motivating effect where a company rewards patent applications by conferring a status advantage within the company on the inventor. In this way employees identify themselves more strongly with the corporate objectives.

[25] Harhoff (2005), p. 183
[26] Schramm (2005b), p. 145
[27] Harhoff (2005), p. 184
[28] Schramm (2005b), p. 147

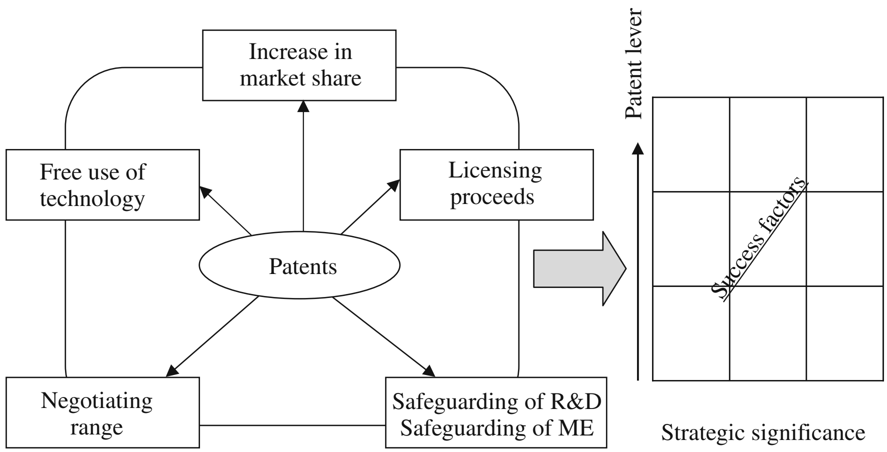

Fig. 7.13 Strategic importance of patent work

Patent applications and ideas originating from quality circles or the company suggestion scheme are valued in the company, which in turn invigorates the company. There are many possible ways in which patents can influence business success, as illustrated in Fig. 7.13. However, one should not lose sight of the cost factor here. The possible monetary or strategic advantage must be compared with the costs incurred. It is also necessary to clarify whether a strategy of non-disclosure [29] would not be more effective. Moreover, it should be noted that the success of a patent application is always uncertain and the process of applying for a patent can take a lot of time and be expensive. Thus it takes four of 5 years after submission of the application to obtain a patent.

When one examines the value distribution of patents, it becomes apparent that in many patent portfolios over 80% of the total value of the portfolio is derived from the most valuable 10% of the patents, from which it follows that the majority of the patents are actually of no value (Harhoff and Scherer study).[30]

In principle, it is possible to dispense with patent protection where:

- Technical or market developments are advancing more quickly than the patenting process at the patent offices;
- It is easy to circumvent the patent;
- For technical reasons it is very difficult to prove infringement of a patent; or
- Although it is possible to prove patent infringement, it would then be prohibitively expensive to enforce the patent law.[31]

[29] One example here is the Coca-Cola company's recipe for the cola drink which remains a secret to this day and is deliberately kept so.

[30] Harhoff (2005), p. 186

[31] Harhoff (2005), p. 186

These and other reasons may mean that patent protection brings only costs and no benefits. Making the right choice of protection mechanism for the results of research is a critical task of a strategic nature for patent management.

Ernst (2002) defines some fundamental aspects which need to be taken into account when determining the patent strategy. In this connection the following questions are paramount:

- Are alternative industrial property rights and especially non-disclosure to be preferred to a patent application?
- What is the right time to apply for a patent?

Applying for the patent early on in a development project ensures the inventor's priority right against subsequent international applications by others. In many areas in which competitors are often working on identical developments in parallel, the time of first filing is often critical.

The breadth of the claim of a patent application is also critical. Especially early on, applications can be filed for broad, conceptual inventions as the focus of possible use has not yet been narrowed down. What starts out as a broad claim can be narrowed down in the course of the patenting process.

When deciding in how many countries to apply for patents, the financial cost must be set against the commercial benefit.

Special attention must be paid to applications for blocking patents, as these serve to protect basic patents. The patent situation must be analysed both prior to and during individual development projects, in order to avoid infringement of third-party patents. After the patent has been granted, it is necessary to monitor and track infringements of one's own patent rights on a continuing basis. The licensing possibilities must be systematically identified and evaluated. The strength of one's own patent position must be communicated to target groups that are important to the company (customers, shareholders, investors, etc.).[32]

According to Ernst, it is important for the successful implementation of patent strategies that the corporate strategy is aligned with the patent strategy, i.e. the possibility of competing goals must be excluded and patent strategies must be chosen in such a way that they support the implementation of corporate strategic processes. If it is to be successfully implemented, the patent strategy will become an integral element of the business area, business unit, technology and product strategies.

It is also very important that the patent system is supported by the top management and is highly valued in the company.

As well as the statutory provisions of the Employee Invention Act, other incentives must be created in order to promote the patent culture in the company. The aim should be initially to increase the number of patent applications and only later to consider the quality of patent applications. Interface problems between the patent

[32] Ernst (2003), p. 26

department and the new development teams must be avoided or overcome. This can be accomplished by giving the project teams individual fixed points of contact in the patent department or making patent managers permanent members of project teams. In addition, patent-specific criteria should be incorporated into the milestone planning of the product development process. This will ensure that the necessary patent-relevant information is available and is taken into account in decision-making (see also Section 7.2.2).

7.3.3 Patent Management and Patent Information

This section describes patent management and the associated tasks. For this purpose, technology management has been broken down into a number of tasks, as shown in Table 7.2. The figure showing the tasks of patent management makes clear the importance and implications of patent information. The variable of patent information and how this can be evaluated is then explained.

Table 7.2 Tasks of strategic patent management

	Technology acquisition	Technology storage	Technology exploitation
Patent function	Information function		Protective function
	Field 1	Field 3	Field 4
Internal	Support for R&D management (tech. analysis of the competition, technology assessment, portfolio analysis etc.)	Technology-oriented information systems and R&D staff management	Protection of own technology and product portfolios
	Field 2	Cross-licensing	Field 5
External	Identification and assessment of external sources of technology acquisition		Optimal exploitation of technological knowledge (e.g. through sale of patents, licensing)

7.3.3.1 Breakdown of Patent Management in Technology Management

Technology management is concerned with the planning, guiding and control of all the technological activities in a company. These include early identification of technology, technology development, technology planning and technology assessment. Ernst defines technology management as follows: "Technology management covers the internal and external acquisition, storage and exploitation of technological knowledge by enterprises".[33]

Gerpott describes the need for technology management in the company as follows: "The management of innovations, that is, the systematic business planning, organisation, implementation, management and control of all the activities in a company that are primarily geared towards the generation and use of technological innovations, is an important and complex task area which in practice is difficult for companies to master".[34]

This is where patent management comes in, assisting with the tasks which need to be mastered in technology management.

Ernst defines patent management as a supporting element in technology management which plans and guides the acquisition, storage and exploitation of technology.

"This is because the evaluation of patent information improves the quality of decisions in technology management and a strong patent position increases the financial return flow from the internal and external exploitation of technology".[35]

7.3.3.2 Tasks and Effect of Patent Management

In the acquisition of technology, the evaluation of technical, legal and strategic patent information amongst other things results in analyses of the competition and technology assessments. Furthermore, technology management is responsible for external technology acquisition and hence also for the selection and evaluation of possible alternatives as well.[36] Essential reasons why one might want to acquire technology from outside are technological superiority in an external office, to compensate for time disadvantages and inadequate resources in the company.[37] Here the analysis of patent data offers an efficient way of identifying and assessing potential sources for the external acquisition of technology. A focussed patent search is used to identify the companies or inventors which/who have applied for patents in the technology fields in question. Determination of the patent quality then makes it possible to form a differentiated assessment of individual patent positions. Later on, overlaps and areas in which partners complement each other in the patent portfolio can become clear and in this way the external acquisition of technology can be

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[33] Ernst (2002), p. 3

[34] Gerpott (1999), p. 1

[35] Ernst (2002), p. 3

[36] Gerpott (1999), p. 61 and p. 103

[37] Ernst (2003), p. 30

very well directed. When it comes to technology storage, it is possible, for example, to identify key inventors, people with outstanding technological knowledge who should be tied to the company in the long term on the basis of their technology competence.[38]

Through their protective function, patents support both the internal and external exploitation of technological knowledge. On the one hand, a strong patent position secures competitive advantages, while on the other hand patents offer the possibility of selling technological knowledge externally. Here the circle in the concept of patent management presented closes, as “cross-licensing” links the external exploitation and acquisition of knowledge to each other.[39] Table 7.2 presents a summary of the individual tasks of strategic patent management.

The arguments presented above make clear that patent management with its tasks affects business success, both directly and indirectly. The patent portfolio lies at the centre of the reference framework and is determined by the number and quality of the patent applications.[40] Figure 7.14 clarifies the effect of patent management.

The interaction among patent management, patent portfolio and business success is influenced by numerous contingency factors. Company-specific aspects include the corporate and technology strategies, the amount of research and development expenditure and the size and age of the company. In addition, industry-specific influences, e.g. the intensity of competition, the importance of technologically induced competitive advantages and the dynamics of technology, must also be considered. Furthermore, system-specific factors such as country-specific aspects, cultural influences and legal framework conditions must also be considered.

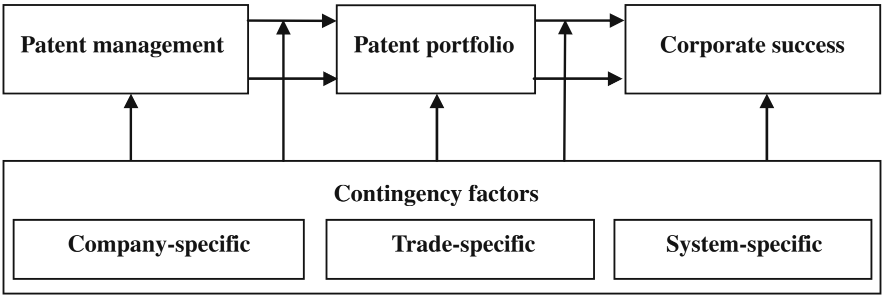

Fig. 7.14 Effect of patent management

[38] Ernst (2002a), p. 99

[39] Ernst (2002a), p. 99

[40] Ibid. p. 98

7.3.3.3 Patent Information and Analysis

Activities in technology management presuppose the acquisition and evaluation of information about technological developments in the competitive environment.[41]

By their nature patents are a very useful information resource. Once published, patents are freely available to anyone and their assignment to products, technology fields or inventors allows plenty of scope for analysis. As only 10–30% of inventions are described outside patent specifications, patent information is indispensable if one wishes to know the global status of technology and the associated commercial exploitation conditions.[42]

Patent information provides insights into commercial and technical developments in different business areas and also into research and development policy in one's own and rival companies. It is possible to draw conclusions about the efficiency of one's own research and development activities and also to gain valuable suggestions for new development strategies. Every innovative company, and especially its R&D departments, has to know the state of the art in order to avoid unnecessary investment in development work already carried out elsewhere. Moreover, the gathering and evaluation of patent information should be used as a means of ascertaining whether any existing industrial property rights stand in the way and thus of avoiding infringement of third-party industrial property rights.

Patents are indicators not only of the research and development performance of individual companies but also of market and technology trends.

In this connection it is the function of patent information to record, supply and evaluate information from patent documents using appropriate means, methods and forms of organisation, so as to enable further patent searches and analysis. The establishment and use of industrial property rights information systems make it possible to realise this function.[43]

Patent analyses are performed on the basis of patent information drawn from extensive patent searches. The sources for patent information are in the first instance public patent databases. But a second source of patent information is in-house industrial property rights information systems. The aim of patent analysis is to obtain core information that will enable technological questions such as the following to be answered:

- Who are the competitors in this field?
- How strong is our overall technology position compared with the competition?
- On what technologies is the competition concentrating?
- Are competitors changing the direction of their technology strategy over time?
- How can one find out promptly about the development of relevant technologies?
- How can the further development potential of technologies be estimated?
- On which development projects should one concentrate?

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41 Brockhoff (1999), p. 23

42 Schramm (2004), p. 138

43 Schramm (2005a), p. 6

- How can redundant research and development be avoided?
- Are third-party or the company's own industrial property rights being infringed?
- Where can external know-how that is relevant to the company be found?
- How can suitable cooperation partners be found?
- Are there any key individuals in certain technology fields? [44]

Table 7.3 lists some important patent key data which serves as an indicator for obtaining information.

The informative value of such indicators enables strategic questions such as those listed above to be answered. However the time dependency and interchangeability of these indicators should be noted. In other words, it is necessary to take into account changes, e.g. in the area of database technologies or patent law, which affect

Table 7.3 Overview of selected patent data

Parameter	Definition	Information provided
Patent activity	Patent applications (PAs) of the company (i) in the technology field (TF)	Extent of patent and R&D activities in the TF; interests of company (i) in the TF
Technology share (based on patent applications)	PAs of all the competitors in the TF	Technological competitive position (quantitative)
Technological importance	Total number of PAs of company (i)	Importance of the technology field to the company (R&D focus)
Frequency of collaboration	Number of patents in the TF applied for jointly with partners	Extent of access to external knowledge (plus identification of partners)
Proportion of applications resulting in the grant of a patent (Q1)	Patents granted to company (i) in the TF	Technological quality of patent applications
International coverage (Q2)	Size of patent family and proportion of triad patents in PA_{IF}	Economic quality of patent applications
Frequency of citation (Q3)	Average citation frequency of the PA_{IF}	Economic quality of patent applications
Patent quality (PQ)	Sum of the individual parameters of patent quality (Q1 to Q3)	Average overall quality of all the company's PAs in the TF
Patent performance (PP)	Product of patent quality (PQ_{IF}) and patent activity (PA_{IF})	Technological strength of the company in the TF
Technology share (based on patent performance)	PP of all the competitors in the TF	Technological competitive position (qualitative)
Relative patent position	PP/maximum patent performance of a company in the TF	Gap between own company and technological leader in technology field F

[44] Ernst (2002), p. 7

the indicators. Thus, for example, the assessment criterion of patent family size[45] has become less sensitive in recent years. The reason for this lies in the successful enforcement of European and international patent application procedures which have reduced the inhibition level for foreign applications. As a result, the correlation between patent family size and the importance of the invention is becoming less pronounced.

The interchangeability of indicators compensates for the reduced sensitivity of assessment criteria. Since there is a linear dependence between frequency of citation and patent family size, for example, these two indicators are used interchangeably in order in this way to obtain core information. The essential dependence of these two indicators derives from the fact that important solutions can be identified[46] as such through both frequency of citation and patent family size.[47]

Patent analysis presupposes the following basic requirements regarding the document base:

- *Timeliness and completeness.* Patent offices normally guarantee to publish the patent specification after 18 months and all inventions are recorded centrally by national and international patent offices and are provided as a complete, sequentially numbered collection of specifications.
- *Detail and standardisation of bibliographic information.* As a minimum, basic data such as the name of the company, the size of the patent family, target country, country of origin, the year, IPC etc. and simplification of patent documents as regards structure, coding, classification etc. must be visible. Patent specification title pages document this.
- *Content indexing using widespread documentation languages.* Thus, for example, the IPC classes enable language-independent classification of inventions over every area of technology.[48]

In practice there are a large number of literature, citation and patent databases that meet these requirements in different ways. When it comes to selecting the most useful database, empirical values play a critical role.

One of the functions of patent management in the area of technology acquisition is to support research and development management. Again, one important task in this area is to determine which internal development projects should be pursued with what intensity.[49] This requires information on the future competitive relevance of the technologies available for selection and regarding the company's own position compared with the competition, in this technology field. Analysis of patent activities in the technology fields can provide information regarding possible development

[45] This is an indicator of patent quality.
[46] Ibid. p. 9
[47] Schramm (2005b), pp. 18–23
[48] Ibid. p. 13
[49] Brockhoff (1999), p. 94

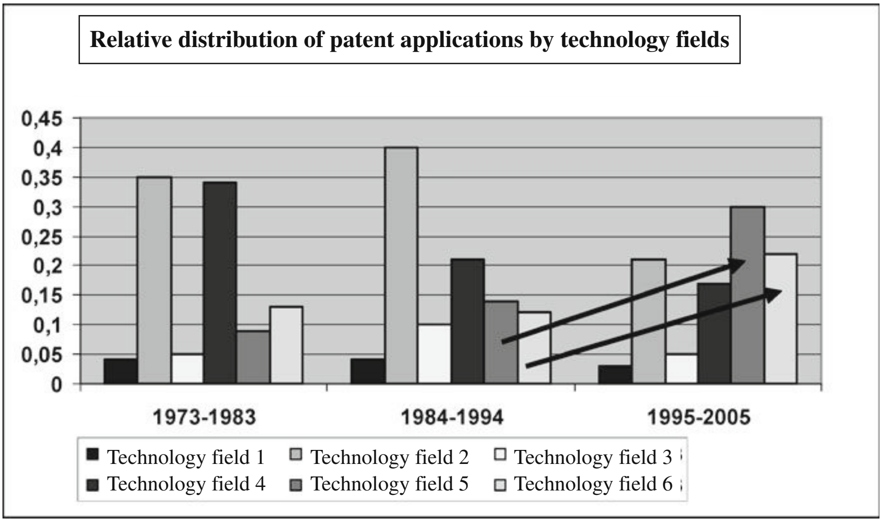

Fig. 7.15 Patent applications in technology fields

trends (see Fig. 7.15). To identify attractive technology fields, growth rates of patent applications are determined, for example.

It is generally assumed that technology fields with high growth rates as regards patent applications are particularly attractive. In the example, technology fields 2 and 4 are not so attractive. It is clear that technology fields 5 and 6 are the most attractive and possibly an indicator of potential new applications. The company's own research and development could therefore be concentrated more in these areas.

Many analyses are based first of all on ascertaining the companies which are generally dominant or which dominate particular technology areas. It should be possible to identify these companies through an analysis of patent applications.

Figure 7.16 shows companies with their patent application behaviour over different time periods. It will be noted that company 1 has submitted the most patent applications; however, this occurred in the years between 1973 and 1983. The companies which have been the most active since 1995 are companies 2 and 3, which therefore deserve particular attention.

Another important parameter is patent quality, which is necessary to work out how strong a company is in a particular technology field. According to Ernst, this parameter consists of three indicators:

- *Proportion of applications resulting in the grant of a patent:* the number of patents granted to a company in a particular technology field in relation to the average number of applications resulting in the grant of a patent in the technology field as a whole.
- *International breadth:* the number of patents which belong to a patent family in relation to the average number of patents per patent family of the company concerned.

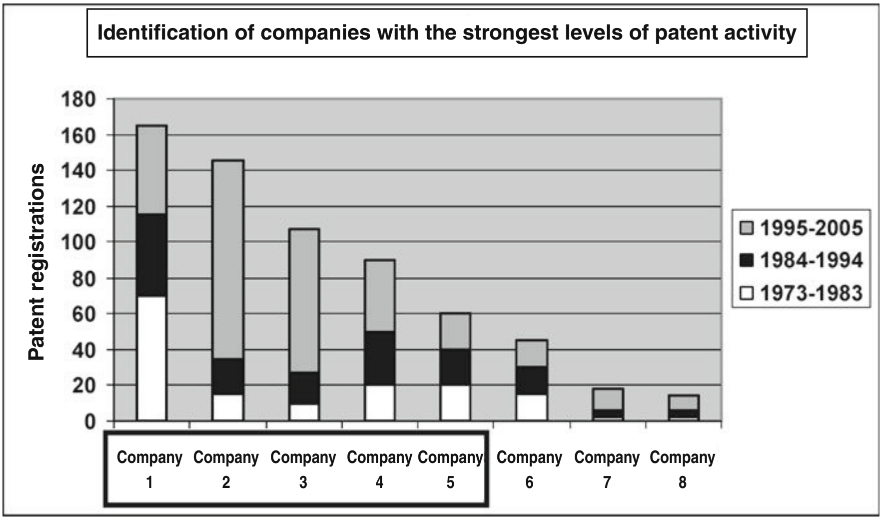

Fig. 7.16 Companies with the strongest level of patent application activity

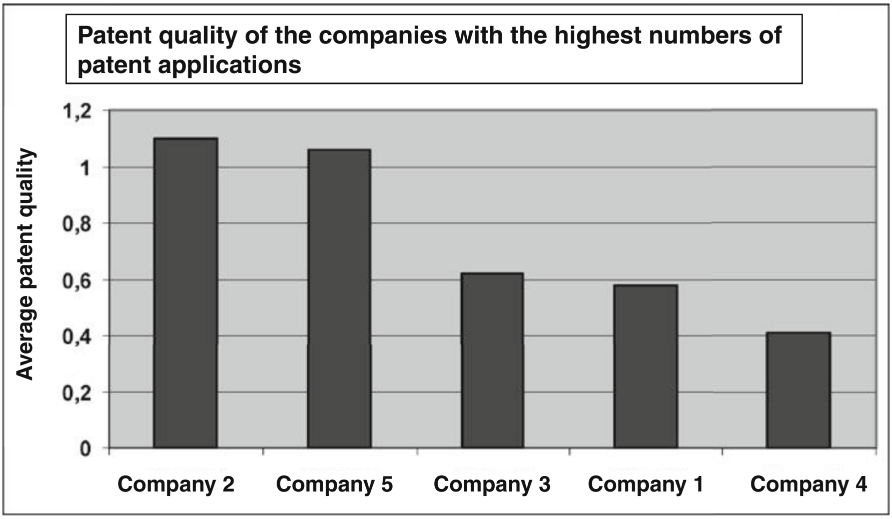

Fig. 7.17 Patent quality of the companies with the most patent applications

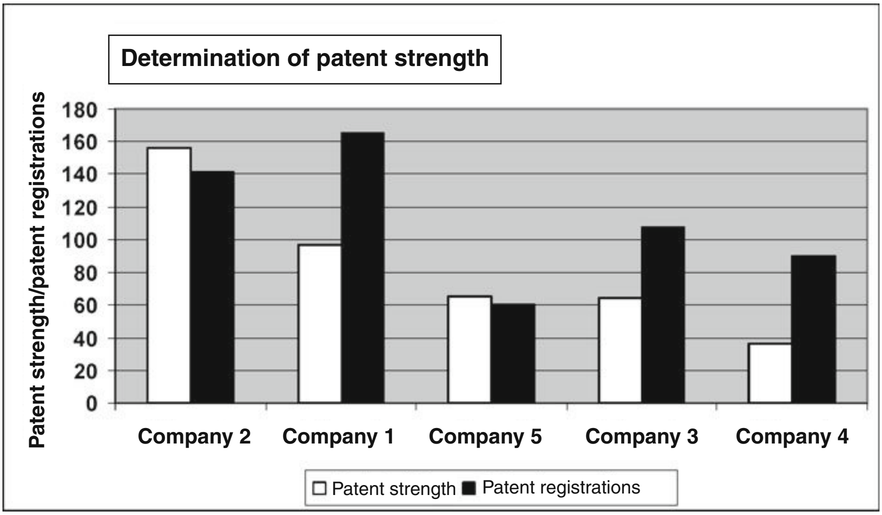

Fig. 7.18 Calculation of patent strength

- *Citation rate:* the number of times a patent is cited in relation to the age of the patent.[50]

These indicators can be added together with equal weightings, producing a measure of patent quality, as shown in Fig. 7.17.

It is possible here to examine several technology fields or certain technology areas.

To ascertain the actual technological strength or patent strength (Fig. 7.18) of a company, patent application and patent quality must be multiplied together.

The following statements are now possible. Firstly, it is clear that on the basis of good patent quality in this technology area, company 2 is the innovation leader despite having submitted fewer patent applications in respect of inventions than company 1. Company 4 is weak on patent quality and emerges in bottom place compared with the other companies.

Frequently the results of such an analysis are illustrated by means of simple or complex patent portfolios as shown in principle in Figs. 7.19 and 7.20. Such patent portfolios have the advantage that they are not dependent on subjective assessments so that the information needed about competitors can be obtained more easily as a

[50] Ernst (2002), p. 11

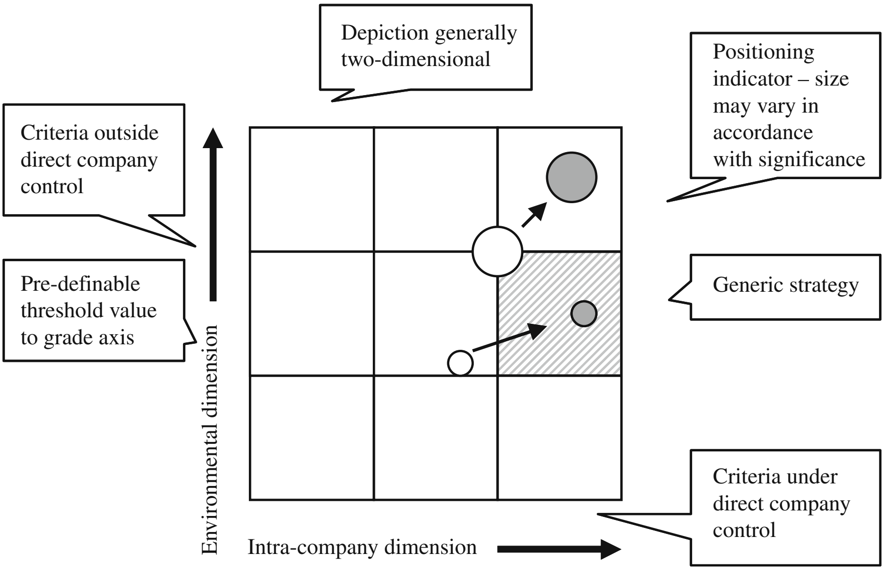

Fig. 7.19 Basic elements of a portfolio representation[51]

result.[52] The background to such patent portfolios is the standard strategies which can be inferred from such portfolios.

As described in the introduction, another avenue is to identify key inventors. Because the inventor is named on a patent specification, the persons behind the

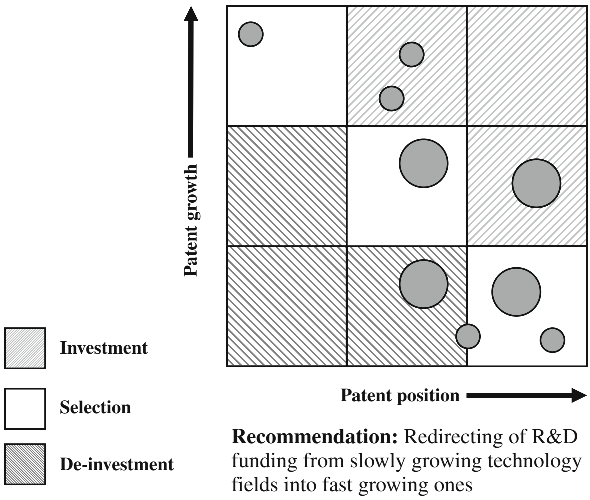

Fig. 7.20 Example of a patent portfolio for a company[53]

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[51] Gerpott (1999), p. 154; Brockhoff (1999), p. 115

[52] Ernst (2003), p. 30

[53] Ernst (2002), p. 20

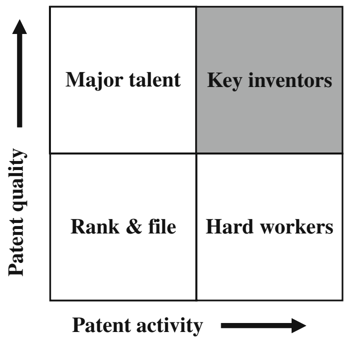

Fig. 7.21 Inventor portfolio (Ernst 2002, p. 32)

inventions are easy to identify and analyse. In this way it is possible to find out who the inventors are so that, if appropriate, they can be approached with a view to gaining access to external technological knowledge.[54] On the other hand, special business measures can be taken to keep the key inventors in the company. Once again it is possible to present this in the form of the inventor portfolio, as shown in Fig. 7.21.

As will have been made clear in previous sections, patent analyses are frequently based on the processing of patent search results from patent databases. Another way of analysing patents is to examine citations for particular patents. As explained above, the frequency with which a patent is cited is also a quality index and is used to determine the patent quality, since the fact that a patent has been cited suggests that it has a value. [55] There are a number of citation databases that can be used to find citations, e.g. the Science Citation Index (SCI) and the Derwent Patent Citation Index (DPCI). Both these indices are published by the Institute for Scientific Information (ISI) and are presented in Table 7.4.

Table 7.4 Types of patent citation and their possible significance[56]

Patent citation			Possible significance	Patent citations recorded in:
Patent specification	Cited	Patent specification	Technically fundamental or defective invention	DPCI Patent database with citations
	Cited	Technical article	Scientifically well-founded invention	
Technical article	Cited Cited	Patent specification Technical article	Scientifically well-founded invention	SCI Literature database with citations

[54] Ernst (2003), p. 31

[55] Schramm (2005b), p. 74

[56] Ibid. p. 75

In the course of the examination process for the granting of a patent by the patent office, references to other patent specifications are often appended to the patent specification. In the course of this work, the patent officer examines other patents which stand in the way of a patent being granted and cites these or includes them in his examination report.

Patent specifications also cite other patent specifications in the summaries for the purpose of acknowledging the state of the art.

Technically and at the same time scientifically important inventions, inventors and applicants are determined by linking different databases as in the example of the SCI and DPCI, for inventions which are cited in scientific journals and frequently in patent specifications are particularly important. In the case of citations it is essential to bear in mind that not all citations worth documenting are included and that not all citations are worth documenting.[57]

All these examples give only an overview of the possible ways of evaluating patent information. A lot more analysis is possible when additional core information is obtained and combined skilfully.

7.3.4 Principles of the German Employee Invention Act

An invention made by an employee can be a service invention or a free invention.

Every invention must be reported to the employer, normally as represented by the patent department or the IPM. A duty of confidentiality applies to all the parties concerned.

If the employer do not want the service invention, the inventor has the right to submit a patent application of his own, but cannot thereby deny the employer the right to exploit the service invention. When the employer releases it (revised employee invention act on 1st October 2009). In the case of a service invention the employee is entitled to compensation, the amount of which is set in the Act. As well as the inventor, the line manager is also responsible for reporting a possibly patentable technical innovation developed by his team. Such an innovation exists where a departure is made from the known state of the art. It is possible through patent searches to find third-party industrial property rights which stand in the way early on and, if necessary, to circumvent them by rewording the patent or taking other deliberate steps.

Suggestions submitted under the company suggestion scheme or arising as a result of ideas management, should also, depending on the individual case, be reviewed to assess their patentability. Ideally the IPM will be a member of the plant

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[57] Schramm (2005b), p. 75

committee responsible for the suggestion scheme and, if necessary, will be able to form an opinion early on as to the case for protecting a suggestion.

Inventions have to be reported in writing and normally a procedural instruction will require that such reports are submitted to the patent department in the form of a signed hard copy, receipt of which is confirmed to the employee.

The responsible office examines the invention disclosure form for completeness and, on the basis of the theoretical importance of the invention and in consultation with the department concerned, makes a decision about the nature of the claim, which has to be notified to the inventor in writing no later than 4 months after receipt of the valid invention disclosure form.

If it appears that the invention is patentable, a patent application appropriate to the company's patent strategy is prepared and submitted to the patent office.

If the invention is not patentable, the inventor's agreement not to file an application is sought. At any rate, this is the case in Germany, but different provisions apply in different countries.

As soon as the employer has made a claim to a service invention, the inventor has the right to reasonable compensation. The amount will depend primarily on the commercial benefits of the invention: so that normally compensation only becomes due when the invention is exploited or where an industrial property right has already existed for several years without exploitation. However, this depends on the company procedures. If two or more inventors have contributed to an invention, each inventor is entitled only to a share of the compensation due commensurate to the proportion of the invention for which he was responsible. Where the invention is exploited, the amount of compensation is assessed primarily with reference to the sales achieved with the protected object.

7.3.5 Technology Transfer and Technology Marketing

Once the stock of patents exceeds a certain size it is necessary to consider how the patent portfolio can be exploited. This requires that it is first of all sorted so as to permit a better overview. This is done using an ideas list, under which as many possible different patent families are registered. The families are defined, for example, by general characteristics (title, patent number or technology assessment, etc.), fields of application (method, materials, concepts, etc.).

As soon as the patents have been assigned to the appropriate patent families, it is necessary to choose which patent families need to be analysed further with regard to requirements for marketing. The patent families are then reviewed as to their suitability for marketing, as a result of which the number of exploitable patent families is further reduced. The remaining families are classified, for example, by value to the company, core technology, non-core technology, development technology, etc. With this classification system, it is possible to define different strategies, i.e. hence goal-oriented approaches, to access the individual patents in each class and exploit them defensively, offensively and/or strategically, as illustrated in Fig. 7.22.

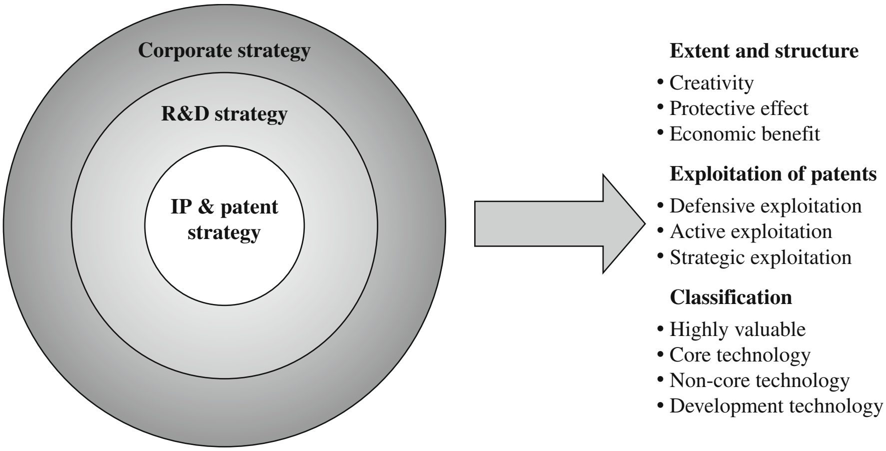

Fig. 7.22 Types of strategy and the patent classification structure required

The outcome of the portfolio analysis is a classification of patents and an estimate of their market and technological attractiveness. The portfolio analysis is followed by an assessment of the exploitability of the patents. This requires that the exploitation potential and the resulting patent value are deduced. The following items flow into the exploitation potential:

- The description of the solution (function, central idea, technological advantage).
- The technology assessment of the solution by degree of innovation, competitive advantages and transferability.
- The technology assessment is used to determine the competitive advantages and the market share that is assumed to result therefrom (based on market assessment of industry structure and product life cycle).
- Assessment of legal protection with regard to extent of protection, legal situation of the industrial property rights and the geographic area covered thereby.

The value of the patent is derived from the exploitation potential after the market potential of the patent in terms of market volume and growth has been ascertained.

When it comes to working out the corporate strategy, the exploitation potential and patent value are taken into account as are also marketing alternatives such as:

- Integration into current day-to-day business,
- Sale,
- Formation of joint ventures, strategic alliances or
- Establishment of separate company, for example in the form of a spin-off.

Potential partners are identified and technologies prioritised. At this point in the analysis it is already possible for the company to decide how it wishes to proceed.

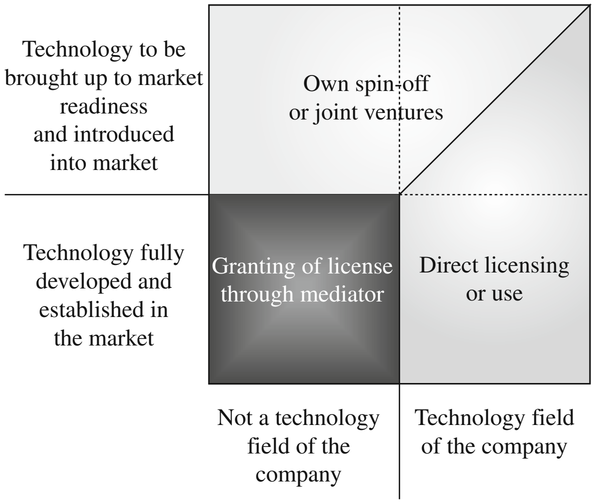

Fig. 7.23 Decision matrix regarding how to proceed with a technology

In other words, the decision has to be made as to what development status the technology has and whether it belongs to the field of activity of the company. A decision matrix, such as is shown in Fig. 7.23, can be helpful here.

After the exploitability has been assessed, the technology and market are analysed to examine potential applications and their market potentials. Here it is possible to sort the applications according to different priorities.

After the patent portfolio has been analysed and applications that are attractive from the marketing point of view have been selected, a marketing concept can be drawn up. The first step here is to clarify the question of to which partner the application should be marketed and how to evaluate potential candidates where the choice of partner has not yet been made. To identify potential partners, the products and technologies of the available partners are compared with the company's own products and technologies. After a further more detailed analysis and financial assessment of the potential partners, priorities can be set, which will assist in the choice of partners.

Successful marketing requires that a corresponding concept is developed and implemented. It is at this phase prior to marketing that

- Documents are prepared
- The establishment of contacts with the partners is planned
- Preparations are made for negotiations.

The documents to be created cover marketing materials and detailed documentation of the patent. The documentation explains the patented technology by giving a technical explanation and naming specific applications. This gives the future partner a clear idea of the patent and its possible uses. The marketing material introduces the company and the technology on the market in the form of brochures and presentations. They contain an introduction to the company and named contact partners. The technology is also explained briefly and possible applications are described.

After all the preparations have been completed, the potential partner is approached and the transfer of know-how initiated. Contact management, under which the contact partners on both sides are identified and the procedure for taking up contacts is coordinated, is an advantage here. If contact has been successfully established and the partners mutually identify with each other, contract negotiations are initiated and contractual arrangements drawn up. Figure 7.24 provides an overview of the procedure involved in exploiting a technology.

7.3.6 Principles of the Legal Protection of Industrial Property

This section starts by defining some terms and describing selected industrial property rights. Focusing particularly on the most important industrial property right, the patent, the patent application and the procedure for the granting of patents are then introduced, as this influences patent strategies. Patent strategies and their boundaries are then listed as the basis for the evaluation of industrial property rights information for patent analyses.

Industrial property rights are defined and delineated from each other in the context of the relevant national legislation. The most important industrial property rights in Germany are patents, utility models, trademarks, designs and copyrights.

Industrial property rights are combined with each other so as to protect the intellectual property of a company in the best possible way. Certain computer-based inventions (hardware) are protected by patents while the associated software is normally protected by the law of copyright. The combining of trademark and patent rights is particularly important, as patent protection is limited to a term of 20 years, whereas trademark protection can often be extended as long as required. By this means companies attempt to build up special distinctive features from the customer point of view through investment in trademarks over the lifetime of the patent.[58]

According to Section 1 para 1 German Patent Act, patents are granted for inventions that are new, involve inventive activity and are susceptible of industrial application. An invention is new if at the date of the application it was not available in the public domain anywhere in the world. An invention is considered to involve inventive activity if, having regard to the state of the art, it is not obvious to a person skilled in the art. An invention is considered to be susceptible

[58] Harhoff (2005), p. 178

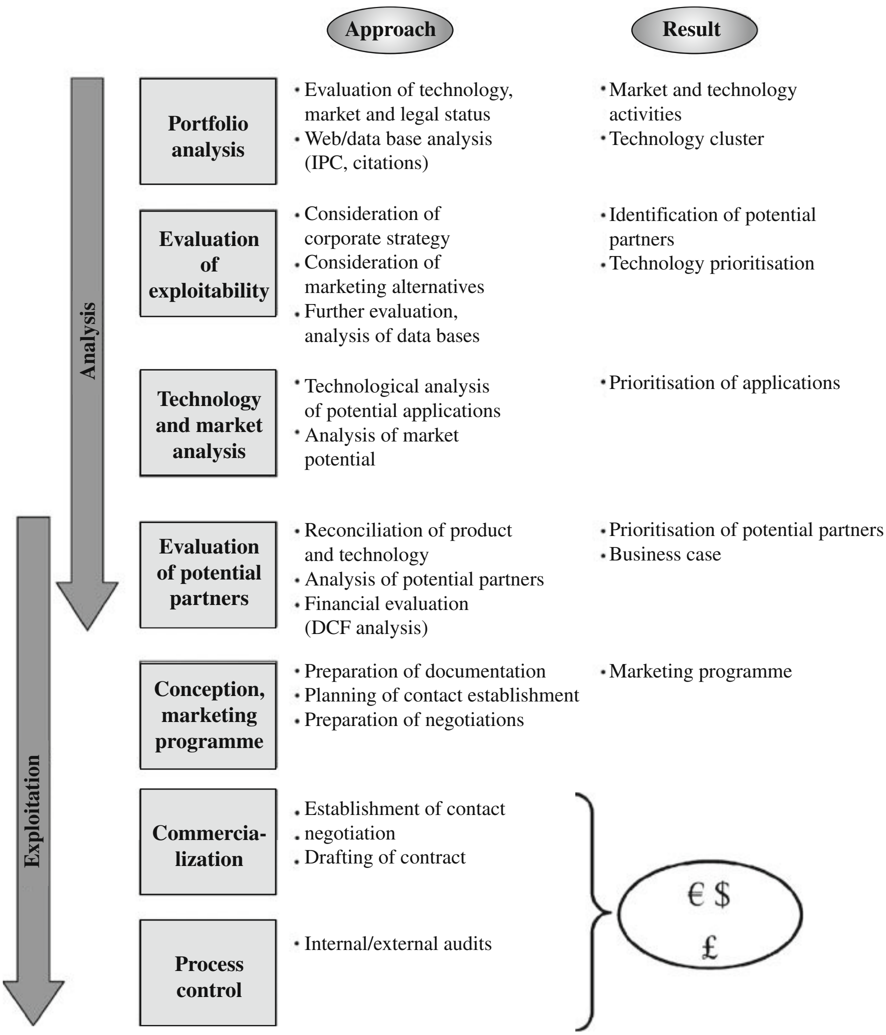

Fig. 7.24 Overview of the procedure for exploiting a technology

of industrial application if it can be made or used in any kind of industry.[59] In this connection it should be noted that free professions such as the professions of doctors, lawyers, writers, artists, do not practise a trade.[60] This means, for example, that machines and devices, foodstuffs, semi-luxuries, medicines and chemical

[59] Mohnkopf (2006), p. 4ff
[60] Schlagwein (2005), p. 12

substances can be patented. On the other hand, business methods, medical procedures, inventions in the area of art or literature, ground rules or instructions for use and inventions which would be contrary to public policy or morality cannot be patented.

The rights in a patent arise by virtue of its granting by a patent authority such as the German Patent and Trademark Office (GPTO) or the European Patent Office (EPO). The maximum term for which a patent can run is 20 years from the date of the patent application.[61] Within this term, third parties are prohibited from manufacturing, offering or marketing a product that is the subject of the patent.[62] These circumstances are referred to under Section 9 Patent Act as "sole authorisation to use the patented invention".

Eighteen months after the patent application date, also referred to as the priority date, the application is published by the patent office in the form of an "unexamined patent application". The reason for this is to keep the competition informed about developments in the pipeline and enable them to push forward their own development work and avoid duplication of work. At the same time, the patent applicant's invention is protected from the moment that the patent application is filed. In this way this process has a stimulating effect on business, as mentioned above.

Utility models, like patents, protect technical inventions. On the other hand, the requirements regarding novelty and inventive activity are lower. For example, the fact that the invention is known to have been used previously or that there are non-verbal explanations of it do not stand in the way of a utility model. Instead of inventive activity as in the case of patents, an inventive step is sufficient here.[63] In the first instance a utility model is granted for a period of 3 years. After that the term can be extended by a further 3 years, followed by two further extensions of 2 years each. This is done by paying the annual fee which then falls due.[64]

Under Section 1 of the Designs Act, a design is the manifestation of a whole product or a part thereof which arises by virtue of the characteristics of the lines, contours, colours, design, surface structure or materials of the product. A design must be capable of stimulating the human aesthetic sense of form. This means that registration of the design protects the form (the design) but not the technical embodiment. Once again, to qualify for protection, a design must have a special character and be new. The term is initially 5 years, but this can be extended a total of four times by 5 years each time through payment of a fee.[65]

Trademarks serve primarily to draw a distinction between the goods and services of one company and those of another. Basically a trademark consists of words and

[61] Section 16, para. 1 Patent Act
[62] Section 9 Patent Act
[63] Section 1 Utility Model Act
[64] Schlagwein (2005), p. 13
[65] Schlagwein (2005), p. 14

pictures and combinations thereof. Unlike utility models, designs and patents, the trademark does not have to be new at the time that the application is submitted.[66] Where two trademarks are identical or similar, there will normally be a legal dispute which usually will be settled in favour of the older trademark. German trademarks run for 10 years and can be extended any number of times by a further 10 years against payment of a fee.

According to the German Copyright Act, this form of protection is available for works of literature, science and art, such as publications, films, illustrations, computer programs and databases.[67] Copyright law protects the intellectual creation of the originator and serves to protect the work. This right begins with the creation of the work and terminates 70 years after the death of the originator.[68]

7.3.7 Innovative Approaches to Patent Information and Patent Monitoring

One of the challenges of the modern information age is the fact that today a company's financial and business success depends ever more on the correct handling of information. Access to information has become easier, wider and cheaper, but at the same time the volume of data available is so great that the selection, evaluation and use of information in everyday business decisions is becoming more and more expensive and time-consuming. The use of modern software-supported information systems considerably facilitates the implementation of corporate strategies, especially in areas such as research and development (R&D). In this connection patent information is an important success factor, as all the technical information is nowhere more complete or better documented than in the patent literature.[69]

Examination of information garnered from industrial property rights and especially from patent specifications yields information about commercial and technical developments in a given area of technology and also about the R&D work being carried out by rival companies. Moreover, this information enables conclusions to be drawn as to the efficiency of one's own R&D policy while at the same time generating valuable ideas as to new developments and strategies worth pursuing in one's own company (Mohnkopf & Klotz 2007, VDM Verlag).

Innovative companies continually obtain information about global developments to ensure that they are always state-of-the-art. This avoids the danger of "reinventing the wheel" at a great cost outlay. Companies lose a lot of money and time on duplication of development work which could have been avoided by conducting the appropriate search in and for patents in advance. Information obtained from patents enables the company to keep informed of global developments in the market in an

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[66] Section 3 Trademark Act.

[67] Sections 1, 2, 4 Copyright Act.

[68] Section 64 Copyright Act.

[69] Einsporn (1999), p. 5

easy and cost-effective way and thus to respond to the activities of competitors. Moreover, patent information is an important factor when it comes to avoiding conflicts with other patent holders. If a third-party patent is infringed, the patent holder demands compensation and in the worst case will even threaten a lawsuit.

In the age of the information society the main problem in monitoring industrial property rights and the associated acquisition of patent information is no longer how to get hold of information but how to decide what is the right information, analyse it, make the link between existing knowledge and new knowledge and ensure that this is actually used.

These days the acquisition, processing and evaluation of patent information requires a software-supported solution in order that the huge volume of information available can be appropriately filtered. If one includes patent bibliographies, patent specifications etc., then the European Patent Office alone has about 50 million patent documents available for inspection.[70] Such volumes can no longer be mastered through individual searches and interpretation. In this connection, the use of in-house industrial property rights information systems is becoming increasingly important and necessary. Such systems are used to acquire, process and exploit relevant industrial property rights for the purposes of industrial property rights monitoring.

In the literature available up to now much has been written about patents and their exploitation and evaluation. Unfortunately the aspects of organisational positioning, the design of industrial property rights information systems and the associated process of industrial property rights monitoring have not been adequately examined. However, the aim is to demonstrate the potential for success of patent information and give recommendations as to how to design a successful industrial property rights monitoring system. In this context, the following are the primary aspects to be examined:

- Patent information as a strategic information resource
- The basic structure of an industrial property rights information system
- The elements and the overall process of industrial property rights monitoring
- Organisational forms and patent information described in the literature for industrial property rights monitoring
- Design possibilities for industrial property rights monitoring in the company
- Selection of a suitable industrial property rights information system in the company.

7.3.8 Industrial Property Rights Monitoring

This section describes the process of industrial property rights monitoring and offers design recommendations for successful industrial property rights monitoring.

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[70] Annual report of the European Patent Office (2006)

The term “industrial property rights monitoring” is taken to be a generic term covering all activities involving the collection, processing and use of information on industrial property rights, especially patents.

7.3.8.1 Process and Elements of Industrial Property Rights Monitoring

This section considers the various elements of industrial property rights monitoring. Here the focus is on the areas to be monitored, organisation, process and methods.

- *Requirements.* What are the aims of monitoring? What monitoring areas can or should industrial property rights monitoring cover?
- *Design principles.* Who will perform the monitoring? What form does the monitoring process take?
- *Methods.* What methods are available for industrial property rights monitoring and communication of the results?

As well as all the general aims of industrial property rights monitoring, i.e. avoidance of duplication of development work and the infringement of third-party patents and early recognition of opportunities and risks as they arise, a number of exploitation possibilities are mentioned in the literature. Depending on the aim of industrial property rights monitoring, a variety of monitoring areas are relevant. Thus, for example, one area to be monitored could be defined as virtually all the bibliographical data in a patent specification. In other words, one could monitor, for example, IPC class, applicant name, keywords and a combination of these. The extent to which interpretation and analysis are designed into the system depends among other things on the decision as to how much attention to pay to a given monitoring area. This decision also depends on the resources available and the basic strategy of the company.

It is also important that industrial property rights monitoring interacts with economic, social and political developments. For example, political decisions can have an enormous influence on technological developments. Examples here include standardisation work and the standardisation of technological developments, which can completely pre-empt superior technologies.

Hence, industrial property rights monitoring should consider not just industrial property rights in the narrow sense but other areas of influence as well. However, this must not result in the collection of an infinite amount of data and information about an area. Without a sensible focus, the results of such industrial property rights monitoring would be confusing and in the worst case would have no effect.

In accordance with the diversity of monitoring areas and ways of exploiting patent information, several different forms of organisation are possible.

- *Central unit.* At corporate level, patent monitoring is performed by a central patent department or a central research department. Here the emphasis is on long-term and strategic subjects, e.g. technology studies, orientation of overall monitoring strategy, areas for mandatory monitoring, etc.

- *Decentralised groups.* Industrial property rights monitoring is operated through development centres in the operating unit of the company, the product areas or business units. Here the emphasis is mainly on monitoring the competition, identifying new markets and customers and technological developments in a horizon of 1-3 years.
- *Combined activities.* The industrial property rights monitoring function can be led by a central group (e.g. patent department) with key persons in other departments serving as information sources or gatherers. Such networks are also oriented by subject, individual core technology area or research project or exist for a fixed period in which there is a special requirement.
- *External networks.* The internal monitoring activities are supplemented by setting up external networks. The possibilities here include setting up an expert network or collaborating with external research service providers and chambers or with universities.
- *Irregular structures.* There are no formal structures for industrial property rights monitoring. Every employee in the company is expected to collect information relevant to industrial property rights in the course of his normal work and to then pass this on to the responsible person, process or file it.

The organisational forms listed above differ as to the nature of the industrial property rights monitoring in the following respects:

- Existing competence of the person performing the monitoring in the technology field that is being watched (technological competence). Normally one is dealing here with staff from R&D departments who bring with them the appropriate expertise in certain technological areas.
- Formal expertise regarding how to go about obtaining and processing information (methods-related skill).[71] Normally this will entail the use of staff from patent departments or else professional, external researchers. They bring with them specialist knowledge regarding the formulation of search queries, the design of IPC classes, knowledge of databases etc.

Both competencies are necessary for successful industrial property rights monitoring. For example, if technology competence is lacking, it is possible that a patent department might only produce information which has long been known in R&D circles.

Without methods-related skill, that is, without knowledge of search algorithms, databases, IPC classes etc., it is virtually impossible to perform a patent database search. Dividing up the monitoring tasks into different organisational units is particularly important to attainment of the solution. Figure 7.25 shows the breakdown of the overall process of industrial property rights monitoring.

[71] Kobe (2001), p. 325

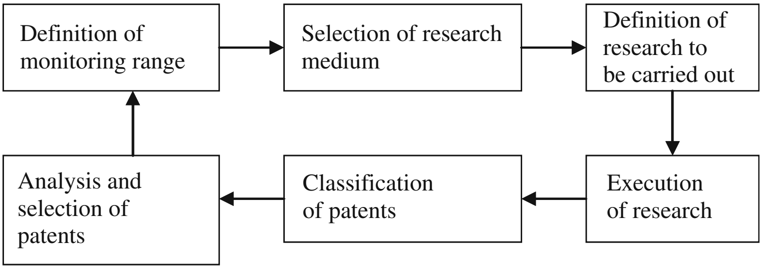

Fig. 7.25 Process of industrial property rights monitoring[72]

Selection of the research medium is dependent on the probability of success at finding patents and the costs associated with the research. Many databases are of a commercial nature and it is expensive to use them. There are also a number of Internet offerings which are free to use. The basic features which differentiate the databases are the degree of specialisation and the functionality. To select the right databases, it is therefore necessary to define the area to be investigated.

The success of a patent search will depend critically on a mastery of different types of access to the underlying technical and patent information,[73] i.e. of particular search syntax and keywords. These are derived from the area of investigation and are fine-tuned or expanded during the search. The time required to conduct a search will vary depending on the patent situation in a given technology area.

Industrial property rights identified are grouped by their importance in relation to the search task. Once the patents have been identified, they can be classified according to their importance. This classification is a subjective process which should be tailored to the corporate landscape and culture. However, objective evaluation criteria exist which support a classification. These include, for example, association with a particular technology field or identified inventor of a technology and its/his technological or commercial strength.[74]

The subsequent assessment of relevance is once again a subjective process, as the significance for technologies and development can only be estimated. Classification is a necessary process step due to the fact that patents of different relevance are picked up during the research. An ensuing analysis of patent specifications can vary as to intensity.

There are numerous methods of obtaining patents and patent information for the purposes of industrial property rights monitoring. Thus, for example, monitoring can be directed manually, it can proceed via public databases or via an in-house industrial property rights information system, or an external service provider can be

[72] Faix (1998), p. 159 ff.
[73] Suhr (2000), p. 396
[74] Ernst (2001), p. 216

Table 7.5 Forms of industrial property rights monitoring

	Definition			
	Monitoring area	Process participants	Steering, leading and responsibility for the process	Example
Non-deliberate monitoring	Defined by interests or task area of the employee	Any staff, within the framework of other tasks	Systematic gathering of information for non-deliberate monitoring, no responsibilities	Electrical engineer conducts research in the area of control engineering and by accident comes across interesting information on other areas
Deliberate monitoring	Active search for relevant industrial property rights relating to a particular subject and/or task	Employees within the framework of their tasks, patent department, R&D department	Repeated, regular monitoring, responsibility lies with the employee in charge of the monitoring	Designer has been tasked with designing a component, in the course of which he is expected to consider conflicting designs
Mandatory monitoring	Defined area, possibly determined by line manager or directives, regular reviews, strategic background	The parties ordering the monitoring, e.g. patent or R&D department	Determines what is to be monitored and to whom what should be communicated, ongoing oversight of the monitoring, responsibility lies with the parties tasked with the monitoring	Patent department is instructed to watch competitors XY and analyse their conduct with regard to new development
Project-specific monitoring / technology studies	Normally defined in project remit or within the framework of R&D services	Project team or R&D managers with corresponding technical expertise in the subject areas	Project manager, own responsibility of the person tasked	Monitoring of a technology area is arranged to run in parallel to development project XY, with a fixed start and end point

tasked with the monitoring. The decision largely depends on the scope of monitoring, the associated resources and the ability to direct the monitoring. The possibility of performing industrial property rights monitoring using an in-house industrial property rights information system will now be considered in more detail.

The term “industrial property rights information system” is not clearly defined in the current research literature. As a result, public databases which are free of charge, in-house databases, patent monitoring systems, patent administration systems, databases with or without evaluation and visualisation facilities, amongst others, are all referred to as industrial property rights information systems. For the present purpose the term industrial property rights information system will be taken to mean an in-house information portal for Industrial Property Rights.

There are a number of software solutions on the market for implementing such a system. In a software-supported system, the process flow can largely be automated. This requires that the monitoring area and the search query are held in the system. The industrial property rights information system then automatically conducts searches at defined intervals. Normally the system will possess interfaces to databases that are publicly available. The documents found are delivered to users of the system in a fashion similar to an e-mail program, or else they can normally be integrated into the existing e-mail program. With these systems it is possible to view bibliographies, patent families, drawings, title pages, etc. and to undertake the first relevance checks at the click of a mouse button. The results are then forwarded internally over the system. In this way the information is made available to the appropriate users. In most systems this step can be automated as well by defining certain restrictions and narrowing search profiles down accordingly. A classification scheme which can be broken down into particular subject areas is created in the storage area of the systems. This storage area is user definable and makes filing very flexible. Subject areas can be maintained in the system, e.g. by technology, development project or competitor. Any number of comments can be added to each industrial property right by individual users. With predefined types of comments, it is possible to generate selective user decision recommendations regarding further steps. This has the advantage of ensuring that the results have been viewed and assessed. Through the use of multiple user profiles, it is possible to divide up the work on the system, which is desirable when there is a lot of patent information.

7.3.8.2 Roles in Industrial Property Rights Monitoring

It is a good idea to have a process manager who preferably comes from the patent department or a development department. This person should have overall responsibility for the collection and tracking of monitoring jobs and following up on industrial property rights-related subjects. For the process of industrial property rights monitoring a process manager should be entrusted with the following tasks:

- Coordination of mandatory monitoring
- Collecting together the results of non-deliberate industrial property rights monitoring

- Stimulation of deliberate monitoring
- Bringing together market and industrial property rights monitoring
- Supporting and participating in research and development projects
- Supporting and maintaining the in-house industrial property rights information system

Normally this will be done by people from research and development or from other areas who raise particular issues in the course of their activities (see Section 7.3.3.3). Search and monitoring jobs are created on the basis of their statements and work. These are staff who act on their own initiative or are explicitly asked to do this within the framework of their tasks and project work.

The skills profile of the persons performing the industrial property rights monitoring will depend on the details of the different organisational forms of industrial property rights monitoring. Two opposing kinds of skill are needed: the methods-related skill required for the research to proceed efficiently and in a goal-oriented manner, and the technology skill necessary to interpret and evaluate patent information. The ideal solution to industrial property rights monitoring is a combination of both types of competence.

7.3.8.3 R&D Organisation

The R&D organisation of a company X is characterised by a central Basic Development unit and development departments in the product lines. Basic Development is active in technology development and preliminary design. New technologies are picked up, preliminary investigations are carried out and expert knowledge is accumulated in order to then pass these technologies on to the development departments of the product lines. The technology strategy of the company is largely determined by Basic Development.

The company is also involved in joint research projects in the outside world. New technologies are to be energetically employed. The company is therefore interested in assessing opportunities and risks through industrial property rights monitoring and in using the knowledge of other leading technology suppliers. The development of new product generations is primarily driven by Basic Development.

Within Basic Development, the Industrial Property Rights department is responsible for the process of industrial property rights monitoring. The foremost objective of the department is to preserve the company's research and development freedom. A patent strategy calling for efforts to generate qualitatively high-value industrial property rights for the company to be stepped up has been specified.

The department is competent in all issues relating to the legal protection of industrial property. Thus, the company's patent portfolio is managed here, applications for industrial property rights are proposed and patent and technology strategies are developed in consultation with those responsible in R&D.

The main tasks include the following:

- Advising inventors and technical departments on all matters relating to industrial property rights

- Accepting invention disclosure forms
- Submitting patent applications to the patent office in cooperation with patent lawyers
- Monitoring own and third-party industrial property rights in relation to possible infringements
- Performing research work, e.g. "state-of-the-art searches"
- Calculating inventor's compensation in accordance with the Employee Invention Act
- Supplying information for the development departments in the product lines, marketing and technology development regarding, for example, technical innovations, actions of competitors, statistics regarding industrial property rights.

7.3.8.4 Example of Background to the Introduction of an Industrial Property Rights Information System

The rising number of invention disclosures within the company and the competitive environment in which it operates, combined with rapid developments in different technology fields, increasingly calls for more efficient and more effective patent management. As part of this there is a need for a goal-oriented patent department with clear tasks, suitable work processes, work flows and methods for monitoring, evaluating and administering patents. It was therefore ascertained that the department possesses potential for development in patent management, which needs to be released. In particular, the problem area of industrial property rights monitoring needs to be addressed.

In the company, especially in the R&D departments, there is uncertainty as to how to proceed with patent information acquired. Patents are normally analysed in an unsystematic way by individual persons who need the information. Moreover it is unclear how exactly information flows and what lines of responsibility exist within the organisation. Another aspect of this is that patent analysis software and information systems are hardly used in the company. A closed process for dealing with patent information, both internal and external, and with the resulting consequences in the form of analysis for the company's own product strategies, is lacking.

To record the current situation in the company, it would be sensible to conduct a survey of staff from the R&D departments since, according to the corporate guidelines regarding patent monitoring, these departments are responsible for the individual task areas and are the users of the industrial property rights information system.

Existing process documentation and corporate guidelines are inspected and reviewed for their relevance to industrial property rights monitoring. The results must be structured, compared with the literature and then fed into a subsequent analysis. Some of the important questions might be:

- Are you familiar with the present industrial property rights information system (database on the intranet)? If not, why not?

- Why do you monitor third-party and the company's own industrial property rights?
- How and for what information do you keep a lookout?
- How often do you use the database on the intranet?
- Do you use public databases for search purposes?
- How do you design your search?
- Do you have any knowledge of professional search algorithms [75]?
- How do you use your search results?
- How do you store your results?
- Are you involved in the circulation of patents [76]?
- Who in your department is responsible for the subject of industrial property rights?
- Do you like the present solution? What could be improved?
- Are you familiar with the corporate guidelines (protection of industrial property rights in the company)?
- How could the patent department help you with your work?
- Do you have any particular expectations or wishes as regards the new industrial property rights information system?

Basically, employees have two ways of conducting industrial property rights research. The first is to search the in-house patent database which is published on the intranet and the second is to conduct online searches in the public databases of the patent offices. A further source is technical journals, which are displayed in the product lines and departments. Again, the patent department can be asked to conduct specific searches.

The patent database in the company's intranet consists of third-party and own industrial property rights and currently comprises 17,500 data records. Every month about 50 new data records are added. The content includes not only complete patent specifications but also information on the applicant, brief information on the patent, the year of application, countries in which patent protection has been sought and the internal reference. The database is classified through the assignment of keywords. The keywords are assigned to different technology fields.

The data records are assigned to classification categories such as propulsion, control systems, ergonomics, etc. There are over 50 classification categories. New categories are added or existing ones deleted as required. The database does not allow family-oriented searches. It is not a relational database. Full text searches, complex search queries and evaluations are not possible. The database permits a simple search function by applicant, keyword and publication number. The database

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[75] In the public databases, it is possible to define particular search algorithms which improve the search both quantitatively and qualitatively. However specialist knowledge is necessary to avail oneself of this possibility.

[76] This refers to the internal circulation of patents for the purposes of patent monitoring in electronic and paper form.

is maintained and continually updated solely by the patent department. A distinction is made among four different types of monitoring. (see Table 7.5)

Non-deliberate Monitoring

Non-deliberate monitoring takes place primarily within the framework of everyday work. The survey results have indicated that this is a common method used within the company. In principle every employee can himself choose how and when to conduct research. For this form of monitoring there is no optimal solution as to how to incorporate employee evaluations in a system in a supportive way. The results of monitoring are primarily passed on via personal communication or by e-mail.

Deliberate Monitoring

Deliberate monitoring normally occurs as part of the daily work. This entails an active search for particular industrial property rights. The trigger for this is issues arising from research and development or from the patent department. When the scope requires, an external service provider is commissioned to perform conduct specific search queries. Manual searches are also performed.

Mandatory Monitoring

Monitoring for certain competitors, technology areas and IPC classes is mandatory. The mandatory monitoring areas are kept by an external service provider. Technical staff from the product lines monitor new developments in their respective technical areas. Staff from the product lines have a duty to keep informed of the latest developments in their areas. Mandatory monitoring is indirectly specified in corporate guidelines and is implemented with the aid of the patent department.

Project-Specific Monitoring

So far there has not been any project-specific monitoring, i.e. monitoring of industrial property rights relevant to possible development projects has up to now been covered under mandatory monitoring. If necessary, search jobs are passed to the patent department. Industrial property rights monitoring is considered at a certain point in the development process, but there is no continuity over the full length of a project. From time to time technology studies are performed by Basic Development.

The engineers from the individual product lines carry out the industrial property rights monitoring and especially the evaluation of results. They are the primary experts at monitoring their technology areas. In this work they are supported by the central Industrial Property Rights office. The staff in the department have a technical training which enables them to rapidly get up to speed in new areas and to assess patent information. Research is also supported by external patent lawyers or research services.

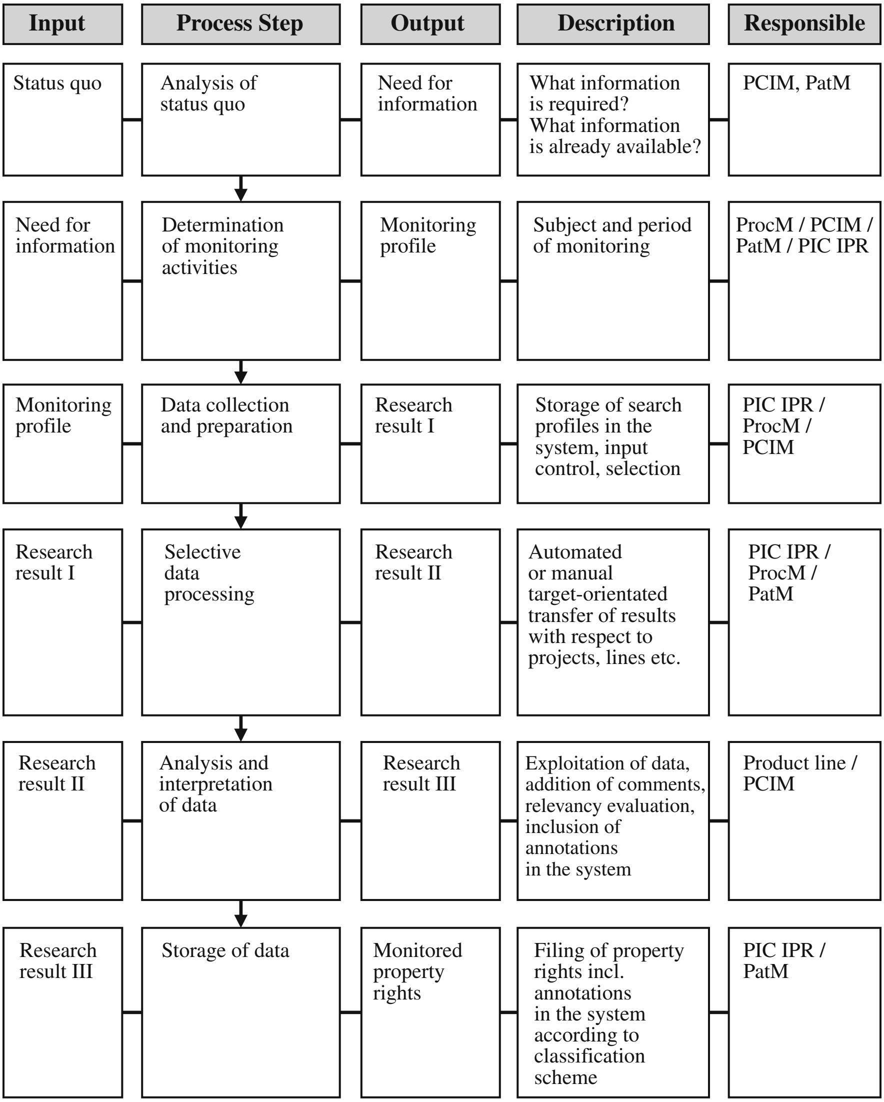

Fig. 7.26 Ideal industrial property rights monitoring process

Figure 7.26 shows the ideal process of industrial property rights monitoring. This ideal process is to be implemented with the aid of a software-supported industrial property rights information system. The abbreviations in the diagram have the following meanings: PICM = person in charge of monitoring, PatM = patent manager, PIC IPR = person in charge of monitoring industrial property rights, ProcM = process manager.

The proposed concept envisages organisationally anchoring industrial property rights monitoring in every development department. A software-supported industrial property rights information system can assist with this. All monitoring of the process is carried out in the patent department or is managed by the process manager concerned. If industrial property rights monitoring is to be properly integrated into the organisation, it is always important to know the background reasons for conducting the monitoring. Thus it is useful to integrate industrial property rights monitoring of new technologies and technology studies into central R&D departments, e.g. Preliminary Design and Basic Development. In case of strategic questions or general observations regarding the competition, integration into the patent department or into strategic departments such as strategic marketing is advisable. If, for example, any design problems, development projects or product improvements are on the agenda, integration of monitoring into the product lines is more goal-focussed. Moreover, a number of roles in the monitoring process need to be defined and designated.

As described, the introduction of a process manager responsible for industrial property rights information and monitoring will bring many advantages in the course of the development process. The patent department has to assume direction of and oversee the industrial property rights monitoring process and should therefore preferably manage the process. Moreover, steps should be taken to ensure that the appointed process manager is always a member of integrated development teams and, in this capacity, is always focused on industrial property rights monitoring.

A patent manager must be appointed in every product line and in each development project and also in areas where there is extensive technology competence, such as in Basic Development or in design departments. The patent manager is the point of contact for the person in charge of monitoring industrial property rights and is responsible for analysing and coordinating the stock of information. Moreover, the monitoring jobs are coordinated with the patent manager and always reviewed to ensure they are up-to-date.

The person in charge of monitoring industrial property rights can also be the patent manager, the process manager or the person in charge of monitoring or any employee from the patent department or one of the R&D departments. It should be noted here that the gathering and evaluation of patent information should if appropriate be separate activities entrusted only to staff who possess the necessary competencies.

7.4 Collaboration Between Industry and Academia

Innovation potentials and expertise in German higher educational establishments is often very important for commercial applications and should be not only used for research and teaching but also protected and marketed. Especially in collaboration between the universities and industry, ideas for innovations are implemented individually or jointly in national and international projects and then increasingly applied in products.

In Germany, for a long time third-party funded research was determined by the legal situation, under which the rights to inventions developed by academic staff belonged to the inventors and not to the employing establishment. The privileged situation of academic staff meant that, although companies had to conclude contracts with the universities where university resources were to be used, contract research and research cooperation agreements also entailed direct contractual relationships between the companies and the relevant academic staff. As a rule, companies also obtained a limited right to use their inventions.

On 7 February 2002 the law changed to the extent that Section 42 of the Employee Invention Act was amended and academic staff became subject to the other provisions of the Employee Invention Act. As a result, where an invention is reported under the Employee Invention Act, the university can now claim the inventions. In order to deal with the special situation of academic staff whose freedom as to research and teaching cannot be restricted (Section 5, para 3, Basic Law), the legislator also introduced the freedom not to publish in Section 42, para 2, Employee Invention Act. Under this provision, an academic has the right not to publish an invention he has developed. In addition, the legislator introduced special compensation provisions for academic staff in their relationship with the academic establishment (Section 42, para 4, Employee Invention Act).

This new legal situation created a need in practice to develop manageable and standardised contract elements for individual aspects of such third-party funded research contracts. To this end representatives of the Berlin higher education establishments, ipal GmbH and companies from all over Germany met in June 2002 in Berlin at the initiative of ipal GmbH, with an experienced moderator in the chair. The result of the negotiations was two non-binding suggestions for contract elements, one relating to research collaboration and the other to contract research. The working party also developed indices drawing the line between the two contract element types.

Since then, various other comparable drafts have been discussed in Germany. The former working party discussed the issue again in the spring of 2007 and met to review the two types of contract element, not least in order to discuss experience at using these two contract element types in the intervening years and, if necessary, to allow appropriate changes to be made.

By chance this rework coincided with the convening of another working party which took up the same subject, although it discussed it in a wider context, namely the R&D Standard Contracts subgroup within the Council for Innovations in the Federal Chancellery.

The two contract element types appear opposite one another in a manual[77] which explains, necessarily in compressed form, the meaning and purpose of each version of the provisions and, to the extent that this is possible, why the working party chose

[77] Developed by the "Berlin contract" working party.

one particular version. The manual is neither intended to give a full commentary in the sense of a legal explanation of the relevant provisions, nor should it be seen as a binding expression of the institutions and companies represented on the working party. However, it aims (beyond these explanations) to also make the naturally complex contract elements more comprehensible precisely for small and medium-sized enterprises and to reference further items that need to be regulated in corresponding third-party funded research contracts.

German versions of the manual, the associated contract elements and also the specimen agreements for R&D collaborative agreements can be downloaded from the Internet from www.ipal.de and www.bmwi.de as a guide towards their use in practice. The English version can be found under www.mohnkopf.eu.

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Part IV
Innovation Performance Accounting in the Context of Strategic Technology Management

Chapter 8
Technology Cost Analysis

Matthias Hartmann

8.1 Introduction to Technology Cost Analysis

The market requirement to offer the technically best products at the lowest prices possible makes the integration of technology management and cost management imperative. Technologies must be viewed as innovation potentials and have a strong influence on the cost level and cost structure of products and processes.

By evaluating products and processes starting from the resource of technology, it is possible to add an appropriate extension of the market-oriented approach of target costing to long-term cost management.

Just as in the concept of target costing the target costs are inferred from the customer benefit, in technology cost analysis the costs of individual technologies are inferred from their attractiveness values as determined by the future performance potential of these technologies.

The idea is that through technology cost analysis, future products and processes are influenced in relation to both their technological capabilities and the effects that they have on costs level and cost structure.

8.2 Integration of Technology Management and Cost Management

The successful transition to new technologies not previously used leads to a radical change of cost level and cost structure among products and processes. In this connection, Jack Welch coined the principle that the market will only accept technologically top products at the lowest prices.[1] This would appear to be a contradiction. On the other hand, the enormous need for the integration of technology management and cost management is apparent here.

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[1] Tichy and Sherman (1993), p. 242.

W. Schmeisser et al. (eds.), *Innovation Performance Accounting*,
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What do we mean by this? Technology management relates to the planning, conduct and control of the development and application of new technologies and changes in technology to create the competitive potentials that are critical to success. The role of cost management is to actively influence the factors which cause costs.[2] Technology-induced cost effects have to be identified early on so that the cost level and cost structures can be determined in a success-oriented manner early in the development of products and processes. Here it is not so much a matter of exact monetary figures as of arriving at *a preliminary indication of the relative costs for the purposes of assessing technological alternatives*.

In this sense, we intend to show with the aid of technology cost analysis (TCA) how the costs of technologies can be assessed in relation to their future performance potentials. The aim of technology cost analysis is to establish relations between technology values and cost values in order ultimately to be able to influence the cost level and cost structure of a product or process. A practical example from the smart-card industry will be used to explain the approach and possible recommendations for action.

8.3 Cost Dynamics of Innovative Technologies

Before we go into technology cost analysis, we will outline the connection between technology management and cost management in three steps. First of all, technologies constitute innovation potentials which, secondly, can have considerable cost effects. In order, thirdly, to be able to assess these cost effects, it must be possible to assess the technologies themselves.

8.3.1 Technologies as Innovation Potentials

Current management behaviour shows that after a phase of intensive downsizing, people are (once again) increasingly talking about *innovation-oriented growth strategies*. Growth depends on the *identification, creation and exploitation of the potential benefits of business resources and combinations of resources for boosting future success*.[3] In this connection, one subset of business resources that is highly relevant to competition is technologies as solution principles incorporated in products and processes. Thus, for example, Hamel and Prahalad stress the fact that technologies and services are the most important resources of businesses.[4]

In this context technologies must be understood as innovation potentials for which initially the market does not always have any need. In this context, the use of a new technology in products or processes would be the expression of a need.

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[2] Männel (1995), p. 27 f.

[3] Pampel (1996), p. 321.

[4] Hamel and Prahalad (1994), p. 224 ff. and p. 291 f.

"New" can refer here to technologies developed for the first time or to technologies that are not actually new in absolute terms but new in the sense of being applied for the first time in a new industry. Accordingly innovation comes about only when there is a product- or process-specific concrete innovation need corresponding to the innovation potential "technology" and the two coincide.[5]

As a result of this competition-critical innovation mechanism, it is necessary to supplement the currently prevalent market-oriented perspectives of customer and process orientation with a resource-oriented or, in this case, technology-oriented perspective. For cost management, this means considering the product, process and resource sides simultaneously and with equal emphasis.[6] On the one hand, concepts like target costing translate customer needs and price estimates from the market into reliable cost levels and cost structures derived therefrom. On the other hand, it should also be possible to translate technology potentials into cost structures in order ultimately to allow innovations to come about at optimal cost through a congruence of customer need and technology potential. The need to supplement market-oriented concepts for the cost management of new technologies on the potential side arises on the one hand from the innovation mechanism, i.e. the congruence of need and potential, and on the other hand from the fact that target costing is based on current needs and current customer ideas. For new technologies which are still under development, the product and cost requirements derived from target costing can lead to the wrong development specification. Needs and customer ideas can also change over time. It is therefore perfectly possible that by the time new technologies have been developed to the point where they are ready for production quite different need structures will exist in the market. Often it is not possible to identify these future needs in advance. Basing the analysis on current needs, as is customary with target costing, will not help when it comes to assessing the benefit effects of new technologies which only take effect in the long term.

8.3.2 Cost Effects of Technologies

When one observes the way innovative technology costs change over time, often one sees extreme cost dynamics. New technologies usually have a radical influence on the cost structures of existing products and processes. *Changes in technology costs over time*, which are fascinating to track in retrospect, for example, in the application fields of smartcards and semiconductor technology, continue to apply to the future. The limits of this development are defined only by physical–technical limits.[7] Even these limits can frequently be overcome by completely novel solution principles.[8] Thus, in their time, mechanical controls were replaced by electronic controls. In

[5] Pfeiffer (1980), p. 422.
[6] Pampel (1996), p. 322.
[7] Wyk (1985), p. 216 ff.
[8] Hartmann (1997), p. 175 ff.

the future the biochip could replace semiconductor chip technology in many areas. Accordingly, new technologies can be understood as innovation potentials whose benefit, however, must be recognised. Thinking in the usual cost relations is therefore a hindrance to strategic orientation if the thinking structures remain tied to currently valid cost structures. The effect of technologies on cost level and cost structures can be graphically presented with the aid of the S curve and experience curve concepts.[9]

"The S curve is a graphical representation of the relationship between the cost of improving a product or process and the results achieved through this investment. It is called an S curve because the results, when graphically presented, normally assume the shape of an S running from the bottom left to the top right".[10] "The core statement of the experience curve concept is that every time the cumulative volume of a product doubles, the inflation-adjusted costs of the added value in one unit potentially decline by 20–30%. In this way, the cumulative production volume is equated to a certain extent with 'experience'".[11] The above figure shows the S curves of two technologies, the later of which is assumed to be more capable. Interpretation on the basis of the experience curve suggests that when two technologies are compared, *the more capable technology in principle exhibits a steeper experience curve*. However, in the technology transition the technology of the first S curve initially demonstrates clear cost advantages compared with the costs of the successor technology. This difference is referred to as the *cost spread*. Here, the phenomenon of the cost spread is a temporary unfavourable unit cost difference which, however, subsequently translates in principle into a unit cost advantage if the more capable technology is single-mindedly developed. Remaining on the old experience curve is a purely defensive technology strategy that leads to a vulnerable cost position and ultimately to products which can no longer be sold. "For example Texas Instruments emphasized the learning curve and became the world's lowest cost producer of obsolete microchips" (Shank 1997, p. 48). A technological first or pioneer uses the new experience curve with comparatively lower costs to uniquely differentiate its products on the market. Only through strategic cost management of the technological resources can the cost effects of new technologies be correctly estimated, controlled and exploited.

8.3.3 Assessment of Technologies

Figure 8.1 shows clearly on the basis of the interpretation of the experience curve that the *transition to a new technology constitutes a change in the cost level*. In the long term, the cost level of the new technology will be lower than that of the old technology. The differences in cost level ultimately result from differences in the cost

[9] See Fig. 8.1 and Hartmann (1997), p. 58.
[10] Foster (1986), p. 27.
[11] Pfeiffer et al. (1991), p. 36.

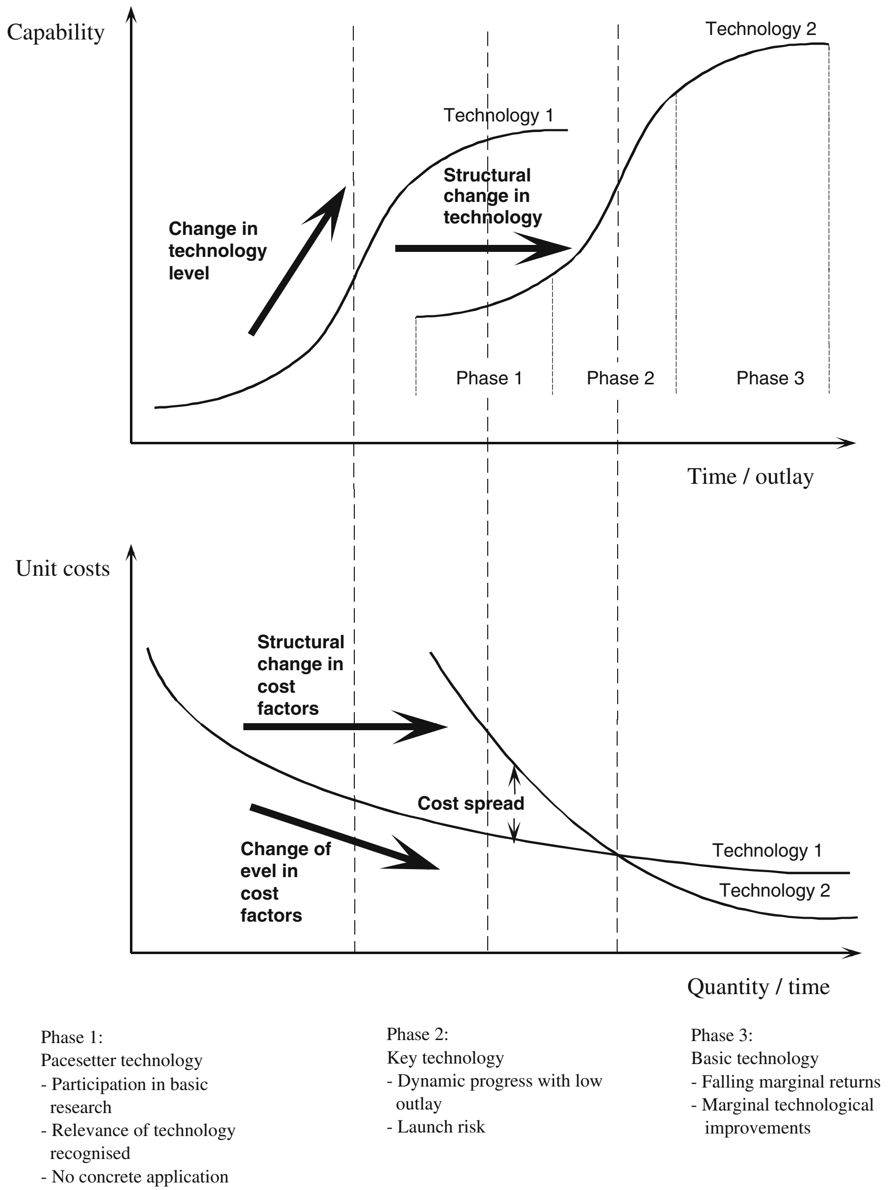

Fig. 8.1 Relationship between technological capability and unit costs

structures of the two technologies. Consistent innovation cost management should take this phenomenon into account in cost-effectiveness analyses. Comparison of one cost level for given technologies with a cost level that results from the cost structures of new technologies often reveals striking cost differences. Costs are interpreted dynamically against the background of ongoing technical development.

In the concept of innovation cost management, technical development, which can be viewed as a dynamic path to ever higher capability, is assessed in terms of *technology attractiveness (TA)*. The more capable one technology is compared with another, the more attractive it is for use in products and processes. Here technology attractiveness is defined as the sum of all the technical/economic advantages which can be gained through exploitation of the strategic further development potential in a technology area,[12] while further development potential refers to potential performance increases of a technology and thus ultimately to the cost reduction potential inherent in it.

The assessment of technology attractiveness entails a rough breakdown into *pacesetter, key and basic technologies* (Fig. 8.2).[13]

A pacesetter technology is assigned a value of 3 (very attractive), a key technology a 2 (average attractiveness) and a basic technology a 1 (less attractive). The possible values at either end, 0 and 4, represent extremes. Depending on the performance level of the technology, one obtains a value of 0, 1, 2, 3 or 4. The classification into pacesetter, key and basic technologies can also be illustrated by referring back to Fig. 8.1: expressed simply, pacesetter technologies lie in the first

Pacesetter technology

- Early stage of development
- Serious effects on competitiveness, big competitive potential can be identified
- Only mastered by the "First" or "First group"
- Integration into products/processes is starting

Key technology

- Clear influence on competitiveness
- Success-critical technology, lends itself to differentiation
- Still mastered by few
- Integration into products/processes already clearly gathering pace

Basic technology

- Low earnings/cost leverage effect
- Differentiation barely possible any more; determines the industry structure
- Mastered by "all" competitors – "the information is on the street"
- Integrated into most products and processes, i.e. the potential range of applications is virtually exhausted

Fig. 8.2 Definition of pacesetter, key and basic technologies

[12] Pfeiffer et al. 1991, p. 85 ff.

[13] See Fig. 8.2 and Hartmann 1997, p. 170.

third of the S curve (phase 1), key technologies lie in the second third (phase 2) and basic technology in the third (phase 3).

8.4 Technology Cost Analysis (TCA)

When one understands the way the cost dynamics of innovative technologies work, certain interactions between technology management and cost management become apparent. Using technology cost analysis, we will now propose a method for recognising the necessity for a technological product or process improvement and expressing it in cost terms. For this purpose we will start by examining the aims of technology cost analysis (TCA) and then consider, in sequence, its course over time, the outcome, recommended actions and finally a special assessment.

8.4.1 Aims of Technology Cost Analysis

Technology cost analysis examines the costs of technologies in relation to their future-related performance potentials. *Just as in the concept of target costing the target costs are inferred from the customer benefit, in technology cost analysis the costs of individual technologies are inferred from their attractiveness values*. Technology cost analysis can be described here as a supplement to target costing on the potential side, since through the cost-related assessment of future-related performance potentials, it goes well beyond the time horizon of target costing. As a result it is possible to assign a cost value to the benefit of a technology which, although initially having only a heuristic character, nevertheless creates a direct link between technology value and cost value.

The aim of technology cost analysis is to establish *relations between technology values and cost values* in order to be able to assess the cost level and cost structure of a product or process. The idea is that, through action recommendations derived from it, ultimately products or processes are actively influenced in relation to both their technological capabilities and the effects that they have on costs level and cost structure.

8.4.2 Course of Technology Cost Analysis

Using an example from the smartcard industry (see Fig. 8.3), we will now demonstrate in practical terms the course of technology cost analysis.

The memory card in question is better known as a healthcare insurance card or a phone card. The technical details will not be discussed further here, but the reader is referred to Lender and Hartmann (1997). The stated cost values for the memory card in question must be viewed as guide values and constitute the full manufacturing costs per unit over the relevant technology life cycle, calculated on the basis of an

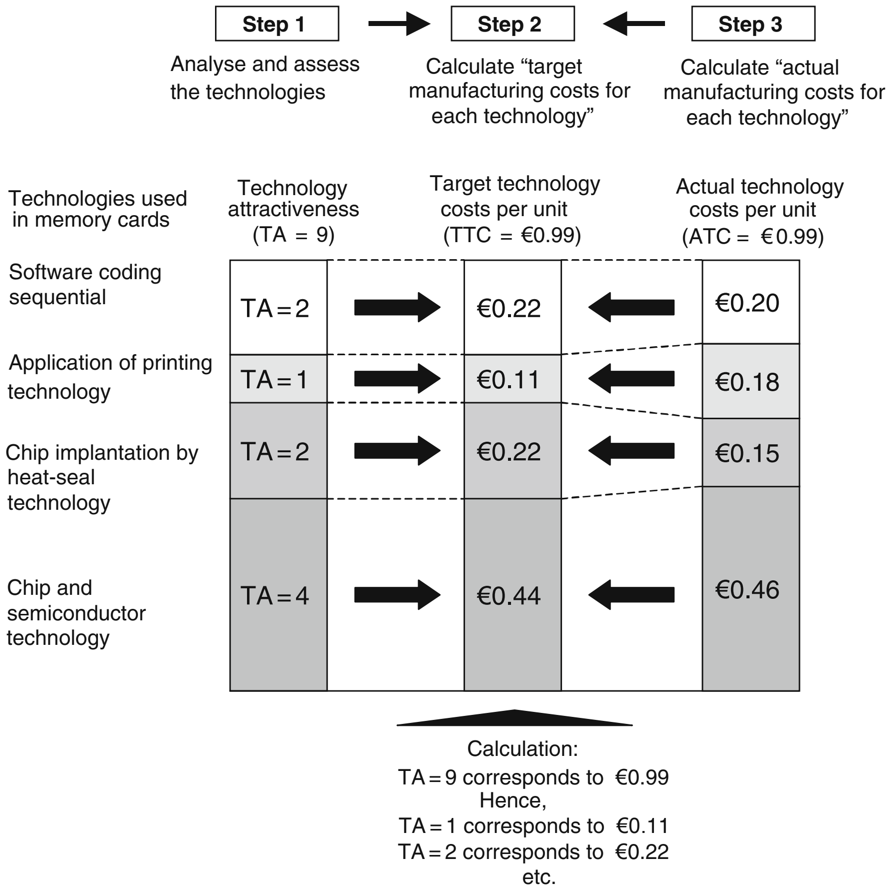

Fig. 8.3 Course of technology cost analysis as illustrated by a memory card

average capacity utilisation. These life cycle costs include the preparatory costs, ongoing production and marketing costs and the post-market costs.[14] The technology cost analysis assumes that every product or process is composed from several individual *technologies*. The technology attractiveness (TA) of a product or process is derived from the sum of the individual attractiveness ratings of these technologies. The breakdown into constituent technologies is accomplished by analysing the functional abstract solution principles that are incorporated in a product or process. In our example, the memory card contains four constituent technologies with different attractiveness values: "Software coding sequential" (TA = 2), "Application of printing technology" (TA = 1), "Chip implantation by heat-seal technology" (TA = 2)

[14] On the life-cycle cost concept, see Männel (1997), p. 128 ff. and p. 157 f.

and "Chip and semiconductor technology" (TA = 4).[15] Accordingly, the sum and hence the technology attractiveness of a memory card is 9.

The *real actual costs of each technology* are now calculated. If the technologies used in existing products and processes continue to be used without change, the actual technology costs are the same as the manufacturing costs. If any existing technologies need to be modified, the manufacturing costs need to be corrected to take into account the cost effects resulting from modification (increase or decrease in costs). Depending on the level of information available, they can be corrected on the basis of estimates, rough calculations or precise calculations. The actual technology costs for completely new technologies can usually be determined only via estimates or rough calculations. The sum of the actual technology costs of the individual technologies produces the actual total technology costs. In the case of the memory card analysed here, the actual unit cost of one memory card, given an average utilisation of production capacity, is equal to the sum of the unit costs of the four constituent technologies ("Software coding sequential" €0.20, "Application of printing technology" €0.18, "Chip implantation by heat-seal technology" €0.15 and "Chip and semiconductor technology" €0.46), i.e. €0.99.

We now work out the *target technology costs* by assigning the complete cost block of the actual total technology costs of a technology in the same proportions as the attractiveness block of a technology. The result is the target costs for each technology. These target technology costs must be interpreted here as the *allowable costs of the technology concerned bearing in mind its attractiveness*. If the €0.99 unit cost of a memory card corresponds to a technology attractiveness value of 9, then the unit cost of the technology "Software coding sequential" may be assumed to be about €0.22, given a technology attractiveness value of 2. The same calculation can be performed for the other constituent technologies, i.e. "Application of printing technology" (TA 1 = €0.11), "Chip implantation by heat-seal technology" (TA 2 = €0.22) and "Chip and semiconductor technology" (TA 4 = €0.44).

It emerges that the actual unit costs of "Software coding sequential" and "Chip and semiconductor technology" are roughly the same as the relevant target technology unit costs. The actual unit cost of "Chip implantation by heat-seal technology" of €0.15 is even lower than the target technology cost of €0.22. By contrast, the actual unit cost of "Application of printing technology" (€0.18) is disproportionately higher than the target technology cost (€0.11).

8.4.3 Results of the Technology Cost Analysis

Generally speaking, three different cases can be distinguished among the results of a technology cost analysis:

[15] Hartmann (1997), p. 171 ff. and p. 210 ff.

1. *The target technology costs are lower than the actual technology costs*. The degree of mastery of a technology is too low in relation to the capability of the technology.
2. *The target technology costs are about the same as the actual technology costs*. The capability of a technology and the costs caused by this technology are roughly the same. The capability corresponds to the degree of mastery of the technology.
3. *The target technology costs are higher than the actual technology costs*. This means that the company has made greater progress in relation to the creation or use of the technology than it has in relation to the capability of the technology.

8.4.4 Recommended Actions

On the basis of the results of the technology cost analysis, four different recommendations can be made as regards future actions:

1. *Increase the application spectrum of a technology*. If, as in the case of "Chip implantation by heat-seal technology", one technology incurs fewer costs relative to other technologies, then this suggests that the technology can be provided more favourably than its technology attractiveness implies. In this case, the aim should be to widen the application spectrum of this technology in order to manufacture new, more capable products or processes or upgrade existing ones cheaply. This approach we call the *extensive innovation strategy*.
2. *Reduce costs with available technologies*. If, as in the case of "Application of printing technology", one technology causes too many costs relative to other technologies, then measures should be introduced to reduce costs. As far as the costs are concerned, this means examining the cost structure of a technology to see if this could be improved. This case we call the *marginal innovation strategy* which, in the case of "Application of printing technology", will definitely not have any big future effects, as the costs of a relatively unattractive technology which therefore is not considered so strategically important, but which is normally well mastered, can only be reduced at high outlay.
   On the other hand, the marginal innovation strategy makes sense for "Chip and semiconductor technology", as this technology has a high technology attractiveness value and the status of the company as regards mastery of this technology is in the first third of the experience curve, suggesting there is still an enormous rationalisation potential. Through simultaneous combination with the extensive innovation strategy, the technology unit costs could be further reduced on the basis of the resulting progressive reduction in costs effect.
3. *Improve technology performance*. The gradual innovation strategy optimises the individual technologies through investigation of possible performance-related improvement potentials. For example, through miniaturisation of the "Chip and semiconductor technology" (reduction of structural width from 0.8 μm to 0.5 μm), it is possible to further increase the unit profits and capability of

the semiconductor chips. At the same time there are substantial cost-reducing effects.

4. *Substitution of a technology*. The in principle innovation strategy, which not only examines the effect of individual technology drivers but aims to *bring the entire product to a new cost level by technological means*, has the biggest effect on the cost position. On the technological development line, an in principle efficiency leap is aspired to. From the cost perspective, this means creating a new experience curve and thus generating an in principle different cost structure. In the long term this strategy will have the greatest impact on the cost level. From the point of view of innovation cost management, the strategy of fundamental innovation is therefore the furthest reaching. The big discrepancy between target and actual technology costs of the technology "Application of printing technology" illustrates the need for action. Given the low technology attractiveness of this technology, the above action recommendations cannot be implemented, hence this technology must be scrutinised. For example, it might turn out on further investigation that technology "Application of printing technology" is an analogue printing technology. In the wake of further reflection, the question must now be asked to what extent the analogue printing technology could be substituted by a digital printing technology.

8.4.5 Opportunity Cost of Not Innovating

Finally, we would like to consider a special evaluation of the technology cost analysis. One necessary way of considering innovative technologies is to estimate the *consequences of not innovating*. The question to be asked is no longer "How much does a technology cost?", but "How much will a potentially relevant technology cost me if I do not have it?" It was in this sense that Henry Ford observed, "If you need a machine and do not buy it, you will pay for it without possessing it".[16] Especially companies which are in a follower position need to consider this opportunity cost. By pursuing the strategy of only using proven technologies, a company ultimately robs itself of the chance to achieve cost structures that could be critical to one's ability to assert oneself against the competition. *The apparent avoidance of risk costs not only forces the company to adopt a follower position, but ultimately causes considerably higher costs*. It could even mean cutting the product out of the programme, as the cost difference between a competitor's product and one's own product can no longer be caught up on the old experience curve (see Fig. 8.1). By resolutely driving the innovative technology forward, the pioneer has attained a cost structure on the newly created experience curve that is hard to beat, and hence a superior cost level. Only by creating a completely new experience curve can this technology once more be up for consideration. One test question for this opportunity cost way of looking

[16] Schmitz and Pelzer (1995), p. B9.

at things is, "What would be the consequences for the cost structure and competitive position if all the technologies in a product were highly attractive?"

As long as new innovative technologies are not in sight and the old experience curve continues to apply, a second opportunity cost angle can be adopted in the form of best cost calculation[17]: "What would be the consequences for the cost structure and hence for the competitive position if the technologies in a product could all be provided at optimal cost?"

8.5 Benefits of Using Technology Cost Analysis

In technology cost analysis, management has available a tool which can accompany the development and application of technological innovations on the cost side right from the start. It is thus a *supplement to existing concepts* such as the costings which accompany development and design, the project based costing and target costing. Combined with target costing, we thus have the possibility of including in strategic cost management not only market orientation but also resource orientation. In this way an enterprise can systematically monitor the condition necessary for an innovation – the agreement of demand and potential.

The radical change in the cost level and cost structure during the transition to a new technology can be estimated early on with technology cost analysis. At the same time recommended actions for the effective development of technology strategies emerge while the effects on costs are simultaneously noted. The variable of technology attractiveness which comes from technology management is used to deduce target costs for a technology which are commensurate with its future performance potential. In this way a measure derived from the technological potential is available to judge the costs of products and processes. Starting from this, one can now aim for substitution, wider use, resolute performance enhancement or cost reduction of a technology.

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[17] Vormbaum, H. (1966), p. 44 f.

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Chapter 9
Technology Balance Sheet

Matthias Hartmann

9.1 Introduction to Technological Corporate Assessment

Conventional audits of a corporate assessment rely heavily on key accounting figures and finally on extrapolating data from a historically oriented analysis of balance sheets or on an estimate of future revenues (gross rental method) or cash flows (discounted cash flow procedure). What is lacking is a substantive statement of technological potential, which is central for assessing sustained turnover and profitability in the future.

This gap can be filled through a technological assessment to complement conventional accounting. By taking both a technological and financial perspective, a two-dimensional technological and financial portfolio with the dimensions of technological and financial attractiveness can be developed, which enables key elements to be differentiated in a corporate assessment.

A company's technological attractiveness can be assessed by using a technology balance sheet that complements the trade balance sheet, which is used to illustrate and evaluate a company's technological potential. The result is a future-oriented, highly aggregated overall overview of the technological situation. Just as the trade balance sheet, the technology balance sheet can also be understood as a system of logically related and structured key figures, which mathematically link asset and liability items. It is developed according to specific principles and likewise offers several ways to analyze balance sheets.

The process of a technological company assessment is illustrated by using the example of a company in the smart card industry. Afterward, the technological and financial assessments will be consolidated into an overall evaluation.

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9.2 Technological Corporate Assessment as a Key Enabler

9.2.1 Problem Definition: Insufficiency of Conventional Accountancy Assessment for Company Assessment

Appraisal reports by due diligence teams, financial institutions, auditors, rating agencies, and lastly, the company itself, mainly rely on key accounting figures, on extrapolating data from historically oriented balance sheet analyses or on an estimate of future revenues (gross rental method) or cash flows (discounted cash flow procedure).[1] In markets subject to slow technological transformation, conventional accounting methods might often still be able to give a warning signal in time. But in markets with rapid technological change and deceptively high growth, these conventional approaches are highly problematic.

Given the booming growth rates in technologically intensive industries, the conventional commercial key figures frequently improve, and the increase in market volume causes the radical technological change to appear less crucial for competition. However, if one sticks to these purely monetary key figures, the technological changes required to actively control a company are frequently not recognized on time.[2] There are just not enough well-founded statements about the technological potential that is practically indispensable in highly dynamic industries for assessing sustainability of turnover, cash flow, and profitability trends of the future.[3]

9.2.2 Objective – Structured Recording and Assessment of Technologies

A corporate assessment should thus also be capable of recording technological potential, i.e. recording and listing technologies on the one hand and evaluating them on the other. An established and structured balance sheet concept like the trade balance sheet would especially be useful for technological decisions to be made on management level. This would enable the technological business to be illustrated and assessed within the context of a time-based statement of inventory values. Until now, tools for technological assessment often resemble – in a figurative sense – a compilation of special statements. Over the past few years, numerous strategic tools for technological assessment have been developed for this purpose, like, for example, the technology portfolio (Pfeiffer et al. 1991), the technology market portfolio (Specht and Beckmann 1996, pp. 95–101), and the technology calendar (Wildemann

[1] Cf Klein and Jonas (1998) and Drukarczyk (1996, esp. p. 87 ff.).

[2] "Key figures generated by outdated accounting systems are often of no help when investments in new technologies and markets are a must for a sustained positioning in global markets." Eccles (1991, p. 15).

[3] Cf "Typical issues in strategically positioning companies in technological markets" Gaynor (1996, esp. Chapter 33.12 ff.).

1993, pp. 564–604 and Eversheim et al. 1996).[4] However, all these tools, for the most part, do not primarily aim at taking inventory of technologies that are available in and used by a company. A technological balance sheet (Hartmann 1997) – analog to the trade balance sheet – can be generated from this type of technology inventory.

9.2.3 Company Assessment – Case Example in the Smart Card Industry

In the following, the author uses the example of a company in the smart card industry to demonstrate how a technological company assessment can complement conventional accounting. This example was selected as the smart card industry with its radical transformation and simultaneously high growth in volume[5] meets the relevant requirements. The booming growth rate is also evident in Germany, since smart cards, after the introduction of the health insurance card, are now common in all households. The imminent integration of the electronic purse into the Euro-check bank card will again change this situation drastically. The sheer number of smart cards, with approximately 80 million health insurance cards, or the electronic purse project, with approx. 35 million smart cards, will result in more widespread use, and thus in greater awareness. In the very near future, practically every household will have one or more smart cards.

Parallel to these sweeping changes, technology is transforming dramatically. Especially given the above-mentioned examples, further technological breakthroughs in memory chips will become necessary (memory chip cards such as prepaid phone cards, health insurance cards) on up to large-scale microprocessor chips (microprocessor chip cards or smart cards such as electronic purse (“Geldkarte”), electronic cash/purse, multi-application microprocessor cards, etc.). Moreover, users’ demands on the smart card manufacturers are increasing. Finally, each smart card should be unique in its functionality.

9.3 Technological Assessment to Complement the Conventional Accountancy Assessment

Before detailing the specific process of a technological company assessment, this section should determine (1) the usefulness of a technological assessment, (2) the measurability of technologies, and (3) the technology balance sheet as a tool for technological company assessment.

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[4] Cf “On additional tools” Pfeiffer and Weiß (1995).

[5] Cf in detail on the technological and market developments in the smart card industry, Lender (1997).

9.3.1 In-depth Perspective with a Technological and Financial Portfolio

A technological company assessment can only be considered as a supplementary means of conventional accountancy assessment. They are interlinked and contingent upon each other. The technological and financial portfolio (see Fig. 9.1) clarifies the mutual interrelationship of the technological and financial sides.

The first statement of this portfolio is that, when taking a purely conventional accounting-oriented perspective, the company can only be rated on the horizontal side (financial attractiveness). Only by also considering technological key figures can distinctions be made between future-oriented companies and crisis-ridden companies or top performing and value destroying companies. The balance sheets of a newly established, future-oriented company can resemble those of a crisis-ridden company. In both cases, the equity base can be low. Demand for products cannot yet be determined for the newly founded technological company, and can no longer be detected for the crisis-ridden company. However, entirely different future perspectives are gained by including the technological perspective. By implementing technological innovations, the newly established technological company can enter new market segments. In extreme cases, the crisis-ridden company will be forced to shut down the last of its outdated product lines. The potential for new developments is no (longer) given. The balance sheets of top performing and value destroying companies can also be similar. The balance sheets of both companies are, in principle, in good financial shape. However, when additionally considering the technological attractiveness, entirely different future perspectives materialize, because: "The technologically crisis-ridden company only reveals its serious sickness on a longer term comparison – and – if possible – in a company benchmarking with technologically or market-related comparable companies. (...) This type of

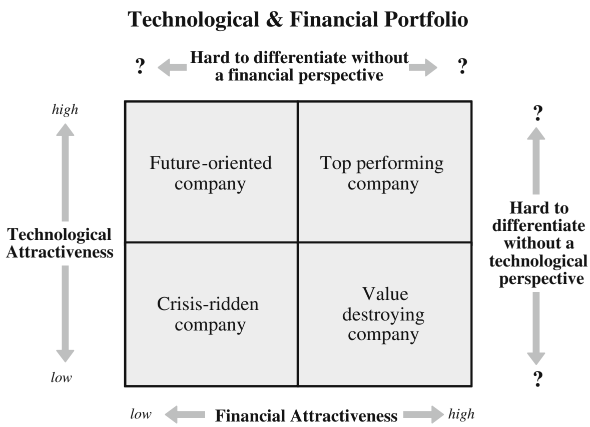

Fig. 9.1 Technological and financial portfolio

crisis-ridden company is much more difficult to identify analytically in balance sheets."[6]

The second message of the technological and financial portfolio is that, similar to the first case when taking a purely technologically oriented perspective without including conventional accounting figures, the company can only be rated on the vertical side (technological attractiveness). It is extremely difficult to differentiate between future-oriented and top-performing companies solely based on assessing technological attractiveness. In both cases, the technical future perspectives are impressive. Only by analyzing key balance sheet figures can the dangerously lean financial line of the future-oriented company be seen.[7] The supplementary technological perspective will also facilitate differentiation between value destroying and crisis-ridden companies.

9.3.2 Measurability of a Company's Technological Attractiveness

In order to rank the previous example of a smart card company in the technological and financial portfolio, the questions of financial attractiveness and of the company's technological attractiveness must be answered. On the corporate level, technological attractiveness is defined as the sum of all technical and commercial advantages to be gained by the full exploitation of all the strategic possibilities for a company's further development potential.[8]

Assessing a company's overall technological potential is first done by recording and listing all of the company's technologies, and second, by evaluating its potential for further development. This approach reveals an interesting parallel to the conventional accounting theory, which, according to Lehmann (1955), can be subdivided into formal and material accounting theories.[9] The formal accounting theory involves the structuring of the accounting content, and the material accounting theory deals with evaluating the accounting content.

If accounting content is understood as the entirety of all technologies,[10] the principles of the conventional accounting theory can be transferred to a so-called technology balance sheet for company assessment. The formal aspects question the structure of a technology balance sheet, and the material side questions the balance sheet assessment. A technology balance sheet consists of a company's technologies, which are recorded, structurally balanced, and evaluated analogously to

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[6] Hauschildt (1988, p. 14); (not emphasized in the original version).

[7] Cf on "Problematic of Assessing Newly Established Technological Enterprises," Peemöller et al. (1997).

[8] Cf Pfeiffer and Weiß (1995, esp. p. 672 ff.).

[9] Cf Lehmann (1955, p. 538).

[10] Within the context of this document, technology is an explication of know-how for functionally abstract problem-solving principles. This presents a key difference to structural know-how about technical systems that can be identified by analyzing part lists or components. Also see Binder and Kantowsky (1996, p. 87 ff.).

the conventional trade balance sheet by conducting an inventory.[11] The result is a future-oriented, highly aggregated overall perspective of a company's technological positioning.

9.3.3 Technology Balance Sheet to Assess a Company's Technological Attractiveness

The framework for developing a technology balance sheet[12] is similar to that of the trade balance sheet (see Fig. 9.2). The assets side of a technology balance sheet shows how the technologies are applied whereas the liability side clarifies their origin. Technologies on the liability side are understood as resources that, once combined, result in products or processes on the assets side. The correlation between the assets and liability sides is that the products and processes balanced on the assets side are depicted as abstract functional problem-solving principles on the liability side.[13] Applying the traditional balance sheet structure to technological issues allows for a structured illustration of a company's technological situation within the framework of a familiar classification system.

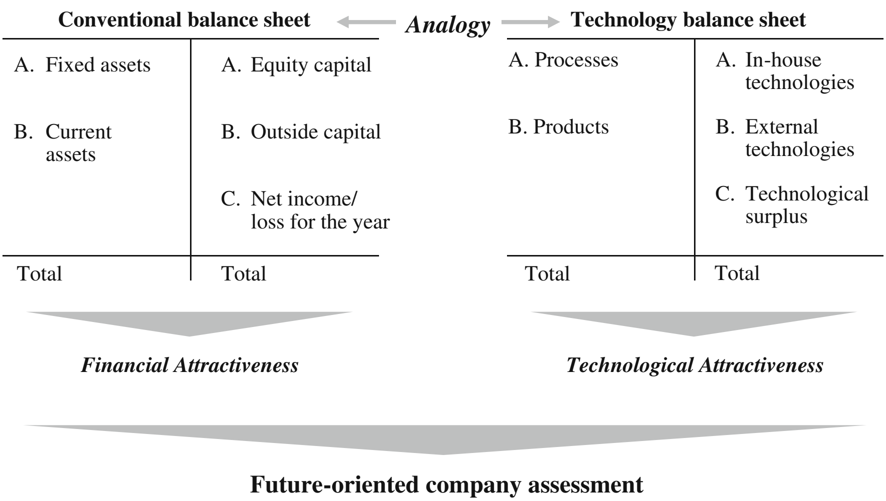

Fig. 9.2 Similarity of trade and technology balance sheets[14]

[11] Cf Hartmann (1997, pp. 24–29 as well as analogously for the technology balance sheet, p. 155).

[12] Cf on the structural design of a technology balance sheet, Hartmann (1997, p. 155 ff.).

[13] "An abstract functional feature presupposes an abstract description of the task to be completed through problem-solving." Lender (1991, p. 15 Fn. 12).

[14] The annual profit/loss statement is not allocated to equity capital in the trade balance sheet in order to emphasize the similarity between trade and technology balance sheets.

Whereas the trade balance sheet is structured in fixed and current assets on the assets side pursuant to Paragraph 266 of the Commercial Code ("HGB"), the technology balance sheet is built upon technological processes and products. Production and process technologies are understood under the term processes. Both balance sheets are thus analogous, since the machines included in the process technologies are balanced in both the trade and the technology balance sheets on the assets side under sector A. The products are either listed under sector B in the technology balance sheet as finished goods or as product technologies.

The assets side of the technology balance sheet is split up into different technological life cycle phases in the second classification level. Depending on the current stage of a technology, it will be listed under the observation stage, emerging stage, market stage, or the disposal stage. Prerequisite for any and all types of strategical technological assessments is an integrated technological life cycle mindset. The informative value of this approach lies in the consideration of the principle dynamics for technological development. Because even though the market cycle records success today, it is actually nothing more than an instantaneous inventory.[15] However, the key for success tomorrow is to forecast the general trend of new technologies currently in the observation and emerging cycles. It will also be a must to break away from outdated technologies or to switch from old-fashioned technologies to new ones.

The liability side of the trade balance sheet is subdivided into equity capital and borrowed capital, and the technology balance sheet is split up into in-house and external technologies. The liability side shows the origin of the technologies, depending on whether it refers to in-house or external developments. The knowledge or know-how regarding a technology can thus be described as corporate capital analogously to the trade balance sheet.

The liability side is subdivided in the second level of classification according to the availability of knowledge about a technology. The four basic components of knowledge are as follows: Knowledge of theory, knowledge of observation, knowledge of skills, and knowledge of systems. Knowledge of theory reflects the theoretical, scientific state of knowledge upon which a technology is based. Knowledge of observation signifies being knowledgeable about cause/effect ratios, however, without the fundamental theories. Knowledge of skills implies technical capabilities in the context of the ability to operate, for example, machines. If a company combines the three above-mentioned knowledge components and uses them for problem-solving, the company is assumed to have system know-how.[16]

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[15] Cf on the risk of a market cycle mindset and the fundamentals of an integrated life cycle mindset, Pfeiffer et al. (1991, p. 22 ff.).

[16] Pfeiffer (1980, p. 433) defines The Principle of System Knowledge as follows: "In practice, one refers to construction, construction idea, constructive principle or innovation principle as well as solutions depending on the degree of product development. As a rule, only by designing the system principle can precise theoretical and practical information be identified, i.e. the specific problem-solving relevance can be determined." See other components of knowledge ibid., p. 426 ff.

Formally structuring the liabilities side finally enables knowledge or rather, know-how to be measured indirectly, thus circumventing the difficulties of a material evaluation. In parallel, knowledge capital is prepared to conduct an overall assessment. The conceptual differentiation by Lehmann (1955) in a formal and a material balance sheet theory can also be effectively applied for the technology balance sheet.

9.4 Developing a Technology Balance Sheet

Analogously to the trade balance sheet, a technology balance sheet is developed by taking inventory of the technologies available within and applied by a company. The evaluation is done in step 2 to calculate the technological profit/loss in step 3 (see Fig. 9.3).

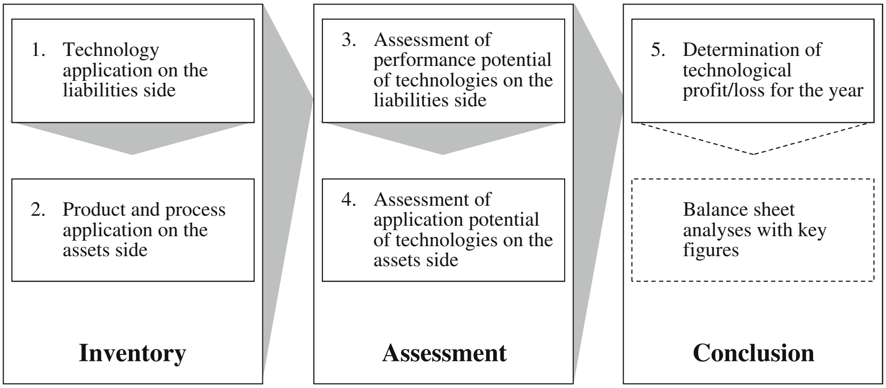

Fig. 9.3 Process of the technology balance sheet

9.4.1 Inventory

The starting point of a technology balance sheet, similar to that of the trade balance sheet, is taking the inventory. A technological inventory entails the structured recording of all technologies available and used within a company. One methodology is the technological analysis by Pfeiffer/Metze (1989). This analysis assesses the technological structures of specific goods, i.e. of processes, products, and components. "Generally, these goods are a mix of different single technologies. Vice versa, this also means that different goods can be tracked back to inherently similar single technologies. These technologies should be understood as single technologies that cannot be further split up into functional components, but which can, however, be differentiated characteristically." In other words, this first means that products differing the most can have shared technological roots, and second, that certain available technologies can be used for different fields of application.[17] The model smart card company has, among others, the following product, namely process technology "interactive programming of microprocessor smart cards," that will play a key role for the future market volume of smart cards.[18]

In order to illustrate and subsequently evaluate the complex process of "interactive programming of microprocessor smart cards" on the assets side of the technology balance sheet as a technological product, it is necessary to define the types of individual technologies incorporated in this process. These technologies should be recorded on the liability side of the technology balance sheet. Some of the most important types of technologies include

1. "Silicon and semiconductor technology"
2. "Software handling for smart card operating systems"
3. "Application of encryption technology"
4. "Handling of encryption keys and routines"
5. "Specifications for interactive data interchange machines"
6. "Personalization machines for smart card encoding"
7. "Interactive software encoding."

This type of technological analysis clearly shows that seven areas of technology are required to efficiently structure the interactive programming of microprocessor smart cards on the application side.[19] Three of the seven areas of technology on the resources side are the so-called in-house technologies. These are "Specifications for interactive data interchange machines," "Interactive software encoding," and the "Application of encryption technology." The four external technologies are "Handling of encryption keys and routines," "Silicon and semiconductor technology," "Software handling for smart card operating systems," and "Personalization machines for smart card encoding." All of these are necessary to build up the process of the "Interactive programming of microprocessor smart cards."

In the model approach for the process "Interactive programming of microprocessor smart cards," all of a company's processes and products are analyzed in terms of their incorporated technological types and transferred to the balance sheet.

[17] Cf Pfeiffer and Metze (1989, Sp. 2004); also especially Betz (1996).

[18] In terms of technical functionality, it should be noted that the programming of smart cards is not just pure data storage like the traditional memory chip cards. It is much more an interactive process with data interchange between smart cards and encoding units. It is also necessary to note the different, flexible selection of subroutines during the encoding process. See Lender and Hartmann (1997, p. 43).

[19] Cf in detail Lender and Hartmann (1997).

9.4.2 Assessment

After structurally listing the company's products and processes on the application side, and the incorporated areas of technologies (in-house technologies or external technologies) on the resources side, the next step is to technologically assess the technology balance sheet. The items on the balance sheet are assessed using indicator technology attraction, part of the technology portfolio method (briefly mentioned above) developed by Professor Werner Pfeiffer of the University of Erlangen-Nuremberg, Faculty of Industrial Economics. Technological attractiveness is defined as the sum of all technical and commercial advantages to be gained by the full exploitation of all the strategic possibilities for further development existing in a technology or – on an aggregated system level – of a technological company.[20] The potential for further development refers to a technology's potential improvement in performance as well as its potential for cost reduction.[21] The assessment of technological attractiveness is based on a categorization into pacemaking, key, and basic technologies.[22] A pacemaking technology is characterized by an early developmental stage with tremendous competitive potential that could have a major impact on future competition. The relevant technology will only be mastered by one or respectively by only very few competitors. A key technology has a major impact on competitiveness, and will be mastered by more than just a few competitors, but is applied more frequently to products and processes. A basic technology only has a minor impact on earning power and cost leverage, and has been mastered by almost all competitors. A basic technology is integrated into almost all processes and products, and its potential range of applications is nearly exhausted. In the concept of the technology balance sheet, a pacemaker technology scores a three (highly attractive), a key technology scores a 2 (moderately attractive), and a basic technology scores a one (less attractive). The other limiting values of 0 and 4 show the extremes (see Fig. 9.4).

Each single type of technology on the resources side in our above-mentioned example should be rated from zero to four by technology experts. As our example features a new and highly complex process on the application side, it is not surprising that the areas of technology involved on the resources side have relatively high ratings. The rating for the above-mentioned process of interactive programming of microprocessor smart cards on the technological application side (A. II.) is calculated by adding the ratings for those audited areas of technology on the resources side which are incorporated in this process. This, for example, consists of seven types of technologies rated on the liability side, which can be evaluated according

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[20] Cf Pfeiffer and Weiß (1995, esp. p. 672 ff.). see Grupp (1997, and esp. p. 396 f.) on Problems of Measuring and Explaining Technical Progress. Also see Pfeiffer (1971) on the General Theory of Technical Development.

[21] Cf on Cost Dynamics of Innovative Technologies. Hartmann et al. (1997).

[22] Besides this comparative measurement structure, other indicator structures can also be applied. For more details, also see Pfeiffer and Weiß (1995) and Hartmann (1997, p. 164 ff.).

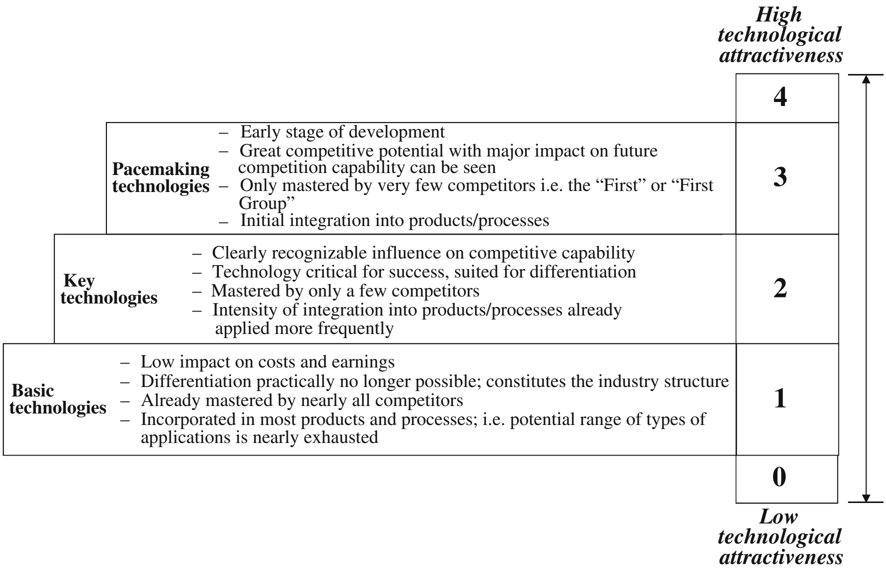

Fig. 9.4 Assessing technological attractiveness with pacemaker, key and basic technologies

to their attractiveness with 0, 1, 2, 3, or 4. The total of these seven types of technologies results in a score of 24 for the interactive programming of microprocessor smart cards (see Fig. 9.5).[23] All products and processes are assessed in terms of their incorporated types of technologies according to this scheme.

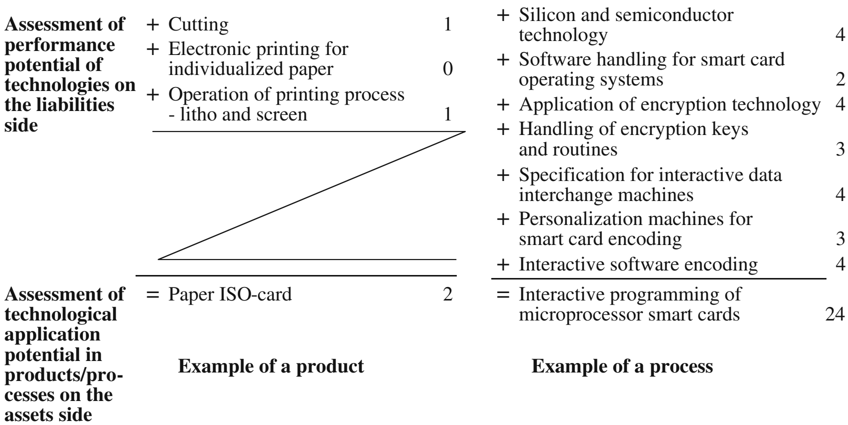

Fig. 9.5 Taking inventory of and evaluating the items on the technology balance sheet

[23] The hidden weighting mentioned herein can be replaced at all times by weighting factors of single technologies (requires further clarification). See Hartmann (1997, p. 188 and p. 193).

Technology Balance Sheet for a Smart Card Company

Technology Application		Total	
A. Processes			
I. Processes at the observation stage			
• Full color electronic printing on plastic materials	9		
• Interoperability of smart card systems	8	17	
II. Processes at the emerging stage			
• Interactive programming of microprocessor smart cards	24	24	
III. Processes at the market stage			
• Litho and screen printing on plastic materials	3		
• Lamination	3		
• Magstripe encoding	2		
• Embedding of chip modules in plastic cards	4		
• Sequential chip encoding	11		
• Optical readable personlisation (laser engraving or thermo transfer printing)	4	27	
IV. Processes at the disposal stage			
• Cutting and punching	1		
• Embossing of plastic cards	1	2	**70**
B. Products			
I. Products at the observation stage			
• Hybrid cards: contact-contactless smart cards	11	11	
II. Products at the emerging stage			
• Hybrid cards: digital/analog	9		
• Hybrid cards: opto-smart cards	17		
• Multi-application smart cards	21	47	
III. Products at the market stage			
• Microprocessor smart cards	14		
• Memory chip cards	9		
• Magstripe cards	6		
• Embossed plastic cards	5		
• Plain plastic cards	4	38	
IV. Products at the disposal stage			
• Thin plastic cards	2		
• Paper-ISO cards	2	4	**100**
Total			**170**

Technology Resources		Total	
A. In-house technologies			
I. Technologies with knowledge of systems			
• Embossing	0		
• Sequential encoding routines	2		
• Cutting	1		
• Electronic printing for individualized paper	0		
• Paper folding technology	0	3	
II. Technologies with knowledge of theory			
• Pixel printing technology	3		
• Specification for interactive data interchange machines	4	7	
III. Technologies with knowledge of theory and observation			
• Insert technique for smart card lamination	3		
• Chip embedding in optical memory cards	3		
• Encoding of opto-smart cards	4	10	
IV. Technologies with knowledge of observation and skills			
• Operation of printing process - litho and screen	1		
• Operation of lamination process	2		
• Hot glue chip embedding process	2		
• Optical readable personalisation process	2		
• Interactive software encoding	4		
• Application of encryption technology	4	15	**35**
B. External technologies			
I. Technologies with knowledge of systems			
• Embossing machines	1	1	
II. Technologies with knowledge of theory			
• Analog technology	0		
• Radio frequency interchange technology	2		
• Production technique for RFID-antenna	2		
• Bonding technique for connection between chip module and antenna	3		
• Handling of encryption keys and routines	3	10	
III. Technologies with knowledge of theory and observation			
• Magstripe encoding technology	1		
• Optical memory cards technology	1	2	
IV. Technologies with knowledge of observation and skills			
• Mixture of printing colors	1		
• Printing colors for plastic materials	2		
• Printing machines	1		
• Lamination machines	1		
• Embedding machines	2		
• Personalisation machines for thermo transfer and laser engraving	2		
• Silicon and semiconductor technology	4		
• Operating systems for smart cards	3		
• Software handling for smart card operating systems	2		
• Knowledge of operating systems change	3		
• Personalisation machines for smart card encoding	3	24	**37**
C. Technological surplus			**98**
Total			**170**

Fig. 9.6 Technology balance sheet for a smart card company

9.4.3 Determining Technological Profit/Loss

A technology balance sheet can be developed after all technologies, products, and processes have been systematically recorded and evaluated (see Fig. 9.6). Technological profit valued at 98 reveals that the company uses its technologies efficiently in numerous products and processes. A deficit would signify that several technologies are indeed available (liability side), but in comparison, that these technologies were used relatively infrequently in products and processes (asset side). The company would have used its technological know-how inefficiently, which could be reflected by a future decline in turnover due to the lack of products or outdated products with excessively high expenditures in R&D.[24]

9.5 Ratio Analysis of a Technology Balance Sheet

A ratio analysis can be conducted based on the completed technology balance sheet. Following the 1st static and 2nd dynamic ratio analyses, the entire company will then be rated technologically in step 3.

9.5.1 Static Ratio Analysis

A single technology balance sheet as a time-related inventory statement already enables numerous questions to be answered with a static ratio analysis. The following includes selected questions that are typical in the scope of a technological company assessment. The illustration below shows how questions posed can be answered by forming key indicators from a technology balance sheet (see Fig. 9.7).

(1) The first question is: *Is the company's technological competence sufficient to develop new products which will secure future profitability and growth?* In order to answer this question, the *Technological Attractiveness (TA)* of technologies rated on the liability side will be analyzed. The results are

– Five technologies are evaluated with TA = 4,
– Eight technologies with TA = 3,
– Ten technologies with TA = 2,
– Eight technologies with TA = 1, and
– Four technologies are evaluated with TA = 0.

This leads to 13 high, 10 medium, and 12 low value technologies in the balance sheet. Given the current industry situation, there is a clear trend toward demanding

[24] On a comparable key figure of Technological Profit, that is, however, not derived from a balance sheet. See Iansiti and West (1997, p. 53).

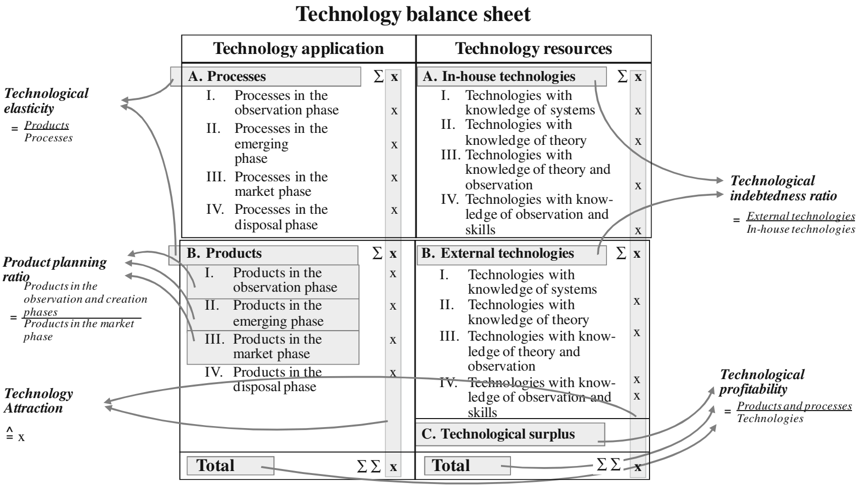

Fig. 9.7 Technology balance sheet with key indicators

technologies with a comparably high number of technologies applied. The company is thus actively working on numerous future-oriented technologies.

(2) The second question is *How successfully can the company implement its know-how into competitive products and processes?* The ratio of *technological profitability* can answer this question, as the asset and liability sides correspond in ratio. Technological profitability is derived by adding process and product values (technology applications side of sectors A and B) and parts of the total divided by all technological values on the liability side (technological origin of sectors A and B). It is used to measure the economic application of technologies in products and processes. This results in (70+100): 72≈2.4; the factor 2.4 shows the capability of implementing technologies. This therefore confirms a relatively good application of technologies used in products and processes. The company is thus applications-oriented.

(3) The third question is *Does research and development work on products that will help to secure success on the market tomorrow?* The *product planning ratio* can provide the answer to this question. The product planning ratio shows the relationship between the technological attractiveness of products at the observation and emerging stages (technology application side – sectors B.I.+B.II.) and the technological attractiveness of products at the market stage (technology application side – sector B.III.). It is also a measure for determining work intensity of R&D on new product lines.

The product planning ratio indicator, with a rating of 1.53 (58:38), shows that the smart card company has more products with greater technological attractiveness at the observation and emerging stages together than at the market stage. The company thus prepares itself for future card generations with high value technologies. This allows for a positive estimate of the future market position that will consequently have an impact on the company's future profitability. If a company is rated with a considerably lower value, this is an indicator that not enough work has been done during the emerging stage. This would clearly indicate that investments should be intensified for new products as the technologies of existing products are outdated which in turn leads to a higher risk of substitution by innovative products of competitors.

(4) The fourth question is: *Does the company have the necessary process know-how to produce the products?* This question can be answered by using the *technological elasticity* ratio. Technological elasticity shows the relationship between products' technological attractiveness (technology application side – sector B) and the technological attractiveness of processes (technology resources side – sector A). It also measures the ratio of product technologies to process technologies.

Technological elasticity, with a rating of 1.43 (100:70), demonstrates that products have higher attractiveness values rather than processes. The smart card company thus places its technological core focus on products. This imbalance of products and processes is a widespread phenomenon in several Western industrial enterprises, and in many cases, has led to cost inferiority in manufacturing processes despite highly innovative product technologies. The same risk is thus also forecast for the smart card company.

(5) The fifth question is: *In which technological fields does the company have to acquire know-how from external suppliers?* The *technological indebtedness ratio* shows the relationship between external technologies (technology resources side – sector B) and the in-house technologies (technology resources side – sector A). It also measures a company's dependence on external know-how.

The technological indebtedness ratio, with a rating of 1.06 (37:35), shows that the smart card company purchases approximately half of its technologies. An in-depth analysis is required to determine whether the share of in-house technology might be too high or too low. For example, the question arises as to whether in-house technological competence suffices to develop the mainstay of sales tomorrow. In quite general terms, the question also involves the types of technological core competence that a company has.

Besides the five questions discussed above, there are several other interesting questions that should be answered. The technological situation is just as important for the entire assessment of a smart card company as conventional expertise based on auditing figures. Only with both the technological and financial auditing can the sustainability of turnover and profitability be assessed. At the same time, the structure of the technology balance sheet poses numerous questions that can lead to an unconventional, new way of thinking.

9.5.2 Dynamic Ratio Analysis

Supplementary to the static ratio analysis of a technology balance sheet, a dynamic analysis can be done by comparing several technology balance sheets from different periods. As additional technology balance sheets were not included within the framework of this article, at least some of the key technological figures with dynamic character should be mentioned.

Supported by *technological default ratio* a determination can be made from target and actual technology balance sheets on whether products that should actually have been introduced on the market have not yet reached the developmental stage. In order to determine this ratio, the new products in the market stage are assessed in relation to products that are still in the emerging stage, but which should already be in the market cycle according to the business plan. This ratio should enable the identification of risks of a delayed implementation of technologies into marketable products.

The ratio of *technological duds* provides insight into the extent to which products already in the development cycle were out-phased. This ratio is determined from products already in the emerging cycle of a previous technology balance sheet that are no longer recorded in the current technology balance sheet. This ratio is an indicator of R&D projects that might be discontinued. The reason for the discontinuance of specific projects should be determined.

If technologies were also recorded when developing a target technology balance sheet that a company would actually require in order to be successful in the existing business segments long term, a company's *degree of technological gaps* can be determined. If there is a major technological gap, the company runs the risk of losing its stronghold in traditional markets.

Comparing technology balance sheets of companies in a specific industry with *technological benchmarks* will provide an estimate of the company's technological situation compared to the competition.

A final example is the ratio of the *rate of change in technologies*, which measures the smart card company's technological progress. The ratio is obtained from the technologies recorded in the balance sheet for the first time divided by technologies no longer included in the balance sheet.

9.5.3 Technological Rating and Overall Assessment

Subsequent to the static and dynamic ratio analyses of the technology balance sheet, a synthetic overall assessment of the company is done based on a technological rating. Just as the conventional rating procedure is based on the evaluation of key figures from the analysis of the trade balance sheet,[25] a technological rating can also be conducted based on the analysis of the technology balance sheet. The objective is to assess the technological overall value in order to position the company in the technology finance portfolio shown earlier. In the end, a technological rating serves to supplement the financial rating to enable new developments to be included in the overall assessment on time.[26]

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[25] Cf, among others Baetge and Sieringhaus (1996) and critically by Hirsch (1996).

[26] Cf also Discussions on the Problematic of Recording New Business Trends in Financially oriented Rating Sytems, among others by Balzer and Ehren (1998).

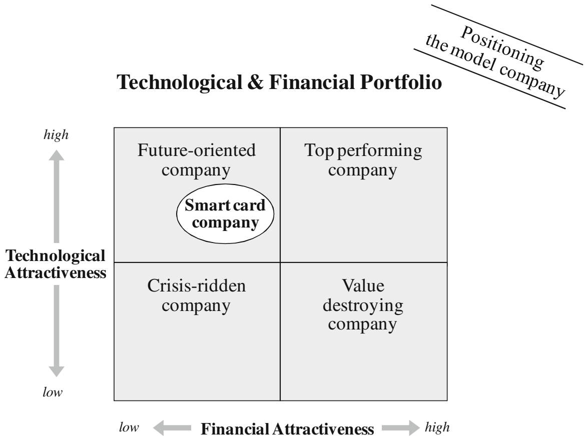

Fig. 9.8 Positioning a smart card company in the technological and financial portfolio

The financial assessment of the smart card company cited as an example is as follows: The company assessed was associated with a group of companies and had just been in business for a few years when the assessment was conducted. The financial resources provided by group headquarters did cover the minimum demand for liquid resources, but the cash flow was not enough to drive dynamic expansion. The necessary investments for revitalizing the company were not approved by group headquarters as the extrapolation of the sales development based on historical data depicted an unlikely boost in sales. The financial scenario revealed a company with moderate capital resources and minimal cash flow. The financial attractiveness was thus evaluated on a scale of A (high attractiveness) to E (low attractiveness) and under average with a D.

The assessment of technological attractiveness for the technology finance portfolio was derived from benchmarking companies in the smart card industry, considering the results up to that point of time. The smart card company mentioned in this article was rated with a B.

After the financial and technological attractiveness had been ascertained, the smart card company could be positioned in the technological and financial portfolio as follows (see Fig. 9.8).

9.6 Conclusion: Corporate Assessment Calls for a Technological and Financial Perspective

The objective of this article was to demonstrate how a technological company assessment is conducted theoretically and practically complementary to a financial assessment. In doing so, the technological finance portfolio should underline the necessity of complementarity of the technological and financial aspects.

Subsequently, it was shown how the technological perspective can be operationalized by the support of a technology balance sheet. The result is a future-oriented, highly aggregated overall overview of the technological situation. Just as the trade balance sheet, the technology balance sheet should be recorded as a system of logically structured technical key figures, which mathematically link asset and liability items. It is developed according to specific principles, and likewise offers a number of possibilities for balance sheet analysis. In addition to the conventional analysis, the technology balance sheet can also serve as the starting point for recommended action plans to change key figure relations to the necessary extent. On the same lines as Schmalenbach's statement on the conventional balance sheet, the technology balance sheet serves as a "direction-setter to enable companies to identify their future (technological) positioning."[27]

9.7 Summary

Conventional audits of a corporate assessment rely heavily on key accounting figures and lastly, on extrapolating data from historically oriented analysis of balance sheets or on an estimate of future revenues (gross rental method) or cash flows (discounted cash flow procedure). What is lacking is a substantive statement about the technological potential, which is central for such a highly dynamic industry as, e.g. the smart card industry for assessing the sustainability of turnover and profitability trends in the future. This gap can be filled with technological assessment to complement conventional accounting. The concept of a technology balance sheet offers a supplementary means of assessment.

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[27] Schmalenbach (1962, p. 6).

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Chapter 10
The Evaluation of Inventions and Innovations with the Technology Portfolio – Prolegomena about Metrics for Inventions and Innovations

Gerhard Metze

10.1 The Principle of the Technology Portfolio for the Evaluation of Inventions and Innovations

The core of an integrated strategic innovation management is the right choice of the innovation object: 80% of R&D activities' success is based on the right choice of the innovation object, and only 20% are influenced by the right realization, e.g. with the methods of project management. [1]

The method of the technology portfolio was set up at the end of the 1970s to support the process of the right choice. It surmounts the weaknesses of pure monetary [2] or pure market-oriented evaluations of innovations, respectively R&D projects, e.g. with the method of the market portfolio. [3]

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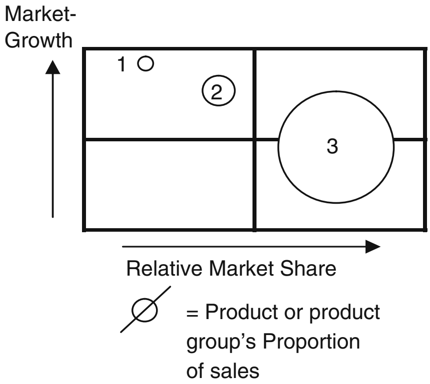
[1] Metze, G., (1986) Experience in the Application of the Technology Portfolio for Controlling R&D. In: Hübner, H. (ed.) The Art and Science of Innovation Management. Amsterdam, pp. 337–344, here p. 337.

[2] Since the 50ties it was obvious that the methods of monetary investment calculations were not suited fort he evaluation of inventions and project ideas. The imaginary exactness was far away from reality. This was the reason for the development and application of scoring methods for the integration of influencing factors which were to quantify in monetary terms, to support the decision process. The design of these methods had a gap in understanding the character of innovations, and thus the effect of these methods was rather a barrier to inventions and innovations than a support: Project proposals were valued negative if they effect a cannibalism of existing products. But even this attribute is the essential item of innovations. See Pfeiffer, W. et al. (1991), Technology-Portfolio zum Management strategischer Zukunftsgeschäftsfelder. 1. ed. Göttingen 1982, 6. reviewed ed., Göttingen 1991, here p. 77.

[3] The strategic component was integrated into the R&D project evaluation by the well known Market Portfolio in the 70ties. With the Market Portfolio product groups were positioned regarding their position in the market, i.e. the objects of the portfolio were launched products. In principle it is possible to map the market targets of products which are just in the development phase. The Market Portfolio, e.g. due to the approach of the Boston Consulting Group, contains market growth

W. Schmeisser et al. (eds.), *Innovation Performance Accounting*,
DOI 10.1007/978-3-642-01353-9_10, © Springer-Verlag Berlin Heidelberg 2010

Fig. 10.1 Market portfolio



Seen from the perspective of the market portfolio, only the criterion "market growth" is important for the management of innovations: New products should be launched only in fields of growth. This is the "question mark" sector of the market portfolio. But a strategic focus needs an answer from marketing and R&D, if the "question mark" has the capacity to turn into a "Star," otherwise it should be abandoned.

This is a necessary supplement to the business plan but it is not sufficient. With the market portfolio, it is possible to deduce information about the power of a marketing strategy. But there is a relevant gap about the technical roots of the planned innovation and the power of the technical roots. This is the capability of the technology portfolio. In the matrix of the technology portfolio, first two criteria were matched, the idea's or invention's "Technology Attractiveness" which comprehends the capability of a technology in the future ("*Y*-axis") versus the "Relative Technology Position" ("*X*-axis"), respectively the "Strength of Resources" as " *X*-axis". If the "Relative Technology Position" is taken, then a *Z*-axis is introduced for the R&D budget, which is characterized by the diameter of the bubble.

The development of the method of the technology portfolio [4] was necessary, as

- all the used methods of strategic planning, e.g. the market portfolio,
- and the traditional economic methods of evaluating inventions, project ideas, R&D projects and innovations like ROI calculations, business plans, scoring- and cost-benefit analysis.

("*Y*-axis") and the Relative Market Share ("*X*-axis") of products. The diameter of the bubble characterizes the relative turnover of the mapped product or product group ("*Z*-axis"). See Pfeiffer, W. et al. (1991), a.a.O., p. 64 ff.

[4] See Pfeiffer, W. et al. (1991), a.a.O., p. 79 ff. To additional methods for the control of innovations see Pfeiffer, W., Metze, G. (1989a) FuE und Innovationsplanung, in: Szyperski, N. (Hrsg.) Handwörterbuch der Planung. Stuttgart, col. 554–566, here col. 556 et. seq.

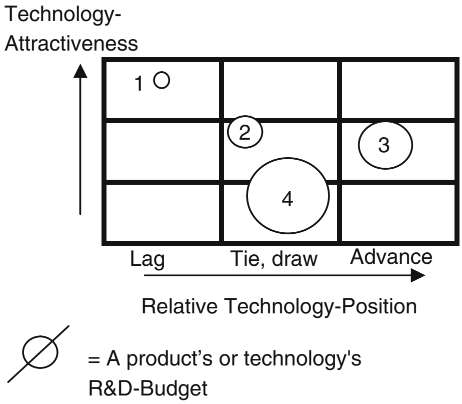


Fig. 10.2 Technology portfolio

did not integrate the technological capability or technical roots in a sufficient manner.

The registration of technologies in the portfolio matrix gives answers to the following questions:

- Which are the right strategic innovations for our business? This is captured by the evaluation of the technologies regarding their technology attractiveness (y-axis).
- How is the relationship to our competitors? For this reason, the technology position of our innovation is compared to the best competitor (x-axis).
- Are our resources (e.g. Know-how, financial resources) sufficient to develop and master the technologies which are needed for the innovation? [5]

In analogy to the market portfolio, the technology portfolio allows the development of "Standard-strategies":

- hold and enlarge advantage positions with a relative high technology attractiveness,
- withdraw and disinvest in fields with a low attractiveness and deficit position,
- in between the single case is to select and to decide.

In spite of citations in doctoral dissertations, and in spite of another rehash in publications about innovation management, the diffusion of the technology portfolio was slow and limited. Even in the 1980s the members of the board of a big electrical company refused the assessment of the technological capability of innovations, the pure economic evaluation of markets and costs in the business plans seemed to be sufficient. The managers of SMEs suppose a too high effort to set up a technology

[5] Vgl. Metze, G. (1985) Perspektiven zukünftigen Innovationsmanagements – Schwerpunkte und Aufgaben des nächsten Jahrzehnts. Congena Texte, Heft 2/3, pp. 59–63, here p. 61.

portfolio. Therefore the technology portfolio is mainly to find in global high-tech companies, and there in most cases in the corporate technology departments.

Rather academia than economic practice developed amendments and variations of the technology portfolio, in most cases a further agglomeration with the market portfolio into one integrated presentation. This direction of development lost the relationship to the applicability and to the theoretical fundament. Therefore we prefer the combination of two different perspectives to enlarge the potential of the technology-portfolio method.

One perspective is given by the model of the life cycle, respectively the differentiation between the development cycle and the market cycle. The other perspective is the hierarchy of objects to be evaluated, starting with the technologies of a single innovation project. On the next level, there is an agglomeration of the most import technologies of all innovation projects of an organizational unit, e.g. a department. The third level regards the strategic business unit or the whole company with "inventory of technologies." Thus not only the ideas, inventions, and innovations as objects of R&D can be evaluated. Further on, it provides an assessment of the technological competence of a company and the quality of innovation management.

Due to the differentiation between the development cycle and the market cycle, there are different criteria used in the technology portfolio. [6]

In the phase of the market cycle all launched innovations are evaluated regarding their technological weaknesses and strengths; it is an evaluation of existing products and processes. Parallel to this technical-oriented evaluation, a market portfolio is to set up. As the economic dimension is given in the market portfolio, it is not necessary to take it into account a second time in the technology portfolio. On the contrary, it would lead to a double weighting of economic factors. Inversely for an evaluation during the development cycle, an exact analysis of the market situation of innovative high-tech product does not make sense.

But just before showing the logical structure of the criteria and their agglomeration, the different fields of application of the method should be outlined.

10.2 Application of the Technology Portfolio

The potential of the application of the technology portfolios is manyfold [7]:

1. For a single project it supports the choice of alternative technologies for a defined function, and it helps identifying the critical technology of the project.
2. On the level of a R&D department with many R&D projects the portfolio is used to control the alignment of resources.

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[6] See for R&D objectives and tasks during the market cycle e.g. Metze, G. (2000b) Entwicklungsprozeß. In: Pepels, W. (Hrsg.) Marketing-Schnittstellen. Köln, Wien, Aarau, p. 109 – 121, here p. 118.

[7] See Metze, G. (1986), p. 339.

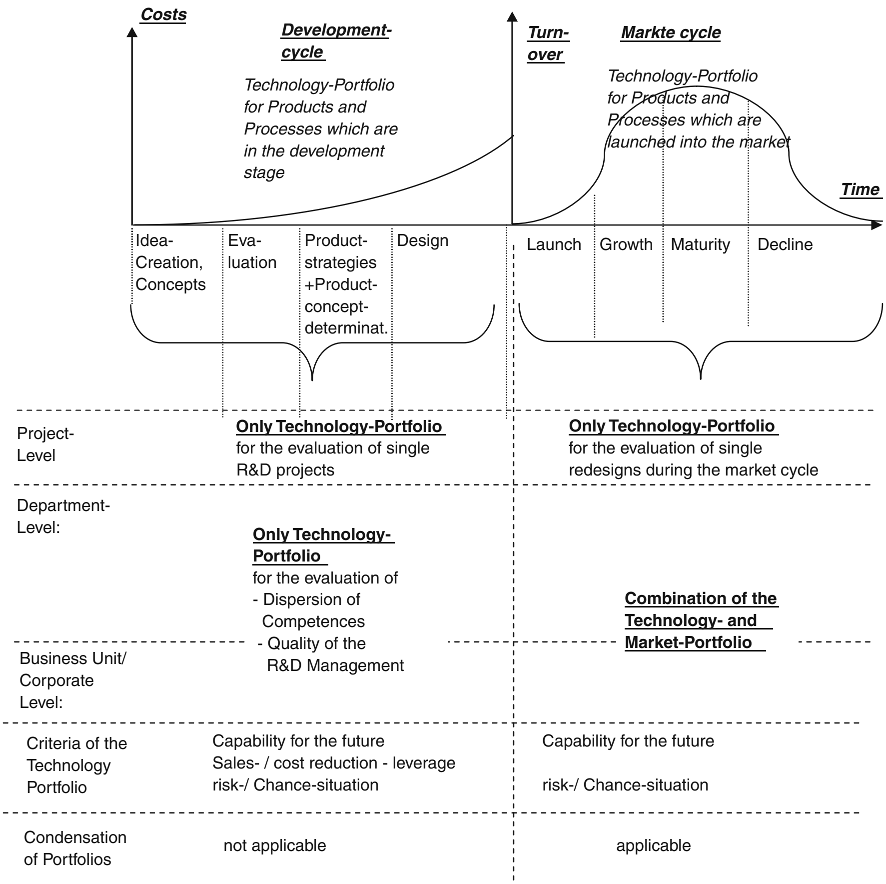


Fig. 10.3 Differentiation of the application of the Technology portfolio

3. For the R&D activities of a business unit, or at the corporate level, it helps to align the R&D focus by showing aspects of selection, concentration, and cooperation.
4. On the level of the strategic business planning, it ties the R&D programs and the market strategies together.

10.2.1 Technology Portfolio for Single R&D Projects

Planning and control of a single R&D project with the technology portfolio focuses on the technological bottleneck of the project. Every bottleneck technology decreases the performance of the whole project and the opportunity for realizing it. This technology is not necessarily tied to the main function of the product to be developed. Sometimes it is to find in the field of interfaces, or related process technologies, which need more resources to balance the project. The example of

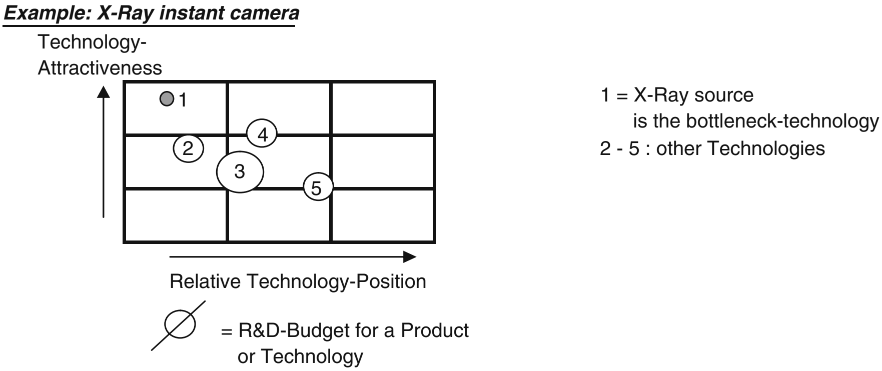


Fig. 10.4 Technology portfolio at the level of single R&D projects

the evaluation of an X-ray instant camera shows a project out of balance. The most import whilst most attractive technology, the X-ray source, is in a lag position, and has received the lowest level of resources. This is a typical mismatch of resources.

10.2.2 Multi-Project Evaluation

On the level of an R&D department with many projects, the alignment of resources should not be performed like a normal budgeting process based on the status quo of the last year. With the technology portfolio it is possible to develop priorities "zero base." Not only projects with technologies of low attractiveness are to prove if to continue them or not. Even projects with highly attractive technologies but at disadvantage positions have to be cleared up for continuing or abandoning.

The validity of integrating single technologies of many single projects on the next higher level, e.g. the department level, depends from the method of agglomeration. As it is not possible to capture all single technologies of all projects in one portfolio, for each project a representative point has to be found, which is part of the agglomeration process. There are two alternative methods:

– an agglomeration due to the geometrical centroid or median point, i.e. the representing point of a project is a simple media of the single values of all single technologies of a project, or
– an agglomeration due to the bottleneck, i.e. the technology which limits the potential of the project, this is in most cases the technology, which has got a high technology attractiveness together with a disadvantage location on the "Relative Technology Position." Only this technology defines the representative position for the agglomeration process.

The consequences are not only different in the picture of the portfolio. An agglomeration due to the principle of the geometrical centroid leads to a pile of bubbles in the middle of the portfolio, i.e. there is no power for differentiating the

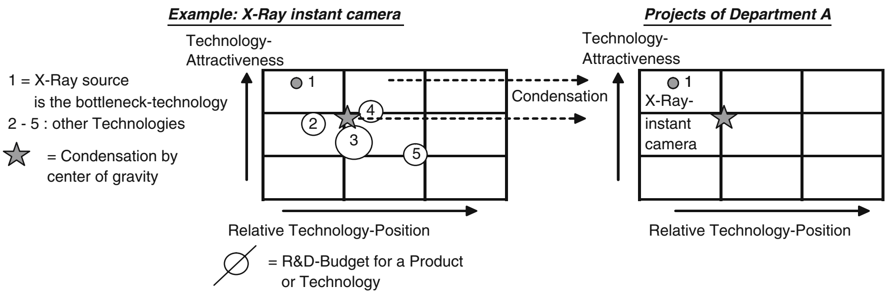
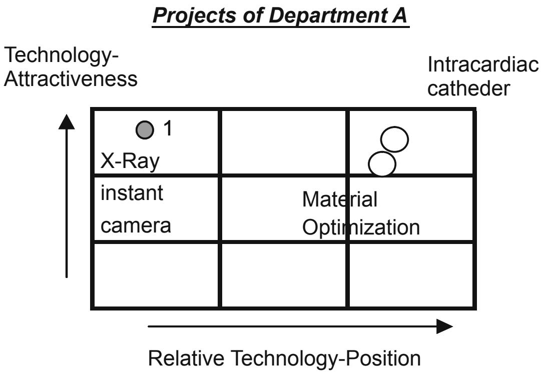


Fig. 10.5 Agglomeration from the project level to the department level

Fig. 10.6 All projects of an R&D department



alignment of resources; whereas the agglomeration due to the bottleneck leads in a quick way to priorities.

The result of this type of agglomeration shows not only the single position of all single projects of an R&D department but also the capability, respectively the competence of the R&D department.

In the given case the question is evident: Does it make sense to continue the development of the X-ray instant camera, or should be met an arrangement with a competitors taking a license. The latter would lead to an unlock of resources which could support an additional strengthening of the intracardiac catheter and the material optimizing project.

An additional problem for evaluation is the relationship between main technologies and supporting technologies as in most cases they are developed in different R&D laboratories or R&D departments. The following example may illuminate this:

The R&D project "Füllnidz" has a high attractiveness regarding its application in coaxial cable (made from copper), as it increases the performance of coaxial cable. This is a new material which optimizes the dielectric attributes, thus optimizing the capability of transportation of electrical signals. This project boosts the performance parameters, it is a new technological S-curve related to the old technology, petrolat. Thus it has a high technology attractiveness. In this example the R&D department has even achieved an advantage position to the competitors.

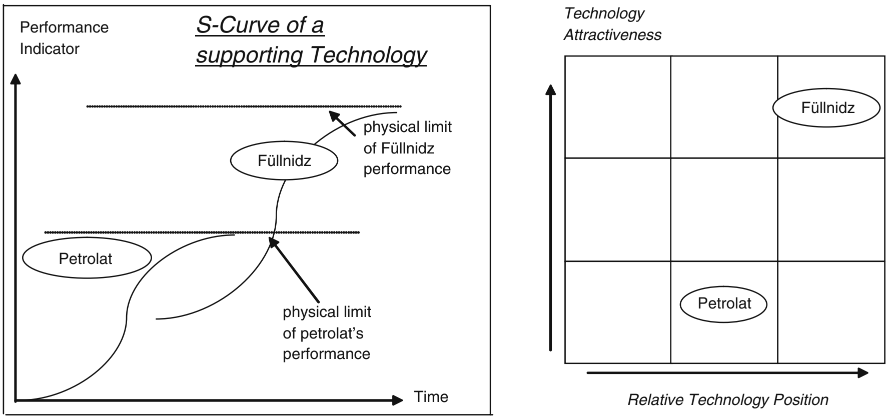


Fig. 10.7 First evaluation of the R&D project "Füllnidz"[8]

At the same time it was obvious that the recently emerged optical fiber technology would substitute the copper coaxial cable.

Regarding the substitution of the copper coaxial cable by optical fibers the attractiveness of the single technology *Füllnids* slumped, as optical fibers does not need an optimization of the dielectric attributes. Therefore in every case supporting and/or complementary technologies can only be evaluated regarding their main technology to which they are belonging. The consequence of this evaluation was the sudden stop of this project.

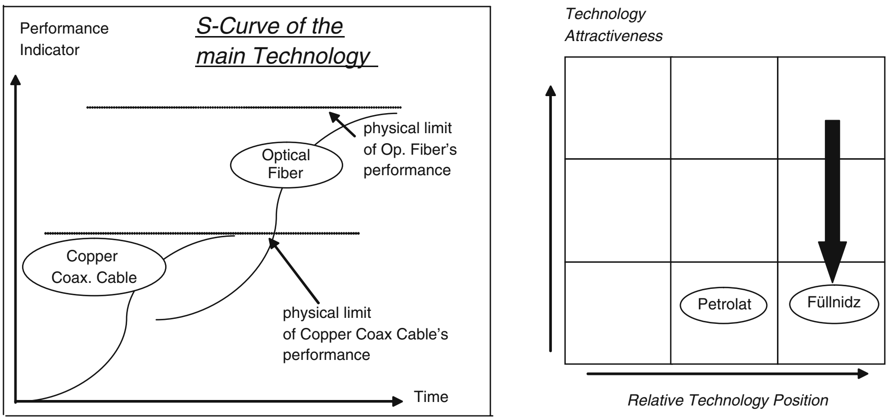


Fig. 10.8 Second evaluation of the R&D project "Füllnidz"[9]

[8] Metze, G. (2000a) Marketing sowie Forschung und Entwicklung. In: Pepels, W. (Hrsg.) Marketing-Schnittstellen. Köln, Wien, Aarau, p. 89 bis 108, here p. 103.

[9] Metze, G. (2000a), p. 103.

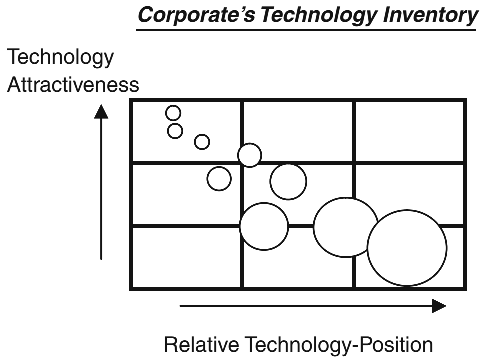


Fig. 10.9 Corporate technology inventory in misbalance

10.2.3 Evaluation at the Business Unit Level

On the level of a business unit or on the corporate level we have to deal with the long-term alignment of R&D activities, especially to answer questions about concentration and selection of resources, and about cooperation. Again as bottom up planning – the position of single R&D projects and departments is condensated to clusters, which represent the position as a whole.

The mapping of the actual situation in the frame of a "Technology Inventory" with technology attractiveness, relative technology position, and R&D budget as indicator for the resources aligned is the prerequisite for the definitions of objectives and the derivation of strategies needed.

On this level we can perform an evaluation of the R&D department. This is a check if the alignment of the resources is adequate. The following picture of the past situation of a famous machine tool company may illuminate this. In this time the alignment of resources was characterized by the perforation of mature technologies, with which the company had an advantage position. At the other hand highly attractive technologies were not supported with sufficient resources in spite of a disadvantage position. The company's technology portfolio at this time proves disaster of all R&D activities which led in a short time to the loss of independence of this company.

Similar misbalances of resources could be found in other industries and companies as well, e.g. in global players (ca. 400,000 members of staff) of electrical products. In this special case the consequences of a miscontrolled technology policy was to see 5 or more years after the performed technology inventory, in particular with the time of the market launch of new products based on weak developed technologies. [10]

A different situation of misbalancing the resources was evident by a technology inventory of a mid-sized high-tech company (ca. 6,000 members of staff). The R&D

[10] Metze, G. (1998) Rückbesinnung auf Pfeiffers frühe(re) Werke als Verpflichtung für die künftige Theorieentwicklung – aufgezeigt am "Fist-Follower-Prinzip" und am "Lean Management". In: Weiß, E., Dirsch,H. (eds.) Innovative Unternehmensführung. Festgabe zum 65. Geburtstag von Professor Dr. Werner Pfeiffer. Nürnber, pp. 39–56, here p. 46.

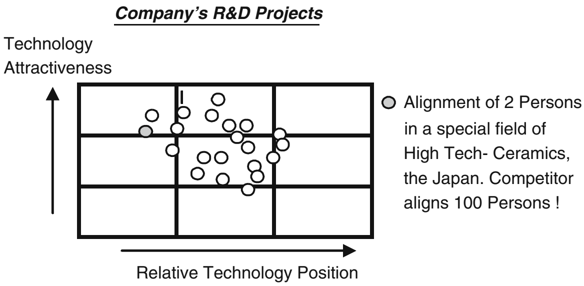


Fig. 10.10 Fragmentation of resources into many small projects with under-critical mass

situation was characterized by many small single R&D projects. It was to confirm that some of the projects did not reach the critical mass of resources needed in relationship to competitors.

In this case a concentration of resources is necessary, based on a selection between the projects.

Also on this level there is to discuss the question of external know-how transfer. The analysis and evaluation should clear up if important R&D projects with disadvantage position could proceed on their own, or if there is a need for taking external licenses. At the other hand it should initiate the analysis and evaluation, if a less important project with an advantage position should be sold to competitors. [11]

10.2.4 Level of Strategic Business Planning

In a technology-driven business it is necessary to amend the traditional marketing philosophy with a "Techno-Logic." This is the important link between market strategies and the R&D program as the following simplified example shows.

The exclusive application of the well-known market portfolio lead to the derivation of these strategies:

- Product A has lost market shares. To counteract this, the activities in the sales force, the sales channels, and the communication to the customer should be intensified.
- The weak position of product B was estimated as hopeless, it should be withdrawn.
- Product C had a tiny market share in a field of high market growth. To increase the market share, the activities of the sales force, the sales channels, and the communication to the customer should be intensified.

In this case, first time the market portfolio was matched with a technology portfolio:

[11] See Metze, G. (1986), p. 340.

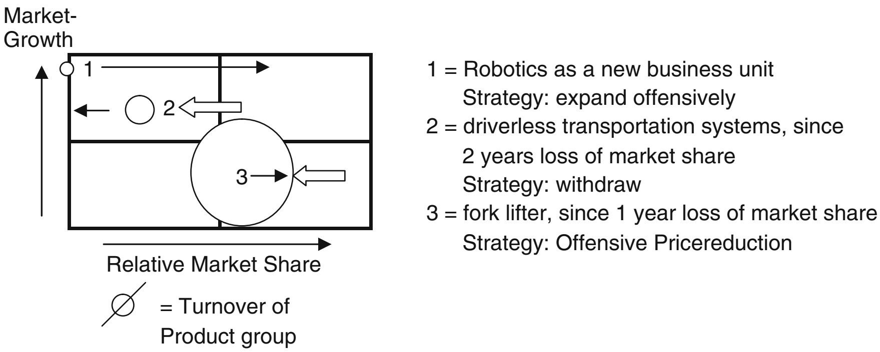


Fig. 10.11 Market portfolio of a vehicle construction company and derived strategies

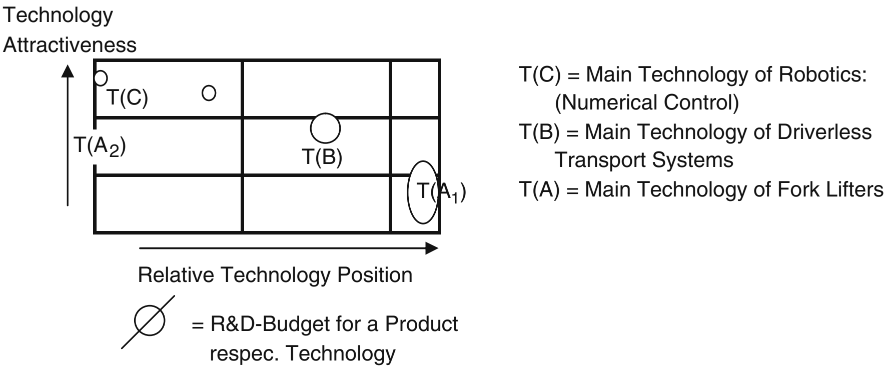


Fig. 10.12 Technology portfolio of a vehicle construction company

The evaluation of the specific main technologies of each product group led to different recommendations for the derivation of strategies:

- The former good relative market position of product A was based in a technological advantage position of technology A(1), but one of the competitors had introduced a new alternative technology A(2) with a much higher performance capability which our company did not control. (Therefore in the portfolio, technology A(2) is positioned direct on the limiting line of the disadvantage field). The loss of market share was based on the disadvantage position which could not be counteracted by sales activities rather than with a new project in developing technology A(2).
- The weak market position of product B is an inconsistency to its relative good technology position of its main technology. To show the customer the technological advantages of this product, it would have been necessary to enhance the qualification of the sales force by training activities.
- The new and hopeful product C had an obvious weak technology position of its main technology, here control software. Without a solution of the software

problems an enhancement of the market position was not possible, i.e. a pure marketing strategy was of no value.

Our conclusion out of this is that technology-driven companies must integrate a technological evaluation into the strategic planning process and match the technology portfolio with the market portfolio. Only with the integration of the technological items the probability of success of product–market concepts, the constitution of marketing strategies, and – at the end – the control of the R&D priorities could be assured.

10.3 List of Technologies

Just before we set up the positions of the single technologies in the portfolio, we have to differentiate between

- product- and process-concepts, which represent the architecture of the combination of a set of technologies,
- the technologies by itself, which are the elements of the products and processes.

Here the question of an adequate depth of analysis regarding the splitting of a breakdown of technologies as prerequisite of their evaluation is most important. [12]

The term technology is used in a very different manner. An engineer defines a special sputter process as technology, whereas the responsible business unit manager defines all different technological processes for the generation of thin structures on thin layers as coating technology despite their different technological roots and different technological attributes.

The problem is that there is no unique “Technical language.” [13]

In most cases the segmentation of technologies leads to application-oriented definitions of technologies, which do not contain any information about identical or different technological roots as Bauernschmid worked out in this book. [14] The evaluation of technologies for the development cycle has to tie on the technological roots. [15]

The segmentation of technologies, i.e. the separation of the technological basis of a product, a product family, or of a strategic business segment in single technologies results at the end in the technological know-how, respectively the technological competence which is the fundament for the design of the products and processes.

[12] Pfeiffer, W., Metze, G. (1989b) Technologische Analyse. In: Szyperski, N. (Hrsg.) Handwörterbuch der Planung. Stuttgart, col. 2002–2015.

[13] Pfeiffer, W. et al. (1991), p. 80 ff.

[14] See Bauernschmid, P. (2008) Ressourcen-Bewertung von Innovationsprojekten zwischen “lean” und “slack” in this book.

[15] Metze, G. (1986), p. 343.

10.4 The Criteria

The evaluation of technologies in the technology portfolio is performed with three dimensions:

- Technology attractiveness, respectively techno-economic importance,
- Relative technology position respectively strength of resources,
- R&D budget.

To fix the position of technologies in the portfolio matrix, the dimensions are to precise with sub-criteria. The sub-criteria of the first-order level should be fixed. If in an individual case it would be necessary to adapt the method, then it should be performed on the level of sub-criteria as a support for quantifying the fixed sub-criteria.

10.4.1 Criterion "Technology Attractiveness" ("Y-Axis")

The "Technology Attractiveness" is built as an index out of different sub-criteria, which could be quantified by scoring methods or a "K.O. criteria" – filter process. Essential sub-criteria of the technology attractiveness are

- the technology's "capability for the future," which is based on the well-known technological "S-curve Model" of the performance of technologies,
- the leverage in sales increase and/or cost reduction of the technology, and further on
- the chances/ risk situation.[16]

Starting point of the assessment of the "technology's capability for the future" is the idea, that every technology has a typical S-curve shaped of a performance indicator with a physical limitation of performance which cannot be exceeded.

The sub-criterion "Technology's capability for the future may be illuminated by the well-known example of communication technology, especially the change from the copper cable technology to optical fiber technology. We see in the picture the time t(o), which is critical for the innovation, as at this moment the new technology has an inferior performance than the old technology. If we take the actual performance as criteria for the evaluation, then the innovation will be killed or starved to death. In 1974 the experts of the watch industry (mainly coming from Germany, France, and Swiss) predicted the dominance of the mechanical watch in the lower and middle segments for the next 10 years on their "World Congress for Chronometry," as the electronic watch were sold with prices around 500 euros at that time. Thus the electrical watch seemed to be suited only for the top segment.

[16] Metze, G. (1986), p. 342.

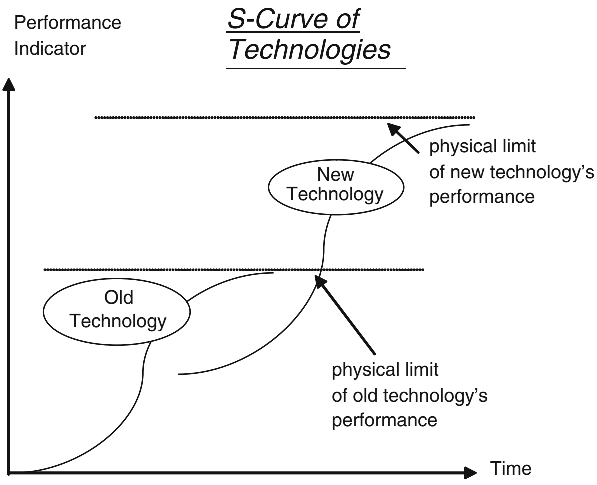


Fig. 10.13 S-curve of technologies

The conclusion out of this is that we should never take the actual performance of an innovation as attribute of decision rather than the technology's "capability for the future."

Therefore the rapid usage of new technologies with a capability for the future is most important for the future position of the company in the market. The higher the technology's capability for the future is estimated, the higher is the importance of the technology for the company.

But this ideal model of the technology's capability for the future, based on the S-curve model, contains some problems. For the exact analysis we have to come back to the performance indicators of the specific technologies, e.g. for diagnosis systems the solution potential of the imaging technology, or the radiation from the X-ray source to the patient.

As each product is based on different technologies, each of them has different performance indicators with different physical performance limitations.

Here we recommend to concentrate on the main technology, or the performance limiting technology of the product or process.

The second sub-criterion, the cost- and/or sales-leverage, is a necessary amendment of the first sub-criterion. Normally the members of an R&D department staff do not have problems to create new ideas which have a high capability for the future. In this case it is important for the marketing department to see if there is a sufficient potential of applications in the market which has a leverage to sales.[17] For innovations in the field of internal applied process technologies, which have a leverage in cost reduction, the manufacturing department should be involved. Thus it can be

[17] Metze, G. (2000a), here p. 99.

analyzed if the R&D-activities are right or wrong, e.g. for a "nice-to-have" supporting function of the product which is not so important for the products performance. The supporting component may have – isolated evaluated – a high capability for the future. As shown above with the example of "Füllnidz," this capability for the future is without any value, as the linked main technology is mature and substituted by a new technology which does not need this supporting technology.

The cost leverage can be analyzed and evaluated without great problems. But to analyze the leverage in sales is much more difficult.

Sales, or turnover, depend not only on technical attributes of the product but also on non-technical success-factors like sales force and sales channels, pricing policy, communications, and so on. The single contribution of each success factor to the company's success cannot be differentiated in the sense of an exact proportion. Therefore we need a "rule of thumb" for quantifying the sales leverage. Here we recommend as an indicator for the sales leverage the relative performance advantage of the new technology in the new product.

The sales leverage as well as the cost leverage is increasing, if we have an increase of the application of the technology into different products or processes. Therefore we integrate the "multi-applicability" of the technology into the evaluation.

The integration of the leverage of technologies to the company's success is necessary for evaluation during the development cycle.

We do not apply this sub-criterion during the market phase, as this attribute is already integrated into the market portfolio. Therefore the technology portfolios of the development cycle are different to the technology portfolios of the market cycle and cannot be compared directly.

To assess the risk- and chance-situation, sub-criteria are

- the existence of technological alternatives and the access to them,
- the dynamic of technological trends,
- the patent situation, etc.

The effect of the existence of technological alternatives to the success of the project depends on the special circumstances of the project. Existing alternatives may increase the risk by a too early and wrong determination of the projects targets. But reverse the existence of technological alternatives may reduce the technical risk, as there is no single dependency from a critical technology.

If the product's function may only realized by the evaluated technology and cannot be realized by different substituting technologies, then the technology is indispensable. This problem is independent from the phase of the technology in the technological S-curve.

The analysis of the dynamic of technical trends deals with the problem of substitution of technologies by others. Information about new emerging technologies should be filtered out of the environment very thoroughly. But mainly the information are based on the company's own fundamental or basic research and need a permanent review.

For critical technologies and a good choice between alternative technologies, there is to perform some effort in pre-analysis or pre-research.

The emerge of new technologies incites mature technologies for mobilizing "the last reserves." This could lead to a wrong assumption that this mature technology has a further potential. Linked with this, there is often an underestimation of the new technology's capability for the future.

The patent situation characterizes the future *Verfügbarkeit* (availability or disposability) of a technology. It contains the question if essential technical trajectories are protected by external intellectual property rights, or if own activities are to secure by patents. The answer to these questions supports the assessment of the risk-situation.

In addition it is possible in analogy to the integration of the technical risk also to integrate the economic risk which is influenced by

- market growth and
- relative strength of competition

of one or more business units to which the technologies to be evaluated are aligned.

This is the task and responsibility of the heads of the business units, not of the engineers and scientists of the R&D department.

10.4.2 Criterion "Relative Technology Position" ("X-Axis")

Deviant from the first publication about the technology portfolio, the former co-author substitutes the criteria "strength of resources" as dimension of the *X*-axis with the criteria "relative technology position." One reason is the problem of gathering information especially about the competitors' strengths. The other reason is the power of presentation. Therefore in industry the relative technology position was preferred as *X*-axis in analogy to the relative market share of the market portfolio. [18] The relative technology position represents the time dimension in the relationship of competing companies for the development of innovations. As the life cycle duration of different technologies are different, e.g. for microelectronics among 1, 5, and 3 years, for electrical motors between 4 and 7 years, we do not take the absolute time duration directly as value of the *X*-axis, it is much more suitable, to characterize an advantage or disadvantage position by relating the absolute value of time difference to the competitor to the expected time duration of the technology's life cycle.

10.4.3 Criterion "R&D Budget" ("Z-Axis")

As mentioned above the former criteria of the "strength of resources" is characterized in this approach by the R&D budget. The presentation of the R&D budget

[18] Metze, G. (1986), p. 343.

Determination of the Relative Technology Position:

Relative Technology Position on an Innovation	Old Techno-logy	Our Inno-vation
Remaining Life Cycle (in years)	1	5
Our Position to the Competitor	*0*	*2,5*
Relative Technology Position	*0*	*50%*

2,5 years in advance

Location in the Portfolio:
in the Middle of the Advantage Field

Fig. 10.14 Determination of the relative technology position

for the technologies on the "*Z*-axis" is the diameter of the bubble which locates the single technologies on the *X*- and *Y*-axes. At a first glance it seems to arise a gap in mapping the criteria know-how respectively, the technological competence. This impression is not right, as the whole picture of the technologies given by technology attractiveness and relative technology position shows exactly the gaps and weaknesses of competence as it is shown in picture 9.

10.5 Matching the Criteria

Normally the criteria are algglomerated by scoring methods. In our example we use the scoring method to integrate the sub-criteria of the technology attractiveness to one value. Here we do not explain the principle of scoring methods as it is often described in literature and practiced in industry daily.

But his does not mean that the scoring method is applied in a right way. One should be conscious that a scoring method matches assessments of values with assessments of facts. [19] The necessary weighting of the sub-criteria "capability for the future," "economic leverage," and chance-/risk-situation is in every case an assessment of values, even it is built in "trans-subjective" manner. [20] In contrast the attributes of the sub-criteria of the different technologies to be evaluated could be analyzed by neutral experts in a transparent and reproducible way as "a matter of facts." Thus the problem of scoring methods lies in the danger of manipulation of the weighting of the criteria. And at the other hand scoring methods have a tendency for a cluster of bubbles in the middle of the portfolio. Thus a "free styled" scoring method is not good suited to differentiate between alternative technologies which have similar effects. But if there are really big and obvious differences between the

[19] For an analysis of the problematic in general see Metze, G. (1980), Grundlagen einer allgemeinen Theorie und Methodik der Technologiebewertung unter den Bedingungen pluralistischer Interessenlagen. Göttingen, p. 285.

[20] See Metze, G. (1980), p. 88.

Scoring Method for the Determination of the Technology Attractiveness

Evaluation Criteria for Inventions and Innovations	Weighting (W)	Degree of Fulfillment of Technology A (F)	W*F	Degree of Fulfillment of Technology B (Biotechnology) (F)	W*F
Capability for the Future	***5***	1	*5*	5	*25*
Sales respec. Cost Reduction leverage	***4***	2	*8*	4	*16*
Chance-/Risk-Situation	***4***	5	*20*	3	*12*
Summed Scores			33		53
Relative Value			51%		82%

Weighting : *From 1 (marginally important) to 5 (very important)*
Degree of Fulfillment: From 1 (scarcely fulfilled) to 5 (completely fulfilled)

Fig. 10.15 Matching sub-criteria to technology attractiveness via scoring method

technologies, then the method is not necessary to be applied. In this case the application of the method is rather a ritual which does not create new information about the preferability of one of the alternatives.

In this case we prefer the application of an evaluation system with a cascade of criteria, including KO-criteria on each level of the cascade.

10.6 Directions of Improving the Technology Portfolio

The improvement of the technology portfolio could be started into two directions by enhancing the metrics for the evaluation of inventions and innovations:

- at one hand to precise the most relevant criterion, the technology attractiveness, on a theoretical basis, and
- at the other hand additional possibilities for agglomeration and appraisals regarding the alignment of resources.

As mentioned above technology attractiveness is mainly based on the subcriterion “capability for the future” with the underlying model of the technological S-curve, and the economic leverage.

Now there are sufficient examples that in spite of a high capability for the future and a clear and evident economic leverage, an invention was not transferred into an innovation, or not in the time duration as it was planned. The economic consequences for the company were in most cases fatal.

An important cause is the effect of an innovative technology to the customer beyond the increase in performance. The more radical the innovation’s effect the more an adaption and change of the customer’s technical structure is needed. This does not only lead to higher costs for additional efforts in R&D regarding the innovation's integration into the technical structure of the customer than planned. In an extreme case like the effect of the digital photography to Polaroid the innovation induces many resistances against, as it could lead to a complete devalorization of the majority of the user's equipment. As mostly the equipment is not fully depreciated, or the depreciations are not fully covered by profit, there is no higher interest of the customer to adapt the dangerous innovation. An recent example is the invention of a holographic flat screen for computers by a medium-sized company. A co-operation with the manufacturer of the state-of –the-art screens does not make sense, as with one stroke the billion-valued investment in equipment of the old-type flat screens would be worthless.

Therefore we suggest to enlarge the basis of the criterion technology attractiveness as most important evaluation criterion by the effect of innovations to the technical structure of the customer.

This is relatively easy to calculate on the basis of the fixed assets analysis' in the balance sheet, regarding the technological structure of the equipment. With this indicator we could also differentiate between incremental and radical innovations.

The other focus in improving the technology portfolio is – as mentioned above – the agglomeration or condensation of many detailed bottom-based information to "top." The situation in many companies is characterized by an abundance of information offered but a gap in information, which is needed.

For a possible solution we tie on the description of picture 9: "A company's technology inventory shows miscontrolled R&D." The R&D activities' position and the aligned resources show a complete flop of the responsible R&D management.

Therefore we suggest the determination of an indicator which captures the alignment of resources in a very condensed way. First we set up a "norm"-weighting of the alignment of resources which is based on the position of technologies on the technology attractiveness ("*Y*-axis") and on the relative technology position ("*X*-axis"). The basic idea is that technologies with a capability for the future are in general to support, but with a disadvantage position it has to be decided if there is any chance to catch up with the competitor.

This type of "norm"-weighting of the alignment of resources is matched to the real alignment of resources in an R&D department as it is shown in picture 9.

Then we multiply the "norm"-weighting with the real alignment of resources in each field of the matrix and sum up to a total resources–effect index.

The proportion between the total resources–effect index to the real alignment of resources characterizes the effectiveness of the allocated resources.

We want to emphasize that the values here are examples. For an application in industrial R&D the norm weighting have to be investigated specific to economic branches and economic sectors. In this connection we remind to the problematic definition of economic branches and sectors and refer to the article of Bauernschmid in this book which allows a first approach to this problem. [21]

[21] See Bauernschmid, P. (2008), in this book.

Fig. 10.16 Determination of the resources-alignment effectiveness

"Standard"-Weighting of Resources	Lag	Tie, draw	Advantage
High	0,5	1	3
Medium	0,3	0,5	1
Low	0,1		0,5

Real Alignment of Resources in R&D (relative)	Lag	Tie, draw	Advantage
High	0,1	0	0
Medium	0	0,4	0
Low	0	0	0,5
SUM			1

Resources Alignment Effectiveness - Index		
0,1	0	0
0	0,2	0
0	0	0,25
SUM		0,5

$$\text{Resources-Alignment-Effectiveness} = \frac{\text{Resources-Effect}}{\text{Resources-Alignment}} = \frac{0,5}{1} = 0,5$$

An additional condensation these indicators could integrate into the framework of a Balanced Scorecard. Deviant from the usual differentiation of indicators for the financial perspective, the customer perspective, the process perspective, and the learning/innovation perspective, we have the opinion that it would be worth to clear up, whether another type of differentiation would create more information, especially a differentiation between effectiveness indicators and efficiency indicators. This is the objective for further theoretical analysis and empirical work.

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Chapter 11
Resources – Evaluation of Innovation Projects Between "Lean" and "Slack"

Peter Bauernschmid

11.1 Research and Development (R&D), Innovation, and Slack

The examination of the resources for R&D activities in general but also within the framework of the strategic R&D planning by means of the technology-portfolio is in particular a central point of the innovation management.

It still remains unclear how many resources for a particular innovation, for a particular R&D department, or generally, for R&D activities are regarded as adequate.

This problem contains two aspects, namely

- the ascertainment of the degree of the resources for the development of certain innovations and technologies respectively and
- whether the employees should be given free control over part of the resources for their own-initialized R&D activities.

Both points are linked in the discussion about Lean R&D. Lean R&D starts everywhere, where "muda," wastage of resources is given. This wastage can have different causes, from mere egoistic enrichment motives to carelessness or non-rational planning and realization of projects and processes carried out. Also when the different variants of the lean management with a participation of the employees is emphasized, it is very much a question of top-down controlled, if anything centralistic approach, to the independent actions of the employees solely within the framework of CIP, kaizen, the suggestion system granted.[1]

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[1] Metze, G. (1998) Rückbesinnung auf Pfeiffers frühe(re) Werke als Verpflichtung für die künftige Theorieentwicklung – aufgezeigt am "First-Follower-Prinzip" und am "Lean Management". In: Weiß, E., Dirsch, H.(Hrsg.), Innovative Unternehmensführung. Festgabe zum 65. Geburtstag von Prof. Dr. Werner Pfeiffer, Forschungs- und Beratungsgruppe für innovative Unternehmensführung, Nürnberg, S. 39–56, hier S. 52 ff.

W. Schmeisser et al. (eds.), *Innovation Performance Accounting*,
DOI 10.1007/978-3-642-01353-9_11, © Springer-Verlag Berlin Heidelberg 2010

There is on the other hand the important older idea, that for innovations "slack" resources are necessary, thus the very opposite of "lean." Cyert and March are the well-known protagonists for the application of "slack." They assume from the viewpoint that organizations with slack in the sense of resources-excess use these for the generation of innovations, which would not be rendered during scarcity of resources.[2]

It is important in the process that the application of "slack" resources – in certain limits – is applied by the operating engineers and scientists according to their free discretion, independent of their official objective and from the management.[3]

These two contrasting positions do not only apply to the resources allocation, but also contain the counter-point in reference to the emergence of strategically relevant activities in companies. Burgelman differentiates here "induced behavior," thus rather from clients animated actions against the "autonomous behavior" that comes from the members of the organization, in technically oriented companies, from which R&D employees come. Furthermore there is another important aspect. Induced behavior is if anything associated with incremental innovations, it goes through the strategic filter of management. It is thus a top-down filtration.

There are, on the other hand, autonomous and strategic relevant actions emerging beneath on the basis in the R&D laboratory. "Autonomous behaviour" thus emerges *entsteht* "bottom up." Thereby strategic chances for radical innovations are created, which can reduce the external threats of the company.[4]

In contrast to this position from the school of the "Behavioral Theory of the Firm" the representatives of the "Agency Theory" name "slack" as a resource wastage.[5]

This conflict between "slack" as a positive requirement for innovations and "slack" as a negative wastage of resources appears solved through the approach of Nohria and Gulati, who postulate an inverse u-shaped process for the interrelation between slack accompany profit: Too little slack is negative, too much slack too. There is only one point, or a zone, within which the "slack" functions positively.[6]

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[2] Cyert, R. M., March, J. G. (1963) A Behavioral Theory of the Firm. Prentice-Hall, New York, p. 279.

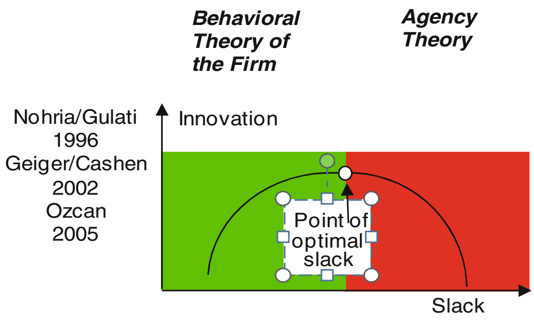
[3] David E. Dimick, Victor V. Murray (1978) Correlates of Substantive Policy Decisions in Organizations: The Case of Human Resource Management. Academy of Management Journal, 21(4) (December, 1978), pp. 611–623, here p. 616.

[4] Slack allows an organization "to adapt successfully to internal pressures for adjustment or to external pressures for change in policy, as well as to initiate changes in strategy with respect to external environment" Bourgeois, L. J. (1981) On the measurement of slack. Academy of Management Review, 6(1) 29–39, p. 30.

[5] Jensen, M. C. (1986) Agency costs of free cash flow, corporate finance, and takeovers. American Economic Review, 76, 323–329; Leibenstein, H. (1969) Organisational or frictional equiplibria, X-efficiency, and the rate of innovation. Quarterly Journal of Economics, 83: 600–623.

[6] Nohria, N., Gulati, R. (1996) Is slack good or bad for innovation? Academy of Management Journal, 39, 1245–1264. Geiger, S. W., Cashen, L. H. (2002). A Multidimensional Examination of Slack and its Impact on Innovation. Journal of Managerial Issues, XIV(I), 68–84. Ozcan, S. (2005) Examining Slack – Innovation Relationship: Longitudinal Evidence from the US Farm Equipment Industry (1996–2000). Paper to be presented at the DRUID Tenth Anniversary Summer

Fig. 11.1 Deduction of the "optimal slack" for the generation of innovations



Therefore the correct measurement of resources is an important precondition for the generation of innovations.[7]

It is not explicitly emphasized by Nohria and Gulati that the effective use of slack requires a certain independence of the employees. But at least it is clear that it can give both "too little" as well as "too much" to R&D resources. When we look at the R&D intensity of companies in an industry, then it must be possible to see which of the companies adopt less and which more on R&D resources, than is on average common in the industry.

Now a large scope of the R&D can indeed be observed in the electronics industry between selected companies. We are not able to measure exactly the innovative strength of these companies. But we assume the following reversal conclusions:

– the electronics industry is an innovative industry.
– Companies who wish to survive in this industry must be innovative, otherwise they will leave the industry.
– Companies which are visible in the electronics industry for a longer time (> 5 years) must affect according to this a minimum of innovations.
– In this respect the companies mentioned here are "innovative."

If therefore the companies in the electronics field listed here are innovative, then according to the logic of companies mentioned above such as Dell, Apple must be exceptionally "lean," in contrast companies such as 3Com or Texas Instruments

Conference 2005 on Dynamics of Industry and Innovation: Organizations, Networks and Systems. Copenhagen, Denmark, June 27–29, p. 5.

[7] Greve, H. R. (2003) A Behavioral Theory of R&D Expenditures and Innovations: Evidence from Shipbuilding. Working paper of the Norwegian School of Management BI, Department of Strategy: http://home.bi.no/a0210001/BehavInnovAMJ.pdf; Forthcoming in the Academy of Management Journal, February 2003.

Fig. 11.2 Overview of the R&D intensity of selected companies in the electronics industry[8]

Selected companies in the electronics field	R&D - Intensity = R&D from the revenue (%)
Compaq Computer	4,00%
Apple Computer	7,10%
Palm	9,30%
Average	10,50%
Sun Microsystems	11,90%
Silicon Graphics	12,00%
Micron Technology	12,30%
Advanced Micro Device (AMD)	13,30%
Intel	14,90%
Texas Instruments	17,60%
3Com	22,30%

display over rather too much slack. Palm und Sun Microsystems are positioned closest to the average. But have Palm and Sun Microsystems really reached the ideal point of slack?

11.2 Definition and Development – Interrelation of Slack

- Slack resources are defined within the framework of this work as those resources available, which exceed the necessary resources minimum, which is necessary for the generation of a defined performance,[9,10] and they are applied for other purposes than the official objectives of the company.[11]
- It is important that the application of slack resources is freely defined by the employees.[12]

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[8] Lake, D. (2001) Pc R&D Is A-Ok – Industry Trend or Event. In: Industry Standard, The, May 21, 2001. http://findarticles.com/p/articles/mi_m0HWW/is_20_4/ai_75098482.

[9] This definition is close to that of Nohria and Gulati's (1996), with the important distinction that slack involves resources that are not only currently within the firm, but also those that are potentially available to the firm (i.e., debt), thus capturing the multidimensional aspect of organizational slack. Geiger, S. W., L. H. Cashen. (2002), p. 55 or p. 54.

[10] Greve, H. R. (2003), p. 9.

[11] "...various ways in which resources and energy that may have been devoted to pursuing organizational goals have been channeled into other things" Levinthal, D. A., J. G. March, J. G. (1981) A model of adaptive organizational search. Journal of Economic Behavior and Organization, 2(4) 307–333, p. 309.

[12] Dimick, D. E., V. Murray, V. V. (1978) Correlates of Substantive Policy Decisions in Organizations: The Case of Human Resource Management. Academy of Management Journal, Vol. 21, No. 4 (December, 1978), pp. 611–623, p. 616.

Slack is subdivided – according to the different implications and various perspectives[13] – corresponding to the identifiability and retrieval possibilities – in three types:

- Non-absorbed, available slack,
- Absorbed, irreducible slack, and
- Potential slack, i.e. the possibility to generate slack in the future.[14]

Without wanting to lead the exact discussion here, we are excluding potential and non-absorbed slack for the examination of the budgeting for R&D projects and activities respectively and concentrating on the development and use of the absorbed slack.

The development of slack is linked to the measurement of the official budget. The official budget for an R&D department or a project is

– either lower than necessary. The assigned resources are not sufficient with the effect of an incomplete realization of the project, combined with many gaps, source of errors and mistakes.
– or it is correctly measured completely i.e. the assigned resources correspond exactly to the demands through the tasks of the project,
– or it is "oversized", thus oversized budget. There are more resources available than are necessary through the tasks of the project.

An oversupply with resources in the sense of a cross-subsidization can of course be used for other projects, which are not supplied adequately. This support can be hidden from the management of the higher management levels or not. Relating to the individual projects this is a typical case of absorbed slack. From the perspective of the company one cannot spot any overreaching costs – according to a very narrow definition – it is not slack.

We define absorbed slack as surplus resources, resulting from an oversupplied project with resources and departmental budget respectively. Hence the employed engineers and scientists can use the free space for R&D activities, which lie beyond the official objectives and determination of aims of the company.

But even in the case of a completely correctly measured project or departmental budget it can happen that the employees implement their own instigated activities beyond the official tasks within the framework of "submarine" projects. It is only possible in this case if the daily business is neglected, whereby actually correctly measured projects are then "undersupplied" with resources.

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[13] Ozcan (2005), p. 6.

[14] Bourgeois, L. J., Singh, J. V. (1983). Organizational slack and political behaviour within top management groups. Academy of Management Proceedings. 43, 43–49.

11.3 Use of Slack

The special interrelation between "slack" and the generation of innovations is not the source of slack, but the relation. Here it is a question mainly of whether the use of slack resources is concealed from the management and remains, or whether the management – in varying degrees – is or will be involved. The following drawing gives an overview of the different uses of slack.

We differentiate in doing so the following types for the use of slack:

- Slack hidden from the management, i.e. this slack is not noticed by the management.[15] Augdorfer has analyzed in detail this type of slack, whose usage is identified as bootlegging or as submarine projects.[16]
- Slack spotted by the management,[17] but
  - Also concealed by the management thereby either,
    - ignored or tolerated,[18] or
    - even with a deep commitment of the management in this slack usage.
  - Again included in the official resource allocation and so converted in official resources, in order that
    - As official conferred slack resources for free use in R&D, or
    - As part of a regular budget without any kind of degree of freedom for the engineers and scientists.

In principle, slack can be used or introduced for the different activities in companies. We are concentrating here on the use of slack in R&D. In doing so engage the "top-down" position of the slack conferred, i.e. we assume the position that

– slack right up to top management should be made transparent, and
– slack should be provided to the involved R&D employees within the framework of the corporate objective.

[15] The formulation about slack as informally activities by appropriating time for tasks or projects that are unknown to higher levels of management indicate that lower levels of management know about these activities or even are involved. Not in all, but in some cases bootlegging is hidden to upper and higher management. See Burgelman, R. A. (1991) Intraorganizational ecology of strategy making and organizationaladaptation: Theory and field research. Organization Science, 2, 239–262. Greve, H. R. (2003), p. 8, and see Augsdorfer, P. (1996) Forbidden Fruit: an analysis of bootlegging, uncertainty, and learning in corporate R&D, DPhil dissertation, Science Policy Research Unit: University of Sussex.

[16] Augsdorfer, P., (1996), p. 71.

[17] To the perception of slack as a prerequisite to the allocation of slack see Greve, H. R. (2003), p. 8.

[18] Augsdorfer, P. (1996), p. 71.

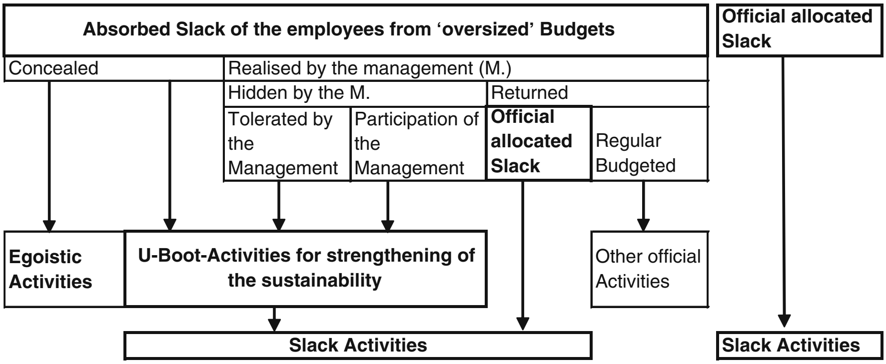

Fig. 11.3 The relation to each other of absorbed slack

The problem of a supervision of autonomous strategic actions at grass-root level is therefore on the one hand the problem of the measurement of the height of the slack, and on the other hand the granting of degrees of freedom for actions of one's own, which to begin with must not be linked completely with the object of a company.

11.4 Determining Factors of Slack

In order to be able to successfully transform slack in innovations, we postulate in the space of two classes, the inter-organizational and the extra-organizational determining factors, the following important factors:

Intra-organizational determining factors:

– The creative individual,
– The mix of creative individuals from different disciplines,
– A cautious supervision of the adoption of slack in R&D, and
– The granting of slack in R&D.

Extra-organizational determining factors:

– The technological S-curve
– The position of the company in the technological value-added chain.

Good empirical investigations are available over the inner-organizational factors and their correlation to slack, which do not have to be remarked on further here.[19] In our opinion the aspect of the "cautious supervision of the slack application in R&D"

[19] See e.g. Augsdorfer, P. (1996), p. 71.

misses out. This should be described in a more detailed way elsewhere. Within the framework of this publication we are concentrating on the external determining factors of the use of slack in connection with the generation of innovations.

11.4.1 The Position in the Technology-Ogee as the Determinant of the R&D Budget

In order to determine the varying sensible application of slack, we refer first of all to the well-known technology S-curve, which characterizes both the development of products and processes, but also of technologies and know-how.[20]

Products, technology, and with it the represented industries and branches can be described through their position in this curve, which is also identified as the technical life cycle.[21]

The technology-ogee represents the accumulation of independent variables, which is depicted by a performance indicator. With the increase of the independent variables, mostly F&D application, the dependent variables go asymptotic against a boundary value.

The technological S-curve encompasses the following phases in succession of the

- Basis – R&D and brainstorming respectively,
- The creation of evaluation models, feasibility studies, proof of concepts,
- Conversion in applicable and deployable products and processes with a growing increase of the corresponding performance parameter of the technology,
- The maturity, characterized through a reduction of the performance increase of the technology, and
- The repletion as approach to the limit value of the performance of a certain technology.[22]

By the time the physical limit value of the technology is almost reached, further R&D activities lead to only marginal improvements. In order to be able to go beyond

[20] The ogee is mostly attributed to Henderson. It was however already e.g. discussed by Jantsch etc, E. (1967) Technological Forecasting in Perspective. Paris OECD. p. 151; Robert U. Ayres (1969) Technological Forecasting and Long-Range Planning, McGraw Hill, New York.

[21] Albach, H., Audretsch, D. B., Fleischer, M., Greb, R., Höfs, E., Röller, L.-H., Schulz, I. (1996), Innovation in the European Chemical Industry, Discussion Paper FS IV 96 – 26, Wissenschaftszentrum Berlin, 1996, p. 4.

[22] Twiss B. C. (1995), Managing technological innovation, Pitman, Publishing, 4 Edt., UK; Shehabuddeen, N. TMH., Probert D. R., Excavating the Technology Landscape: Deploying Technology Intelligence to Detect Early Warning Signals. International Engineering Management Conference 2004; 0-7803-8519-5/04/2004 IEEE; pp. 332–336.

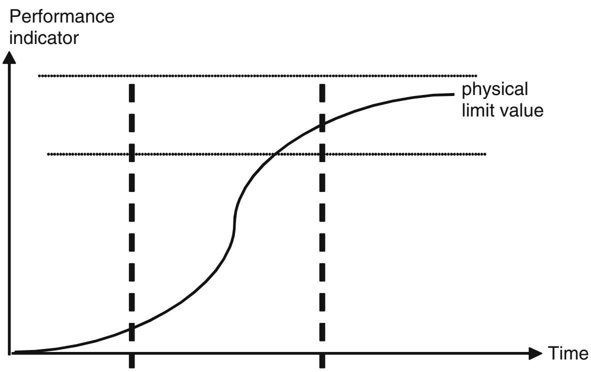

Fig. 11.4 The technological S-curve and the level of maturity of a technology respectively

this limit value a new technological solution must be found, which can effectively outperform the hitherto technology.[23]

If we combine the progress of the S-curve with an optimal R&D intensity, then we postulate for the measurement of the R&D resources as follows.

During the basic principles of the F&D and of the brainstorming at the start of the ogee less slack should be allowed, so as to support the development of a variety of ideas. The risk is thereby reduced to determine a new way too soon. The fewest resources for R&D are allocated here.

- When the decision about a certain technology is made, then all resources are concentrated on the creation of evaluation models, feasibility studies, and/or "proof of concepts." A search for further alternatives is rather prohibited, in this respect no slack should in this phase be allocated or tolerated.
- In the middle of the S-curve during the conversion in applicable and deployable products and processes more slack can be applied again, so that companies from the further development of the given technology in different ways.
- At the end of the S-curve in the maturity stage and phase of saturation the R&D activities for this technology should anyway be reduced. Parallel to this slack resources for the determination and generation of new technologies are urgently necessary. This period is especially critical for companies. Precisely successful companies with the "old" technology remain too attached to this and miss the introduction in new technologies. A prime example from the recent past is Polaroid, but also Kodak with the very costly development of the Advanced Photo System (APS), based on the mature technology photo-chemical processes, that was a flop through digital photography, e.g. through the Sony company etc.

[23] Singh, S., Singh Chhatwal, S., Yahyabhoy, t. M., Heng, Y. c.,(2002) Dynamics of Innovation in E-Banking. Paper presented at ECIS 2002, June 6–8, Gdańsk, Poland, pp. 1527–1537, p. 1529 ; Foster, R., "Innovation: The Attacker's Advantage", Summit Books, New York, 1986.

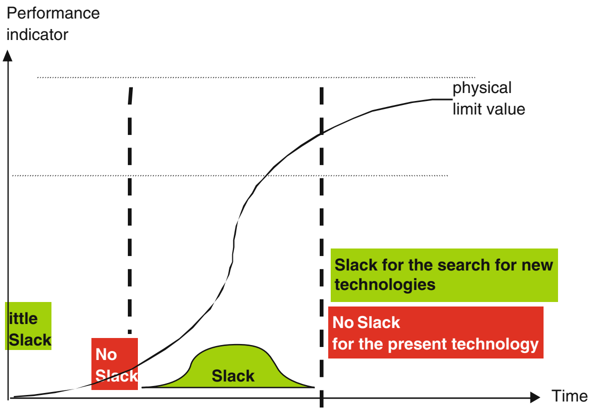

Fig. 11.5 The principal classification of slack according to technological level of maturity

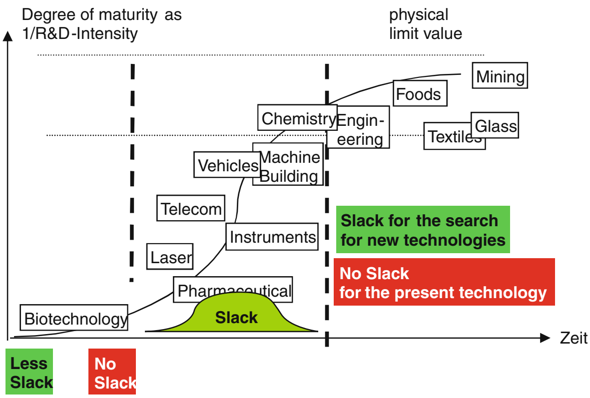

Fig. 11.6 Allocation of different technically characterized industries according to the level of maturity of the core

These postulates mentioned below are quantified in the sense of a simulation or "first approximation." They are of course substantiated in consecutive academic analyses, or to discard. For these departments we initially revert to information about the R&D intensity of different industries.

As a rule we find a conglomerate of technologies in the most different industries. But in many cases some fewer core technologies can be identified, which stand in the centre of the products and processes, in addition belong in the automobile industry security technologies.

Because c.p. with the increasing technological level of maturity decreases the R&D, one can conversely infer from that by the R&D intensity on the technological level of maturity.

Industry	R&D - Intensity (%)	Slack- share on R&D	Slack - Intensity(%)
Mining	1,2	15%	0,18
Foodstuffs	1,6	15%	0,24
Textiles/Clothing/Leather	1,9	15%	0,285
Glass/Ceramics/Masonry	1,9	15%	0,285
Metal production/working	2,8	15%	0,42
Automotive engineering	4,3	5%	0,215
Chemistry/Pharma/Petroleum	4,4	5%	0,22
Engineering	5,2	5%	0,26
DP/Telecommunications	6,4	5%	0,32
Electronics industry	8,3	10%	0,83
Instrumentation technology	8,8	10%	0,88
Electronics	10	10%	1
Laser technology	10	10%	1
Pharmaceutical	14,1	10%	1,41
Biotechnology (2. Phase)	36	5%	1,8
Biotechnology (1. Phase)	71,5	0%	0

Fig. 11.7 The deduction of the height of slack according to the technological level of maturity of the core technology of an industry[24]

Correspondingly the granting of slack would be allocated. Based on slack with a maximum value of about 15%,[25] then the slack share here of 10% on the R&D intensity as an average basis-benchmark is accepted. Above a "first simulation" subsequent "suitable" slack shares on the R&D budget are derived according to the phase of the main technology corresponding to the technological S-curve.

11.4.2 The Position in the Technological Value-Added Net as Determinants of the R&D Budget

The characterization of technologies through the S-curve explains differences in the R&D intensity between different kinds of technologies, which represent the core technology of certain industries. These differences are readily visible between industries with very different core technology, such as the steel industry, the

[24] Results of unpublished analyses by Prof. Dr. Gerhard Metze, Institut für Innovations- und Risiko-Management. http://www.baytech-netzwerk.de/institut-fuer-innovationsund-risiko-management-einleitung.html

[25] Siehe auch die Ergebnisse der Untersuchung von Augsdorfer, P. (1996), a.a.O.

automobile industry, the electronics industry. But with the S-curve alone clear differences within an industry cannot be explained (see Fig. 11.2).[26]

This is due to the fact that the identification of the different industries is application-oriented, and there is no information about technological homogeneities and homogeneities in an industry, i.e. about the collapsed lying technical structures and roots.

As a bad exemplar of this application-oriented classification in connection with innovations, the research work of Greve[27] has investigated the innovations in the shipbuilding industry in connection with slack.

Greve himself remarked that a comparison of the conditions of the generation of innovations is only possible if a comparable basis exists for those objects to be investigated. For this reason he reverts to – in his opinion – the quite closed economic sector, indeed the shipbuilding industry.

In so doing he verifies his theoretical scope by means of 11 large Japanese shipbuilding companies and at the same time investigates their innovations over 36 years.[28]

When one looks at the included companies more closely, then it becomes clearer that the companies are not so similar to one another, as Greve himself defined as a requirement for a feasible analysis.[29] This comes from a completely application-oriented definition of the companies and their business: The uses of the products and technologies of these companies are contracted almost entirely in shipbuilding. But their technological companies are entirely different, e.g.

– Welded robots,
– Ship antennae
– Anti-rolling management,
– Diesel-motor management
– Multi-purpose ship simulator,
– Special propeller pistons, etc.[30]

The technologies, which are R&D tasks, and activities are more similar between a welded robot for shipbuilding and a welded robot for the automobile industry, than between a welded robot for shipbuilding and a diesel engine control mechanism.

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[26] Lake, D. (2001), Pc R&D Is A-Ok – Industry Trend or Event. In: Industry Standard, The, May 21, 2001.http://findarticles.com/p/articles/mi_m0HWW/is_20_4/ai_75098482, und siehe www.destatis.de/. . ./Internet/DE/Presse/pk/2005/Biotechnologie/Publikation__Biotechnologie,property=file.pdf

[27] Greve, H. R. (2003), a.a.O.

[28] Greve, H. R. (2003), p. 13.

[29] “. . ..require that the organizations be involved in similar forms of business. . .”, Greve, H. R. (2003), p. 18.

[30] Greve, H. R. (2003), p. 39.

Therefore for innovations in the area of technologies a comparison is therefore only meaningful on the basis of technical similarities, but not on the basis of the application of the technology, e.g.

– a group of aerial companies, independent of the application, be it for ships or for police stations,
– a group of robot companies, independent whether for the automobile industry or for ship building,
– a group of companies, which manufacture diesel engines controls, be it for ship diesel or for stationary diesel engines, which generate the electrical current.

Therefore – from our perspective – shipbuilding cannot be identified as a closed industrial ecosystem, in which the R&D intensity and innovation results of the companies are able to be compared with one another.

The other approach, the technological heart of organizations using the patents to classify, fails pretty much in the same problem.

The problem lies in the gaps of the used patent classifications, which are a mixture of functional and technological descriptions, embedded in a hierarchical ranking structure.[31] In this way for example pharmaceutical agents are registered under section A (lifetime demand) in the technological class 61 (health), although a strong affinity of technological knowledge is given to section C too (chemistry).[32]

A further approach, which can be regarded as the analogy to the food chain, is the representation of the value-added chain.

An organization with its metabolism is embedded in a specific value-added chain between suppliers and clients.

This value-added chain – according to Porter – contains in an abstract manner:

- The suppliers of the suppliers of an organization,
- The manufacturer, virtually in the middle of the value-added chain (Original Equipment Manufacturer, OEM),
- The direct clients and users respectively, and
- The clients of the clients and private end customer respectively.[33]

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[31] Stephan, M. (2005) Vertikale Spezialisierung und technologischer Kompetenzabbau? Eine empirische Analyse der Auswirkung der Reduzierung der Wertschöpfungstiefe auf das Technologieportfolio von Unternehmen. Beitrag im Rahmen der Fachtagung der Kommission Technologie- und Innovationsmanagement. 7. Fachtagung der Kommission für Technologie- und Innovationsmanagement (TIM) im Verband der Hochschullehrer für Betriebswirtschaft e. V., Universität Erfurt, 27–29 November, Erfurt 2005, p. 15.

[32] Stephan, M. (2005), p. 15.

[33] Porter, M. (1985) Competitive Advantage: Creating and Sustaining Superior Performance. New York: The Free Press.

This type of representation of the value-added chain is based on the process thoughts. It takes place on the "mid-level," i.e. it combines the organization looked at with the particular input suppliers and the output purchasers, the clients.[34–39]

The generation of innovations is not only influenced by a close interdependency between manufacturer and client but there exists an interdependency which is at least just as big as between the manufacturer and the suppliers.

Thus innovative companies are more and more dependent from the interplay to complementary know-how, and with it to complementary companies beyond one's own company borders.[40] The innovation process may arise at a position of the value-added chain. But it is influenced by and covers the whole value-added chain.[41]

Das Porter model of the value-added chain is however too abstract for our purposes, as it could represent the innovation-relevant elements of the technical structure of products and systems. The aspect of a technology-hierarchy is missing in particular.

On the face of it this hierarchy corresponds to the technical structure of a product, similar to a list of items. But here this is the core of the model that contains the material connection from the very start, from the processing of the raw materials, via the varying manufacturing process to the point of the manufacture of complex products and systems. It is more a network than a chain.

Within this network an exchange between material, energy, and information takes place, which assumes a hierarchical lower standard, and this ends at the "upper" end in the consumption through the end customer, similar to the food chain in a natural ecosystem.

[34] "CS involve a high degree of precision and customization in design and production", "Consequently, users involve themselves intimately in the innovation process", Miller et al. (1995), pp. 364–365.

[35] "... supply large user firms rather than mass market consumers.", "... persistent bilateral oligopoly.", "...needs of large sophisticated business users...", Miller et al. (1995), pp. 364–365.

[36] "Users are heavily involved in complex products because they are dependent upon them for their business growth, profitability and survival.", Miller, R., Hobday, M., Leroux-Demers, T., Olleros X. (1995): Innovation in Complex Systems Industries: the Case of Flight Simulation, in: Oxford University Press, Industrial and Corporate Change, Brighton 1995, pp. 363–400, p. 371.

[37] "Consequently, the buyer's involvement in R&D, design and production methods will often take place throughout the product's development and not just at the early stages, as in the conventional model. Users may be responsible for important post production innovations involving maintenance, upgrading, performance modifications and information feedback for future production and re-innovation (Rothwell and Gardiner, 1989). Unlike mass market buyers, CS user organizations learn and internalize (verinnerlichen) much of the systems technology in order to be effective in their own business.", Miller et al. (1995), p. 372.

[38] "That the users have an important stake in the innovation process.", Miller et al. (1995), p. 372.

[39] "intensity of user involvement", "uncertainty/change in user requirements", "intensity of other supplier involvement and intensity of regulatory Involvement.", Hobday (1998), p. 10,

[40] Roelandt, T. J. A., Gerbrands, P. W. L., van Bergeijk, P. A. G. (2002): Markets and innovativeness: Does structure influence innovation performance? Research Memorandum 9902, Erasmus University Rotterdam, https://ep.eur.nl/bitstream/1765/844/1/rm9902.pdf, p. 18.

[41] Roelandt, T. J. A. et al. (2002), p. 19.

The intrusion of combination of novel technologies in the fields of application mechatronics (1970s), optitronics (1980s), and the biotechnological industry, or multi-media (1990s)[42] can be explained better than with a classification according to industry terms.

In the manufacture of technological goods the value-added chain begins with

- The preparation of the raw materials to a semi-finished product,
- The manufacture of parts and components as well as software elements,
- Sub-functions, incorporated in the hardware components and software modules,
- Products and tools as the combination of hardware and software, and
- Systems as the combination of products and tools, mostly realized through additional software and integrated hardware systems.[43]

Some examples of companies from the same industry show that there are very important differences in the location of the value-added net between the companies. The different locations in the value-added net have direct consequences on the definition of the respective inner structure of the companies, and their very specific "metabolic" with their environment. In the following figure we see the differences of very different business areas as an example of the manufacturer of personal computers.

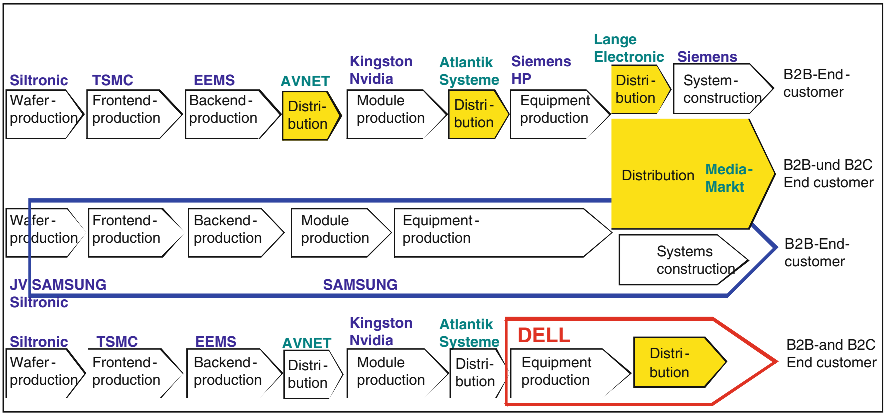

Fig. 11.8 Diverse location of companies in the value-added chain of PC manufacture[44]

[42] Roelandt, T. J. A. et al. (2002), p. 19.

[43] Pfeiffer, W., Metze, G., Schneider, W., Amler, R. (cit. as Pfeiffer, W. et al.) (1991), Technologie-Portfolio zum Management strategischer Zukunftsgeschäftsfelder. 1st edition Göttingen 1982, 6th reviewed edition Göttingen 1991, here p. 82.

[44] Results of unpublished analyses by Prof. Dr. Gerhard Metze, Institut für Innovations- und Risiko-Management. http://www.baytech-netzwerk.de/institut-fuer-innovationsund-risiko-management-einleitung.html.

The innovations activities of companies can be precisely assigned with this approach and indeed both concerning the vertical as well as the horizontal dimension in the hierarchy of the value-added net. Christensen und Rosenbloom (1995) characterized the term for this purpose of the "value-network".[45]

Stephan emphasizes that the position of a company in the technological value-added net also characterizes the technological knowledge,[46] or, vice-versa the potential of the technological knowledge characterizes the position of the company in the technological value-added net in an economic sector.

In any case the position of a company in the value-added net determines the technological knowledge, that in products and processes for these products, seen abstractedly, are transformed into troubleshooting for the environment of the organization.

In addition to this "core position" a company has naturally even more possibilities to determine its business concept. This is in turn indicated within the framework of the model of the value-added net. For especially in the "next neighborhood" on the horizontal level e.g. complementary technologies can come into consideration. In the vertical level down in the hierarchy expansion of the know-how on the technology is above all necessary if the danger exists of dependence only a supplier. This

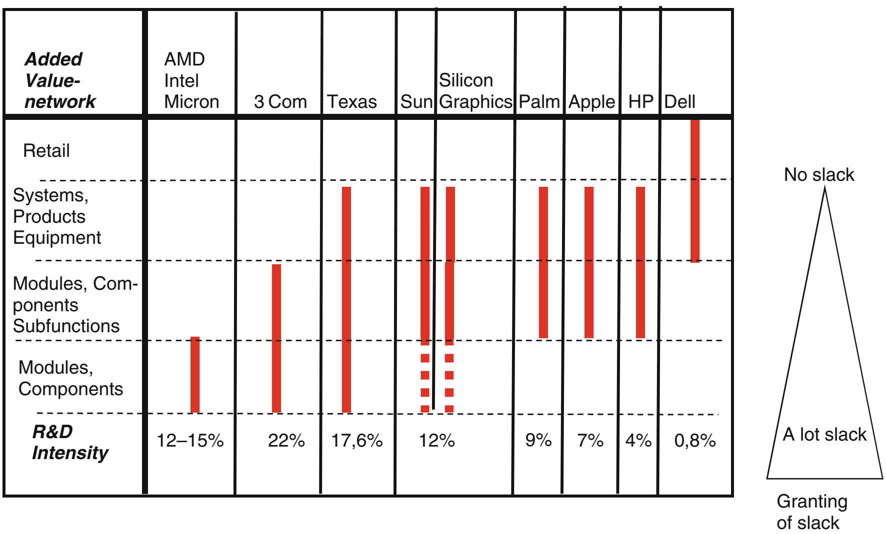

Fig. 11.9 Location of companies in the technological value-added chain net and R&D intensity

45 Christensen, C. M., Rosenbloom, R. S. (1995) Explaining the attackers advantage: technological paradigms, organizational dynamics, and the value network. Research Policy 24, 233–257 and see Murmann, J. P., Frenken, K. (2002) Toward a Systematic Framework for Research on Dominant Designs, Technological Innovations, and Industrial Change. Papers on Economics and Evolution from Max Planck Institute of Economics, Evolutionary Economics Group; Working paper 12, 2002, p. 27.

46 Stephan, M. (2005), p. 29.

is all part of a conscious determination of the business concept or business concept of an organization.[47]

When on the basis of this model we allocate and compare the different companies in the electronics industry, then one clearly sees their differences in the localization of their top priority and in the covering of a part of the value-added chain with plausible consequences on the R&D intensity.

We can verify the following tendencies here deductively:

– With a concentration in the lower levels of the added value network a higher R&D intensity is given than in the higher levels, and
– The coverage of more than a level in the value-added chain heightens the R&D intensity too.

We postulate from this knowledge the following correlations, which are still to be verified through further empirical investigations, and the dependence of slack of the localization of the position of a company in the value-added network, and the coverage of the different levels of the value-added network concern:

When the location in the technological value-added network relates to the base level e.g. materials and modules and components respectively, then more slack is deployed, which heightens the innovation performance, and vice-versa.

- *When the coverage of the company relates to the value-added network at the upper end, thus products, equipment and systems, then not too much of slack should be allocated. Otherwise the performance of the system is compromised basically as a result of a wastage of resources, and vice-versa.*
- *When the coverage of the company in the technological value-added network relates to the middle part, thus on product architecture and process start of production on the level of components, sub functions etc, then the targeted application of slack will heighten the innovative performance of the organization and vice-versa respectively.*

We can imagine that our suppositions – in the sense of a simulation – can be substantiated as follows:

We can assume according to this in the measurement of the R&D budget, and with it in the allocation of slack of a clear setting of priority in the lower levels of the technological value-added network.

[47] Roelandt, T. J. A. et al. (2002), p. 19. Enright, Michael J. (1995), Regional Clusters and Economic Development: A Research Agenda, Paper prepared for the Conference on Regional Clusters and Business Networks, November 18–20, Fredericton, Canada.

Levels in the Technological-Value-added Network	R&D - Intensity (%)	Slack- share on R&D	Slack - Intensity (%)
System	3,5	5%	0,175
Module	7	10%	0,7
Element	14	15%	2,1

Fig. 11.10 R&D intensity and slack according to the levels in the technological value-added network

11.5 The Combination of the Technological S-Curve and of the Technological Value-Added Network as Determinants of the R&D Budget and Slack

The next step is the deduction of the measurement of slack in the dependence of a combination of the technological S-curve observation and of the inclusion of the technological value-added network.

We step up on the correlation of the values derived out of the technological value-added network of the R&D intensity as the intensity relation. As the benchmark the

R&D-Intensity in dependence of the level of maturity of the technology and of the position in technological value-added network			Levels in the technological value-added network		
			Element	Module	System
		Intensity-Relation	2	1	0,5
			↓	↓	↓
Level of maturity Industry	**FuE - Intensity (%)**				
Growth decreasing	2%	→	4%	2%	1%
Growth in the lower area	5%	→	10%	5%	3%
Growth in the middle area	8%	→	16%	8%	4%
Growth in the upper area	12%	→	24%	12%	6%
Begin	> 25 %	→	50%	25%	13%

Fig. 11.11 Deduction of the R&D intensity as the function from the level of maturity and the technological S-curve level respectively, and the technological value-added network

Slack share on the R&D intensity in dependence of level of maturity of the technology and of the position in the technological value-added network				Levels in the technological value-added network		
				Element	Module	System
			Slack - Intensity according to the position in the network	15%	10%	5%
			Intensity Relation	2	1	0,5
Level of maturity Industry	FuE - Intensity (%)	Slack - Intensity according to level of maturity				
Growth decreasing	2%	15%	→	30%	15%	8%
Growth in the lower area	5%	5%	→	10%	5%	3%
Growth in the middle area	8%	10%	→	20%	10%	5%
Growth in the upper area	12%	5%	→	10%	5%	3%
Begin	> 25 %	0%	→	0%	0%	0%
Begin Pre-development	> 25 %	15%	→	30%	15%	8%

Fig. 11.12 Deduction of the appropriate height of slack derived from the R&D intensity as the function from the level of maturity and technological S-curve, and the technological value-added network respectively

middle level of the module with a value of 1,0 is chosen. Arising out of this the element level of the intensity factor 2,0 for the system level of the intensity factor 0,5.

From the model of the technological S-curve and the technological degree of maturity, we can –according to the phase – derive the values 2, 5, 8, 12% and >25% for the R&D intensity. Resulting from this the following differentiated basic matrix for the classification of R&D intensity:

This result of the R&D intensity can be converted in reference values in the sense of a further simulation type of projection, under which conditions how much slack should be allocated. For this reason, in an essentially differentiated way, concrete statements about the granting and height of slack respectively is attained than in the investigations up until now.

These numbers are logical deductions on the basis of the suppositions made above. The basics of the suppositions is indeed based on empirical fact, not however the consequences drawn out of it. They are – as carried out – rather a simulation in the sense of a first differentiated approximation of the problem, to see the granting of slack.

The values generated here can at first be seen as reference values, on which a specific company can apply its external position in regard to technological level of maturity of the core technology and in relation to its position in the technological value-added network.

As the next step, which should only be named here, the intra-organizational determining factors must be included as a requirement for the innovative success in the contemplation.

It is less useful for an excellent position relating to the extra-organizational determining factors, if no creative individuals are available in the companies. This is a basic requirement. Investigations have proven the relevance of multi-disciplinarily. Creative engineers and scientists, if possible from different specialized fields, should be brought together. From the top-down position, the application of slack is not allowed to be effected without the supervision of the management. Here it is essentially whether the management restricts the definition of the action field to the involved employees on the basis but conceding the corresponding degree of freedom. And it is not sufficient to formally report a part of the official budget and to allocate motivated employees. As above all with highly innovative products and processes are necessary after their market introduction and application of considerable post-developments, a corresponding timeframe for slack activities must be made available. This poses – despite every well-meant intention and assurance by the top management – the biggest hurdle above all in place when the company has a good growing order situation.

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Part V
Target Costing and Process Innovation Costs as Operating Cost of Technology Management and Innovation Marketing

Chapter 12
Conjoint-Based Measurement of Benefits of Product Functions and Generation of Target Prices[1]

Fee Steinhoff and Volker Trommsdorff

12.1 Introduction

A significant function of the innovation profitability analysis is the determination of success: Expenses and revenues as well as their net balance as the innovation output should be recorded (Hauschildt 1994, p. 1018). In order to be competitive as a company, expense control must already come into play in the very early phases of the innovation process so that the target customers can be offered a suitable product at an acceptable price. As a result of heightened price consciousness in many markets, the question "What will the product cost?," which focuses on the objectivity of technology and the economy, is being replaced in product development by the question "What may the product cost?," which focuses on the subjectivity of the perceptions of target customers. This question must be asked early in the process: A large part of the product costs (some estimates claim 70–80%) are determined in the early phases of the value chain (research and development (R&D) as well as design, thus in the core phases of the innovation process), such that little leeway remains for cutting costs in the production phase (Serfling and Schultze 1996, p. 29).

Target costing addresses the question "What may the product cost?" by comparing target prices, target margins, and target costs. Conjoint analysis delivers significant input data for this question, including the price that potential customers in the market are willing to pay as well as the benefits of product functions. With conjoint analysis, the contributions of individual product features to the subjective overall benefit of the product can be quantitatively estimated. This paper will first present an overview of the method of target costing (Section 12.2). It will then focus on conjoint analysis for the generation of target prices and the benefits of product functions (Section 12.3). To this end, an introduction to conjoint analysis will be provided (Section 12.3.1), the relevant process steps of conjoint analysis will be

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[1] For a detailed presentation, please refer to the practice-oriented textbook Trommsdorff and Steinhoff (2007) "Innovationsmarketing," published by Franz Vahlen GmbH, Munich.

W. Schmeisser et al. (eds.), *Innovation Performance Accounting*,
DOI 10.1007/978-3-642-01353-9_12,

highlighted (Section 12.3.2) and an example of its application will be given (Section 12.3.3). The paper will end with a summary (Section 12.4).

12.2 Target Costing at a Glance

Target costing was developed in Japan and has been successfully used there since the 1970s. Toyota took a leading role in 1965 when it developed the concept "genka kikaku," which later became known as target costing (Horváth et al. 1993, p. 3). But the concept made use of well-known principles. For example, back in the 1930s, when developing the Beetle, Volkswagen set the sales price right from the start at a maximum of 990 Reichsmarks in a customer-oriented process (Bullinger et al. 1977, p. 1). What was new in target costing was the systematic and integrated approach. In Germany, Audi was one of the first companies to use target costing in the innovation process. It was introduced in response to the intensification of competition in the automobile industry in the 1980s and thus the necessity of shortening the length and cost of the development processes (Hessen and Wesseler 1994, p. 150 et seq.).

Target costing combines the systematic focusing of the design of product functions to the needs of the market with the necessity of lowering product costs in the early phases of the value chain, i.e., in the innovation phases. The objectives of target costing are (1) strategic, market-oriented R&D, (2) dynamic cost management right from the start of the innovation process, and (3) motivation to total quality management through a focus on market needs instead of abstract objectives.

The most important characteristic of target costing is customer orientation as the starting point of pricing. Not the technological possibilities, but rather the maximum price accepted by the target customers depending on specific product functions should control the product development. To this end, cost-effective technology and process standards of the innovating company should initially be disregarded in order to attain a degree of freedom for cost control. Resources should only be deployed in accordance with customer requirements, and costs should be incurred only where they bring customer benefits (Seidenschwarz 1993, p. 80 et seq.). Target costing combines the technical side of product development with the operational, quantitative side of key indicator control. Target costing documents the effects of implementing technical product requirements on marketing and cost goals during the development process. Since product development is oriented to customer requirements, too great a focus on technology rather than the market ("over-engineering") must be avoided (Horváth et al. 1993, p. 7).

The following process steps are subject to the target costing principle (see, among others, Horváth et al. 1993, p. 11 et seq.; Listl 1998, p. 101 et seq.):

1. Determination of the overall target costs. Target costing begins by gathering market data: information concerning the price that target customers are willing to pay and the requirements they have for the innovation ("market into company" approach). Conjoint analysis, in which preferred price structures are collected from target customers depending upon the peculiarities of relevant product attributes, is especially suited for the collection of this data (see following section).

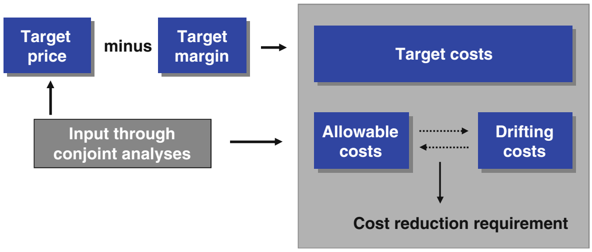

Fig. 12.1 The basic principle of target cost determination
[Source: based on Horváth et al. (1993), p. 12]

Figure 12.1 visualizes the basic principle of target cost determination and clarifies the connection with conjoint analysis. The price that customers are willing to pay for a product concept, which can be ascertained with the help of conjoint analysis, sets the target price and comprises the target margin (desired profit) and the target costs. The target costs are the overall target costs of the innovation, normally a compromise between the highest permissible costs based on (conjoint-based) customer requirements and competitive conditions ("allowable costs") and the budgeted costs achievable under the current technology and process standards ("drifting costs"). These are the manufacturing costs that are just about achievable at the relevant point in time and are generally too high. They are used to ascertain the need to lower costs. The determination of the target costs is usually an iterative process of "cost massaging" (Serfling and Schultze 1996, p. 30; Seidenschwarz 1993, p. 116 et seq.).

2. Breakdown of the overall target costs into product components and parts (target cost breakdown). When realizable target costs have been set, the target costs of the product components and parts are determined. There are two different methods for this process: the component method and the function method. The component method allots the target costs directly to the components and parts of the new products with reference to reference products. Due to the necessary reference standards, this is only suitable for product modifications (Horváth et al. 1993, p. 13). In the function method, the benefits of the product functions from the perspective of the customers (ascertained with conjoint analyses) form the starting point for target cost breakdowns. The target costs of the overall product are initially divided into the customer-relevant product functions in accordance with their benefit values (utilities). In the subsequent steps, the target costs are broken down further with the help of a component/function matrix into the product components and parts necessary for fulfilling the product functions. The target costs of a component are thus determined on the basis of the contribution it makes to fulfilling the functions desired by the customer. Overall, this should ensure a focus on customer requirements at all product levels (Coenenberg et al. 1997, p. 385 et seq.).

3. Target cost implementation. Target costs are implemented with the aim of consistently aligning product design and development with the target costs. For instance, the expected production and life cycle costs of the product or product components can be estimated by cost pre-checking based on the current actual planning. The target costs are subsequently compared with the current (estimated) costs using a target cost control diagram (Serfling and Schultze 1996, p. 37; Listl 1998, p. 103). An iterative review and adjustment of the target cost control diagram supports the customer-oriented search and exploitation of cost reduction potential. Thus each step proactively attempts to set the course for achieving target costs as early as possible (Listl 1998, p. 103 et seq.). Accompanying approaches for integrated cost reduction are, for example, Kaizen costing (cost reduction through continuous improvement), early integration of suppliers and systematic time management (Stops 1996, p. 627 et seq.).

Target costing is a valuable approach for market-oriented cost management in product development (Specht et al. 2002, p. 179). The opportunities of target costing lie in higher market acceptance of the innovation by consistently aligning costs or pricing with customer needs. R&D costs are reduced by exploiting cost cutting potential. The resulting cooperation between the marketing, R&D, and production departments leads to an improved culture of innovation. Risks can arise as a result of increased outsourcing of partial services without sufficient strategic evaluation, simply because they can be had so much more cheaply. Furthermore, the use of target costing demands a high degree of coordination of all areas involved in product development and, consequently, in addition to efficient interface management, it also requires systematic internal marketing to counter any resistance which may arise (Laker 1993, p. 63 et seq.; Serfling and Schultze 1996, p. 31 et seq.).

12.3 Generation of Target Prices and Benefits of Product Functions Through Conjoint Analyses

12.3.1 Introduction to Conjoint Analysis

Conjoint analysis provides a tool for estimating the additive contributions of individual product features to the subjective total value (benefits, attitude, willingness to pay) of products. For this purpose, in the quasi-experimental investigation design, interviewees are hypothetically presented with products described only by their significant attributes. The interviewees must (in the basic version of conjoint analysis) merely form ordinal preference judgments among pairs or triads of the furnished product descriptions. The process examines these stated ordinal preferences as dependent variables of an experiment, while the attributes (product characteristics) are seen as independent variables on which the preference values depend. These ordinal preference judgments are then examined as input data using a type of non-metric variance analysis to establish which benefits of the attributes (and thus utilities) must have led to these judgments. Because an interviewed person provides many such stated preferences concerning ever changing combinations of fictitious products and the input data are therefore correspondingly redundant, metric utilities of the product concepts and metric additive part-worths for the individual attributes can be estimated from the ordinal input data. The criterion for optimizing the estimate of the utilities behind the empirical rankings is consistency between the generated total benefit rankings and the empirical ranking values (compare Teichert 2000, p. 471 et seq.; Backhaus et al. 2006, p. 550 et seq.).

Conjoint analysis works through "decomposition": Underlying part-worths are chosen for overall judgments. This contrasts with "composing" methods of benefit or attitude measurement, where interviewees assess individual product attributes, which are then aggregated to arrive at total values. In the de-compositional, conjoint approach, interviewees state preference judgments on integral product concepts (stimuli). On the basis of the overall judgments on the stimuli, the conjoint algorithm estimates the contributions of the individual attributes to the overall benefit. The implication is that the overall benefit is additively comprised of the individual part-worths (utility per attribute) (Backhaus et al. 2003, p. 551). This process corresponds to the reality of the market: Target customers perceive the products as a whole and evaluate them holistically. The customer weighs up various products and decides in favor of the alternative with the highest overall benefit (Stadler 1993, p. 32).

Conjoint analysis was developed at the beginning of the 1960s as a process of mathematical psychology. It was applied to marketing for the first time approximately 10 years later by Green and Rao (1971). At the end of the 1980s, the process made a breakthrough into German market research practice. Since then, conjoint analysis has become one of the most frequently used market research methods in practice (Voeth 1999, p. 155 et seq.). For the most part, conjoint analysis is used to determine optimal product features when planning new products and/or to determine prices (Hartmann and Sattler 2002, p. 4). Figure 12.2 provides an overview of example areas of application and questions asked by conjoint analysis.

Areas of application for conjoint analysis

- **Product policy (new product planning)**: E.g., what product features influence preference behavior and how strongly?
- **Determination of the price response function**: How much may a new product cost?
- **Market segmentation**: E.g., what benefit-based market segments can be identified?
- **Development of a communication concept**: Which features relevant to purchases should be emphasized in the communication?
- **Market-share simulation (analysis of market reactions):** What decisions do target customers make in various supply situations, and what kind of impact does that have on market share?
- **Training (collaboration of R&D and marketing)**: What is really important to potential customers?
- **Brand-value measurement:** What value does a brand have and what are potential customers prepared to pay for it?

Fig. 12.2 Areas of application of conjoint analysis
[Source: based on Teichert (2000); Wittink et al. (1994)]

12.3.2 Process Steps of Conjoint Analysis

The main features of the process and methodology of classical conjoint analysis will be described below (see Backhaus et al. 2006, p. 557 et seq.):

1. Determination of features and attributes. At the start of a conjoint analysis, the features and their attributes must be defined to describe differing product concepts. One advantage of conjoint analysis is that the features must meet only minimal scaling requirements, a nominal scale of measurement is sufficient. Figure 12.3 shows example features and attributes of a number of product categories.

The definition of features and characteristics is decisive for all subsequent steps in a conjoint analysis. Brainstorming sessions, expert discussions, literature analyses, and qualitative customer interviews can be used as sources of information (Büschken 1994, p. 75). Knowledge of the market and methods as well as intensive collaboration between market researchers and product managers are crucial (Auty 1995, p. 197 et seq.).

The following criteria should be met when selecting features and attributes to be integrated in the design:

- Relevance of the features. Only features that are presumed to have a strong influence on the decision to purchase should be considered.
- Ability of the manufacturer to influence the features. It must be possible to vary the features within the parameters of product design and they must be technically feasible.

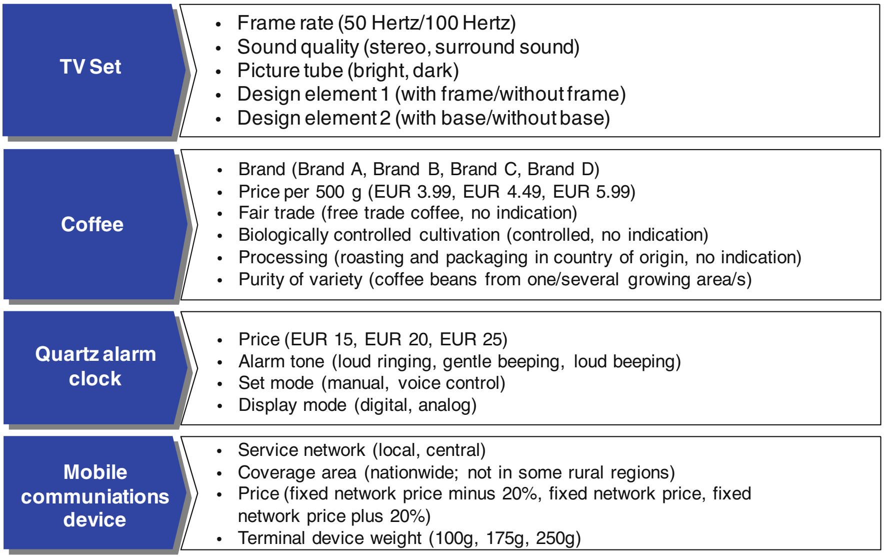

Fig. 12.3 Example features and attributes of conjoint analysis
[Source: own presentation based on Strebinger et al. (2000); Hensel-Börner and Sattler (2000); Ernst and Sattler (2000); Voeth and Hahn (1998)]

- Autonomy of the features. The benefit of an attribute should not depend on other features (no feature interaction).
- Compensatory relationship of the features. The conjoint analysis model assumes that the less favorable characteristics of one feature can be compensated by the favorable characteristics of another.
- No use of exclusion criteria. Attributes may not be knock-out criteria, in the sense that they subjectively must necessarily be present.
- Limited number of features and attributes. Depending upon the variant of conjoint analysis, there are different feasibility constraints, especially in regard to what is reasonable to expect of the interviewees.

This last point should be examined in greater detail: Since the collection of data for a conjoint analysis actually takes the form of an experiment, critical limits for interviews and estimates must be observed. The higher the number of features, the more stimuli must be assessed by the interviewees. If there are too many stimuli, the load limits of the test subjects could be exceeded, impairing the consistency of the data and consequently also the validity of the results. The limits depend on the dispositions of the interviewees. Tscheulin and Blaimont (1993, p. 845) empirically determined a significant influence of educational level and occupational orientation; however, this general effect was not confirmed in an experiment by Sattler et al. (2001, p. 784 et seq.).

Regardless of this, however, the limit in classical conjoint analysis should normally be fewer than seven features with an average of less than three attributes (Hartmann and Sattler 2002; Teichert 2000). The variant of adaptive conjoint analysis (see also below), in which data is analyzed simultaneously with computer-assisted collection and progresses with each individual answer input of the interviewee, increases the upper limit of features and attributes because not all foreseeable stimuli must be evaluated, but rather only as many as are needed until the ongoing analysis shows stable results.

2. Collection structure. For the collection structure, stimuli must be defined (combinations of feature attributes to be evaluated). The full profile and the trade-off methods represent the most important forms of data collection methods. In the full profile method, the stimuli consist of the combinations of the respective attributes of a feature with all characteristics of all other features to be assessed. In the case of only three features each with three possible attributes, there are $3^3 = 27$ different stimuli. This number increases exponentially with the number of features and attributes per feature. In the trade-off method, each stimulus comprises a combination of the attributes of only two features, while the other features are not included in the fictitious product description. In the case of relatively high numbers of features, this drastically reduces the collection structure, but at the expense of the high realism of holistic product assessments. In practice, the full profile method has caught on due to its higher correspondence to reality compared to the trade-off method. Normally, however, a subset (reduced structure) is selected from the set of theoretically possible stimuli (complete structure) for reasons of research economy (see in addition Backhaus et al. 2006, p. 559 et seq.).

3. Assessment of the stimuli. The generated stimuli can be presented to the interviewees for assessment as a verbal description (spoken, printed out, or shown on a monitor), as a visual or multimedia presentation or as a physical product (prototype). As a matter of principle, the presentation should be as realistic as possible. The state of research regarding the effects of the different modes of presentation on the validity of conjoint analysis forecasting is still somewhat controversial (for an overview, see Strebinger et al. 2000, p. 56 et seq.; Ernst and Sattler 2000, p. 162 et seq.). Ernst and Sattler (2000, p. 170) in an empirical test could not identify any appreciable differences between the use of multimedia (text, pictures, and sounds) and the use of purely text-based stimuli. For certain product groups (e.g. design-oriented products or products in need of greater explanation), they recommend multimedia stimuli. On the basis of an experiment with bicycle pumps, Dahan und Srinivasan (2000, p. 106 et seq.) report almost no difference between the results of virtual and real prototypes, which speaks for the quicker and more cost-effective alternative of virtual prototypes.

Ordinal stimulus assessments are the data input in classical conjoint analyses. The interviewees rank the stimuli by perceived benefit, be it by comparing pairs or triads or using ratings scales. Another variant of conjoint analysis collects fictitious purchase decisions instead of preferences, also giving interviewees the option of indicating that they do not wish to purchase any of the products in each comparison of stimuli. This choice-based conjoint analysis (CBC) generally leads to more valid results which better forecast actual behavior.

4. Estimating the utilities. The part-worths of the individual feature attributes are empirically estimated from the collected ranked data. Metric (e.g. ANOVA, OLS) or non-metric (e.g. LINMAP, MONANOVA) estimation procedures are used as calculation methods (see in detail Backhaus et al. 2006, p. 565 et seq.). The results obtained are the part-worths for each interviewee and each feature characteristic. These part-worths express contributions to the overall benefit which the interviewee, unconsciously, or in any case without so stating, has assigned to the feature characteristics in his trade-offs. One advantage is that utilities can also be interpolated for attributes not surveyed (Teichert 2000, p. 507).

5. Aggregation of the utilities. The aim in aggregating the results is to consolidate individual estimates into one generally applicable result or into a few, meaningful samples. Individual specifications can be aggregated before a common conjoint analysis (aggregation of raw data, for ordinal measured values through medians) or after each individually performed analysis (arithmetical aggregation of the metric utilities). Aggregation according to individual analyses has the advantage of providing benefit-based market segmentation that lends itself to interpretation ("benefit segmentation," Green and Krieger 1991, p. 20 et seq.).

A prerequisite for each aggregation is a relatively uniform database in each case. If it is not provided, the aggregation of raw data is not an option and a preceding cluster analysis of the raw data is recommended, resulting in several relatively uniform interviewee segments for which separate conjoint analyses must be prepared. In this context, we differentiate between a-priori and a-posteriori segmentations. For a-priori segmentation, the interviewees are classified in advance on the basis of variables which presumably influence the preference structures (e.g. age, gender). In a-posteriori segmentation, individuals with similar preference functions (part-worths) are clustered. Subsequently, target group-specific, aggregated overall utilities can be determined for all stimuli and relative importance can be calculated for all features (Schubert 1995, p. 384 et seq.).

Part-worths can be used to simulate market reactions (market simulations). The decision-making behavior of the interviewees between different products (as described using the feature attributes used in the conjoint analysis) is simulated. It is presumed that the interviewee makes a rational decision and chooses the alternative with the highest overall benefit for him (first-choice rule). Aggregating the results for all interviewees provides the estimated market shares for differing product concepts. This makes it possible to determine price-response functions and optimize new products based on market potential. Additionally considering the costs of feature attributes makes it possible to identify profit-optimized product concepts ("conjoint+cost approach," see Bauer et al. 1994, p. 82 et seq.). However, the simulation results are subject to assumptions and are only valid in regard to the respectively surveyed product range structure which represents the competitive environment (Büschken 1994, p. 81 et seq.).

Hildebrandt (1994, p. 25 et seq.) points out that, for high-grade innovations, although it is possible to obtain knowledge for product design with the help of traditional conjoint analysis, estimates of market potential are very uncertain due to the interviewees' lack of product experience. Büschken (1994, p. 85) goes so far as to assume that conjoint analysis has insufficient foundation for high-grade innovations due to want of stable preferences. Backhaus and Stadie (1998, p. 184) refer to limit conjoint analysis, one of the variants of conjoint analysis described below, for acceptance estimates for high-grade innovations.

6. Variants of classical conjoint analysis. In addition to the traditional process of conjoint analysis presented up to this point, modern processes have been developed. The most important are choice-based conjoint analysis (also called discrete-choice analysis), hybrid conjoint analysis and adaptive conjoint analysis (for a comprehensive overview of alternative investigation approaches, see Backhaus et al. 2006, p. 602 et seq.). A feature of choice-based conjoint analysis (CBC) is that preferences are recorded as realistic selection decisions ("Which of the described product concepts would you choose? Concept 1, Concept 2, None of the above"). In this approach it is thus also possible to accept none of the stimuli – a significant realistic advantage in contrast to classical approaches. The CBC method is especially suitable for simulating market reactions (Backhaus et al. 2006, p. 604 et seq.; Weiber and Rosendahl 1997, p. 114). In practice, approximately two-thirds of CBC applications are used for pricing (Hartman and Sattler 2002, p. 3 et seq.).

Hybrid models (including adaptive conjoint analysis (ACA)) combine the de-compositional approach of the classical conjoint analysis with a compositional approach. In this process, direct assessments of the importance of individual product features as well as preferences for the attributes of the features are asked for in the compositional portion. In the de-compositional portion, interviewees assess product

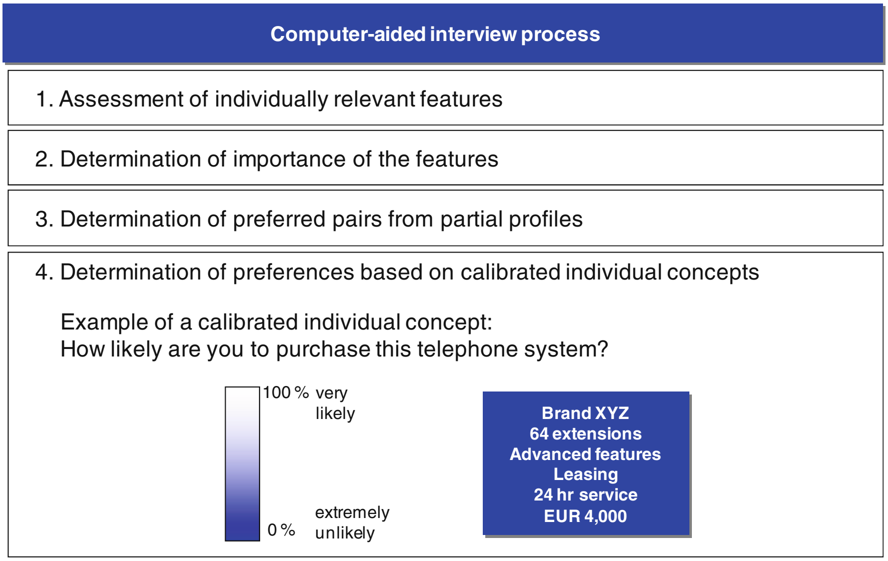

Fig. 12.4 Process of adaptive conjoint analysis (ACA)
[Source: based on Backhaus et al. (2006), p. 606]

profiles. Part-worths of the feature attributes are adjusted to the compositional data (Green and Srinivasan 1990, p. 11; Teichert 2000, p. 501).

Figure 12.4 provides an example of the steps of ACA. In this context, "adaptive" means that the test subjects' individual answers are taken into account in the questions which follow, such that an individual collection structure is created for each interviewee. The advantages of ACA are computer-aided or online collection (see Dahan and Hauser 2002, p. 336 et seq.; Dahan and Srinivasan 2000, p. 99 et seq.), the availability of corresponding software (Sawtooth), and especially that ACA makes it possible to assess more features (maximum of 30) and attributes (maximum of 9) than is possible in classical conjoint analysis (Hartmann and Sattler 2002, p. 7; Schubert 1995, p. 380). Nevertheless, the higher the number of features and attributes, the greater the risk of exhaustion effects on the part of the interviewees (Teichert 2000, p. 502). The modern variants such as CBC and ACA have become established in practice (Hartmann and Sattler 2002, p. 4; Wittink et al. 1994, p. 51 et seq.; see Backhaus et al. 2006, p. 607, for a comparative assessment of different approaches).

In addition to the modern approaches discussed, additional process innovations and conjoint modifications have been developed (e.g., customized computerized conjoint analysis (Hensel-Börner and Sattler 2000), limit conjoint analysis (Voeth and Hahn 1998), MaiK-conjoint analysis (Köcher 1997)). Backhaus and Stadie (1998, p. 186) recommend a limit conjoint analysis based on multimedia stimuli, for example, for estimating the acceptance of high-grade innovations. Comparisons between diverse variants do not produce clear results (Teichert 2000; Weiber and Rosendahl 1997, p. 111).

12.3.3 Example of Application

In order to explore the market potential for a target product expansion and to describe potential target segments in terms of their differing consumer requirements, a German manufacturer of motor-powered gliders performed a primary analysis (for details, see Trommsdorff and Steinhoff 2007, p. 384 et seq.). It was assisted by the Berlin Institute of Technology (Technische Universität Berlin) and the management consultants trommsdorff + drüner, innovation + marketing consultants. For the investigation, three interested target groups – motor glider pilots, glider pilots, and motor aircraft pilots – were interviewed online about their preferences using an ACA approach. On the basis of secondary analytical research, discussions with in-house and external experts and users, six defining product functions of gliders were specified (crash safety, glide ratio, price, wing structure, design, and brand name) and their respective attributes (e.g. glide ratio: 41, 42, 43, 44, or 45; wing structure: 2-part or 3-part) were defined.

On the basis of the results of the primary analysis, it was possible to derive ideal concepts for the three target groups investigated, harmonized with strategic considerations for the target groups and formulated as development recommendations. By including price components within the framework of the analysis, it was possible to determine the prices that target customers are willing to pay for each product function. For example, the glider pilot target group was willing to pay EUR 19,400 for an increase in the glide ratio to 45. This information was used for implementing decisions in addition to as an input in the target costing process. Put more simply: Are the costs arising from a modification greater or smaller than the price the target groups are willing to pay?

12.4 Summary

The innovation profitability analysis aims to calculate expenses and revenues associated with innovations as well as the profit or loss resulting from the innovation. Target costing makes it possible to influence expenses in line with the market at an early stage. Target costing processes in turn require input data, in particular the prices that potential customers are willing to pay and specific contributions of product functions to overall benefit. This data can best be identified through conjoint analysis.

Conjoint analysis was developed at the beginning of the 1960s as a process of mathematical psychology, was applied approximately 10 years later to marketing, and now is among the most frequently used methods of innovation market research. Conjoint analysis aims to quantitatively estimate the contributions of individual product features to the subjective total value (benefit, attitude, willingness to pay) of products. For this purpose, in the quasi-experimental investigation design, interviewees are hypothetically presented with products described only by their significant functions. On the basis of overall judgments on the stimuli (ordinal preference judgments among pairs or triads of product descriptions), a conjoint algorithm estimates the contributions of the individual product functions to overall benefit. In other words, the extent to which the sum of the product functions of an innovation represents an important benefit feature for customers can be quantitatively estimated.

Conjoint analysis is a very valuable methodology for target costing processes and is a recognized practice. The costs for software products and personnel training or the engagement of an external market research institute are quickly offset by the resulting gain in information. Target costing processes primarily aim to calculate the prices that potential customers are willing to pay and the contributions of the various product functions to the overall benefit. However, exact knowledge of the efficiency and limits of the process is crucial. The interviewees must feel a certain level of interest, otherwise a "slapdash effect" is likely to arise. If interest is low, then the validity of the conjoint analysis forecast will suffer, because the interviewees will be less concerned with the stimuli than with completing the survey as quickly as possible (Strebinger et al. 2000, p. 67). The process is therefore especially suitable for products that are subject to a purchasing decision-making process (intensive assessment of relevant alternatives) similar to the progression of the survey. This applies particularly for more complex products but less for products that are influenced by habitual or impulsive buying behavior (Büschken 1994, p. 88; Teichert 2000, p. 507).

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Chapter 13
On the Integration of Target Costing and Process Costing into the Berlin Balanced Scorecard Approach, as Illustrated by Development and Design Projects in the Car and Mechanical Engineering Industry

Wilhelm Schmeisser and Sebastian Bertram

The purpose of this contribution is to expand on the Berlin Balance Scorecard approach to incorporate target costing and process costing as well. Using these two tools, specific measures applicable to the development and design departments of a car manufacturer which permit better control of an innovation project will be developed. The approach will be substantiated from the customer- and finance-oriented perspectives and the linking of the two perspectives will be illustrated by a practical example.

13.1 Amplification of the Berlin Balanced Scorecard to Include Target Costing

The Balanced Scorecard is a strategic management tool that is optimally supplemented by the tools of process costing and target costing. Assuming that development capacity is limited, companies face the problem of how best to technically and economically direct the development and design processes of their innovation projects with the aid of internal management accounting. The answer to this question comes from the problem situation in which the company finds itself. If analysis indicates that high fixed overheads and inefficient processes are the main problem, then one should start with process costing. If the company is in a difficult market environment as regards competitor prices, it should focus on target costing, and if the company is rethinking its strategy and wants to orient its organisation towards this strategy, it should concentrate on the Balance Scorecard.[1] Each of the three tools mentioned is a highly efficient controlling instrument which, if correctly applied, can improve the cost position of a company's innovation project.

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[1] Horvath, P., Kompass für das Rechnungswesen, 2001, p. 52.

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DOI 10.1007/978-3-642-01353-9_13,

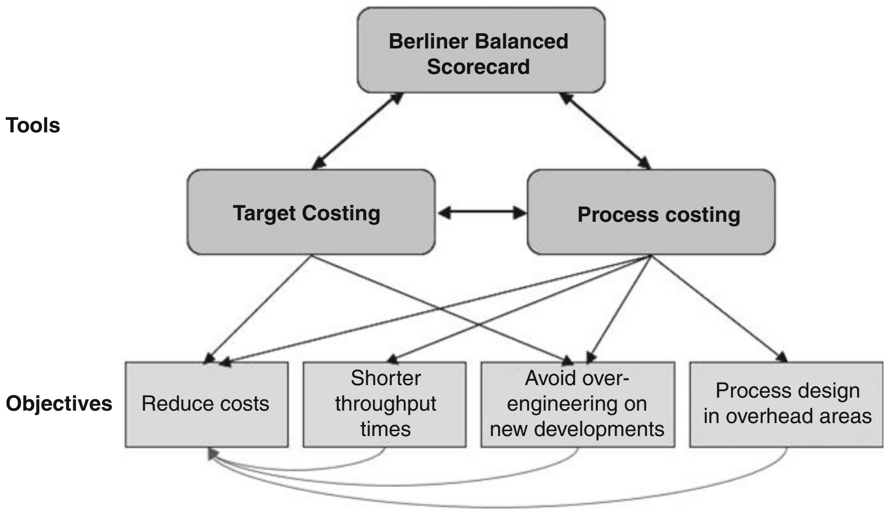

Fig. 13.1 Linking of Berlin Balance Scorecard with the tools of target costing and process costing

The next section considers the integration of target costing into Schmeisser's Berlin Balance Scorecard approach. Figure 13.1 shows how they are interlinked. By using the three tools together, tighter and cost-focused cost management has a beneficial effect on the innovation project.

13.1.1 Implementation of Target Costing in the Customer-Oriented Perspective of the Berlin Balanced Scorecard

The Balanced Scorecard is a management system which, using monetary and non-monetary key figures, constitutes a wide-ranging system for controlling the strategic and operational management of a company.[2] Faced with steadily increasing competitive and cost pressures, more and more companies are replacing their product-oriented strategies with customer-oriented strategies. Against this background, quantification of customer relations within the framework of the Berlin Balanced Scorecard, as a tool for implementing strategies and as a supplement to the classic direct costing per product, is becoming increasingly important.[3]

Target costing employs retrograde, top-down calculation of costs using market research data to ascertain the maximum price that the market will accept, the target price. The maximum allowable costs for a new product are then the target price

[2] Schmeisser, W. et al., BBSC Einführung, 2006, p. 90.
[3] Schmeisser, W. et al., BBSC Einführung, 2006, p. 77.

minus the planned profit (target margin). The direct inclusion of customer, competitor and market data has the effect of orienting the costs associated with the product towards the market in a consistent manner. In this way the market price and the profit objectives of the company determine the maximum costs for a product.

As the costs allowed by the market are only seldom achieved, there is normally a gap between the allowable costs and the drifting costs, which has to be closed. Depending on the objectives of the Berlin Balanced Scorecard defined for the customer-oriented perspective, it is now in the hands of management to determine a value. This value should be realistic, i.e. it should be based on the results of market research, and also appropriate in time, i.e. geared towards the period in which the development, design and production processes are expected to take place.

In the discussion below, we will concentrate on the most important field of application of target costing, new product development, for only targeted planning and control of product cost decisions in the early phases of product development will secure the maximum benefit for the company and thus give it critical competitive advantages. This is because although only 10 percent of the cost are incurred during the design phase, decisions made already at this stage determine 80 percent of the costs (see Fig. 13.2). Influencing basic decisions made in this period will have the biggest impact on optimising product and process costs.[4] In this way, target costing supports the Berlin Balanced Scorecard in relation to a stated corporate strategy, e.g. cost leadership in a particular technology area with the same level of quality as the competition.

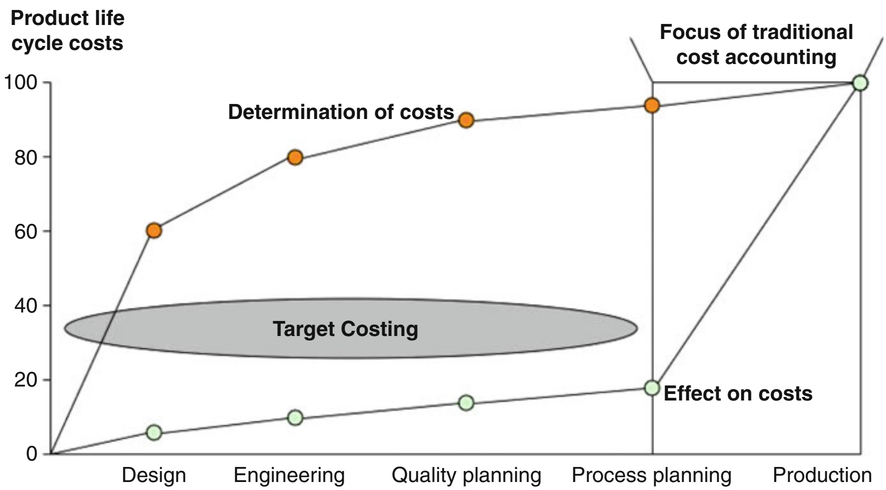

Fig. 13.2 Cost determination and incidence of costs
[Source: Horvath, Strategieorientiertes Kostenmanagement in der Produktentwicklung, www.sfb374.uni-stuttgart.de/forforum2002_vortraege/3_sfb_270202_horvath.pdf]

[4] Horvath, P., Niemand, S., Wolbold, M., State of the Art, 1993, p. 5.

The aim of linking target costing with the Balanced Scorecard is to localise and remedy any need for rationalisation early on. Through ongoing market and customer orientation, the price achievable on the market is determined by customers and competitors. Adding target costing to the customer-oriented perspective of the Balanced Scorecard ensures that strategy remains customer-oriented throughout. We will now use a fictitious example to show that it is possible to integrate target costing into the Berlin Balance Scorecard approach.

13.1.2 An Example of How to Integrate Target Costing, as Illustrated by the Practical Example of a Fictitious Car Company

13.1.2.1 Market Conditions in Which Car Company Operates

The Porsche Panamera, the fourth vehicle series of sports car manufacturer Porsche, is scheduled to roll off the conveyor belt from 2009 along with the 911 Carrera, the Boxster/Cayman and the Cayenne. The Panamera is a premier class sports coupe.

When it comes to the interior and exterior design of the vehicles, customers can in addition to series-produced vehicle parts also have parts customised by Porsche's customisation department. The department responsible for this is the Sales Customer Centre Customisation (SCCC), a separate profit centre of the Porsche company. Department SCCC is involved in development, planning and sales and also supply chain management/scheduling for the Tequipment and Exclusive business units.

The Porsche Tequipment programme was initiated in 1994 with the aim of offering customers an attractive customisation and accessory programme for upgrading their vehicles. By offering this, Porsche is underlining its competence as a supplier of experience products with the core dimensions of design, individuality, innovation and sportiness. The Tequipment products give both the customers and also the Porsche centres the opportunity to visually and functionally upgrade used vehicles. The same applies to the Exclusive business unit, except that in this case the customisation takes place in the factory i.e. prior to delivery of the new vehicle.

In time for the sales launch of the Porsche Panamera, department SCCC wants to offer an aluminium wheel, the "Panamera Sports Wheel", as a way of refining the vehicle.

Product Features of the Panamera Sports Wheel

- Product type: lightweight aluminium wheel
- Rim size: front axle 8.5 × 20 in.
  rear axle 11.5 × 20 in.
- *Adapter track plates* offer the possibility of installing the wheel rims on the current 911 Carrera and Boxster/Cayman sports car models.
- GT silver metal painted spoked rim
- Multi-coat paintwork will ensure the highest quality of the surface

- Bright polished rim flange
- Wheel hub cap with colour Porsche insignia

Product Features of the Panamera Sports Wheel

- The enlarged wheel contact surface compared with the basic wheel gives the vehicle a more sporty appearance and improved traction.
- A multi-part multi-spoke design should underline the commitment to motor sport.
- Because the vehicle will be positioned in motor sport, the rims have to satisfy the highest requirements as regards stability, durability and finish.
- The fact that the rims can be fitted to all the Porsche sports cars should make it possible to obtain a better price from the supplier due to the expected higher order volume.

Product development is a collaborative affair involving department SCCC and the producer of the wheel.

The profitability analysis for the Panamera Sports Wheel is drawn up with a planning horizon of 3 years. The Porsche company calculates that 20,000 Panamera units will be sold in the first year. The SCCC department predicts that 7.5 percent of Panamera vehicles will be upgraded with the new rims (1,500 wheel sets). For the 911 Carrera and Boxster/Cayman series, SCCC predicts a total of 1,450 wheel sets per year. In this way, the projected sales within the planning horizon come to a total of 8,850 wheel sets (see Fig. 13.3).

Unit sales figures for the "Panamera Sports Wheel"

Vehicle type	FY 2009/10	FY 2010/11	FY 2011/12	Total
Panamera	1,500	1,500	1,500	4,500
911 Carrera	900	900	900	2,700
Boxster/Cayman	550	550	550	1,650
Total	2,950	2,950	2,950	8,850

Fig. 13.3 Sales forecast for the Panamera Sports Wheel
[Source: own, entirely fictitious figures]

13.1.2.2 Determination of Target Costs

In this example, the target costs are calculated using the "market into company" subtraction method. Analysis of a market research study carried out especially for this purpose suggested a target price of €3,500 (net) per wheel set. The target price constitutes the price ceiling determined by the market. When one deducts the planned profit of 30 percent, one obtains the following target costs:

Sales price (net)	€3,500
− Target profit (30%)	€1,050
Target costs	**€2,450**

The target costs calculated are the maximum costs that the wheel set may cost, given the planned quality features and taking into account market requirements and competitor products.[5]

From the available costing data and after negotiating with the supplier of the wheels, the costs are estimated at around €2,600 per wheel set. The starting point for working out the drifting costs was the present state of technology in the company.

If one considers the maximum allowable costs and the drifting costs, it becomes clear that the drifting costs exceed the allowable costs. In practice this situation is quite normal. The reason is that the product does not comply with the customer requirements or it has characteristics which the customer does not appreciate. The result is overengineering. Target costing recognises the need to reduce costs.[6] The task of management is to determine to what extent it is desirable to close this target cost gap and with what measures this objective can be accomplished.

As the cost gap expressed is not high in percentage terms and department SCCC is operating in a difficult market, in which competitor and cost pressure is very highly due to free Porsche tuners, management decides to eliminate the target cost gap of €150, giving a cost ceiling of €2,450. This will have to be achieved by suitable measures (see Fig. 13.4).

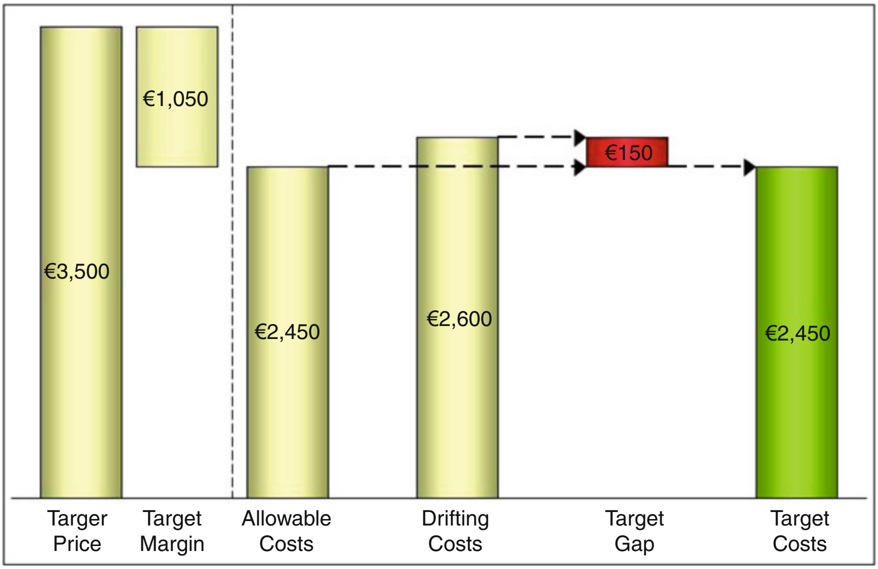

Fig. 13.4 Calculation of target costs
[Source: own fictitious set of figures]

5 Horvath, P., Niemand, S., Wolbold, M., State of the Art, 1993, p. 5.

6 Serfling, K., Schultze, R., Target Costing, 1997, p. 67.

The target costs constitute the total target manufacturing costs for the product including general administration, development and sales overheads. Controlling these general overheads is difficult to accomplish using target costing.[7] In the example, the overhead rates were initially calculated with reference to the mark-up rates that are typical in the company. We will examine the control and influencing of overheads in Section 13.2 using process costing.

13.1.2.3 Breakdown of Target Costs

The target costs calculated refer to the complete wheel set. However, overall product costs are too sweeping and undifferentiated for effective cost management.[8] To be able to optimally influence the target costs, the overall product costs must be apportioned between the various components and parts.

In the example, the costs are broken down using the function method. The adoption of a customer-oriented perspective here ensures that the market is constantly in focus. Using a market-oriented function analysis, the product functions that customers want are ascertained. The overall target costs are apportioned and allocated at subassembly and component level on the basis of the importance that customers attributed to the individual functions in the function analysis.

The breakdown of target costs entails two steps.

Assignment of Target Costs to Product Functions

From the market research data, the following critical product functions are ascertained for the Panamera Sports Wheel: design, durability/stability, weight, transportability, assembly, maintenance and resistance to corrosion. On the basis of customer surveys, the various product functions were weighted as follows:

Design	45%
Durability/stability	25%
Weight	7%
Transportability	3%
Assembly	7%
Corrosion resistance	10%
Maintenance	3%
Total	100%

Starting from the target costs determined, one arrives at the following costs for the individual product functions:

[7] Joos-Sachse, T., Controlling, 2006, p. 303.
[8] Joos-Sachse, T., Controlling, 2006, p. 303.

Design	€ 1,102.50
Durability / stability	€ 612.50
Weight	€ 171.50
Transportability	€ 73.50
Assembly	€ 171.50
Corrosion resistance	€ 245.00
Maintenance	€ 73.50
Total	€ 2,450.00

Allocation of Function Target Costs to Product Components

The Panamera Sports Wheel consists of the following product components:

C1	Rim flange
C2	Spoked rim
C3	Rim base
C4	Centring
C5	Wheel hub cap

The weighted product functions from the previous step are now compared with the product components to be implemented, using a function cost matrix. The role of target costing is to determine to what extent the components influence the function. When one examines the proportion of the desired customer function provided by each of the individual product components, the following pattern emerges (Table 13.1):

The percentage share of the target costs provided by the individual components is obtained by multiplying the function weightings with the proportion of the desired customer functions provided by each product component (see Table 13.2).

Table 13.1 Proportion of customer functions provided by each product component [Source: own fictitious figures]

	Functions (as a %)						
Components	Design (45%)	Durability/ stability (25%)	Weight (7%)	Transportability (3%)	Assembly (7%)	Corrosion resistance (10%)	Maintenance (3%)
Rim flange	25	20	25	30	17.5	35	25
Spoked rim	51	30	28	30	20	30	40
Rim base	10	30	40	30	20	25	25
Centring	6	15	5	8	37.5	5	5
Wheel hub cap	8	5	2	2	5	5	5
Total	100	100	100	100	100	100	100

Table 13.2 Calculation of the percentage share of the target costs provided by each individual component [Source: own fictitious figures]

	Functions (as a %)							
Components	Design	Durability/ stability	Weight	Transportability	Assembly	Corrosion resistance	Maintenance	Proportion of benefits attributable to each component (%)
Rim flange	11.25	5.00	1.75	0.90	1.23	3.50	0.75	24.38
Spoked rim	22.95	7.50	1.96	0.90	1.40	3.00	1.20	38.91
Rim base	4.50	7.50	2.80	0.90	1.40	2.50	0.75	20.35
Centring	2.70	3.75	0.35	0.24	2.63	0.50	0.15	10.32
Wheel hub cap	3.60	1.25	0.14	0.06	0.35	0.50	0.15	6.05
Proportion of overall benefit attributable to each function	45.00	25.00	7.00	3.00	7.00	10.00	3.00	100.00

In the final step, the component target costs are obtained by multiplying the proportion of benefits attributable to each component by the total costs of the product (see Table 13.3). Theoretically these components could break down further at the parts level.

13.1.2.4 Achieving the Target Costs

Inferring the Target Cost Index

The target cost index shows whether the use of resources for a given component also corresponds to the importance attributed it to it by customers. Accordingly, functions rated highly by customers are also allowed higher target costs.[9] The target cost index is calculated as follows:

$$\text{Target cost index} = \frac{\text{Proportion of benefit attributable to the component}}{\text{Proportion of costs attributable to the component}}$$

The proportion of costs attributable to each component is obtained from the manufacturing costs, the drifting costs. In the present example, these are obtained from the available costing data and after talking to the supplier. However, at the beginning of a target costing project, for the sake of simplicity the component costs of comparable, existing products can also be used.[10] The percentage proportion of the total costs attributable to each component must then be calculated. In our fictitious example, we obtain the following data:

Component	Drifting costs	Proportion of costs
Rim flange	€400	15.38%
Spoked rim	€950	36.54%
Rim base	€500	19.23%
Centring	€300	11.54%
Wheel hub cap	€450	17.31%
Total costs	€2,600	100.00%

From the cost and benefit contributions ascertained, we can then calculate the target cost index. In our fictitious example, we obtain the following target cost index:

Component	Proportion of benefit as a %	Proportion of costs as a %	Target cost index
Rim flange	24.38	15.38	1.59
Spoked rim	38.9	36.54	1.06
Rim base	20.35	19.23	1.06
Centring	10.32	11.54	0.89
Wheel hub cap	6.05	17.31	0.35

[9] Coenenberg, A. G., Kostenrechnung, 2003, p. 453.

[10] Coenenberg, A. G., Kostenrechnung, 2003, p. 451.

Table 13.3 Calculation of absolute proportion of target costs attributable to each component [Source: own fictitious figures]

	Functions (in €)							
Components	Design	Durability/ stability	Weight	Transportability	Assembly	Corrosion resistance	Maintenance	Proportion of benefits attributable to each component (%)
Rim flange	275.63	122.50	42.88	22.05	30.01	85.75	18.38	597.19
Spoked rim	562.28	183.75	48.02	22.05	34.30	73.50	29.40	953.30
Rim base	110.25	183.75	68.60	22.05	34.30	61.25	18.38	498.58
Centring	66.15	91.88	8.58	5.88	64.31	12.25	3.68	252.72
Wheel hub cap	88.20	30.63	3.43	1.47	8.58	12.25	3.68	148.23
Proportion of overall benefit attributable to each function	1,102.50	612.50	171.50	73.50	171.50	245.00	73.50	2,450.00

The optimal target cost index is around 1. At this point, the costs attributable to a given component correspond exactly to the amount of benefit it contributes.

However, in our example only components 2 (spoked rim) and 3 (rim base) are anywhere near a target cost index of 1. Action is needed in relation to the other three components. Components 4 (centring) and 5 (wheel hub cap), with a target cost index of < 1, are too expensive in relation to the benefit that they contribute. Component 1 (rim flange), with a target cost index > 1, has a design too simple in relation to its benefit. To achieve an optimal cost-benefit ratio in this case, additional resources need to be allocated to this component.

Target Cost Control Diagram

This can be presented in graphical form by a target cost control diagram (see Fig. 13.5). As the target cost index of 1 is not always feasible in reality, management defined a tolerance zone (target cost zone) in which the individual components have to fall. This target cost zone is dependent on parameter q. As the component becomes more important, the tolerance zone gets smaller, whereas components less highly valued are allowed a greater bandwidth in the target cost zone.[11] The x-axis shows the proportion of benefit attributable to each component (as a percent) while

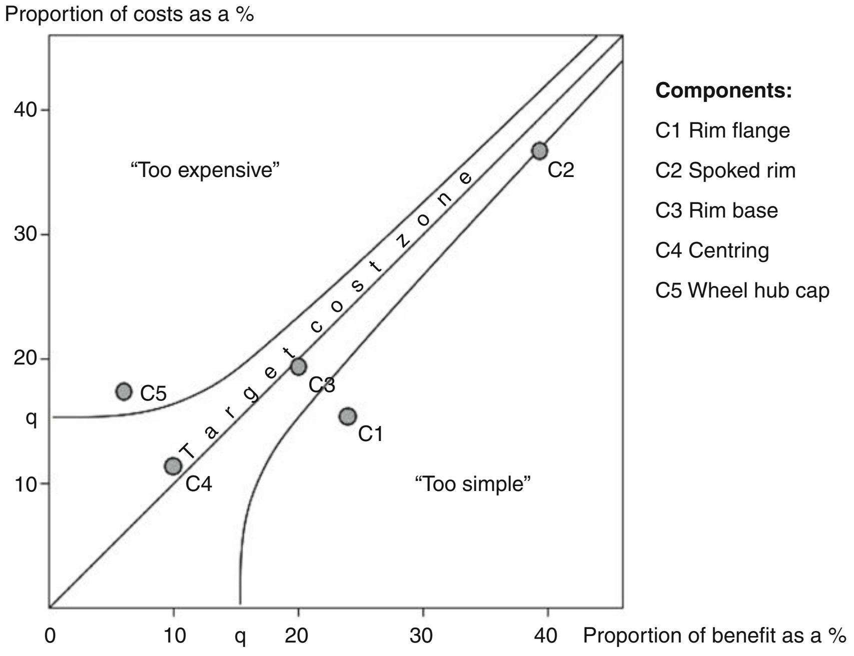

Fig. 13.5 Target cost control diagram
[Source: based on Coenenberg, A. G., Kostenrechnung (2003), p. 454.]

[11] Coenenberg, A. G., Kostenrechnung, 2003, p. 454.

the y-axis shows the associated proportion of costs (as a percent). The ideal target cost index of 1 is indicated by the diagonal line that bisects the point of origin.

When one looks at the diagram it is apparent that components 5 and 1 lie outside the target cost zone. In the case of component 5, we now need to ascertain whether there is any potential for reducing costs which could be implemented and, in the case of component 1, to what extent the component can be upgraded.

Identifying by How Much the Costs Need to Be Reduced

The extent to which the costs need to be reduced is obtained from the difference between the drifting costs and the allowable costs. In our example, the amount that needs to be trimmed is €2,600 − 2,450 = €150 or 106.12 − 100% = 6.12%. The maximum allowable costs are currently exceeded by 6.12 percent and have to be reduced by precisely this amount for each wheel set.[12] Table 13.4 shows the precise amount that needs to be trimmed for each component.

Working on the assumption that the allowable total costs are €2,450, the already calculated proportion of benefit attributable to each component is multiplied by the allowable total costs. By this means, the benefit-commensurate proportion of costs is calculated for each component (see column 4). If one then reduces the benefit-commensurate proportional costs by the relevant drifting costs, one obtains the amount of costs that need to be trimmed off each component (column 6).

The graphical results of the target cost diagram are confirmed numerically in this step. The amount by which the costs need to be trimmed comes to €47.16 for component 4 and €301.78 for component 5. On the other hand, the situation as regards component 1 is quite different. Here, another €197.31 needs to be added. The amounts that have to be trimmed for components 2 and 3 are only marginal and can therefore be ignored.

Achieving Target Costs

Once the target costs have been finalised and the project has been approved, the implementation phase now follows, in the course of which the target costs have to be achieved through specific technical and materials-related measures. At the beginning of the target cost implementation, the concrete starting points for the cost reduction measures are identified. The focus here is naturally on components which have an unfavourable cost-benefit ratio.[13] In the present case, this is components 1, 4 and 5.

To determine the costs in the optimal way, department SCCC decides to involve the producer of the rims in the product development process in order to benefit from the learning and experience effects of the other company and make it possible to together implement cost reduction potentials. As everyone is keen to live up to the high requirements of the customer Porsche, it is decided not to change the physical characteristics of the rim, such as the quantity and weight, to avoid any possible loss

[12] Coenenberg, A. G., Kostenrechnung, 2003, p. 460.

[13] Gaiser, B., Kieninger, M., Target Costing, 1993, p. 67.

Table 13.4 Calculation of the amount by which the costs need to be reduced [Source: based on Coenenberg, A. G., Kostenrechnung (2003), p. 456.]

Components	(1) Proportion of benefit (as a %)	(2) Proportion of total drifting costs (as a %)	(3) Share of drifting costs (in €)	(4) Benefit-commensurate proportion of allowable costs (in €)	(5) Share of drifting costs as a proportion of the allowable costs (as a %)	(6) Required cost reduction (in €)
Rim flange	24.38	15.38	400.00	597.31	16.33	197.31
Spoked rim	38.90	36.54	950.00	953.05	38.78	3.05
Rim base	20.35	19.23	500.00	498.58	20.41	−1.43
Centring	10.32	11.54	300.00	252.84	12.24	−47.16
Wheel hub cap	6.05	17.31	450.00	148.23	18.37	−301.78
Total	100.00	100.00	2,600.00	2,450.00	106.12	−150.00

of quality. To realise the cost reduction potentials in the wheel hub cap, it is decided to use identical parts[14] on existing rims rather than manufacture a special rim for the Panamera Sports Wheel. By reducing the development, production and inventory costs, it is possible to achieve a cost reduction potential of €300 per wheel set. As a result, the costs associated with the component wheel hub cap are now only €150. The new proportion of costs is now roughly commensurate with the proportion of customer benefit that is attributable to this component.

To eliminate the unfavourable cost-benefit ratio for component 1 (rim flange), department SCCC decides to upgrade the rim flange. The previous production plans are altered. The bright polish of the rim flange will now be replaced by an elaborate process which gives the rim flange a high-gloss finish. It is hoped that the superior design of the component will deliver the corresponding amount of customer benefit. As a result of this procedure, the costs of the rim flange rise by €200–600. Once again, the new proportion of costs is now roughly commensurate with the proportion of customer benefit that is attributable to this component (Fig. 13.6).

As a result of the above changes, the total costs of each wheel set are reduced by €100. This causes the drifting costs to fall from €2,600 to €2,500; however, they are still approximately €50 above the maximum allowable costs (see Table 13.5). In the next section, process costing is employed to try and close the remaining cost gap.

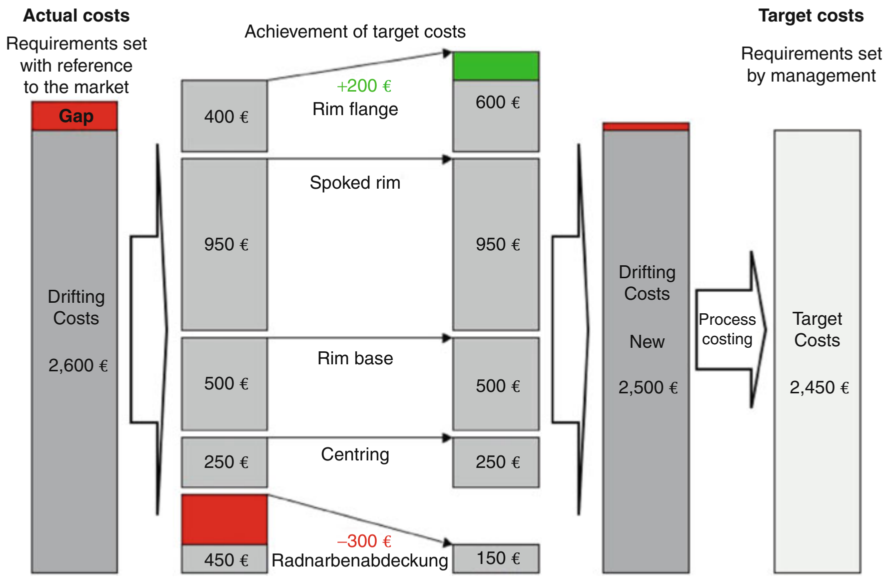

Fig. 13.6 Effects of target costing measures on drifting costs [Source: own fictitious figures]

[14] Components which are already used in previous versions of the model or in other models.

Table 13.5 Change in drifting costs due to cost adjustments undertaken [Source: based on Coenenberg, A. G., Kostenrechnung (2003), p. 456.]

Components	(1) Proportion of benefit (as a %)	(2) Share of drifting costs (old) (in €)	(3) Proportion of drifting costs (old) (as a %)	(4) DC adjustment (in €)	(5) Share of drifting costs (new) (in €)	(6) Proportion of drifting costs (new) (as a %)	(7) Benefit-commensurate share of allowable costs (in €)	(8) Required cost reduction (new) (in €)
Rim flange	24.38	400.00	15.38	+200.00	600.00	24.00	597.31	−2.69
Spoked rim	38.90	950.00	36.54	–	950.00	38.00	953.05	3.05
Rim base	20.35	500.00	19.23	–	500.00	20.00	498.58	−1.43
Centring	10.32	300.00	11.54	–	300.00	12.00	252.84	−47.16
Wheel hub cap	6.05	450.00	17.31	−300.00	150.00	6.00	148.23	−1.78
Total	100.00	2,600.00	100.00	−100.00	2,500.00	100.00	2,450.00	−50.00

As there is no question of further outsourcing functions for department SCCC and the possibilities of buying in components have been exhausted, they consider measures to reduce the level of overheads in the indirect areas. This will be accomplished through process costing. The aim is to identify the overheads attributable to processes for areas indirectly involved and close the remaining cost gap through simplification or elimination of activities.[15] The next section describes how target costing is linked to the process costs.

13.1.3 Linking of Customer-Oriented Perspective with Financial Perspective

13.1.3.1 Contribution Income Statement as a Statement of Earnings in the Customer-Oriented Perspective of Berlin Balanced Scorecard

The contribution income statement, as a short-term statement of earnings in the customer-oriented perspective, enables individual products to be planned and analysed so that strategy performance can be assessed. The contribution income statement breaks costs down into fixed and variable costs. Contribution is the difference between income and the variable costs of the product, and shows to what extent the product contributes to cover the fixed costs.[16]

Knowledge of the contribution made by different produces provides a company with key information on the basis of which to perform a business analysis. Contribution can be expressed both in terms of the entire volume of a product (Cont.), and also on a per item basis (cont.).[17]

Starting from planned sales of 8,850 units, a target price of €3,500 and drifting costs of €2,500 per wheel set, we obtain the following values for the planning period (see Fig. 13.7):

The contribution per unit is then calculated as follows:

$$\text{Cont.} = \text{€ } 15{,}045{,}000$$

$$\text{cont.} = \frac{\text{Cont.}}{\text{Sales quantity}}$$

$$\text{cont.} = \frac{\text{€ } 15{,}045{,}000}{8{,}850}$$

$$\text{cont.} = \text{€ } 1{,}700.00$$

The aim of department SCCC is to maximise the contribution so as to be able to achieve as high a profit as possible after covering the fixed costs. With a positive unit contribution of €1,700, each Panamera Sports Wheel sold contributes towards covering the fixed costs.

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[15] For example, test procedures etc.

[16] Schmeisser, W. et al., BBSC Einführung, 2006, p. 46.

[17] Gabler Wirtschaftslexikon, 2004, p. 658 f.

Quantity	8,850	
Target Price	3,500	
Drifting costs	2,500	
Net sales		€30,975,000
(–) Variable selling costs		€923,940
(–) Variable product costs		€15,006,060
(=) Contribution I		€15,045,000
expressed as a % of net sales		48.6
(–) Fixed costs in the period	€3,097,500	€6,195,000
Development & manufacture	€911,029	
Administration	€2,186,471	
Sales & marketing		
(= Net income (profit))		€8,850,000
expressed as a % of net sales		28.6

Fig. 13.7 Single-stage contribution income statement for the Panamera Sports Wheel [Source: own fictitious figures]

13.1.3.2 Linking of Customer- and Finance-Oriented Perspectives Using Break-Even Point Analysis

The profit, which is defined as the additional portion of fixed costs, pushes the break-even point upwards in Fig. 13.8. As the profit is an element of the RoI component of percentage return on sales, there is a direct link between the customer-

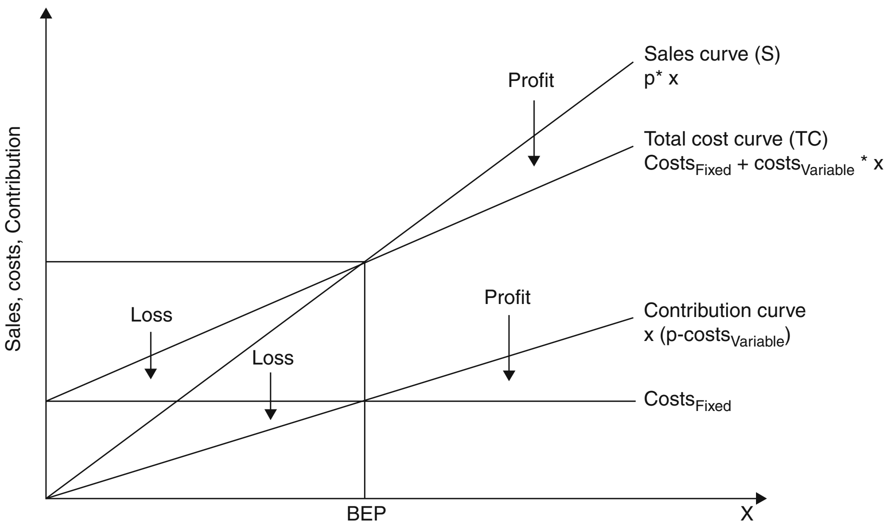

Fig. 13.8 Determination of break-even point
[Source: Schmeisser, W. et al., BBSC Einführung (2006), p. 45]

and finance-oriented perspectives.[18] The link between contribution income statement and return on investment will be demonstrated using break-even point (BEP) analysis.

Break-even point (BEP) analysis allows one to control and monitor the company and its products. It shows how changes in the fixed costs, the magnitude of the variable costs, the sales quantity and sales price affect the profit and as a result directly influence the return on investment. Furthermore, with the aid of the BEP-A it is possible to work out the minimum sales quantity necessary to cover costs or the break-even point (see Fig. 13.8).[19]

Starting from the following equation,[20]

$$\text{TC} = \text{x} \times (\text{p} - \text{costs}_{\text{Variable}}) - \text{Costs}_{\text{Fixed}}$$

it is possible to calculate the break-even point for the Panamera Sports Wheel immediately. The break-even sales quantity (x) is defined from the fixed costs ($\text{Costs}_{\text{Fixed}}$), the revenue per unit (p) and the variable unit costs ($\text{costs}_{\text{Variable}}$), whereby the expression ($\text{p} - \text{costs}_{\text{Variable}}$) represents the unit contribution (cont.). The break-even sales are determined from the product of the revenue per unit p and the sales quantity x.

As the break-even point is defined as the point at which neither a profit nor loss is made, the profit (P) is equal to nil at this point. Transferring this to the initial formula, we obtain the following:

$$\text{P(profit)} = \text{x}^* \, (\text{p} - \text{costs}_{\text{Variable}}) - \text{Costs}_{\text{Fixed}}$$

$$0 = \text{x}^* \, \text{cont.} - \text{Costs}_{\text{Fixed}}$$

$$\text{x} = \frac{\text{Costs}_{\text{Fixed}}}{\text{cont.}}$$

$$\text{x} = \frac{6.195.000 \, €}{1.700{,}00 \text{ S(Sales)}}$$

$$\text{x} = 3.644{,}12$$

For the predicted sales quantity of 8,850 wheel sets, a target price of €3,500 and drifting costs of €2,500, the break-even point lies at 3,645 wheel sets. At this point the fixed costs are completely covered by the contribution and each wheel set sold beyond that number contributes directly towards increasing the company's profit.

[18] Schmeisser, W. et al., BBSC Einführung, 2006, p. 48.

[19] Schmeisser, W. et al., BBSC Einführung, 2006, p. 50.

[20] Schmeisser, W. et al., BBSC Einführung, 2006, p. 50.

13.1.3.3 Achieving the Target Profitability by Adjusting the Target Quantity

As the cost of each wheel set is still €50 above the target costs, the percentage return on sales (RS) in the example does not agree with the original estimate of 30 percent. The output quantity required to nevertheless achieve the target return is calculated as follows:

$$x = \frac{\text{Costs}_{\text{Fixed}}}{\text{contribution} - \text{Rs}^{*}\text{p}}$$

Assuming that we want to achieve a percentage return on sales of 30 percent, we obtain the following critical output quality for the example[21]:

$$x = \frac{\text{Costs}_{\text{Fixed}}}{\text{cont.} - \text{Rs}^{*}\text{p}}$$

$$x = \frac{6.195.000}{1.700_{\text{€}} - 0{,}3^{*}3.500_{\text{€}}}$$

$$x = 9.530{,}77$$

This means that with an output quantity of 9,531 wheel sets, the original target profitability of 30 percent will be achieved. Accordingly, if the target costs are exceeded by €50, then 681 (9,531 − 8,850) wheel sets more will have to be sold in order to achieve the target profitability which has been set. In this way an increase in the output quantity contributes directly towards increasing the percentage return on sales. Figure 13.9 shows how the contribution and net income change as the output quantity is altered.

	Quantity	8,850	**9,531**
	Target price	3,500	3,500
	Target costs	2,500	2,500
(=) Net sales		€30,975,000	€33,358,500
(–) Variable selling costs		€923,940	€995,036
(–) Variable product costs		€15,006,060	€16,160,764
(=) Contribution I		€15,045,000	€16,202,700
expressed as a % of net sales		48.6	48.6
(–) Fixed costs in the period		€6,195,000	€6,195,000
(=) Net income (profit)		€8,850,000	€10,007,700
expressed as a % of net sales		28.6	**30.0**

Fig. 13.9 Change in contribution and net income as a result of adjusting the output quantity

21 Schmeisser, W. et al, BBSC Einführung, 2006, p. 50.

13.2 Further Development of the Berlin Balanced Scorecard Using Process Costing

By integrating process costing into the Berlin Balanced Scorecard it is possible to develop effective and performance-oriented cost management for innovation projects through the combination of operational and strategic tools. Using cost accounting, it is possible to represent the costs of operational processes in such a way that they can then be assigned to the appropriate cost units on a cause–effect basis. This information enables overheads to be planned and controlled and as a result leads to internal process optimisation, reduced costs and increased profits.[22] For example, a reduction in throughput times[23] with unchanged quality of performance inevitably leads to greater customer satisfaction and hence a rise in customer loyalty, which in turn could lead to higher sales.

Integration of process costing is essential if cost reduction potentials are to be systematically realised, as marginal costing, which is frequently used in practice, does not take overheads into account even though important cost drivers could be concealed in the overheads. The consequence of ignoring overheads is that the strategic aspects of cost management are neglected, which may in turn result in false control impulses. As well as cost and process transparency, the integration of process costing also offers the starting point for internal productivity comparisons with a view to the permanent benchmarking of cost, time and quality values. Through targeted process cost management, management obtains an overview of cost drivers within the company and of the possibilities for reducing costs. Here the Balanced Scorecard is a complementary approach which optimally links together customer-, finance-, quality- and employee-oriented perspectives.[24]

Process costing recognises the cost drivers and possibilities for reducing costs without losing sight of performance. On the other hand, the Berlin Balanced Scorecard reveals the value drivers of the corporate strategy. In this way it calls for a management system to be possibly set up differently over the entire company process organisation. The combination of the two tools enables synergy potentials to be realised. The objectives of process costing can be transferred into the individual Berlin Balanced Scorecard perspectives without further ado. Moreover, process costing produces the basic figures used in the Berlin Balance Scorecard and supports the phase of strategy formulation through the provision of important information.[25] Hence, a process cost-oriented Balance Scorecard is essential for effective, performance-oriented cost management.

[22] Kipker, I., Veil, M., Kostenmanagement, 2002, p. 11 f.

[23] For example, in the processing of customer orders.

[24] Kipker, I., Veil, M., Kostenmanagement, 2002, p. 12 f.

[25] Kipker, I., Veil, M., Kostenmanagement, 2002, p. 13 f.

13.2.1 Relationship Between Process Costing and Target Costing

Target costing enables products to be designed on the basis of market requirements in such a way that they contribute towards company profit throughout the entire product life cycle. The aim here is to achieve as short as possible a break-even time (BET),[26] for example, in order by this means to generate profit as fast as possible. Reducing the BET is often also an objective found in the BSC.[27]

Target costing ascertains the target costs for a new product. These target costs include the costs of the overhead areas involved. They have to be scrutinised and controlled. In order for target costing to be informative, it is therefore necessary to know what resources are used by the various function areas (process costs). Only in this way is it possible to ensure that products which are lean in terms of overheads are developed in a goal-oriented way.[28]

When linked with the Balanced Scorecard, the interaction of target costing and process costing produces an optimal tool for process optimisation. Process costing supplies all the necessary cost information needed to monitor the ever more strongly rising proportion of overheads in companies and, if necessary, to counteract this. In this way, process costing can be viewed as the basis for market-oriented target costs for the product cost planning performed under target costing. See (Fig. 13.10)

Target costing is not a new cost accounting procedure for accounting, but rather a market-oriented methodology for planning target costs to accompany the development and design phases. Attention is focused at the product level. On the other hand, process costing is a cost accounting method that is specifically used in the area of overheads. The costs of the overhead areas are assigned to the cross-department business processes with the aim of obtaining transparency in the overhead block.[29]

This enables companies to plan and control their overhead budgets through process quantities and process costs in order in this way to gain control over the ever bigger problem of overheads. Overhead cost controlling is thus a management approach to maintaining a grip on overheads, the aim of which is to bring transparency into the overhead block, optimise the internal processes and, using permanent overhead management, influence overheads in a targeted way.[30]

The interaction between process costing and target costing lies in the fact that empirical values on the causes of costs from process costing, e.g. which costs are

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[26] Time to the point at which the fixed costs are covered so that every succeeding sale generates a profit.

[27] Jeker Frei, C., Bachmann, M, Prozesskostenmanagement, 2001, p. 51.

[28] Jeker Frei, C., Bachmann, M, Prozesskostenmanagement, 2001, p. 51.

[29] Mayer, R., Target Costing und Prozesskostenrechnung, 1993, p. 77.

[30] Mayer, R., Target Costing und Prozesskostenrechnung, 1993, p. 80.

attributable to a new part number or how much a procurement operation costs, can be used in target costing. As a result, the effects of design or production sequence organisational alternatives on overheads can be exposed. In this way it is possible to express how many new parts or product variants of a new product to be planned can actually be afforded if the total costs Y (including overheads) must not be exceeded.[31]

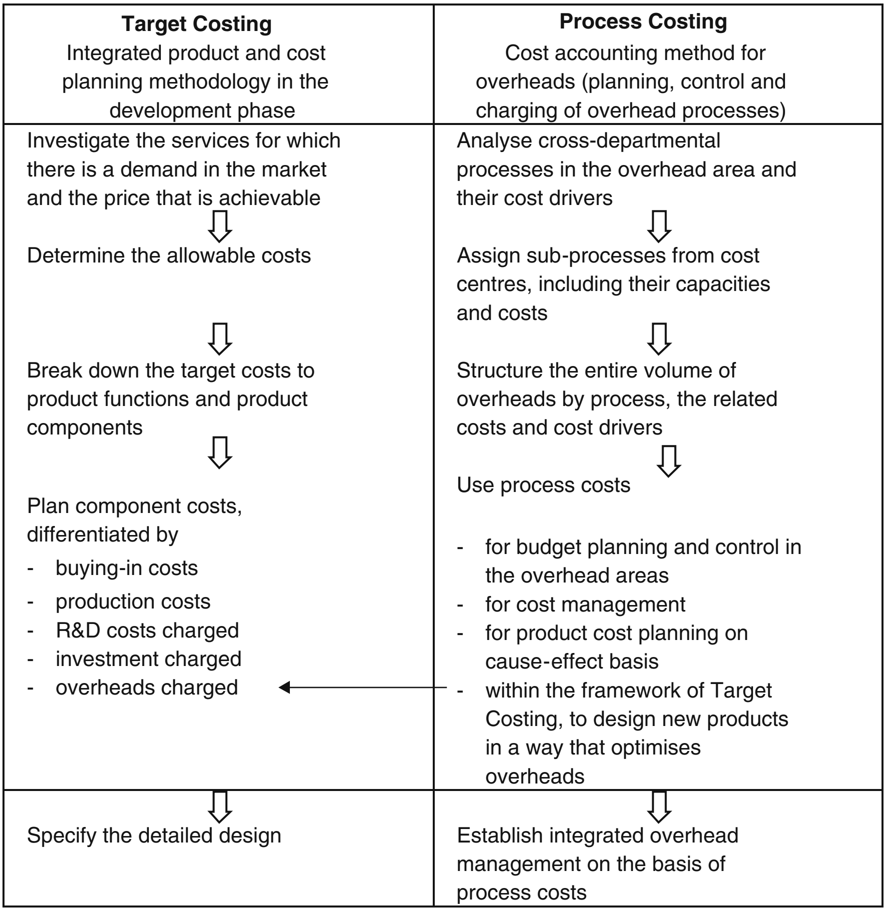

Fig. 13.10 Interaction between target costing and process costing
[Source: Mayer, R., Target Costing und Prozesskostenrechnung (1993), p. 79]

31 Mayer, R., Target Costing und Prozesskostenrechnung, 1993, p. 77.

13.2.2 Use of Process Costs in Target Costing as Illustrated by the Practical Example of the Car Company

13.2.2.1 Ascertaining the Main Processes, the Cost Drivers and the Associated Process Costs

The example of the Panamera Sports Wheel from the last section will be used again. In order to be able to define and assess the main processes, all the sub-processes of the cost centres involved have to be summarised. The project team developed a full list of the main processes for the areas involved. The investigation carried out by department SCCC using the steps listed in Section 13.1 resulted in the figures shown in Table 13.6.

Table 13.6 shows all the essential main processes, their cost drivers, the cost driver quantity, the total of the main process costs and the corresponding process cost rate which arises in a single pass.[32] The total of the costs for all the main processes corresponds to the cost centre budget of the area under investigation.

Unlike cost centre accounting, process costing indicates which costs arise in connection with cross-departmental activities. Main process no. 8 from Table 13.6, "Procure materials on a one-off basis", contains all the sub-processes from materials planning, purchasing activities, receipt of goods inwards, incoming goods inspection, quality inspection, placement in storage and posting through to payment.[33] About 10 sub-processes from multiple cost centres flow into this main process.

For example, the sub-processes for cost centre Purchasing are spread over the main processes involved in Table 13.7.

13.2.2.2 Process Costs in Target Costing

Target costing always relates to one product unit, whereas processes tend not to be proportional to volume. The dependency relationships of processes can be broken down into three categories: preparatory processes, support processes and handling processes.[34]

Preparatory processes are processes that occur during product development. They involve administrative and planning activities which cannot be charged through project or order numbers. In our example, there are two main processes here: MP1, "Introduce new parts" and MP3, "Introduce new products". Both processes contain all the administrative activities that are a prerequisite to the production or procurement of parts or which are necessary to prepare the way for sales.

[32] Mayer, R., Target Costing und Prozesskostenrechnung, 1993, p. 78.
[33] Mayer, R., Target Costing und Prozesskostenrechnung, 1993, p. 80.
[34] Mayer, R., Target Costing und Prozesskostenrechnung, 1993, p. 84.

Table 13.6 Main processes of department SCCC [Source: based on Mayer, R., Target Costing und Prozesskostenrechnung (1993), p. 81]

MP no.	Main processes	Cost driver	Cost driver quantity	Cost volume in €	Process cost rate in €
1.	Introduce new parts	Number of new parts	400	2,000,000	5,000
2.	Manage parts	Number of current part numbers	4,500	2,500,000	556
3.	Introduce new products	Number of new products	20	500,000	25,000
4.	Support variants	Number of variants	1,000	2,000,000	2,000
5.	Implement product changes	Number of changes	50	1,500,000	30,000
6.	Support suppliers	Number of suppliers	90	450,000	5,000
7.	Procure materials under framework agreement	Number of orders	8,000	1,200,000	150
8.	Procure materials on a one-off basis	Number of orders	1,500	450,000	300
9.	Procure indirect materials	Number of orders	1,000	100,000	100
10.	Pick stock for customer orders	Number of order items	20,000	300,000	15
11.	Process order	Number of orders	5,000	1,500,000	300
12.	Market support	Number of markets	17	510,000	30,000
13.	Customer support	Number of customers	4,500	1,800,000	400
Total cost volume for area of investigation				14,810,000	

Table 13.7 Cost example of Purchasing cost centre [Source: based on Mayer, R., Target Costing und Prozesskostenrechnung (1993), p. 85]

Cost centre Purchasing						
SP no.	Sub-process	Capacity (in man-yrs)	Assigned costs (in €)	Process quantity	Process cost rate (in €)	Allocated to MP no.
1.	Conclude framework agreement	0.9	63,000	90	700	MP7
2.	Place order under framework agreement	2.0	168,000	8,000	21	MP7
3.	Place one-off order	1.5	105,000	1,500	70	MP8
4.	Order indirect materials	0.8	42,000	1,000	42	MP9
5.	Maintain contact with supplier	1.2	90,000	90	1.000	MP6
Total cost centre costs			468,000			

Preparatory processes are handled like research and development costs in target costing. To obtain the amount of unit costs, charging is based on the planned total number of units.[35]

Support processes comprise activities which are caused by the very existence of product, a supplier or a customer even without any product being sold, any part being procured or any delivery to a customer. In the present example, the processes in question are "Manage parts", "Support variants", "Support suppliers", "Market support" and "Customer support".[36] In the case of these processes, the costs always relate to a year and are therefore allocated to the planned average number of units for the year.

Handling processes comprise all the logistics and administrative activities involved in procuring materials and parts, producing products and processing customer orders. In the present example, the processes in question are "Procure materials", "Pick stock for customer order" and "Process order". These processes always relate to order fulfilment. Within the framework of target costing, the planned batch sizes are divided.

The special case of product changes is particularly important, as the cost of changing a product can account for up to 25 percent of the total volume of overheads. However, product changes cannot be divided into the three sub-categories mentioned. They are of the nature of a handling process, but do not relate to a specific order but to the planned total number of units. Product changes are therefore

[35] Mayer, R., Target Costing und Prozesskostenrechnung, 1993, p. 84.

[36] Mayer, R., Target Costing und Prozesskostenrechnung, 1993, p. 86.

charged in the same way as preparatory processes. The question which one has to ask here is what the ceiling should be on product change costs over the entire product life cycle if the product costs only permit a certain amount? [37]

13.2.2.3 Overheads in Target Costing

The components to be analysed are differentiated in terms of whether they are bought in, produced in-house or finished products. A finished product is more than the sum of the component costs, as the overheads of product assembly and product introduction, support costs and sales overhead are assigned at the finished product level.

In the present example, the components are not produced in-house, hence only bought-in components and the finished product are considered.

Bought-in Components

The newly developed rim component and the common wheel hub cap part are supplied by a company with which Porsche has had business dealings for many years. On the other hand, the centring comes from a new supplier.

For the calculation of process costs, the following processes are relevant: MP2 “Manage parts”, MP7 “Procure materials under framework agreement” and to some extent MP1 “Introduce new parts”. In addition to the total and annual unit numbers, information about the minimum batch sizes that the supplier is prepared to supply is also important for costing purposes. The relevant overheads for the components in question can then be calculated from the formulae in Table 13.8 (see Fig. 13.11).

Finished Product Level

The following processes are relevant to the calculation of process costs: MP3 “Introduce new products”, MP4 “Support variants”, MP5 “Implement product changes”, MP11 “Process order”, MP12 “Market support” and MP6 “Support suppliers”. In addition to information about total and annual unit numbers, information about the planned number of variants, product changes and the average customer order size is also relevant for costing purposes. Because the product can be installed on all Porsche sports cars, six variants are to be produced. It is assumed that there will be four product changes in the course of the product life cycle and that the average customer order will be for three wheel sets.

The relevant overheads can then be calculated from the formulae in Table 13.8 (see Fig. 13.12).

The process costs for a complete wheel set thus amount to €305.72 (295.03 + 6.75 + 2.25 + 1.69). In the next section an attempt will be made to optimise these overheads in order to eliminate the target cost gap.

[37] Mayer, R., Target Costing und Prozesskostenrechnung, 1993, p. 86.

Table 13.8 Formulae for charging overhead processes in target costing [Source: based on Mayer, R., Target Costing und Prozesskostenrechnung (1993), p. 89]

Category	Example	Charging formula				
Preparatory processes	Introduce new parts	Process cost rate	×	No. of new parts	=	Expected total no. of units
	Introduce new products	Process cost rate			=	Expected total no. of units
Support processes	Manage parts	Process cost rate	×	No. of new parts	=	Expected annual quantity
	Support variants	Process cost rate	×	No. of variants	=	Expected annual quantity
	Support suppliers	Process cost rate	×	No. of additional suppliers	=	Expected annual quantity
	Market support	Process cost rate	×	No. of necessary markets	=	Expected annual quantity
	Customer support	Process cost rate	×	No. of necessary new customers	=	Expected annual quantity
Handling processes	Procure materials	Process cost rate	×	No. of parts	=	Average customer order size
	Pick stock for customer order	Process cost rate	×	Average no. of order items	=	Average customer order size
	Process order	Process cost rate			=	Average customer order size
Product change processes	Implement product changes	Process cost rate	x	No. of expected changes in product life cycle	=	Expected total number of units

Bought-in components			
Total number of units			8.850
Annual number of units			2.950
Minimum batch size		C1	25
		C2	100
		C3	100
C1 Wheel			
MP1, Introduce new parts	5,000	8,850 =	€0.56
MP2, Manage parts	556	2,950 =	€0.19
MP7, Procure materials under framework agreement	150	25 =	€6.00
Overheads per unit			**€6.75**
C2 Centring			
MP1, Introduce new parts	5,000	8,850 =	€0.56
MP2, Manage parts	556	2,950 =	€0.19
MP7, Procure materials under framework agreement	150	100 =	€1.50
Overheads per unit			**€2.25**
C3 Wheel hub cap			
MP2, Manage parts	556	2,950 =	€0.19
MP7, Procure materials under framework agreement	150	100 =	€1.50
Overheads per unit			**€1.69**

Fig. 13.11 Process costing of bought-in components
[Source: based on Mayer, R., Target Costing und Prozesskostenrechnung (1993), p. 91]

Finished product					
Total number of units					8,850
Annual number of units					2,950
Variants					6
Product changes					4
Additional suppliers					1
Customer order size					3
"Panamera Sport" wheel set					
MP3, Introduce new products	25,000		:	8,850 =	€2.82
MP4, Support variants	2,000 x	6	:	2,950 =	€4.07
MP5, Implement product changes	30,000 x	4	:	8,850 =	€13.56
MP6, Support suppliers	5,000		:	2,950 =	€1.69
MP11, Process order	300		:	3 =	€100.00
MP12, Market support	30,000 x	17	:	2,950 =	€172.88
Overheads per unit					**€295.03**

Fig. 13.12 Process costing at finished product level
[Source: based on Mayer, R., Target Costing und Prozesskostenrechnung (1993), p. 91]

13.2.2.4 Conclusions from the Analysis of Overheads

The following conclusions can be drawn from the individual results of the overhead analysis[38]:

- The costs of order processing rise sharply as order batch size falls. It is critical to achieve bigger order batches.
- The cost of procuring materials also rise as order batch size falls. Here it is necessary to check whether bigger orders could compensate for the additional storage costs that would result.
- The stipulation and implementation of a higher customer order batch size must be an urgent objective, and appropriate steps must be introduced to make this possible.
- The biggest cost driver, market support, offers a lot of optimisation potential. Here too appropriate steps must be introduced to reduce these costs in the long term.
- There is a need to check whether any optimisation potential can be realised for changes to the product.

13.2.2.5 Achieving the Target Costs of Target Costing Using Process Costs

We still need to reduce costs by €50 per wheel set, which could not be accomplished through target costing. Starting from the overheads per unit for the components and the finished product, management has decided on several measures to achieve the target costs. Here they have concentrated primarily on optimisation measures which are relatively quick to implement. (Fig. 13.13).

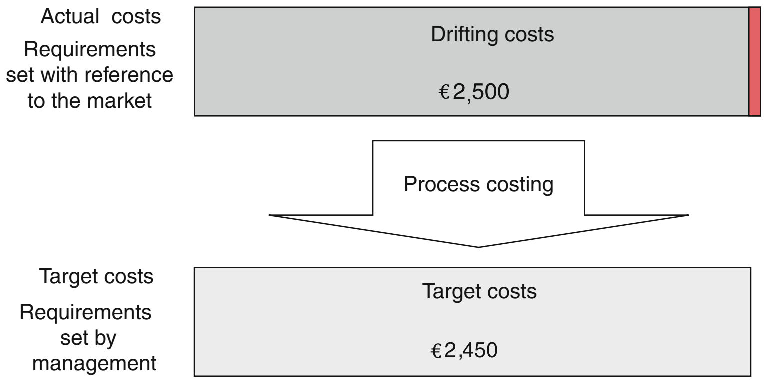

Fig. 13.13 Cost gap remaining to be closed through process costing

38 Kempf, K., Kieninger, M., Kostensenkung durch Prozessoptimierung, 1998, p. 281.

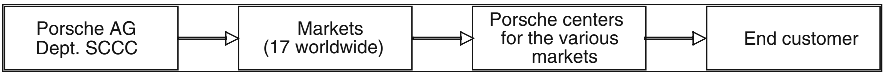

Fig. 13.14 Distribution structures of department SCCC
[Source: fictitious]

The distribution structures of department SCCC are presented in Fig. 13.14. As the end customer is not supplied directly, it has been decided to stipulate a minimum customer order size of six wheel sets in order to counteract the cost driver of insufficiently large orders.

Raising the average order size to six wheel sets reduces the order processing overheads from €100 to €50, as a result of which a saving of €50 could be achieved for each wheel set ordered (see Fig. 13.15). In this way, the target cost gap could be completely closed.

Once the planned target costs have been achieved, the company must then make the attempt to improve processes an ongoing activity.[39] Among the measures adopted in the long term in the measures catalogue are optimisation of the biggest cost driver, market support, and a review of whether the number of product changes can be reduced. The number of product changes during the product life cycle has

Finished product, new				
Total number of units				8,850
Annual number of units				2,950
Variants				6
Product changes				4
Additional suppliers				1
Customer order size				**6**
"Panamera Sport" wheel set	25,000	:	8,850 =	€2.82
MP3, Introduce new products	2,000 x 6	:	2,950 =	€4.07
MP4, Support variants	30,000 x 4	:	8,850 =	€13.56
MP5, Implement product changes	5000	:	2,950 =	€1.69
MP6, Support suppliers				
MP11, Process order	300	:	**6** =	€50.00
MP12, Market support	30,000 x 17	:	2,950 =	€172.88
Overheads per unit				**€245.03**

Fig. 13.15 Optimised process costing at finished product level
[Source: based on Mayer, R., Target Costing und Prozesskostenrechnung (1993), p. 91]

[39] Jakobi, H.-F., Optimierung indirekter Funktionen, 2003, p. 469.

been very difficult to assess in the past. The reasons for product changes include, for example, changes in statutory requirements in individual countries, particularly in relation to environmental protection or product liability issues, also changes to the model maintenance[40] for a given vehicle type.

13.2.3 Linking of Process Costing with the Berlin Balanced Scorecard

13.2.3.1 Contribution Income Statement as a Statement of Earnings in the Customer-Oriented Perspective

With the aid of the contribution income statement it is possible to control the effects of the chosen measures in conjunction with the process costing. To do this, however, it is necessary to apportion the cost savings into fixed and variable costs. The resulting information provides the company with important initial information for a business management analysis.

By influencing the cost driver of main process 11, "Process order", a cost saving of €50 per wheel set was achieved. The overheads in this process refer to all the cost of processing a sales order, from receipt of the order to product completion, packaging and dispatch. Analysis of the costs involved in this main process revealed that the proportion of fixed costs was 70 percent. In this way, every wheel set sold saves €35 of fixed costs and €15 of variable costs. Starting from the planned sales quantity of 8,850 wheel sets, one obtains the following change in contribution and net income (see Fig. 13.16).

Quantity	8,850	8,850
Target price	3,500	3,500
Target costs	2,500	2,450
	Old	**New**
Net sales	€30,975,000	€30,975,000
(–) Variable selling costs	€ 923,940	€791,190
(–) Variable product costs	€15,006,060	€15,006,060
(=) Contribution I	€15,045,000	€15,177,750
expressed as a % of net sales	48.6	**49.0**
(–) Fixed costs in the period	€6,195,000	€5,885,250
(=) Net income (profit)	€8,850,000	€9,292,500
expressed as a % of net sales	28.6	**30.0**

Fig. 13.16 Change in contribution and net income as a result of process costing

[40] Model maintenance in the car industry refers to a visual and technical review of a vehicle model.

The reduction in variable costs causes contribution to rise by €132,750 (€15 × 8,850), equivalent to an increase to 49 percent of net earnings. Unit contribution is now €1,715. By simultaneously reducing fixed costs by €309,750 (€35 × 8,850), net income has risen by €442,500. This corresponds, starting from the net earnings, to the originally planned target return of 30 percent.

13.2.3.2 Linking of Customer- and Finance-Oriented Perspectives Using Break-Even Point Analysis

The link between the customer- and finance-oriented perspectives is also accomplished through break-even point (BEP) analysis. BEP analysis shows how the changes in fixed and variable costs affect the break-even point.

Starting from the cost adjustments as a result of process costing, the new break-even point which is necessary as a minimum to cover costs is now worked out.

Starting from the following equation,[41]

$$P(\text{profit}) = x^{*}\,(p - \text{Costs}_{\text{Variable}}) - \text{Costs}_{\text{Fixed}}$$

$$0 = x^{*}\text{cont.} - \text{Costs}_{\text{Fixed}}$$

$$x = \frac{\text{Costs}_{\text{Fixed}}}{\text{cont.}}$$

$$x = \frac{5.885.250\bar{\text{U}}}{1.715{,}00\bar{\text{U}}}$$

$$x = 3.431.63$$

we obtain a new break-even point of 3,432 wheel sets, given a predicted sales quantity of 8,850 wheel sets, a target price of €3,500 and target costs of €2,450. This is equal to a reduction of 213 wheel sets in the BEP (3,645 − 3,432). At this point the fixed costs are completely covered by the contribution and each wheel set sold beyond that number contributes directly towards increasing the company's profit.

13.2.3.3 Effects on Sales Forecast

The sales forecast is very important for meaningful target costing. As a static concept, target costing implies that there will be no further changes once the total target costs have been set. The higher target costs for product introduction, compared with the average target costs, are in this case balanced by the later lower target costs, for example, as a result of the dynamic success of experience curve effects.[42]

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41 Schmeisser, W. et al., BBSC Einführung, 2006, p. 50.

42 Coenenberg, A. G., Kostenrechnung, 2003, p. 461.

The sales forecast considers two variables, market price and unit numbers. If the actual values differ from the predicted values, as is often the case in practice, mistakes may be made in control.

The following example illustrates the consequences of incorrect prediction of the number of units, with the correct market price forecast (Fig. 13.17):

The price of the wheel set and the percentage contribution remain the same in this example. However, the changes in sales quantity lead to value changes in contribution which are explained by the constant fixed cost block, and the result is a change in net income.

The following example illustrates the effects of an incorrect market price forecast (target pricing), with correct prediction of unit number (Fig. 13.18):

In this example, the sales quantity remains constant, so the variable costs do not change. Changes in sales due to changes in market price have a direct effect on contribution, both in value and percentage terms, and hence on net income. As the difference in contribution and net income shows, target cost management is determined by the sales forecast drawn up at the beginning of development. Adjustment of the sales forecast later on proves problematic if the development and design work have already begun on the basis of the originally estimated target price.[43]

Unit sales	7,500	8,850	10,000
Target price	€ 3,500	€ 3,500	€ 3,500
Net sales	€ 26,250,000	€ 30,975,000	€ 35,000,000
(-)Variable selling costs	€ 670,500	€ 791,190	€894,000
(-)Variable product costs	€ 12,717,000	€15,006,060	€16,956,000
(=)Contribution I	€ 12,862,500	€ 15,177,750	4 17,150,000
expressed as a % of net sales	49.0	49.0	49.0
Fixed costs in the period	€ 5,885,250	5,885,250	€ 5,885,250
(=)Net income (profit)	€ 6,977,250	€ 9,292,500	€11,264,750
expressed as a % of net sales	26.58	30.00	32.19

Fig. 13.17 Effects of changes in unit number forecasts with target price held constant

Unit sales	8,850	8,850	8,850
Target price	€3,000	€3,500	€4,000
Net sales	€26,550,000	€30,975,000	€35,400,000
(-)Variable selling costs	€791,190	€791,190	€791,190
(-)Variable product costs	€15,006,060	€15,006,060	€15,006,060
(=)Contribution I	€10,752,750	€15,177,750	€19,602,750
expressed as a % of net sales	40.5	49.0	55.4
Fixed costs in the period	€5,885,250	€5,885,250	€5,885,350
(=)Net income (profit)	€4,867,500	€9,292,500	€13,717,500
expressed as a % of net sales	18.33	30.00	38.75

Fig. 13.18 Effects of a change in target price, with unit numbers held constant

[43] Coenenberg, A. G., Kostenrechnung, 2003, p. 461.

It is clear from both examples just how big the deviations in planned target return resulting from changes in sales quantity or sales price can be. It is therefore very important for target costing to have an accurate sales forecast for innovation marketing.

13.3 Summary

Through the integration of strategic measures the Berlin Balanced Scorecard creates the central costing and organisational framework for all the innovation management processes of a company. It contains financial key figures for past performance and future performance drivers. The most important item in the Berlin Balanced Scorecard is the communication of strategy to the innovation team. The chosen corporate strategy is uncompromisingly translated into tangible performance goals and measures on the basis of multiple perspectives, and as a result long-term success is guaranteed. The Berlin Balanced Scorecard determines the end goals (target goals) of the company strategy and indicates whether changes undertaken (actual figures) have achieved the hoped-for results. With the aid of the Balanced Scorecard, the gap that exists in many companies, the lack of systematic processes to implement and feed back the company strategy on innovation projects, is closed.[44]

With target costing, an instrument that further strengthens the strategic orientation of the company strategy to market requirements is added to the Berlin Balanced Scorecard approach. For only a cost-oriented implementation of customer wishes, in the earliest phases of product design, will in the long-term secure innovative success potential for companies and ensure their financial success. The resulting effective cost management is important for the achievement of competitive product costs.

However, it is not always possible to consider every customer wish, as customers are often unable to specify or articulate their actual needs. At this point it makes better sense for companies to consider empirical values derived from past projects and to base their developments not solely on market-specific customer information. This will ensure that the company not only responds to developments in the market but also proactively develops innovative products. Nevertheless, the company should never lose sight of the market, otherwise there is a risk of developing something for which there is no demand on the market.

One important benefit of target costing is that technical and business planning are combined, with the aim of optimising costs and technical quality.

The tendency for indirect costs to assume an ever greater proportion of costs in companies makes it imperative to implement a combination of target costing and process costing. The aim of implementing process costing was to ensure market-oriented planning and control of the indirect company areas. The two tools were developed independently of each other. The basic thought behind process costing

[44] Kaplan, R. S., Norton, D. P., Balanced Scorecard, 1997, p. 19.

is to influence overheads in the long term. Once the overheads have become fixed, it becomes relatively difficult to influence them. The aim is therefore to identify the factors that influence overheads already during product development in order to be able to influence them. This chapter has shown that overheads can no more be claimed than set through target costing.

Through the integration of overhead cost controlling into the Berlin Balanced Scorecard approach, one obtains information about the overheads in the indirect processes and discovers ways of influencing costs. As the overheads are largely fixed, changes in the causes of fixed costs do not necessarily reduce costs. In this case steps must be taken to ensure that free capacity is used for company growth or else eliminated. Through the integration of process-oriented costing, one obtains transparent dependencies between costs and cost drivers in the overhead areas. This alone, however, is not sufficient to solve the problems identified. The main problem is to use the information acquired to find suitable technical measures and make the right decisions in order ultimately to achieve process optimisation.

The extended Berlin Balanced Scorecard can, however, only be successfully implemented if all the participants have internalised the basic ideas of target costing and process costing. The tools must become part of the management philosophy in the company, for the successful implementation of corporate strategy depends on employee acceptance. The technical staff and engineers need to change their way of thinking. Cost saving potentials should be implemented through a change in cost awareness. To accomplish this, there is a need for ongoing persuasion work on the part of Controlling.

One important advantage of integrating process costing lies in the creation of a costing methodology that relates causes to effects in the company areas involved. By getting rid of flat rate mark-ups, staff feel more responsible for the costs generated in their areas.

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Part VI
Technology Strategies Evaluation as General Concept for Innovation (The "Berlin Balanced Scorecard Approach")

Chapter 14
Innovation Marketing Profitability Analysis Within the Framework of the Berlin Balanced Scorecard Approach from the Point of View of a Finance-Oriented Customer Value Analysis

Wilhelm Schmeisser, Lydia Clausen, and Falko Schindler

14.1 Introduction

This chapter combines the use of different controlling-oriented strategic and operational control instruments in an all-embracing innovation management approach that is intended to ensure an increase in and utilisation of development and design results. A combination of potential customer value, shareholder value and Berlin Balanced Scorecard incorporating the R&D area is presented below. The special focus is in the area of research and development. In the past this problematic area has been neglected in the literature even though controlling is assigned a coordination function in this respect.[1] However, controlling can only perform supporting coordination functions effectively for technological engineering functions if it succeeds in coordinating all the control instruments in the company in an efficient way. The present study proposes a methodological approach for such a control model.

Tougher capital market requirements and increasing competitive pressure are forcing companies not only to be more customer-oriented but also to adopt cost-conscious, value-oriented management controls in the technological area. For some years added value management has been becoming increasingly the focus of the strategic management control and technology innovation policy.

In this way an added value-oriented innovation and growth policy is becoming a fixed element of value-oriented company management. Value management combines strategic management with the analysis of value increases and links the lessons of strategy[2] with those of value orientation. In value management, the performance

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[1] In practice, different instruments of management control are combined in multiple ways. Due to the interdependencies that exist, this raises the question of how one arrives at the best mix of individual instruments. "As isolated analysis is already by no means trivial, examination of combined use leads to theoretically complex problems." Hofmann, C. et. al. (2004), p. 564.

[2] Strutz, E. (1993), p. 109 f. Unlike other control models, value management focuses strategy on the actual entrepreneurial paramount objective of value enhancement – see Koller, T. (1994), p.87.

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of companies, business areas or strategic alternatives is valued on the basis of discounted future free cash flows through the analysis of value increases.[3] The measure of value creation is the cost of capital.

The orientation is towards future scenario-based development and hence to profit expectations. Value management concepts pursue the goal of orienting all the management and control principles and also the entire portfolio structure of the company towards the long-term generation of value in line with capital market requirements.[4]

In order to achieve success, the valuation procedures and instruments for increasing value must be integrated into the overall control system of the company.[5] However, linking value management to strategic management and especially the transfer of value management into the operational area in practice still poses many difficulties.[6] The reason for this is that the instruments for implementing the value increase are either inadequately applied or are wholly lacking. Normally value-oriented strategies are formulated together with appropriate initiatives, but operationalisation is frequently omitted. The result is that the technical and commercial managers and individual staff at the relevant company levels lack the possibility of inferring their own value contribution across cause and effect relations or of analysing departures from goals.

Value management is frequently treated as a calculation instrument for valuing the company rather than as a purposeful management function. However, integration into a universal, value-oriented management system and hence the universality of the target values and parameters of value management through to operational control parameters are critical to the success of the value orientation. Traditional systems are mostly based entirely on financial figures and are normally oriented towards the past. They deliver primarily state descriptions and only highlight critical developments with a time lag. As a result, it is difficult to derive from them future-related control information. Furthermore, they do not provide any information about the causes of company developments. Conventional systems often do not adequately integrate key figures and performance indicators that are concerned with the relevant technical customer and market segments. Innovation, growth and development potentials at the level of employee or of R&D are often ignored. This is where the Berlin Balanced Scorecard comes in, as a control and management instrument that offers an all-embracing concept for considering the relevant company data. The Balanced Scorecard system that was originally developed by Kaplan and Norton is an instrument for translating corporate strategy into goals, control parameters and measures. In this way a link is created between operational and

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[3] Several different mathematical financial valuation and calculation procedures have been developed for analysing increases in value. Amongst these are the Discounted Cash Flow, the Economic Value Added and the Cash Value-Added approaches – see Rappaport, A. (1998), p. 33 ff.

[4] Moser J.-P. (2001), p. 69 f.

[5] This is substantiated by a study by Horváth & Partners – Horváth & Partners (2003a).

[6] A detailed discussion of this problem is contained in. Günther (1997), p. 2, who in this connection talks of an implementation gap in Shareholder value management; see also Moser J.-P. (2001), p. 70 ff.

strategic planning. Kaplan and Norton obtain their balance of individual company areas, "perspectives", through the interaction of qualitative and quantitative parameters. However, up to now a computational link between the individual perspectives was missing. This is where the Berlin Balanced Scorecard approach comes in. It demonstrates that it is possible to calculate, link and dynamise the perspectives with the familiar models of internal and external accounting.[7]

14.2 Customer Value Management as an Instrument for the Valuation of Customer Relationships

For successful companies it is virtually taken for granted that company management should be oriented towards market and customers.[8] Studies have shown that it is five to ten times more expensive to win new customers than to turn existing customers into loyal customers. For this reason, customer management and customer retention are becoming more and more central to corporate strategy. However, customer retention has to be pursued in a differentiated way as otherwise companies invest valuable resources in customers who mainly cause costs. Hence, customers and customer segments should primarily be considered in terms of their profitability. The exploitation of hitherto unused customer potentials and also cost reduction in the area of unprofitable customer relationships are both important aspects in customer value management. The quantitative assessment of customer relations is an important precondition to this.

The determination of customer value is based on the assumption that not all customers are similar as regards their behaviour (e.g. order frequency and volume), needs (e.g. their needs for service and support) and profitability. A customer valuation at the individual customer level, the analysis of individual customer values and the definition of customer segments based thereon are used to determine strategic marketing and sales goals and distribution of the budget over the customers and customer groups identified. The ascertainment of customer values helps to concentrate resources and budgets on customers who generate a positive contribution to profit for the company. Customer values constitute the basis for value-oriented customer management. The development of the customer base with the focus on customer value flows into customer value management. Customer value becomes a measure of the success of customer management.

Customer values indicate the attractiveness of a given customer at the present time. Above all one can ascertain how much revenue has been generated with which customers and which costs and expenses were caused by customers. One also considers which soft factors, such as recommendation or information behaviour, influence customer value. In a broadly based understanding, as well as ascertaining

[7] Schmeisser, W. et al..(2004), p. 99.

[8] Weber and Lissautzki (2004), p. 7.

customer value, the future expected contribution to profit on innovation projects is also included.

14.2.1 Customer Value Analysis and Customer Value Management

Value-oriented customer management covers, independently of their value contribution, the management functions of planning, directing and control in relation to the selection, establishment, shaping, retention and termination of business relations with particular customers and customer groups. For the purposes of practical implementation, the functions can be broken down into the areas of analytical, strategic and operational customer value management.[9] The aim of value-oriented customer management is to increase the value of the entire customer base by tying in selected regular customers, selecting new customers on a targeted base and increasing the value of existing customers.[10] Accordingly, errors in customer value management are found in the areas of customer acquisition, customer retention and customer value generation.[11]

How customer value changes over time is basically determined by brand and supplier preferences, satisfaction and the perceived costs of switching on the part of the customer. It is also influenced by the nature of demand in a market, i.e. by cycles in demand or the demand for additional or complementary goods.[12] There are three instruments for increasing monetary customer value: cross-selling, up-selling and increasing the "share of wallet". The use of these instruments cannot be categorically limited to the customer group in focus. Customers capable of developing and less valuable customers should not be denied the possibility of higher value offers simply because they belong to a worse customer category.

Building on the results of the customer value analysis, one works out a strategy for the value-oriented canvassing of selected customers or customer groups. The assessment and classification of customers according to their value makes it possible to not treat all customers in the same way. This presupposes that one knows the customer values and customer loyalty characteristics. Normally the procedure for creating a customer value strategy entails two stages. The results of the customer classification are used to select certain customers and customer groups for further canvassing.

After the strategy has been determined, the innovation marketing budget has to be shared out. In particular, marketing resources should be used for the targeted canvassing of those customers and customer groups on which one is focussing. Here it is necessary to determine the measures and financial resources, especially for customers with high actual or expected contributions to profit. Customer group-specific

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[9] Bruhn et al. (2006), p. 29 ff.

[10] Büschken et al. (2006), p. 10.

[11] Helm and Günter (2006), p. 24 ff.

[12] Büschken et al. (2006), p. 23 f.

canvassing is in principle possible at every level of market prospecting. With regard to the costs that arise, customer group-specific communication or pricing policies can be implemented comparatively favourably. The development and positioning of segment-specific brands is more costly. If an additional sales channel is to be established for each segment and/or a specific product variant is to be developed for each segment, it is necessary to plan for comparatively high costs for the segment-specific approach.[13]

When it comes to increasing customer loyalty, selected instruments from communication, pricing, service and sales policy are considered. Cornelsen presents possible approaches for marketing and sales instruments aimed at increasing customer value.[14]

Systematic customer valuation makes it possible for sales staff to objectivise decisions made subjectively or based on gut feelings in customer canvassing and thus to avoid one-sided and possibly financially unfounded preferences between customers. Moreover, many promising, so far overlooked customer relationships can be identified and moved to the centre of future sales activities. Using the customer values ascertained, it is possible to plan customer development in a more focused way, e.g. with regard to cross-selling and up-selling activities. Customer values provide reference points as to where the focus should lie in soliciting customers. The nature and frequency of customer visits and the giving of purchase incentives such as discounts, volume-based rebates and other incentives can be directed in a more objective way. In this way, customer values facilitate the setting of priorities in marketing and sales.

Despite their low value contribution to company profit, dealings with less profitable customers should also be organised professionally. Customers assigned to a less valuable group could yet become valuable customers in the future for an innovation project. Their development and possibly their strategic potential must therefore be examined. Exit strategies must be designed in such a way that a less valuable customer does not feel poorly treated as a clearly valueless customer and does not provide negative publicity by word-of-mouth. This can damage a company much more than the loss of revenue from the customer would initially suggest.[15]

14.2.2 Factors Determining Customer Value

The value of a customer to a company is measured not only in the contribution to sales and profits already realised or expected. As well as the monetary customer value resulting from factors like sales, contribution, future cash flows or customer lifetime value, there are other intangible value components on which in some cases

[13] Homburg et al. (2006), p. 39.

[14] Cornelsen (2000), p. 288.

[15] Weber and Lissautzki (2004), p. 42 f.

it is possible to put a value, such as information value, strategic value and customer lifetime potential value.[16]

Tomczak and Rudolf-Sipötz divide the factors that determine the customer value into factors which equate to the market potential of the customer and factors that characterise the customer's resource potential.[17] The market potential is an expression of the realised and expected sales successes of a customer relationship in the case of innovations. The market potential covers all those variables which are either monetary or can be expressed in monetary terms such as income, development, cross-buying and loyalty potential. The resource potential of a customer consists of all those characteristics which indirectly contribute to company profit. Indirect contributions to profit arise from viewing the customer as a corporate resource. The resource potentials consist of the reference, information, cooperation and synergy potential of the customer.

14.2.3 Methods for Measuring Customer Value

In the literature, several different methods for valuing customers are proposed, both qualitative and quantitative. Monetary customer valuation methods assess the customer value in terms of sales, expected sales and customer contribution margin already realised and/or expected. Non-monetary models consider variables such as reference potential and/or behaviour, information potential and/or behaviour, cooperation potential or synergy potential. For example, Günter und Helm provide a detailed overview of the commonest methods and their drawbacks.[18]

The profit potential of an individual customer can be determined with reference to customer profitability. Customer-specific contribution income statements and customer lifetime valuation are particularly useful here. Customer contribution margin is calculated as follows (Fig. 14.1):

The differentiated calculation of customer contribution margin will be discussed in greater detail below.

The Recency-Frequency-Monetary (RFM) or Recency-Frequency-Monetary Ratio (RFMR) method is the original model of the scoring models used for valuing customers. Under this model, the customer value of an individual customer is measured on the basis of his past ordering behaviour. The shorter the time interval since the last transaction (recency), the more frequently a customer has received goods in the past period (frequency) and the higher the sales initiated by the customer (monetary ratio), the more probable a transaction in the future is, hence the higher the customer's current and future profit contribution and hence his RFMR value. As is customary with the scoring methods, these dimensions are allocated points, weighted and condensed into a single key figure. It is possible to extend

[16] Winkelmann (2005), p. 285 ff. and Cornelsen (2000), p. 30 f. also 199 ff.

[17] Tomczak and Rudolf-Sipötz (2003), p. 132 ff.

[18] Günter and Helm (2006), p. 15 ff.

Customer gross revenue per period
- Sales deductions (discounts, volume-related rebates)

= Customer net revenue per period
- Cost of products received by the customer (variable unit costs as per product costing * purchase quantity)

= Customer contribution margin I
- Order costs which can be clearly assigned to the customer (jigs, shipping costs etc.)

= Customer contribution margin II
- Visit costs which can be clearly assigned to the customer (cost of travel to and from the customer etc.)
- Other relative direct costs per period (salary of specifically responsible key account manager, engineering assistance, mailing costs, interest on receivables)

= Customer contribution margin III

Fig. 14.1 Scheme for calculating customer contribution margin
[Source: based on Helm and Günter (2006), p. 21.]

the model beyond these basic criteria.[19] One example of a calculation schema for calculating the RFMR is mentioned by Cornelsen.[20] The higher the RFMR value, the higher the likely future attractiveness of the customer. The RFMR method was developed in the USA in the 1930 s as a means of valuing customers in the mail order business.[21] It was demonstrated in empirical studies that customers respond more positively to a mailing

- the more recently their last order was placed
- the more frequently they have ordered goods and
- the higher the sales that they generated.[22]

For the direct marketing and mail order sectors, it has been shown that these customers have an influence on long-term customer profitability.[23] On the other hand, critics note that the amount of value depends on the nature and weighting of the underlying criteria.[24]

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[19] Bruhn (2004), p. 420.
[20] Cornelsen (2000), p. 150.
[21] Homburg et al. (2006), p. 186.
[22] Cornelsen (2000), p. 150.
[23] Weber and Lissautzki (2004), p. 14.
[24] For criticism, see Cornelsen (2000), p. 151 f.

14.2.4 Customer Segmentation on the Basis of Customer Value

Customer segmentation allows decisions to be made about how intense the customer relationship should be in future. In the capital goods business, given that the number of customers is comparatively straightforward, often it is possible to make decisions about the value of the future business relationship at the level of the individual customer. If the number of customers exceeds a critical variable to be specified in the individual case, it is appropriate to strategically determine the future nature of the business relationship on the basis of customer segments.[25] The definition of different segments in business-to-business markets serves to lay the basis for different levels of intensity in customer canvassing.[26]

Segments are defined systematically and applying the same criteria over an extended period of time in order to ensure comparability over time. Since in principle it is possible to perform a segmentation on the basis of different criteria, the decision has to be made individually as to what segmentation is appropriate for a given company. The segmentation criteria are chosen in such a way that they are measurable and relate to purchasing behaviour and the special features of the business model. The segments themselves can be addressed directly. Furthermore, the segments defined must be neither too big nor too small. If they are too big, there is a danger of segment-of-one marketing. If the segments are too small, the cost of the segmentation itself and of segment-specific marketing and sales measures can quickly exceed the benefit, i.e. the segment size must be cost-effective. Ideally the segmentation structure is reflected in the sales structure.

ABC analysis is used to rank customers according to the value of their purchases or the profit that they contribute and hence to prioritise customers. The definition of segments in the form of A, B or C customers is oriented to the cumulative sales or profit contribution. Segments can be subdivided into classes on any basis. One popular approach is to define A customers in such a way that between them they account for 80% of the company's sales or profit, B customers as accounting for the next 15%, and C customers as the remainder. If one compares the item values for customers in the ABC analysis by sales with the item values by contribution, often one obtains differences. Customers who buy a lot of goods are not necessarily the customers that generate the most profits, as customers who make a lot of purchases often enjoy higher monetary concessions than customers making fewer purchases. At the same time ABC analysis is a control instrument for changing the customer structure over time. It is possible to predict whether the proportion of A and B customers can be increased at the expense of C customers.[27]

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[25] Weber and Lissautzki (2004), p. 31.

[26] Narayandas (2005), p. 40.

[27] Helm and Günter (2006), p. 15.

Portfolio models allow customer prioritisation. Using portfolio models, customers are grouped into categories. Customer portfolios form the basis for standard strategies of customer canvassing, but their practical application should be critically scrutinised in the individual case.[28] One positive feature of portfolio models is that the presentation of customers and their value is very appealing. On the negative side, the criteria are very time-consuming to work out; from a certain number of customers the portfolio becomes unclear and the models do not enable one to make any direct statements about the profitability of the customer.[29] The pyramid model is one of several models for the classification of customers discussed in the literature.[30] According to the pyramid model, the regular customers of a supplier can be broken down into a total of four levels (Fig. 14.2). Customers are assigned to the platinum, gold, iron or lead levels according to their profitability.

At the top of the pyramid is the smallest and most profitable customer group, the **platinum customers**. This group consists mainly of heavy users who can be largely viewed as loyal customers. Platinum customers typically are very interested in product innovations, behave as if they are not sensitive to price and are extremely pleased with the services of the supplier. The majority of customers are assigned to the iron group. **Iron customers** only buy in small quantities and are not viewed as very loyal. From the point of view of the supplier, they are not very profitable. The most problematic customers from the supplier's point of view are the **lead customers**. In the case of lead customers, the costs of customer canvassing exceed the revenues. In some cases there are reasons for maintaining the customer relationship, at least temporarily, e.g. to serve as references or because a greater volume of sales expected in the future.

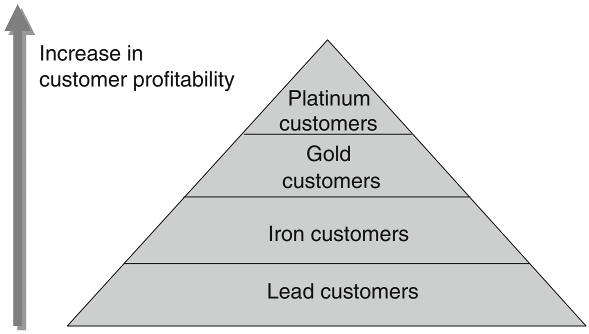

Fig. 14.2 The customer pyramid
[Source: Helm and Günter, p. 17.]

[28] Helm and Günter (2006), p. 20.
[29] Homburg et al. (2006), p. 200.
[30] Helm and Günter (2006), p. 16 f.

14.3 The Berlin Balanced Scorecard Approach as the Basis for Value-Oriented Performance Measurement, Taking Special Account of a Shareholder Value-Oriented Solution Algorithm

Having demonstrated the linking and denomination of the four Balanced Scorecard perspectives through the Berlin Balanced Scorecard approach,[31] it is necessary to develop a closed key figure system for each perspective in order to be able to identify and, if appropriate, eliminate value-generating and/or value-destroying factors.

The identification of relevant value factors makes consistent, goal-oriented planning and control possible, along with holistically value-oriented company management. Especially with regard to the role of intangible assets (e.g. customer and employee potentials, also the area of research and development) as important value and growth generators, the Berlin Balanced Scorecard approach[32] offers a future-oriented, all-embracing means of valuation and control. Specifically, when it comes to internal control and also external company valuation, closed key figure systems for each Balanced Scorecard perspective can help to ascertain the real value of a company.

14.3.1 Quantification of Customer-Oriented Perspective

Companies are moving more and more towards replacing or supplementing product-oriented strategies with customer-oriented strategies. Against this background, quantification of customer relationships is becoming increasingly important as a supplement to the classic product performance statement.[33]

With the aid of customer contribution margin accounting it is possible to assign in a more goal-oriented way both direct costs and also, with the aid of process costing, overheads which up to now have generally been expressed only as a percentage (e.g. sales, marketing and order processing), to the cost object "customer" through the use of additional reference parameters. In this way it is possible to assess the profitability of customers. Knowledge of the profitability of individual customers offers both starting points for cost reduction measures and also the possibility of operating better customer and yield management in order ultimately to raise the profitability of the entire company.[34]

A customer contribution margin is deduced from the product contribution, which ultimately is transferred into a customer cash flow. In addition, a capital budgeting

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[31] Schmeisser, W. et al. (2004, p. 99 ff.

[32] Schmeisser, W. et al. (2004), p. 99, pp. 112–114.

[33] Fischer, T. M. and von der Decken, Tim (o. A.), p. 1.

[34] Fischer, T. M. and von der Decken, Tim (o. A.), p. 1.

based calculation of customer value and the customer's role in enhancing the company value and/or market value within the framework of an innovation project is also undertaken.

14.3.1.1 From Product Contribution to Customer Contribution Margin

Product-specific costing is essential for the management of a company, as the processes to be planned, directed and controlled first need to be fixed for the innovative product or the new service that is to be introduced. For in-house processes, it is the product costs which are most relevant, as long as no individual customer order requirements which can be directly attributed to the products concerned need to be considered. The next figure provides a rough schematic overview of the process of working out a customer contribution margin by first performing the product-specific costing and then using this to establish the peculiarities of the customer-specific costing (Fig. 14.3). [35]

The "customer overheads" listed here are broken down below in a more differentiated way using process costing and thus assigned on a more cause–effect basis. In this way it is possible to significantly increase the informativeness of the customer contribution margin.

14.3.1.2 Process Costing

Process costing is an approach with whose aid the costs of indirect company areas can be better planned and directed and assigned to products or services. The functions processed in the cost centres of the company are broken down into

	Product costing		Customer costing
	Sales revenue		
–	Sales deductions		
–	Variable costs		
=	**Product contribution I**		Product contribution I
		–	Customer direct costs
		=	**Customer contribution margin I**
		–	Customer overheads (to the extent that these vary according to the number of customers)
		=	**Customer contribution margin II**

Fig. 14.3 Product costing versus customer costing (accruals accounting)[36]

[35] Schirmeister, R. and Kreuz, C. In Günter, B. and Helm, S. (eds.), Kundenwert (2003), p. 337.

[36] Schirmeister, R. and Kreuz, C. In Günter, B. and Helm, S. (eds.), Kundenwert (2003), p. 338.

process-specific activities. Costs are assigned to these activities on the basis of cost drivers and used to work out process cost rates.[37]

$$\text{process cost rate} = \frac{\text{process costs}}{\text{process quantity}} = \text{costs per process variable}$$

Example[38]: “Procure and store materials” process
Process costs = €7,605,000
Process unit = removal of stock from storage
Process quantity = €650,000

If one insert this data in the above formula, one obtains the following:

$$\text{process cost rate} = \frac{7{,}605{,}000}{650{,}000} = \text{£}11.70 \text{ per removal of stock from storage}$$

Process costing reflects the calls on corporate resources and thus offers the possibility of “a more cause-related cost allocation than overhead costing, under which overheads are charged only as a function of the amount of a value-related overhead rate base through proportional percentage additional charges”.[39] The central problem in calculating process-specific costs data is that the processes under consideration here normally relate to multiple departments and hence multiple cost centres. It is not possible to gather this data directly through conventional costing, broken down by cost centre. Process-specific charging is normally carried out in two stages. The main processes constitute the top level considered. In process costing, this is a chain of homogeneous activities which are subject to the same cost influencing factor and are worked out for the process costs. The main processes are normally activities which span several departments.[40]

The subordinate level is made up of activities that are carried out in one cost centre and may have their own cost drivers. In the individual cost centres first of all an activity analysis is performed, in which the individual activities are analysed and their associated costs ascertained. The costs identified are divided into output-induced (oi) and non-output-induced (noi) costs. Output-induced costs are variable in relation to the cost drivers considered, whereas non-output-induced costs are fixed costs in relation to the cost drivers. The non-output-induced costs are then assigned to the output-induced costs via allocation variables.[41] To allocate these costs, the following allocation rate is used[42]:

[37] Coenenberg, A. G. (1999), p. 225 ff. and Michel, R. et al. (2004), p. 266 ff.
[38] Coenenberg, A. G. (1999), p. 230.
[39] Coenenberg, A. G. (1999), p. 231.
[40] Coenenberg, A. G. (1999), p. 225 ff. and Michel, R. et al. (2004), p. 266 ff.
[41] Coenenberg, A. G. (1999), p. 232 and Michel, R. et al. (2004), p. 273 ff.
[42] Coenenberg, A. G. (1999), p. 232.

$$\text{allocation rate} = \frac{\text{process costs (noi)}}{\text{process quantity (oi)}} \times 100 = X\%$$

The costs of the individual activities thus calculated are then aggregated with the costs of the main processes. Here it is normally assumed that constant, proportional relationships exist between the cost driver of the main process and the cost drivers of the individual activities. If the number of executions forms the cost driver, this means that every time the main process is performed, the individual activities always have to be performed the same number of times.[43]

The costs of the individual activities ascertained from process costing can be used within the framework of the process design to assess different variations cost-wise for the (main) processes.

However, the process costing data can also be used to monitor the efficiency of ongoing processes. For this purpose the costs incurred are distributed over the number of units of the cost driver which correspond to the capacity of the relevant area. If the actual utilisation is smaller than the capacity, only a proportion of the costs is assigned to the actual activities in the area. The remaining costs constitute the costs of the capacity that is available but not used. As it is usually easier to add capacity than to cut it, a higher proportion of costs for unused capacity should prompt one to think about how the free capacity could be productively used. In a second approach, all the costs are spread over the actual number of executions of the process (or the actual value of the cost driver).[44] As the costs constitute an input variable and the process quantity an output variable, the cost rate thus calculated (or, more accurately, its reciprocal) can also be viewed as a measure of the productivity of the process, and can be calculated with the following formula[45]:

$$\text{process cost rate} = \frac{\text{process costs}}{\text{process quantity}} = \frac{\text{input}}{\text{output}} = \frac{1}{\text{productivity}}$$

14.3.1.3 Strategic Information Advantages of the Effects of Process Costing

The following effects[46] are observed in process costing:

- allocation effect
- complexity effect
- and degression effect

[43] Michel, R. et al. (2004), p. 272 ff.

[44] Michel, R. et al. (2004), p. 288 ff.

[45] Coenenberg, A. G. (1999), p. 225 ff. and Michel, R. et al. (2004), p. 266 ff.

[46] Coenenberg, A. G. (1999), pp. 235–238.

The **allocation effect** specifies the precise attribution of overheads for indirect service areas in accordance with the claims of operating resources to the product/service units.

The **complexity effect** conveys the consideration of the complexity of the production process and the wealth of variants of individual products as influencing factors in the costing.

The **degression effect** of process costing shows, in contrast to the traditional procedure of overhead costing and reference variable costing, that the fixed overheads per unit fall as the number of units rises.

14.3.2 Target Costing

"Target costing can be defined as a cost management instrument for reducing the overall cost of a product over its entire life cycle…"[47]

Thanks to the enormous technical progress of recent years, companies are exposed to a considerable number of complex influences. These result in some cases from saturated markets and lead to differentiated customer demand.

Through the increasing use of state-of-the-art production methods and technologies, today companies are able to expand or alter their product range accordingly.

Standardisation of products is on a steady decline. Specific customer requirements and advancing technologisation call for high flexibility and adjustments in the production process. Companies in every industry are required to adjust to these new framework conditions and orient their strategic planning accordingly.[48]

Target costing and target cost control are suitable instruments for assessing the costs that will be incurred in the future.[49]

14.3.2.1 Aspects of Target Costing

Target cost management differs from operational cost and profit planning by

- taking a market-oriented view
- assembly is taken into account in the design of products under development
- costs are considered over the entire life cycle.

Target costs have the function of presenting not only the cost of the technology of a company but, in particular, the cost implications of customer requirements, as internal accounting, have to be oriented to customer requirements.[50]

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47 Sakurai, M., Target Costing and how to use it (1989), p. 39.

48 Brühl, R., Controlling (2004), p. 196.

49 Franz, K.-P. (1992), Moderne Methoden der Kostenbeeinflussung, p. 1493.

50 Brühl, R., Controlling (2004), p. 196.

To work out market-oriented values for target costing purposes, customer surveys are conducted. In this way the cost implications of demands on and expectations of the product on the part of customer and production process are taken into account.

14.3.2.2 Influencing Costs During the Product Life Cycle

Precisely during the product development phase, it is important and sensible from the point of view of cost management to influence the costs of products. As product development advances over time, there is hardly any opportunity to minimise the costs decisively, as the decisions on how much material will be consumed and what production methods will be used are made in advance. From this point onwards there is little scope for influencing the cost elements of a product (Fig. 14.4). [51]

Target costs take into account changes in technologies, whereas planned costs are based on existing technologies and methods.

14.3.2.3 Phases of the Life Cycle and Costing

Target costs are applied during product development, whereas planned costs are applied in ongoing production.

The aim and purpose of target costing is to gather information in the initial phase of product development in order to eliminate information gaps in costing during the development and design phases of product planning.

It is the upstream processes of product development that are critical here, not the ongoing production process. Target costing is therefore applied during the development cycle of a product. It is therefore an indispensable aid and planning tool when it comes to decisions over the long-term pricing of products.

The products, the process and product quality are therefore the objects of target costing and target cost control for the entire life cycle.[52] A product normally has a life cycle that extends over several years. This means one is dealing with planning over multiple periods, which has a dynamic character.

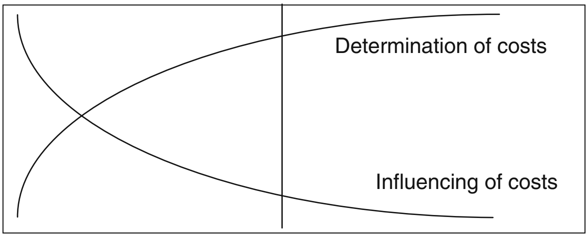

Fig. 14.4 Influencing costs in the product life cycle[53]

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[51] Brühl, R., Controlling (2004), p. 197.

[52] Sakurai, M., Target Costing and how to use it (1989), p. 41.

[53] Brühl, R., Controlling (2004), p. 197.

The special characteristics and features of target costing and target cost control should show the differences compared with operational cost and profit planning, since in theory and practice a static target cost management model is frequently used.

14.3.2.4 Working Out the Target Costs

One important function of target cost management (target costing) is the market- or customer-oriented determination of monetary requirements for the development of products.[54]

The next Fig. 14.5 shows the most important reasons why German companies have introduced target cost management. It is clear that above all the market and customer orientation is a major influence.

Strategic planning systems cover product planning and product–market combinations. On the other hand the resulting adaptation of strategic objectives and resources are elements of business area strategies.[55]

This leads to alignment between one's own resources and capabilities and the possibilities of the product–market combinations. At the centre of strategic cost management there is thus a formal target-oriented assessment of strategic activities.

Product–market combinations always relate to a homogeneous product group or product totality. Target cost management has the function within this product totality strategy of providing information about a certain product unit.

Cost reductions	1.86
Greater cost transparency	1.44
Influencing the cost structure	1.48
Reading cost structures	0.84
Reducing programme complexity	0.47
Quality improvements	0,66
Greater market/customer orientation in product development	1.43
Bringing forward the time at which costs can be influenced	1.30
Shortening of development time	0.72
Coordination of development activities	0.66

Fig. 14.5 Aims of introducing target cost management[56]

[54] Becker, W., Kostensteuerung (1993), pp. 279–287.
[55] Brühl, R., Controlling (2004), p. 199.
[56] Arnaout, A., Anwendungsstand des Target Costing (2001), pp. 289–299.

14.3.2.5 Market Orientation in Target Costing

To obtain sensible and accurate information about a product unit, it is necessary to have information about the activities required. If, for example, it is a condition that target price and target costs are used, then the target costs must be worked out on the basis of accurate analysis of the separate life cycle phases.[57] The specific market orientation in target costing is applied to determining the target costs of the product concerned. The starting point is the total target costs of a product units which are determined on the basis of any appropriate market research strategy and the amount of desired profit.

The difference between market price and target profit becomes the "allowable costs".[58] These represent the upper limit on costs allowed by the market. At this point a comparison can be made in a company between the calculated planned costs and the initial target costs. The target costs per product unit ascertained by this route serve as a guide to the subsequent calculation of individual target cost components.

After working out all the target costs for a product, these costs must basically be broken down as otherwise there is no sensible way of allocating them. The market-oriented determination of target costs is always based on customer requirements that refer to functions and characteristics of the product. This customer-related analysis stands in contrast to the traditional technologically oriented view. The comparison between the value that customers place on the product on the one hand and the cost comparison on the other hand often reveals clear discrepancies between the actual customer requirements and the ideas and judgments of the technicians, product development and designers in the company.

The planning process to work out the target costs takes as its starting parameters the market price and the company's idea of profit, both of which are a result of tactical and strategic planning. The company obtains market price information using a variety of market research instruments. For example, under conjoint measurement customers are asked to rate the product benefit and different prices.[59]

14.3.2.6 Skimming and Penetration Pricing Strategies

The information gathered in this way is used in strategic planning to develop a pricing strategy that relates to the entire life cycle of a product. The most well-known and most frequently used pricing strategies are the skimming strategy and the penetration strategy.[60]

The skimming strategy initially calls for a high price in order to then gradually reduce it. This strategy is aimed at short-term profits.

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[57] Brühl, R., Controlling (2004), p. 199.

[58] Sakurai, M., Target Costing and how to use it (1989), p. 43.

[59] Backhaus, K., Erichson, B., Multivariate Analysemethoden (2003).

[60] Brühl, R., Controlling (2004), p. 200.

The penetration strategy begins in the early periods with a very low price with the aim of winning market share and then achieving profits in the long term through scale effects and the experience curve effect.

In view of market-specific changes, there is the problem that a price may change in the course of the product life cycle. In this way it is not possible to definitively set the price. What price should one now set as the target price? Possible solutions are the entry price which comes from the pricing strategy, the lowest price or an average price.[61]

Under the skimming strategy, the entry price should not be used as this is not sensible if it is planned to reduce the price in the future.

Similarly, one can argue against the penetration strategy, as the price should be used as a strategic lever to win market share and potentially realise experience curve effects

Cost and profit calculations are based on a static model, so that price dynamics can only be represented with very rough estimates and assumptions. In a simple static model, average values must be calculated for the target price. The next important item of information is the amount of planned profit of the product, the target profit. It should be noted here that one is dealing with the profit per unit sold.

14.3.2.7 Working Out the Profit Per Unit Sold

The basis used here is the figure of company profitability.[62] This figure is to be preferred to use of the return on capital, as the latter is regarded as too difficult to calculate due to the difficulty of calculating the capital tied up.[63] The starting point for determining the target costs is the percentage return on sales, which indicates the relationship between profit and sales for which the company is aiming. The advantage of percentage return on sales is that if one knows the price of each product, which at the same time is the sales value of the product, it is very quick to calculate the profit per unit sold.

In practice, return on capital is seldom used for multi-period calculations because it takes so long and is so difficult to calculate the capital tied up. Key figures such as return on capital should therefore only be used as a single period measure.

Return on capital is considered as the definitive goal. However, it has a major drawback: how does one calculate the amount of capital tied up in each product? Only then is it possible to link the return on capital with the percentage return on sales through the capital turnover.[64]

$$R_k \frac{G}{K} = R_U * UH_K = \frac{G}{U} * \frac{U}{K} \, [\%]$$

[61] Brühl, R., Controlling (2004), p. 200.

[62] Sakurai, M., Target Costing and how to use it (1989), p. 43.

[63] Franz, K.-P., Target Costing (1993), pp. 124–130.

[64] Brühl, R., Controlling (2004), p. 201.

If the return on capital is the foremost goal of target costing, when specifying the percentage return on sales it is necessary to stick to a constant turnover rate for capital. The further the constant capital turnover falls, with percentage return on sales remaining constant, the faster this brings with it a falling return on capital.

If one relates the target price and the target profit, one obtains the target costs for the finished product:

$$K_z = p_z - g_z$$

14.3.2.8 Allowable Costs

Target costs (allowable costs) constitute the costs allowed by the market and represent the upper limit on costs per product unit. Assuming that the target price reflects the return that the company wants, this upper limit must be adhered to.[65]

Normally the planned or standard costs (drifting costs) are compared with the allowable costs. The allowable costs relate to the current state of technology. They are based on the expenditure which could arise within the company on the basis of existing technology and its application possibilities, but do not take into account the development and design costs in the innovation project.

To find a middle way, the target costs lie between the allowable costs and the drifting costs, as the costs prescribed or allowed by the sales market are deemed to be too low and unachievable. However, this method and approach do not appear very sensible if one assumes that the market prices are at a certain level and are not going to change. Thus the profit and return expectations of a company cannot be achieved.

In succeeding phases of breaking down the target costs, the formula for the target costs for the finished product is applied again, as it is necessary to plan the optimal costs for the new products. Only in a further step is it sensible to match this target value with the technological knowledge and technical possibilities in the company in order to make cost reductions and savings possible.

14.3.2.9 Breakdown of Target Costs

To apportion the target costs to the existing product, it is necessary to create and work out requirements for the individual components of the product from the overall target costs. This is a gradual process as technicians, developers and designers need figures which are as accurate as possible for their respective production processes. Only then is it possible to launch the product on the market with maximum profit.

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[65] Brühl, R., Controlling (2004), p. 201.

This planning process entails the following steps[66]:

- Break down the product into its characteristics and functions in order to emphasise the requirements desired by the customer.
- Weight all the characteristics and functions of the product in accordance with the customer ratings.
- Develop a pre-product or prototype which fulfils the characteristics and functions of the product.
- The product components of the prototype constitute the starting point for estimation of the costs. Separate cost proportions are developed for each component.
- The components are weighted by comparing the product functions which the product has to fulfil with the individual product components. An estimate is necessary to determine the weighting to give individual product component, reflecting how much of a given function it performs.
- Target costs for the individual product components must be determined with reference to their weightings and importance.

A breakdown of target costs leads to a gradual apportioning of the upper ceilings on cost to the various product components. The most important task is to apportion and determine the individual budgets in a market-oriented way, as the target costs basically have to be worked out for the finished product.

14.3.3 Hierarchical Levels of Revenue and Cost Items

This section presents the various hierarchical levels at which cost and revenue items are captured, e.g. products, orders, customers, market statements and companies. At each level the relevant costs are recorded; for the purposes of obtaining decision-relevant cost information, the costs are differentiated in terms of the potential to reduce them within the period under consideration.[67] Figure 14.6 illustrates the procedure graphically.

In most companies the product level costs are already available (contribution income statement) without any additional expenditure being required. The order-related costs are primarily determined by the number of orders processed, the order value, the shipping costs and the number of quotes required to generate an order. At the customer level there are costs which are determined by customer-specific product modifications, customer-specific services, discounts agreed and delivery terms.

Furthermore costs arise in relation to marketing (e.g. introductory offers, promotional gifts, customer visits), customer support (e.g. data maintenance, payment

[66] Brühl, R., Controlling (2004), p. 203.

[67] Coenenberg, A. G. (1999), p. 51 ff. and Fischer, T. M. and von der Decken, Tim (o. A.), p. 3.

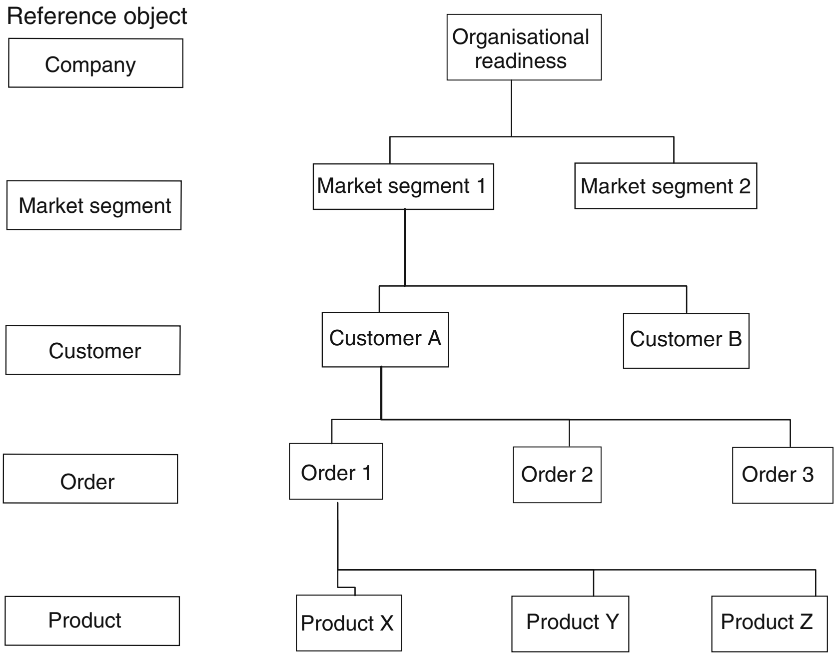

Fig. 14.6 Cost hierarchy [Source: based on Fischer, T. M. and von der Decken, Tim (o. A.), p. 3.]

reminders, credit assessment, customer service) and for maintaining customer relationships.[68]

In the area of market segments, there will be costs which cannot be assigned to individual customers but are attributable to a market segment, for example, advertising costs for particular market segments.

The highest level of the hierarchy contains costs which it has not been possible to causally allocate to any of the other levels. These are primarily readiness costs, for example, the cost of the Human Resources and Controlling departments, the company management team, rent and depreciation on the company premises.[69]

14.3.3.1 Calculation of Differentiated Customer Contribution Margins Using Process Costing

After the relevant costs of the individual levels of the hierarchy have been collected, the customer contribution margin can be worked out for a previously defined period. First of all the sales made to a customer in the period under consideration are obtained. Sales deductions (e.g. discounts, discounts for prompt payment,

[68] Fischer, T. M. and von der Decken, Tim (o. A.), p. 3 f.

[69] Fischer, T. M. and von der Decken, Tim (o. A.), p. 4.

volume-based rebates) are now deducted to arrive at the net revenue. In the next step, the various cost items are subtracted from the net revenue one by one.[70] The next Fig. 14.7 explains the procedure in more detail.

To work out customer contribution margin I, first of all the customer-specific direct costs of the reference parameters for product (standard manufacturing costs plus any costs for customer-specific product modifications), order and customer are deducted from the net revenue from the customer. Here one considers both the variable and also the fixed (direct) costs caused by the customer relationship.[71] To work out customer contribution margin II, the process costs of the product, order and customer hierarchy levels are subtracted from the customer contribution margin I. Fischer proposes that at this point one should also deduct the "costs of capacity that is not required" which result from the fact that the process cost rate for the reference objects is calculated with the maximum possible process quantity for the given resources and not with the budgeted or actually implemented process quantity. However, these costs should only be deducted if there is an identifiable causal relationship between "costs of capacity not required" and reference object (product, customer, order, market segment). The costs of capacity not required refers to those costs which result from partially utilised resources and can be calculated using the following formula[72]:

Customer costing using process costing			
	Customer sales revenue		
–	Customer sales deductions		
=	**Net customer revenue**		Net customer revenue
		–	Product direct costs
		–	Direct order costs
		–	Customer direct costs
		=	**Customer contribution margin I**
		–	Product process costs
		–	Order process costs
		–	Customer process costs
		=	**Customer contribution margin II**

Fig. 14.7 Calculation of customer contribution margin[73]

[70] Fischer, T. M. and von der Decken, Tim (o. A.), p. 5.

[71] Fischer, T. M. and von der Decken, Tim (o. A.), p. 5.

[72] Fischer, T. M. and von der Decken, Tim (o. A.), p. 5.

[73] Schmeisser, W./ Clausen, L., DStR 51–52/2005, p. 2198 ff., based on Fischer, T. M. and von der Decken, Tim (o. A.), p. 4.

$$\text{Costs of capacity not required} = \text{process cost rate} \times (\text{maximum possible process quantity} - \text{process quantity actually implemented})$$

14.3.3.2 Interpretation of Customer Contribution Margins

As customer contribution margin I only contains cost items which can be recorded as direct costs, this contribution shows directly what proportion of the profit in the period under consideration would not have come about without the customer relationship. Because the overheads have not been apportioned, customer contribution margin I reflects the customer profitability and thus is helpful for the decision regarding the composition of a profitable customer base. However, one should bear in mind that the direct cost items can sometimes contain fixed (direct) cost items (e.g. salary of a key account manager who looks after one major customer), which it is not possible to eliminate in the period under consideration.[74]

Customer contribution margin II is arrived at after deducting the overheads allocated to the customer using process costing. Some of these overheads, such as indirect salaries (invoicing, payment reminders, customer service, order processing etc.), could not be cut even if the business relationship with a given customer was terminated. "In this way customer contribution margin II should be interpreted primarily as an indicator of the customer-specific claim on the corporate resources".[75] Customer contribution margin II shows which customers or customer groups make more claims on corporate resources than is justified by the sales volume achieved. In this way, customer contribution margin II can be used to support strategic planning, since with its assistance it is possible to identify starting points for increasing profitability.[76]

The profitability of a customer changes over the entire cycle of the customer relationship. At the beginning of a business relationship the costs can exceed the revenues achieved, for example due to high customer canvassing costs. At later phases of the business relationship, this ratio ideally reverses and normally profits are achieved.[77] If, when one is interpreting the customer contribution margins, one ignores the pertinent phase of the customer relationship, this can lead to mistaken decisions such as premature termination of a customer relationship where customer contribution margin is negative.

When interpreting the customer contribution margins, it must be noted whether the data was worked out using historic revenue and cost items or with future planned figures. In principle, historic data cannot be extrapolated to future customer profitability for innovations, since not only the demand behaviour of individual

[74] Fischer, T. M. and von der Decken, Tim (o. A.), p. 7 f.

[75] Fischer, T. M. and von der Decken, Tim (o. A.), p. 8.

[76] Fischer, T. M. and von der Decken, Tim (o. A.), p. 8 f.

[77] Andon, Paul, Baxter, Jane and Bradley, Graham in Günter, Bernd and Helm, Sabrina (eds.) (2003), p. 301 ff.; Fischer, T. M. and von der Decken, Tim (o. A.), p. 9 and Franz, Klaus-Peter in Günter, Bernd and Helm, Sabrina (eds.) (2003), p. 445 ff.

customers but also their claims on corporate resources, the competitive environment and the production programme of the company could change over time. "To this extent, when interpreting customer contribution margins, market research data and analyses regarding future demand behaviour, the overall economic trend and customer-specific demand for new products coming onto the market must be included as well".[78]

14.3.4 From Customer Contribution Margin to Customer Cash Flow

The calculation of customer contribution margin is based on historic accounting data which does not consider all the liquidity relevant aspects. Also of interest are aspects relevant to financial success, which are included in categories such as expense and income as well as costs and payments. This suggests that one should derive the necessary planning data from the internal accounting profit data by using the calculation schema for customer contribution margin and concentrating on its liquid components. Revenue (corrected by sales deductions) definitely affect the cash position, whereas this is not entirely true for costs. Hence pure value-related cost elements, such as depreciation, have to be traced back to their original payment (e.g. acquisition cost). For a certain planning horizon (e.g. year, month) considerable differences can arise in this way between costs related purely to value and ones which entail a cash outlay.[79]

The next figure presents the detailed calculation of the customer cash flow, which is then explained in detailed below.

To obtain the customer cash flow, one starts by subtracting all the variable and fixed costs from the net revenue and eliminating through addition any non-cash costs which have already been deducted within the relevant cost type. These include fixed customer direct costs, for example, depreciation of fixed assets, which are neutralised in the line "Non-cash customer direct costs" as long as they do not entail any payments in the relevant period. Non-cash customer overheads could include, for example, imputed interest on equity. Finally, one still has to deduct investment-induced payments to the extent that the original payment falls in the period of the business relationship of interest.[80] Furthermore, when working out the customer cash flow one needs to be sure that cash receipts and earnings do not fall within different periods as is the case with credit sales or customer down payments. In the case of credit sales, the incoming payment surplus is less than the cash flow, whereas down payments from customers behave in the opposite way. Again, any difference in period between outgoing payments and expenditure, as in purchases on

[78] Fischer, T. M. and von der Decken, Tim (o. A.), p. 9.

[79] Schirmeister, R. and Kreuz, C. in Günter, B. and Helm, S. (eds.), Kundenwert (2003), p. 344 f.

[80] Schirmeister, R. and Kreuz, C. In Günter, B. and Helm, S. (eds.), Kundenwert (2003), p. 344 f.

Customer cash flow calculation			
	Customer sales revenue		
–	Customer sales deductions		
=	Net customer revenue		**Net customer revenue**
		–	Cost of materials
		–	Variable production costs
		–	Variable selling costs
		+	Variable non-cash costs
		=	**Cash-based product contribution margin**
		–	Depreciation of fixed assets
		–	Ongoing marketing costs
		+	Non-cash customer direct costs
		=	**Cash-based customer contribution margin I**
		–	Material overheads
		–	Production overheads
		–	Staff overheads
		–	Administrative and sales overheads
		+	Product advertising
			Non-cash customer overheads
		=	**Cash-based customer contribution margin II**
			Investment-induced payments
		=	**Customer cash flow**

Fig. 14.8 From customer contribution margin to customer cash flow
[Source: Schmeisser, W. and Clausen, L., DStR 51–52/2005, p. 2198 ff. Based on Schirmeister, R. and Kreuz, C. In Günter, B. and Helm, S. (eds.) Kundenwert (2003), p. 345 and Fischer, T. M. and von der Decken, Tim (o. A.), p. 4.]

credit, advance payments to suppliers etc., should be noted. With regard to advance payments to suppliers, the revenue surplus is once again lower than the cash flow.[81]

14.3.5 Capital Budgeting Based Summary for Customer Value

The period-specific customer cash flows worked out constitute the series of payments for the investment appraisal. To work out the value of a customer relationship, a method of dynamic investment appraisal, the discounted cash flow method, is used. The discounted cash flow method involves calculating the cash value, taking into account future customer cash flows or the difference between future incoming and outgoing payments, and discounting it at an internal rate of discount to the present point in time.[82] This method is primarily useful in the business-to-business area, i.e. where there are long-term business relationships and it is possible to make a reasonable forecast of future incoming and outgoing payments. Moreover, this method is

[81] Perridon, L.and Steiner, M. (2003), p. 564 f.

[82] Perridon, L.and Steiner, M. (2003), p. 61.

also suitable for fairly reliable values, i.e. where business relationships have a contractual basis, as in insurance companies or newspaper publishers.[83] The formula for calculating customer value (CV) is as follows:

$$CV = e_0 - a_0 + (e_1 - a_1)^* \, (1+i)^{-1} + (e_2 - a_2)^* \, (1+i)^{-2} + \ldots + (e_n - a_n)^* \, (1+i)^{-n}$$

Another way of calculating it is to use the "cash-based customer contribution margin" (CCCM) calculated in Fig. 14.8:

$$CV = -I_0 - CCCM_0 + CCCM_1 {}^* \, (1+i)^{-1} + CCCM_2 {}^* \, (1+i)^{-2} + \ldots + CCCM_n {}^* \, (1+i)^{-n}$$

where,

e_t = predicted customer-specific incoming payments for period t
a_t = predicted customer-specific outgoing payments for period t
i = internal rate of discount
t = period (t = 0, 1, 2,. . .,n)
n = duration of business relationship

The question of how the internal rate of discount is determined is discussed below.

14.3.6 Deciding on the Internal Rate of Discount

To calculate the net present value of a business relationship, the predicted cash flows have to be discounted at a suitable internal rate of discount. As the customer value constitutes part of the capital value of a company, it is recommended using the methods used to value companies and investment projects.[84] To fulfil the requirements of the investors, the weighted average cost of capital (WACC) can be used as the minimum interest rate. The cost of equity rate is determined on the basis of the capital market model (CAPM),[85] the aim of which is to determine a risk-adjusted required return for every capital investment.[86]

83 Fischer, T. M. and von der Decken, Tim (o. A.), p. 22.
84 Fischer, T. M. and von der Decken, Tim (o. A.), p. 25.
85 For further discussion, see Perridon, L. and Steiner, M. (2003), p. 119 ff.
86 Perridon, L. and Steiner, M. (2003), p. 119 ff. and Fischer, T. M. and von der Decken, Tim (o. A.), p. 26.

The cost of equity is calculated as follows:

$$\text{Cost of equity} = \text{risk-free interest rate plus risk premium for equity capital}$$
$$\text{Risk-free rate} = \text{“real” interest rate} + \text{expected inflation rate}$$
$$\text{Risk premium} = \text{Beta} * (\text{expected market return} - \text{risk-free interest rate})$$

The risk premium of the market represents the additional reward that investors require to invest in the company instead of in a “safe” investment.[87]

To determine the cost rate of borrowed capital, one should use the average of all the costs of borrowed capital incurred through customer relationships during the planning period.

14.3.7 Possible Uses of Customer Value and Interpretation of the Results

Depending on the size of the expected customer cash flows, the aggregate customer value may represent a substantial part of the company's value.[88] To the extent that the company management has set itself the goal of increasing the company value, the prospective customer value can be used as a measure to define payment objectives and monitor the attainment of objectives. Especially in the marketing area, use of the prospective customer value can support strategic decisions to the effect that the possible effects on their positive influence on customer value are examined in order to use corporate resources in a way that increases value. Analogous possible uses present themselves in the selection of new target groups, dealing with existing customers, the development of new products and the implementation of new marketing strategies. Through the direct connection between company and customer value, the benefits of strategic decisions can be examined directly from the point of view of potential investors.[89]

To the extent that the customer value is ascertained with the aid of process costing, the available data can be used to value a customer on the basis of the costs caused by the customer and thus to create the basis for optimisation of the overall customer base. Furthermore it is possible to deduce information on continuous optimisation of the business processes. However this presupposes that all the relevant payments (including overheads in the sales, production planning, scheduling, purchasing areas etc.) are captured, costed and charged in a customer- and process-specific way.

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[87] Rappaport, A. (1999), p. 46 f.

[88] Fischer, T. M. and von der Decken, Tim (o. A.), p. 28.

[89] Fischer, T. M. and von der Decken, Tim (o. A.), p. 28 f.

14.3.8 Key Figure Hierarchy for the Customer-Oriented Perspective

The key figure hierarchy for the customer-oriented perspective shows how one works out the customer contribution margin. First of all, any sales deductions are subtracted from sales, followed by all customer-specific direct costs and overheads, to arrive at customer contribution margin. To obtain the customer cash flow, the customer contribution margin is reduced by possible customer-relevant investment and increased by non-cash customer costs. The customer cash flow can then flow into the calculation of shareholder value as the value of one business area. (Fig. 14.9).

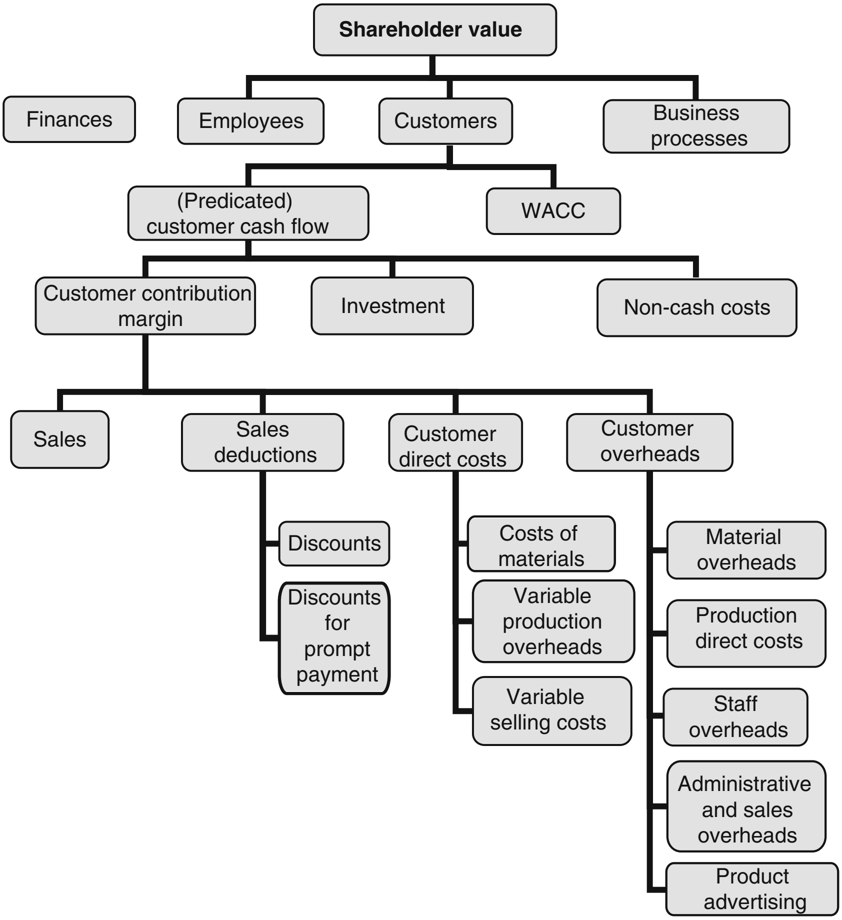

Fig. 14.9 Key figure hierarchy for the customer-oriented perspective
[Source: Schmeisser, W. and Clausen, L., DStR 51–52/2005, p. 2198 ff]

14.4 Integration of R&D into the Berlin Balanced Scorecard Model

Taking the example of the customer- and finance-oriented perspectives and also an independent, additional R&D-oriented perspective, the Berlin Balanced Scorecard is presented below as a way of integrating an innovation profitability analysis into the overall Berlin Balanced Scorecard model.

14.4.1 Differentiation of R&D According to IAS 38.8

The process of the internal creation of intangible assets within a company is divided over the phases: research and development. Under IAS 38.8, research is defined as the independent and planned search for new scientific or technical knowledge. Development integrates the results of the research or other knowledge into the planning and/or production for a product, significantly improved materials, systems, procedures or services.[90,91] IAS 38 covers both technological innovation processes and also all processes involving the development and creation of intangible assets. Theoretically and for practical purposes, development costs are downstream from research costs. In practice, there is often a reciprocal dependency which makes it difficult to draw a clear line between the two phases and hence to collect data.

14.4.1.1 Prerequisites for the Recognition of R&D Expenditure

According to the IAS, there is an obligation to recognise an intangible asset created within the development phase if the following conditions are cumulatively fulfilled (IAS 38.57)[92]:

- It is technically feasible to complete the project in the sense that it is available for economic exploitation by being used within the company or sold.
- There is an intention to complete the project and to exploit it through sale or use within the company.
- The ability to use the intangible asset within the company or to sell it exists.
- The future economic benefit can be shown, whereby amongst other things the company has to supply proof that there is a market for the intangible asset itself or for the products to be generated through it or, in the case of in-house use, that the asset concerned is useful.

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[90] Pellens, B. et al. (2004), p. 259 ff.

[91] For the two definitions, see IAS 38.8.

[92] Pellens, B. et al. (2004), p. 260 f.

- The necessary technical, financial and other resources required to complete the project can be shown or demonstrated to be available through a business plan or finance commitment (IAS 38.61).
- The manufacturing costs can be reliably assessed or measured (IAS 38.62).

In principle intangible assets are valued on acquisition on the basis of acquisition or production cost.[93] Based on the rules for tangible assets, the manufacturing costs cover all the costs which can be directly allocated to the creation, manufacture or preparation of the asset for its intended use.[94] Reporting them in the accounts at the fair value at the time of acquisition is only possible where they are acquired within the framework of a company acquisition or with the aid of public grants.[95]

After initial recognition, intangible assets can either be valued at net book value or using the revaluation method. However, the latter is only permitted if there is an active market for the assets concerned.[96]

If an intangible object fulfils neither the definition of nor the criteria for recognition as an intangible asset, then according to IAS 38 expenditure on this object must be charged as an expense at the time incurred.[97]

Since, according to IAS 38.63, it is not possible to prove a likely future benefit resulting from the project in the research phase, then according to IAS 38.21 (a), an intangible asset requiring recognition does not exist.

14.4.1.2 Capitalisation Rules for Self-Created R&D Expenditure

Irrespective of the distinction between research and development according to IAS 38.63 and the criterion for the recognition of development costs, the following self-created items cannot be recognised even if they constitute intangible assets within the meaning of IAS 38.7: brands, trademarks, printing and publishing rights, customer lists, customer relationships and the like.[98]

14.4.2 Key Figure Hierarchy for the R&D-Oriented Perspective of the Berlin Balanced Scorecard

The key figure hierarchy for the R&D-oriented perspective shows in what way costs can be integrated into the Berlin Balanced Scorecard. Starting from the sales of innovative products and/or services, the first step is to subtract the specific direct costs and overheads and also any sales deductions to obtain the R&D contribution.

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[93] IAS 38.24.
[94] IAS 38.66 f.
[95] IAS 38.33 f./ 38.40.
[96] IAS 38.75.
[97] IAS 38.68.
[98] Pellens, B. et al. (2004), p. 260.

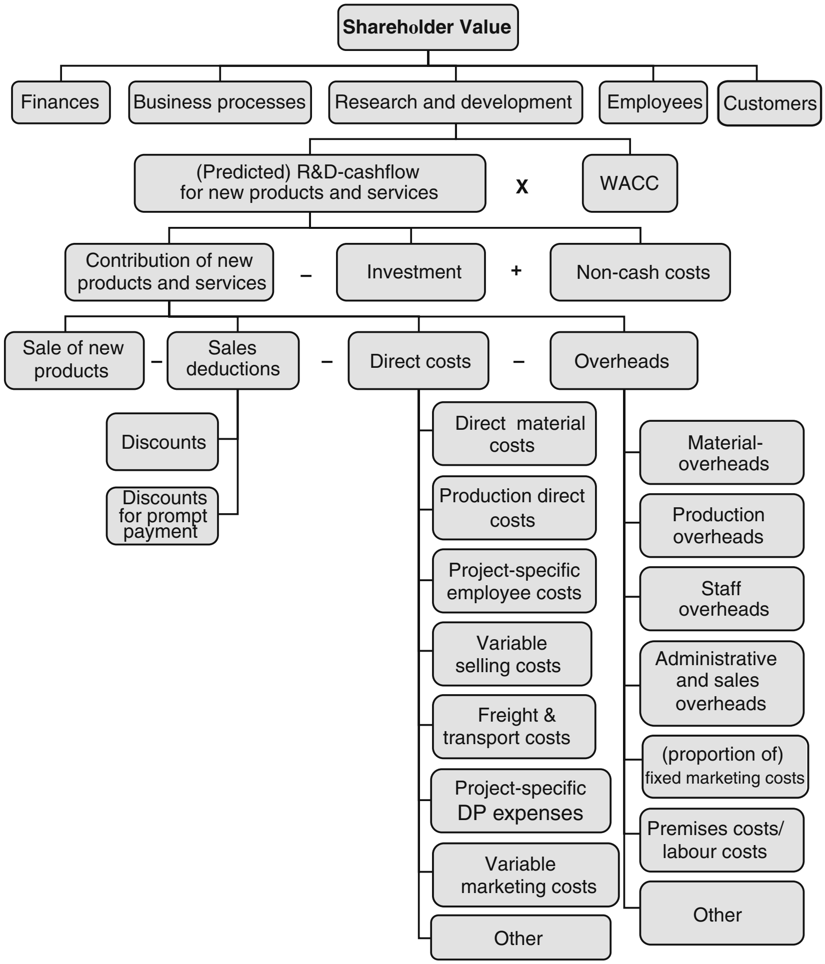

Fig. 14.10 Key figure hierarchy for the R&D-oriented perspective

To obtain the R&D cash flow, the R&D contribution is reduced by possible relevant investment and increased by any non-cash R&D costs. In this context, investment covers primarily capitalisable expenditure on licences, patents, usage rights, information, know-how of staff and research and development. The R&D cash flow can then flow into the calculation of shareholder value as the value of one business area (Fig. 14.10).

14.4.3 Model for Direct Integration of the R&D Area

Another possible way of integrating the R&D amounts into the original model of the Berlin Balanced Scorecard entails directly linking it to the customer-oriented

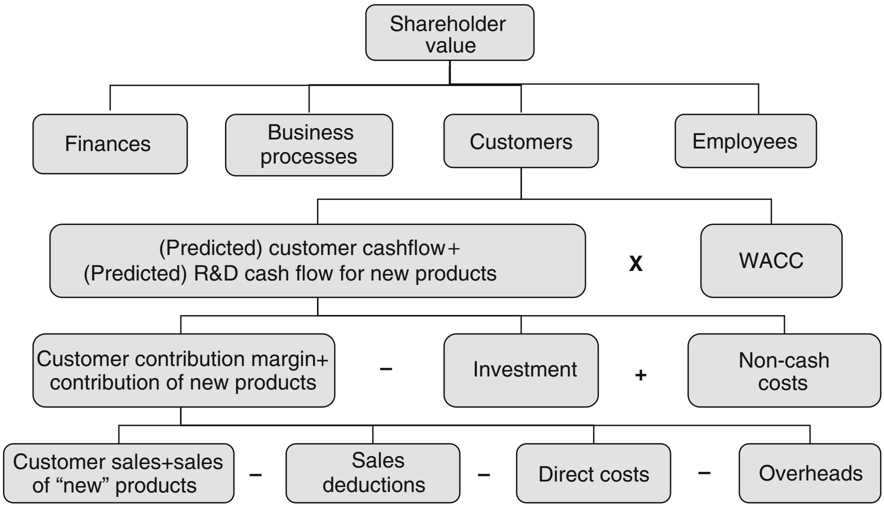

Fig. 14.11 Model of direct linking

perspective in the form of customer contribution margins in respect of innovative products and/or services.

The relevant values are ascertained in a manner similar to the calculation of R&D and customer contribution margins, and can be presented graphically as follows (Fig. 14.11):

14.4.4 Integration of R&D into the Finance-Oriented Perspective of the Berlin Balanced Scorecard

An alternative way of recording the profit contributions derived from innovations is to integrate these into the finance-oriented perspective of the Berlin Balanced Scorecard.[99]

The Berlin Balanced Scorecard (BBSC) is an important instrument for controlling business processes. It is the connecting link between the value-oriented goal of increasing the company value, the corporate strategy and the operational implementation.

The driver tree of the finance-oriented perspective of the Berlin Balanced Scorecard shown in Fig. 14.12 clarifies the relationship between shareholder value, Berlin Balanced Scorecard, cash flow statement and working capital, also the integration of R&D. The advantage of this presentation lies in the finance-specific,

[99] Schmeisser, W., Clausen, L., DStR 21/2007, p. 917 ff. also 22/2007, p. 964 ff.

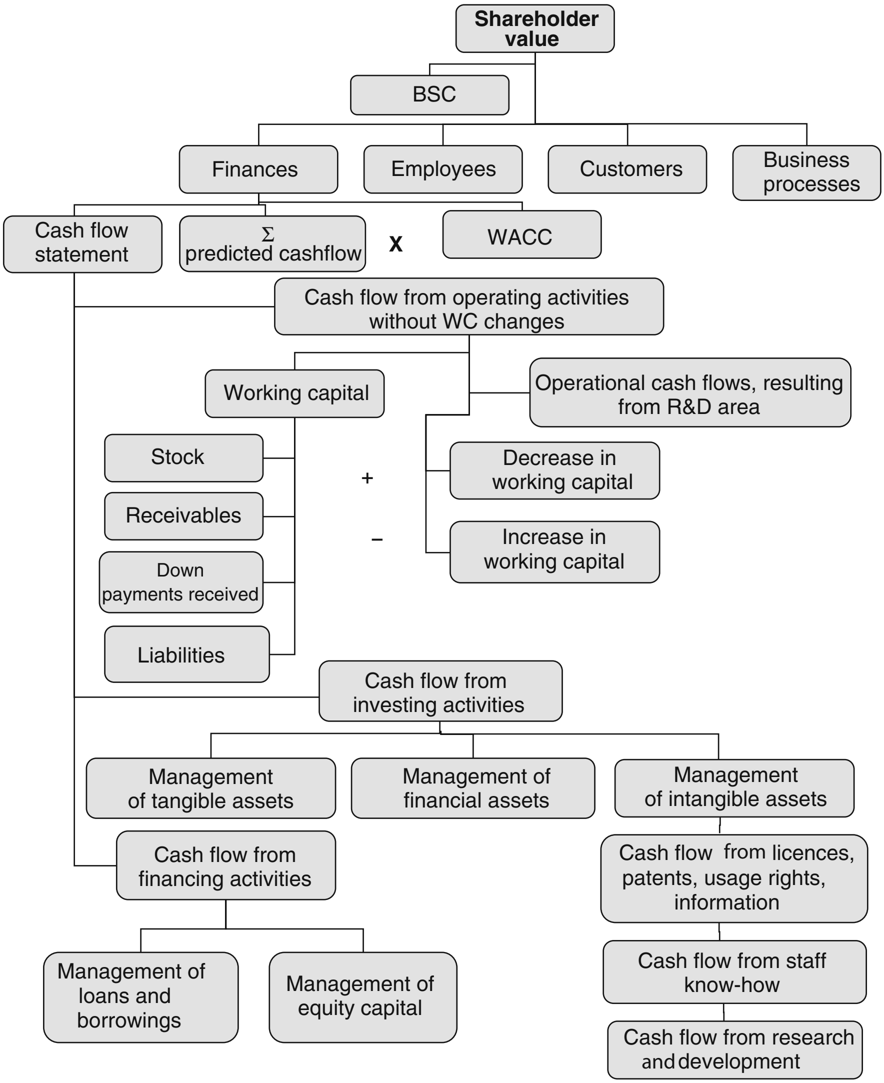

Fig. 14.12 Integration of R&D into the finance-oriented perspective of the BBSC [Source: based on Schmeisser and Clausen, DStR 22/2007, p. 967]

all-embracing presentation of the interrelationships of the cash-releasing components, thus preventing one from considering and optimising individual elements in isolation.

14.4.4.1 Management of the Operating Cash Flow

In the operational area, working capital management is extremely important. The function of working capital management is to optimise stock, receivables, down payments received and liabilities. As well as the monetary perspective – the structure of outgoing and incoming payments over time – working capital management also considers efficient production components, i.e. the efficient use of resources.[100]

Another important component in this area is the cash flows generated from R&D which, depending on the capability of the research area, can make a significant contribution, both now and on a sustained basis, to the overall profit.

14.4.4.2 Management of Cash Flows from Investment Activity

The directing, planning and control of cash flows from investment activity essentially covers the management of tangible assets, the management of financial assets and the management of intangible assets.

Management of tangible assets includes the planning, directing and control of investments/disposals in property, buildings, machinery and operational and business equipment for the purposes of determining the operationally necessary tangible assets for research and development purposes.

Management of financial assets covers acquisitions and disposals of shareholdings and securities, the repayment and taking out of loans, and the acquisition and sale of subsidiaries and other business units.

Management of intangible assets focuses primarily on the planning, directing and controlling of investments/disposals in licences, patents, usage rights, information, know-how of staff and research and development.

14.4.4.3 Management of Cash Flows from Financing Activity

This area divides into the management of loans and borrowings and equity capital management.

Management of loans and borrowings could place special emphasis on the drawing up of contracts when granting and taking up loans in order in this way to optimise the payment flows, e.g. payment of interest.

Equity capital management is concerned essentially with additions to equity capital, amongst other things profit retention and payments to shareholders, e.g. dividends.

14.4.5 Cash Flow Statement

Along with the balance sheet, profit and loss statement, details of changes in the equity capital and the notes to the accounts, the cash flow statement is a mandatory element of consolidated financial statements prepared according to the IFRS. The standard for drawing up a cash flow statement in individual and consolidated financial statements that is relevant to all IFRS users is the 2005 version of IAS 7. In

[100] Schmeisser, W., Clausen, L., DStR 21/2007, p. 917 ff. also 22/2007, p. 964 ff.

conjunction with the other elements of the financial statements, the cash flow statement provides the readers with information that enables them to obtain an insight into the financial situation of a company. Through comparison with planned liquidity figures, it is possible in this way to draw conclusions about the solvency of a company.[101]

Furthermore, through extrapolation of the cash flow for past periods it is possible to assess the timing and amounts of future cash flows and thus to assess a company's liquidity requirements.[102] Under the provisions of the IFRS, the amounts shown in the balance sheet and profit and loss statement are valued both on the basis of acquisition and production cost, but increasingly also in terms of fair value. In this way the values shown are also the result of interpretations and assumptions which have the effect of weakening the reliability of statements. Under the accrual principle required by the IFRS, expenditure and outgoing payments are not necessarily assigned to the same period as the related income and incoming payments. Hence, to create the payment streams for a given reporting period, separate presentation in the form of a cash flow statement is required. Due to the requirement to cover all payments and receipts in a given period, the cash flow statement is one of the few parts of company accounts that are largely comparable irrespective of which accounting standards are followed. Moreover, these days the future (free) cash flows normally supply the basis for the valuation of companies or parts of companies. With the aid of discounted cash flow methods, the first indications beyond the assessment of the financial situation as to company values can be derived from the cash flow statement.[103]

14.4.5.1 Basic Principles for the Creation of a Cash Flow Statement

The overarching framework principles also apply to the cash flow statement since it is a mandatory part of IFRS accounts. The essential principles are as follows[104]:

Principal of Clarity

The information must be presented in a manner that the recipients can understand. The individual items must be formulated in a clear and unambiguous manner.

Principal of Comparability

According to IAS 1.36 the previous year's figures must be included in the cash flow statement. If the structure or presentation of the cash flow statement has changed, then the comparison figures for the previous period must be adjusted accordingly.

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[101] Pellens, B. et al. (2004), p. 162.
[102] Pellens, B. et al. (2004), p. 163.
[103] Ibidem.
[104] Pellens, B. et al. (2004), p. 164 f.

Principal of Reliability

For the information to be deemed reliable, the following conditions apply:

- It must be free of material errors.
- It must be neutral, that is, free of deliberate distortion and manipulation.
- It must be credible.
- The calculation must be based on a financial perspective.
- Where uncertainty exists, it must be conservative and free of distortion.
- It must be complete.

It is important that all incoming and outgoing payments of the company are included.

Further, the gross principle must be applied to the cash flow statement. According to IAS 7.21, incoming and outgoing payments must not be offset against each other. The only exceptions are as follows (IAS 7.22–23):

- "Incoming and outgoing payments which are effected in the name of customers and are attributable more to activities of the customer than to activities of the company,
- Incoming and outgoing payments which result from postings involving a high turnover frequency, large amounts and short delivery times".[105]

14.4.5.2 Presentation of the Cash Flow Statement

The cash flow statement presents in detail the changes in liquid resources that have occurred during the past business year. The liquid resources cover cash and cash equivalent assets. They include cash and sight or demand deposits, also short-term, extremely liquid financial investments which can be converted to definite cash amounts at any time and are subject to only minor risk of fluctuations in value.[106] Figure 14.13 summarises this in diagrammatic form:

According to IAS 7.6, cash assets essentially comprises

- "cash on hand in euros and foreign currency
- sight balances with domestic and foreign banks (including central and postal banks)
- domestic and foreign postage stamps and any available franking equipment

[105] Pellens, B. et al. (2004), p. 165. "The two examples from the IASB specifically cited on the second point relate primarily to banks. Thus, loan amounts against credit card customers, the purchase or sale of financial investments or credit with a term of three months are cited (IAS 7.23)."

[106] Pellens, B. et al. (2004), p. 165 f.

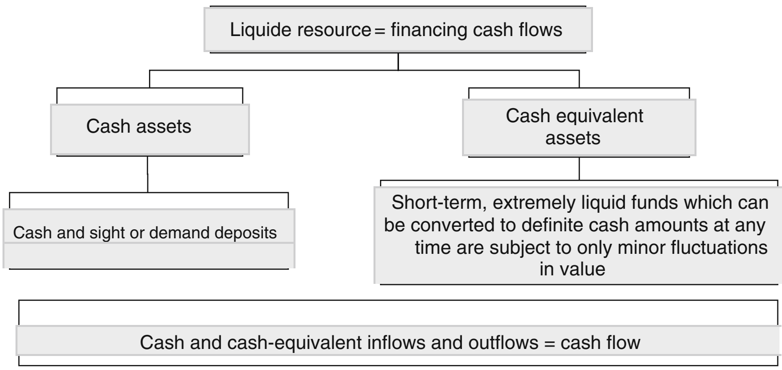

Fig. 14.13 Composition of financing cash flows
[Source: Pellens, B. et al. (2004), p. 165]

- cash and non-negotiable cheques which have not yet been cashed, as cheques are always due upon presentation irrespective of when dated (Article 28, German Cheques Act).

On the other hand, cheques issued must be deducted from the sight balances, even if the account has not yet been debited".[107]

Financial investments, which have a short term, can be transferred into cash assets without any problem and are subject to only minor risk of value fluctuation are also included under cash equivalents (IAS 7.6). The remaining life from the acquisition period is assumed to be 3 months (IAS 7.7). Shares cannot be included in the funds, except where the shares concerned by their nature constitute cash equivalents (IAS 7.7). According to the IAS, bank borrowings must basically be attributed to the financing activities of the company and therefore are not included in financing cash flows. Short-term liabilities (bank overdrafts) have to be included in the funds to the extent that they constitute an independent element of the cash management of the company (IAS 7.8).[108]

Payment streams in foreign currencies must basically be converted into the currency of the financial statements at the historic exchange rate at the time of the payment concerned (IAS 7.25). The currency conversion can for reasons of simplification be undertaken at weekly or monthly average exchange rates as long as there are not pronounced currency fluctuations (IAS 7.27 in conjunction with 21.9 f.). Payment inflows and outflows from extraordinary business activities must be shown separately (IAS 7.29).

[107] Pellens, B. et al. (2004), p. 165 f.
[108] Pellens, B. et al. (2004), p. 166.

14.4.5.3 Special Allocation Issues

Interest and Dividends

Cash inflows and outflows relating to interest and dividends must be shown separately. Interest paid and interest and dividends received can be shown either as part of ongoing operating activities (the normal case) or under investment and financing activities (IAS 7.33). Dividends paid can alternatively be assigned to the financing area (the normal case) or to ongoing operating activities (IAS 7.34). However, whichever method of presentation is chosen, consistency must be observed (IAS 7.31).[109]

Income Taxes

Income taxes must be shown separately under ongoing operating activities. However, tax payments which can be assigned to specific investing and financing activities must be reported under those areas (IAS 7.35–36).[110]

Acquisition and Sale of Subsidiaries and Other Business Units

Payment streams from the acquisition and sale of consolidated companies and other business units must be shown as separate items under investing activities (IAS 7.39).[111]

Non-cash Transactions

Business transactions which do not lead to change in funds should not be included in the cash flow statement. These have to be reported in additional notes (IAS 7.43).

14.4.5.4 Breakdown and Structure of the Cash Flow Statement

IAS 7 does not impose any formal requirements on the presentation of the cash flow statement. Comparative figures for the previous period must be provided (IAS 1.38). The cash flow presentation is divided into three major areas (IAS 7.10), to which the inflows and outflows of cash and cash equivalents must be assigned. Figure 14.14 shows the rough structure in vertical format.[112]

To meet the information function of the cash flow statement, the individual cash flows from operating, investing and financing activities have to be broken down further.

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[109] Pellens, B. et al. (2004), p. 169 f.
[110] Pellens, B. et al. (2004), p. 170.
[111] Pellens, B. et al. (2004), p. 175.
[112] Pellens, B. et al. (2004), p. 171.

	Cash receipts from operating activities
–	Cash paid in connection with operating activities
=	**Cash flows from operating activities (1)**
	Disposals
–	Cash paid to acquire investments
=	**Cash flows from investing activities (2)**
	Cash receipts from financing activities
–	Cash paid in connection with financing activities
=	**Cash flows from financing activities (3)**
	Net change in cash flow ((1) + (2) + (3))

Fig. 14.14 Rough structure of cash flow statement
[Source: Pellens, B. et al. (2004), p. 171]

Payment inflows and outflows from operating activities can be presented by either the direct or indirect method (IAS 7.18 ff.). For payment inflows and outflows from investing activities and financing activities, only the direct method is permitted (IAS 7.21).

For the presentation of cash receipts and payments, basically the gross principle and the consistency principle apply. However, net presentation is permitted for individual named payments streams (IAS 7.22 ff.).

Cash Flow from Operating Activities

If the direct method is used to arrive at the cash flow from operating activities, it must be done directly on the basis of inflows and outflows of cash and cash equivalents. Based on German Accounting Standard 2 (GAS 2), the presentation could be as follows (Fig. 14.15):

The indirect method calculates the cash flow from operating activities as presented in the profit and loss statement (Fig. 14.16). The net income for the period

	Cash receipts from customers
–	Cash paid to suppliers and employees
+	Other cash receipts which are not attributable to investing or financing activities
–	Other cash payments which are not attributable to investing or financing activities
–	Income taxes paid
+/–	Cash receipts and payments from extraordinary items
=	**Cash flow from operating activities**

Fig. 14.15 Direct presentation of cash flow from operating activities
[Source: Pellens, B. et al. (2004), p. 173]

	Net income for the period before extraordinary items and taxes
+/–	Depreciation/write-ups of non-cash assets
+/–	Increase/reduction in reserves
+/–	Other non-cash expenditure/income
–/+	Profit/loss from retirement of fixed assets
–/+	Increase/decrease in stock, trade receivables and other assets which are not attributable to investing or financing activities
+/–	Increase/decrease in accounts payable and other liabilities which are not attributable to investing or financing activities
–	Income tax payments
+/–	Cash receipts and payments from extraordinary items
=	**Cash flow from operational activities**

Fig. 14.16 Indirect presentation of cash flow from operating activities
[Source: Pellens, B. et al. (2004), p. 174]

before extraordinary items and income taxes is adjusted for non-cash business transactions. The necessary correction steps required under IAS 7 based on GAS 2 are shown in the next figure

Cash Flow from Investing Activities

When it comes to the presentation of cash flow from investing activities, once again the IASB does not prescribe any minimum breakdown requirements. The direct method to be used shows separately every main class of gross receipts and gross payments. If the breakdown schema given in GAS 2 is used, one obtains the following (Fig. 14.17):

	Cash receipts from the disposal of non-cash assets
–	Cash paid on investment in non-cash assets
+	Cash receipts from the disposal of intangible assets
–	Cash paid on investment in intangible assets
+	Cash receipts from the disposal of financial investments
–	Cash paid on investment in financial investments
+/–	Cash receipts and payments from the acquisition and sale of subsidiaries and other business units
=	**Cash flow from investing activities**

Fig. 14.17 Direct presentation of cash flow from investing activities
[Source: Pellens, B. et al. (2004), p. 174]

	Cash receipts from additions to equity
–	Cash paid to equity providers
+	Cash receipts from the issue of loans and taking up of borrowings
–	Cash paid out for the redemption of loans and borrowings
=	**Cash flow from financing activities**

Fig. 14.18 Direct presentation of cash flow from financing activities
[Source: Pellens, B. et al. (2004), p. 175]

As shown in the above figure, acquisitions and sales of subsidiaries and other business units are counted as investing activities (e.g. the acquisition of Schering by Bayer AG). According to IAS 7.39, payment streams from the acquisition/disposal of consolidated companies have to be classified as investing activities and shown separately; their amount is calculated as the purchase/sales price minus cash/cash equivalents received or paid (e.g. the exchange of shares).[113]

Changes to the companies included in the consolidation are non-cash transactions and therefore are not included in the cash flow statement.

Cash Flow from Financing Activities

Once again the cash flow from financing activities is only presented using the direct method and covers the payment streams resulting from transactions with the company's proprietors and minority shareholders and consolidated subsidiaries as well as the taking up or repayment of loans.[114] GAS 2 recommends the following presentation (Fig. 14.18):

14.5 The Link Between Shareholder Value and the Berlin Balanced Scorecard

The linking of the shareholder value approach with the Berlin Balanced Scorecard as a method for the identification and measurement of value-oriented performance indicators leads to value-oriented management (value-based management). However, the problem of consistently applying the shareholder value approach manifests itself in the fact that the corresponding value drivers are seldom transferred into operational management and hence to the middle and lower levels of management. Performance figures which have an indicator function for the increase in value have to supplement existing management and control instruments. The key figure hierarchy of the customer-oriented perspective constitutes the link between the BSC perspectives and the created shareholder value. When one considers the individual

[113] Pellens, B. et al. (2004), p. 174 f.

[114] Source: Pellens, B. et al. (2004), p. 175.

	Cash value of predicted operating cash flows
+	Cash value of residual value
+	Market value of securities traded on the stock exchange
=	Company value
–	Market value of borrowed capital
=	Shareholder value

Fig. 14.19 Calculation of shareholder value according to Rappaport[116]

perspectives of the BSC as business areas of a company, it becomes clear that the total of the predicted cash flows represents the calculation basis for shareholder value, which according to Rappaport is composed as follows (Fig. 14.19):

Just calculating the shareholder value does not bring a company any increase in value. Rather, it is necessary with the aid of the Balanced Scorecard to actively and systematically design the process of identifying, formulating and implementing a strategy in order in this way to successfully implement strategies and thus increase the company value. This presupposes that the effects of strategic decisions on company value can be quantified. By working out quantitative parameters for every perspective, it is possible to explicitly identify those factors of shareholder value which increase and decrease the company's value. As soon as the problem area has been identified, remedial action can be taken in respect of those cost factors which influence value through detailed research of causes within the corresponding key figure hierarchy.

14.6 Summary

The foremost objective of every company must be to continuously increase profitability. Due to the propensity of market situation and customer needs to change, this objective can no longer be achieved just by increasing sales volume. The creation of long-term ties with customers is becoming a critical competitive advantage. Products/services which are geared towards customer needs and cultivation of individual customers are the critical variables for permanently improving customer loyalty. In this connection it is particularly important to know and make use of a customer's preferences.

Here the models presented for integrating the fruits of innovation make detailed analysis possible. Separate capture of the individual components and ultimately of the proportion of total profit attributable to "new products/services" brings out the innovation productivity on the one hand and the satisfaction of customers with the products/services offered on the other hand.

Through integration of the fruits of innovation into the model of the Berlin Balanced Scorecard we obtain a concept that directly brings out the proportion of value increase in the company profit. Close integration of the concept into external accounting enables seamless integration into the planning and finance publicity process of the company. Moreover, the relevant parameters are subject to external auditing, so that the credibility and acceptance of the concept are assured, even for analysts outside the company.

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