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HUMAN RESOURCE MANAGEMENT

Human resource management (*HRM*) had early developments in large organizations such as the militia and religious institutions in which objectives were clear and command structure was hierarchical with a monarch, general, or archbishop at the apex. Successful in building empires, winning wars, and spreading the faith, the organizational structure was adopted by government agencies and business entities, as they grew in size and complexity, with decision-making vested at the top and orders flowing downward. Employees were instructed in all facets of their jobs with work behavior becoming routinized over long periods of drill and practice. Work required little knowledge and thought, and interaction with sophisticated machinery was nonexistent. Worker rights were unknown and employment conditions frequently unhealthy and even dangerous. Employers and managers viewed the worker as an automaton on par with the simple tools that may have been used.

Changes emerged after the American Revolution with its democratic underpinnings of individual freedom together with the Industrial Revolution of mass production, sophisticated technology, and division or specialization of labor. The spread of political self-determination logically led to human rights and organized labor especially in the United States. Union leaders successfully won greater compensation and benefits in exchange for higher worker productivity gained in large measure through the installation of machinery on the factory floor and the adoption of uniform work rules and standards. These gains, however, left the worker of secondary importance to the machine, and output was determined by how fast and how long the line was operated.

The Industrial Revolution, begun largely in England, and the independence of the American colonies resulted in a major flow of technology, capital, and people from Europe to the New World. Technology transfer and capital investments were motivated by business profit and financial return while immigration was undertaken for political freedom and economic opportunities. All movements were sustained by the powerful economic growth of the American economy as well as the lack of intrusion in the private sector by a fledgling and splintered central government. This was in contrast to efforts by Great Britain to prevent the new technology from going abroad even if it meant detaining individuals with technical know-how from international travel and/or immigration. Export permits for most technology and equipment (including blueprints) were disallowed.

Over time, the vastness of the British Empire, the prominent role of its international trade, and the growing power of its capitalist and banking classes undermined the government's efforts at stemming the technological outflow. Foreign business branches, the necessary training of overseas workers, the immigration of skilled workers, managers, and inventors to (former) colonies spread the seeds of the Industrial Revolution. The diaspora was abetted by the uninhibited outflow of capital from London, then the world's financial capital, for the infrastructural development of railroads, ports, and canals in the newly industrializing areas. London's source of capital was derived from profits of both its early industrialization and international trade in its far-flung empire. British capital underwrote the sale of bonds for overseas projects with investors attracted by the high rates of interest on these financial instruments compared to comparable domestic bonds. The availability of capital and introduction of technology created a shortage of labor needed to operate the new factories and machines and work on massive development projects like the building of cities and the intercontinental railroad. Immigrant labor would take up much of these tasks in the middle of the nineteenth century, and the severe working conditions prompted calls for work reform by labor unions, government, and social agencies.

The building and operation of capital assets—machines, assembly lines, plants—however, would continue to take precedence over a firm's human resources.

Fordism and Scientific Management

At the beginning of the twentieth century, production processes would be greatly altered by (1) the startup of the Ford Motor Company in 1903 and (2) the publication of *Principles of Scientific Management* by Frederick Winslow Taylor in 1911 based on his work in the steel industry. The mass production plant of Henry Ford and the time and motion studies of Taylor would tacitly acknowledge the importance of the human machine operator in increasing output and productivity even as labor unions were declaring such practices dehumanizing and undemocratic. Because of the complexity and fast-paced nature of the new processes as well as sophisticated machinery used and products made, the production worker now required training and skills in specific jobs with oversight provided by experienced supervisors knowledgeable in the operations of the factory floor. Workers could also turn to increasingly powerful labor unions like the United Auto Workers for better supervision and working conditions. Employee concerns were beginning to be addressed by company employment departments, with the B. F. Goodrich Company launching the first such group in 1900.

Although Henry Ford is better known for developing the Model T automobile, his assembly line innovations in manufacturing processes remain his greatest contribution to industrial history. These included:

- Standardized parts and assembly times
- An automatic conveyor belt to carry the car chasis upon which the Model T was assembled
- Division of labor with specialized, routine worker skills
- Mechanization to bring parts to individual work stations along the assembly line
- Automatic tools to expand worker capability, reduce job times, and improve quality of mass-produced items
- Economies of scale to bring down per unit costs and the price of each car, enabling the mass marketing of mass-produced Ford automobiles

Many of these process innovations are still widely used. The Model T, on the other hand, became obsolete in Ford's day by the rising affluence of the American public and its increased desire for product styling, comfort, and performance.

Henry Ford's assembly line divided work into discrete jobs and Taylor would establish time standards of performance using stopwatch measurements and statistical methods. Such time and motion studies would come under the purview of human resource departments with results transmitted to other technical areas such as plant layout and process design. Job description, hiring, and training were also centered in personnel departments with their influence in the corporation increasing as their methods and practices led to greater output, higher productivity, and increased profits.

Standardized Production Times. With the use of Taylor's scientific management principles, a plant's output and worker's productivity could be quantitatively determined. Since these had direct impact on profits, top management was more inclined to experiment and adopt productivity enhancing conditions as the Hawthorne studies at Western Electric demonstrated in the 1920s. The study concluded that concern and attention for safe, working conditions were motivating factors for increasing plant productivity even though output would still be determined by how long and how fast the machine or assembly line was operated. Determinants of output were codified in equations calculating the number of machines, M, needed to complete a certain job or similar jobs as given by Krajewski and Ritzman (1).

$$M = \left(\sum D_i P_i + \sum (D_i/L_i) S_i\right)/N\left(1 - \frac{C}{100}\right) \qquad (1)$$

where D is the number of units to be made of a particular product, P and S are product processing and machine setup times, L is the lot size per run, D/L is the number of lots requiring machine setup, N is the amount of machine time available, and C is an allowance for downtime. The machine time N is dependent upon the number of days the machine is operated in a given production period multiplied by the number of shifts per workday and the hours per shift. The human operator worked whenever the machine was operated, which was as continuously as possible, in order to (1) keep up with demand for the product, (2) permit the capitalization of fixed equipment costs over a longer production run, and (3) extract as much use before advances in technology made the machine or operation obsolete.

The length of production runs is highly dependent upon the processing times of Eq. (1), which were determined using Taylor's scientific measurement techniques. In calculating standard processing times for a job, the entire task was broken into discrete parts with each part timed and the data from several trial runs statistically averaged. Since the processing time depended upon the operator's work efficiency at inputing and handling the material or machine, the processing time was standardized by the performance rating of the worker doing the job. Operators were consequently tested and rated by employee relations departments for each task performed with a rating of 100% the norm (with faster workers having ratings less than 100%). The averaged processing time was then multiplied by the operator's efficiency rating to yield the standard time. Specific human factors increasing processing time included break time and allowances for illness, fatigue, and other unavoidable delays. These increased the standard time by about 15% and were routinely added to work schedules to boost productivity, morale, and safety.

Employee Learning

As manufacturing and its underlying technology became increasingly complex, the productivity and training of skilled workers have become integral management aspects of a company's competitiveness. Simple products could be easily fashioned with simple tools used by unskilled laborers, but sophisticated, automated, computerized equipment required on-the-job learning even for highly trained operators. Smart machines are currently custom-made, computer-controlled, and dedicated to particular processes with advancing technology and shifting consumer tastes frequently making these capital assets obsolete within a short period of time. Such obsolescence necessitates the redesign of production processes and the learning of new work routines by human operators. Efficient on-the-job learning translates into faster assembly times and conversely into reduced labor requirements, worker hours, and costs (1). Per unit labor costs thus decrease with experience as the number of finished units, n, is increased. The drop in skilled worker time is frequently exponential with the falloff described by

$$k_n = k_1 n^b \qquad (2)$$

where the nth k is the time required to make the nth unit, the first k is the corresponding time for the first unit, the exponent b is the ratio of log r divided by log 2, and r is the learning rate (usually 80%–90%). With $r < 1.0$, log r and the exponent b are negative, thus making successive k's serially smaller than the value of preceding k's. The application of Eq. (2) can be demonstrated as follows. If the first k, the time it took to make the first unit, equaled 100 h, with r equal to 90% learning, the second unit could be completed in 90 h, while if

Table 1. Calculation of Labor Requirements with Learning

Week	Production Units	Cumulative Labor Hours	Labor Hours Per Week	Number of Workers	Labor Costs
1	5	373.78	373.78	9.3	$ 9,300
2	8	766.48	392.70	9.8	$ 9,800
3	15	1334.70	568.22	14.2	$14,200

r equaled 80%, the second unit would take only 80 h. Such improvements do not occur in even smart machines with which processing times usually deteriorate with use.

When labor costs are a major manufacturing component, the degree of learning can be factored into future cost-price considerations as is done in the pricing of future generations of memory chips. In contract bidding for lengthy projects, the labor requirements for individual work periods can be calculated by numerically integrating Eq. (2) over the number of units produced. The labor hours required, the number of workers, and their labor costs can then be estimated as shown in Table 1. A simple schedule for a three-week production run with worker learning of 80% permits greater production during the second and third weeks without commensurate increase in labor costs. If the first unit is expected to use 100 labor hours, then the time to produce five units in the first week would be, in the absence of learning, 500 h. If each worker had a 40-h work week, the number of workers needed would be 12.5. With each worker earning $1,000 per week, labor costs are $12,500. In contrast, with an 80% learning rate, only 9.3 workers are needed in week 1 for costs of $9,300. The cumulative labor hours listed in week 2 is for the cumulative 13 units produced in the two weeks. The hours required for week 2 alone is the difference between the cumulative hours for the first two weeks. Even with the greater production in weeks 2 and 3, the number of workers and their costs do not rise proportionately. For example, in week 3, the number of required workers would come to 14.2 insted of 37.5 and costs would be $14,200, a huge saving compared to $37,500 without employee learning.

Human Resource Management

The numerical parameters used in the preceding calculation are usually estimated by the HRM department with the learning gains contingent upon how well important functions such as hiring, training, remuneration, employee development, and labor relations are carried out. HRM duties also increase as business pursues markets abroad with foreign production and government regulations becoming integral to a firm's operations. The work is complicated by the difference in environmental, civil and human rights, labor, occupational safety, child labor, equal employment laws, and practices among host countries. Because technology transfer, marketing, worker training, and negotiations have usually not been tried in diverse cultural settings, these activities are frequently undertaken on an ad hoc basis with the HRM department taking on a greater role in systemizing the work.

In turn, the shifting global environment and technological advances are restructuring much of HRM, even as immediate concerns focus on such tasks as staffing of the business or branch, employee appraisals and compensation, training and development, planning and information analysis, legal compliance, interaction with other functional or staff areas such as the production department or technical analysis, improving quality of work life, and worker productivity. The tasks, furthermore, must be undertaken within the operating framework governing the firm. Laws, economic conditions, business competition, the labor pool from which workers are drawn, available technology, organization and the firm's hierarchy, corporate culture, outlook, and goals of top management all impact on decision-making in the HRM department.

Legal Framework. While many business influences are often random events, peculiar to individual circumstances, a country's legal framework such as that in the United States can be explicitly detailed as in Table 2. The laws enacted in the 1930s recognizing organized labor and the rights of workers were a direct result of the Stock Market Crash of 1929 and the Great Depression. The laissez-faire policy that had accompanied America's industrialization and economic growth since the Revolution was abandoned with the presidential election of Franklin D. Roosevelt running on his New Deal platform. In addition to the labor legislation, the Roosevelt presidency signed into law the first Social Security Act in 1935, which provided for retirement benefits on a national basis, independent of a worker's place of employment. Later amendments to the act would also codify benefits for disabled workers and in 1965 enact the Medicare federal health-insurance program for people over 64 years old. While the federal government would attempt to balance its prolabor legislation of the 1930s with the Taft-Hartley Act of 1947, its move into social welfare programs would continue unabated with the Civil Rights Act of 1964, creation of the Occupational Safety and Health Administration (*OSHA*) in 1970, creation of the Environmental Protection Agency in 1970, and the Employee Retirement Income Security Act (*ERISA*) of 1974. Financing for these programs had already been provided prior to the Great Depression in 1913, with ratification of the 16th Amendment to the Constitution, establishing the graduated, national income tax. The stature of the federal government, in the eyes of its people, was also elevated by ultimate victories in both World Wars and economic recovery from the depression. In effect, the central government became the insurer of last resort as companies and their retirement programs went bankrupt, downsized, or left the country and as membership faltered in labor unions. High educational attainments of the electorate abetted the transition as voters used the political process to support continuation and expansion of government benefits and welfare regulations especially under the Social Security program. These took on global dimensions when industrializing countries throughout the world enacted legislation paralleling the laws in Table 2 forcing HRM departments to adhere to these mandates as they ventured abroad. In addition, multinational enterprises were often pressured by American consumer groups and the media to curb, for example, the exploitation of child labor in sweat shops located in low-cost, third world countries. International business practices, coming under greater scrutiny, were becoming uniform.

The Human Resource Department. Whether involved in international activities or not, all business enterprises engage in HRM practices such as employment and staffing, compensation and benefits, training and development, and employee (formerly, labor) relations. The competitive business environment, the advent of the "knowledge worker" and rapid-on-the-job learning, and national laws ensure that these activities must be performed in a systematic, intelligent manner if the enterprise is to succeed. In large organizations, the importance of these responsibilities means that the human resource vice president or manager must have clear access to top management as well as other important functional areas such as production, research and development (*R&D*), engineering, and marketing—all staffed by the HRM department—to ensure compliance with, for example, equal employment regulations and civil rights legislation.

Employment and Staffing. Recruitment of new employees has perennially been the most notable HRM activity with the employment department responsible for writing job descriptions for open positions and preparing the recruitment program in coordination with line managers who may be at distant facilities. Hiring in a highly professional field like electrical engineering (*EE*) is particularly problematic because (1) booming markets have increased the demand for EE graduates at all degree levels, (2) the supply of graduates is constricted by the rigor of the EE curriculum, which discourages students, (3) the high cost of laboratory equipment and instruction prevents many educational institutions from offering the major, (4) federal funding for EE programs especially from the Department of Defense has notably diminished, (5) advances in science and technology quickly make training in electronics obsolete, (6) top engineering personnel frequently are promoted into management positions or leave the firm for entrepreneurial reasons, (7) a large percentage of engineering graduates are from abroad and may have visa or immigration problems, (8) growing markets and

Table 2. U.S. Laws Affecting the HRM Department

Year Enacted	Legislation	Focus of Legislation
1931	Davis-Bacon Act	Pay prevailing wage rates
1935	Wagner Act	Legitimized unions
1938	Fair Labor Standards Act	Requires premium pay rates for overtime; restricts child labor
1940	Investment Company Act	Established mutual fund industry
1947	Taft-Hartley Act	Balanced union power
1963	Equal Pay Act	Requires equal pay for equal jobs
1964	Civil Rights Act	Prohibits discrimination
1967	Age Discrimination in Employment Act	Adds age to protected group status
1970	Occupational Safety and Health Act (OSHA)	Protects workers from workplace hazards
1974	Privacy Act	Permits employees to review personnel files
1974	Employee Retirement Income and Security Act (ERISA)	Protects employee retirement funds
1976	Health Maintenance Organization (HMO) Act	Requires alternative health insurance coverage
1978	Mandatory Retirement Act	Raises mandatory retirement age from 65 to 70; uncapped in 1986
1986	Immigration Reform and Control Act	Requires verification of citizenship or legal status in the United States
1986	Consolidated Omnibus Budget Reconciliation Act	Provides for benefit continuation when laid off
1988	Employment Polygraph Protection Act	Prohibits use of polygraphs in most HRM practices
1989	Plant Closing Bill	Requires employers to give advance notice to affected employees
1990	Americans with Disabilities Act	Prohibits discrimination against those with disabilities
1991	Civil Rights Act	Overturns several Supreme Court cases concerning discrimination
1993	Family and Medical Leave Act	Permits employees to take unpaid leave for family matters

Source: Adapted from David A. DeCenzo and Stephen P. Robbins, *Human Resource Management*, 5th ed. Copyright © 1996 by John Wiley & Sons, Inc. Reprinted by permission of John Wiley & Sons, Inc.

new positions may be in foreign locations, (9) "raiding" of personnel by competitor firms or losing employees to nearby firms as in Silicon Valley is common, (10) the high cost of living in high-tech centers discourages employees from relocating, and (11) stressful working conditions frequently engender engineer burnout.

Data from the 1995 Annual Report of the Intel Corporation (2) illustrate the dynamic nature of employment at the multinational enterprise. The number of employees at Intel increased from 18,200 in 1986 to 24,600 in 1991 and 41,600 in 1995. While two-thirds of the 9,000 employees hired in 1995 was for manufacturing—many in foreign countries—Intel's R&D spending increased by close to 19% compounded annually over the same ten-year period, indicating its strong need for engineers and scientists in new product and design development.

On-line Recruitment. With the growing use of the Internet in commerce and communications, elaborate recruiting Web sites by enterprising companies have been launched to attract qualified applicants. Compaq Computer Corporation, headquartered in Houston, Texas, lists nine career areas on its current openings Web pages (3), which include design and development in hardware and software engineering, information management, manufacturing/operations, and business planning. The page on career opportunities is followed by a recruitment schedule, one of which was for 17 specific locations where company representatives had interviewed job candidates in April and May 1997. The exact day, time, interviewing center address, and local phone number where information is available was specified for each location. The 17 listings are spread throughout the country with stops in Boston, Philadelphia, New York, Chicago, New Jersey, St. Louis, Denver, Phoenix, Las Vegas, San Jose, and Los Angeles. To assist in this nationwide recruitment effort, Compaq has further installed informative Web pages about the corporation, its college recruitment activities, submitting a resume to the company, and life in the Houston area. Such competitive recruitment particularly for engineering personnel has become commonplace among electronics, computer, and semiconductor companies. At the center of these efforts, the HRM department has important follow-up tasks once the job applicant becomes interested in the company.

Compensation and Benefits. Starting salaries in electrical and electronics engineering play crucial roles in recruitment of qualified personnel. Moreover, employers in booming markets are forced to pay competitive rates with frequent, periodic surveys of the labor market conducted to determine suitable compensation scales. A considerable quantity of competitive information and data is already available in the recruitment files of large companies in which accounts of interviews, job offers made and accepted, follow-up interviews of candidates and hiring managers give an overall picture of professional labor rates. Compensation must also be integrated in the long-term growth and profit projections of the firm. This is done to avoid a “boom and bust” cycle in which huge starting salaries are used to attract engineers who proceed to leave the company or are dismissed when revenues and work falter.

Stock options by smaller, dynamic firms have increasingly become an effective tool for attracting and motivating exceptional talent. Such future remuneration played important roles in several high-technology, startup companies, with Apple and Microsoft being prominent examples. The particular confluence of America’s venture capital enterprises, booming stock markets, and revolution in information technology makes equity participation in a company’s stock performance a key aspect in attracting and keeping exceptional personnel. In addition to assuaging the financial situation for a young firm that has little or no earnings, stock options are becoming of crucial importance in retirement plans for valuable employees.

Benefits. The high cost of health benefits and the linking of corporate retirement plans with individually managed investment accounts are adding to the workload of the HRM staff. Versatile and portable, the growing number of private programs fall under the department’s oversight duties. Employers make large financial contributions and premium payments to employee benefit plans through the HRM staff in consultation with top management determining the list of approved plans from which an employee can select. Plans are periodically evaluated, and some are delisted. The advent of health maintenance organizations (*HMO*s) has had considerable impact on the health insurance field, where unlike traditional plans, the HMO provides services for a fixed fee and from a set of approved physicians and facilities. Health care outside the HMO can be elected at greater cost to the employee. A related system is the preferred provider organization (*PPO*), which offers more of a choice for a personal physician and medical care.

In the area of retirement programs, the traditional defined benefit plan is giving way to defined contribution plans, again as a means for controlling costs. The traditional program entailed a fixed retirement income, funded by the employer and based on a percentage of average earnings over a period of time. In the latter case, the employer contributes a fixed percentage of an individual’s salary, with matching funds from the employee, to a pension plan that is often overseen by an independent organization like a mutual fund. Funds can be invested in a wide range of approved instruments such as equities, bonds, mutual funds, real estate, and money market funds, as determined by the individual employee. Allied with the contributory retirement plan is the 401(k) program, which permits an employee to contribute a certain percentage of earnings to a retirement account on a federal income tax deferred basis. Contributions are also made on a pretax basis, thus lowering the individual’s taxable income. Also widespread, individual retirement accounts (*IRA*s) are completely independent of the employer with a tax deferral feature on income earned from investments in the IRA. IRA contributions are made on an after-tax basis and thus do not lower a person’s income tax.

Training and Development. Development and organization of the work environment together with employee training have undergone considerable changes since the time of Henry Ford. Automobile manufacturing and assembly were particularly affected when, in the late 1970s, transplanted assembly operations from Japan were established in the United States, several in alliance with General Motors, Ford, and Chrysler. The transplants followed strong growth of Japanese compact and subcompact auto imports, a direct consequence of the energy crisis of fuel shortages growing out of the Arab oil embargo and Iranian revolution. Accompanying deep recession and hyperinflation especially in gasoline prices significantly altered manufacturing and marketing in the industrialized world. The demand for fuel-efficient, inexpensively priced small cars could not be met by the existing Ford-Taylor production paradigm, which had become part of an oligopolistic motor vehicle industry with low labor productivity, little cost containment, and poor quality control. Labor-management strife was pervasive with strikes, layoffs, absenteeism, substance abuse on the job, and plant closings. Contractual work rules and strict job classifications made worker cooperation difficult. Professional departments such as R&D, product design, engineering, and manufacturing also had little interaction with each other and a top-down, heirarchical management system solicited little input from staff and line positions. To rectify these inequities, Japanese practices used by the transplanted operations were tried and adopted by assembly and manufacturing facilities throughout the world. These focused on greater flexibility in managerial and worker ranks, leveling of the corporate heirarchy to facilitate communications, and rapid response to changing competitive pressures, greater worker productivity, and shifting plants abroad in major efforts at cost containment. Some of the notable practices are explained below:

- Lifetime employment has increased worker motivation and training and facilitated the adoption of new technology and the transition to new product and process designs. Continuity in employment enabled the capitalization of training costs over the long working life of the employee and reduced hiring, job adjustment and layoff costs. The system permitted the use of a simple salary scale based on seniority with greater communication and mentoring among employees whose advancement was not predicated upon competition with each other.
- Long-term arrangements with supplying firms also reduced unproductive rivalry among ancillary firms and promoted the adoption of just-in-time (*JIT*) inventory systems in which parts are delivered to the assembly plant or work station at the time they are needed. Inventory holding costs and working space requirements are consequently conserved. JIT systems also promote quality control with the individual inspection and removal of defective parts before they are assembled into the product. Cooperation in the design of new or modified parts between the main assembler and its suppliers is encouraged by long-term relationships in which process and product technology can be shared among engineers of principal and supporting companies.
- Total quality management (*TQM*) rests markedly on employee involvement, particularly in continuing improvement programs in productivity and quality control. Suggestions from employees working in teams called quality control circles produced measurable cost savings in plant layout and design. Use of tools, fixtures, and color coding reduced error and operating time. Statistical methods such as control charts and acceptance sampling required employee training and analysis in courses arranged by the HRM department.
- Cooperative organizational arrangements like keiretsu industrial groups, labor enterprise unions, and the Industrial Structure Council of the Ministry of International Trade & Industry (*MITI*) have evolved in war-torn Japan to husband and efficiently allocate resources. The keiretsu industrial groups—Mitsubishi, Mitsui, and Sumitomo being the three largest—included firms in diverse industries such as Mitsubishi Bank, Mitsubishi Motor, and Mitsubishi Electric, which organized around a large bank, trading company, or manufacturer. Firms were bound together by intercorporate stock holdings, frequent meetings of top executives, and interlocking directorates. Since the firms were not in competition with each other, business information and insight could be freely exchanged. The labor union also took a less adversarial position with management because of its organization, which was tied to a specific company and not industry-wide as in the United States. This discouraged any labor strife that threatened the well-being of the company. Unions were also more inclined to adopt new technology and work rules, which increased the competitiveness of the firm. Industry-government cooperative groups like the Industrial Structure Council further promoted communication between top management and the government. The Council retained an important advisory role in MITI's policy decisions, favoring certain industries for expansion such as consumer electronics, computers, and semiconductors and downgrading others such as textiles and toys. During early developmental stages of select industries, MITI protected the domestic market from the competitive threat of foreign multinational firms.

- Foreign direct investments in overseas transplants entailed considerable travel and interaction between personnel from the parent company and employees at the subsidiary location. While process and design engineers often went abroad, employees in the United States, for example, traveled to Japan for on-the-job training. Job rotation moved personnel to different locations and at times to different countries on a permanent basis. Some employees were educated and then stationed in foreign countries. New technology and markets also meant constant consultation with vendors, suppliers, and customers on a global basis. Meetings and employee transfers were generally coordinated by the HRM department, which itself had to keep abreast of advancing technology and international practices in order to keep management and operating personnel informed.

To illustrate the preceding information, Fig. 1 is a concrete training and development program for white-collar employees at Sumitomo Metal Industries Ltd., a keiretsu multinational enterprise (*MNE*) primarily engaged in steel making. The vertical axis rises with increasing managerial responsibility and the horizontal axis highlights specific training in technical skills and conducting business overseas. Note that programs such as technology seminars, dispatch of personnel to other organizations (even beyond the company and country), international business communications programs including English classes, and overseas studies are taken by all staff and management levels above clerical ranks. The pronounced training in technology, international studies and assignments, and the English language grew out of corporate Japan's concerted efforts to catch up with the United States after World War II. Extensive study of Western technology and markets led to the purchase of advanced manufacturing processes followed by exports of technology-intensive products. Teams of managers and engineers were detailed to laboratories and factories in the United States for work assignments and first-hand observations of the huge U.S. market and technological base. The global interactions figured prominently in Japan's economic recovery and were consequently adopted in nearly all human resource development programs at international firms.

Employee Relations. The advent of the knowledge worker—highly educated and a productive user of advanced technology, capable of considerable learning on the job—has placed the HRM department in a pivotal position between top management and corporate personnel. The work culture and environment, as implemented by the department, often determine whether the firm will succeed in attracting and keeping its best employees. This, in turn, determines whether the company is competitive in challenging global markets.

In its central role, the HRM department has codified corporate guidelines to ensure that employees understand the underlying values and objectives of the organization. Hewlett-Packard (*HP*), for example, lists five operating principles on its Web site to be adhered to by its work force: (1) trust and respect for individuals, (2) highest quality work performance in the production of goods and services, (3) uncompromising integrity in business relations, (4) emphasis on teamwork and cooperation throughout the organization, and (5) flexible and innovative work practices of a diverse work force.

HP's flexible practices are implemented through (1) alternative work schedules not confined to the eight-hour day or five-day work week, (2) part-time employment of 20 to 40 hours per week, (3) job sharing on one full-time position between two or more people, and (4) telecommuting. Cooperation and new approaches are encouraged with employment surveys, coffee hours, communication lunches, "management by wandering around," and other informal modes of interaction (5). The company contributes to its community particularly through equipment grants to colleges and hospitals, and it has a voluntary toxics-reduction initiative to protect the environment.

International Dimensions

Having substantial applications in military and consumer products, the electronics industry has strongly expanded internationally as armed forces have retooled with purchases of "smart" weaponry, as trade and

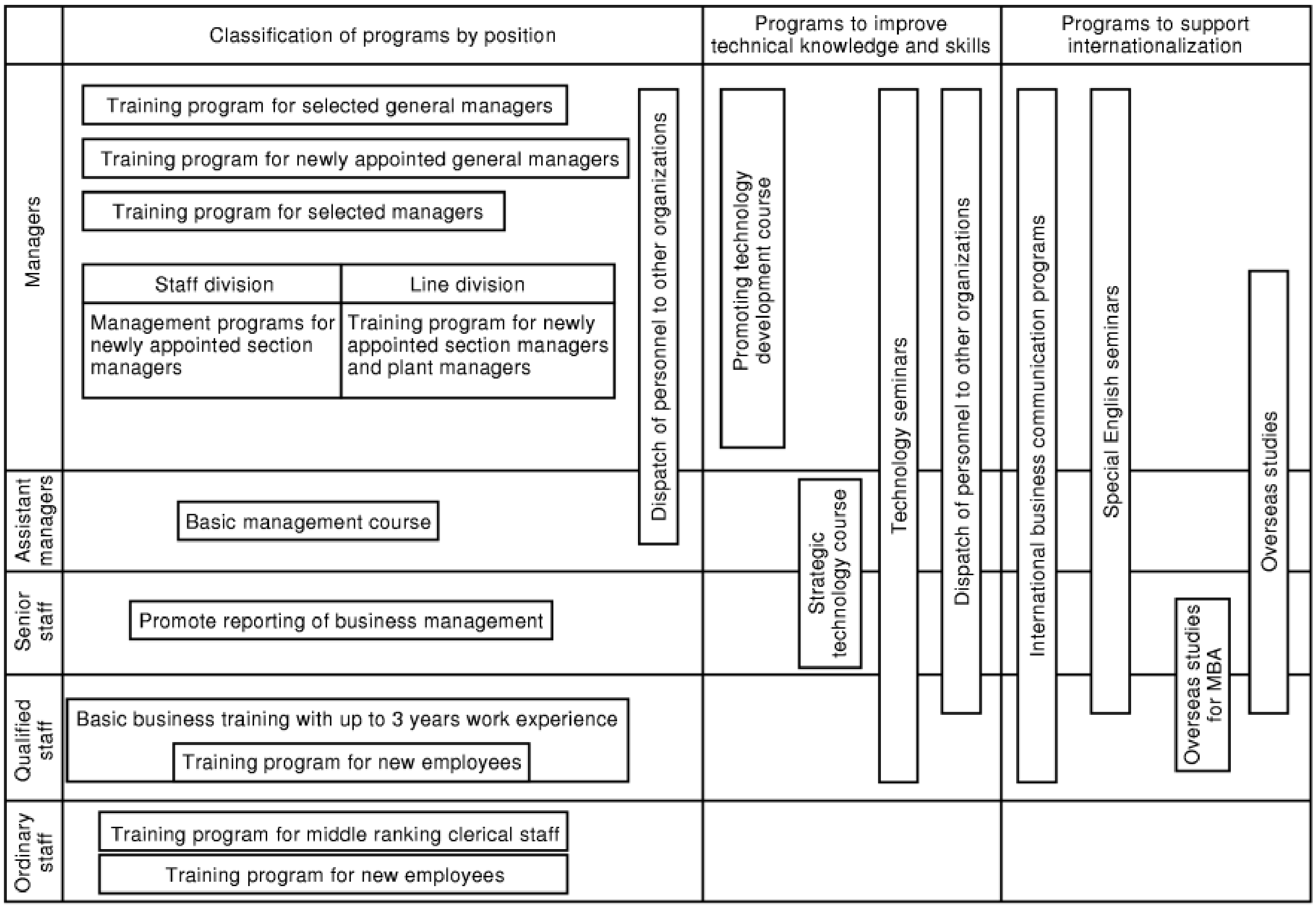

Fig. 1. White-collar training at Sumitomo Metal Industries. Source: K. Tsuda, The strategy for human resources development in SMI. *Int. J. Technol. Management, 12*: 538, Figure 3, 1996, published by Inderscience Enterprises Ltd., World Trade Center Building, C.P. 896, CH-1215 Geneva 15, Switzerland. Used by permission.

investment barriers were lowered prompting considerable gains in multinational business, and as rising levels of affluence produced a worldwide boom in both consumer and business demand. Sales of electronically controlled weapons were given a temporary boost by their effective demonstration in the Desert Storm conflict. Long-term advances in technology and competitive forces have continued the absolescence of nearly all electronic items even as they have given impetus to the Information Revolution in new product and service development.

Among principal user groups participating in the revolution, the ending of the cold war in the late 1980s shifted government expenditures especially in the United States and Russia away from military programs and, in the former, toward tax cutting and the reduction of budgetary deficits. The fiscal policies, in turn, spurred spending and investments in private business and consumer sectors. Deregulation of capital and money markets in New York, London, and Tokyo further assisted the financing of international investments as aging populations sought greater returns abroad for personal retirement plans. The General Agreement of Tariffs and Trade (*GATT*), since its founding after World War II, also made significant gains in reducing protectionist barriers to world trade. Regional groups like the European Union, the Association of Southeast Asian Nations (*ASEAN*), and Mercosur of South America used the GATT framework to reduce barriers and bolster economic activities in their regions. The United States, supported by its huge manufacturing base and domestic market, remained in the vanguard of promoting global trade and used its large free market and development aid to accelerate recovery after World War II in Western Europe and Japan. These moves became the geopolitical foundation of the capitalistic world, ultimately leading to massive increases in direct and portfolio investment flows and trade in goods and services. Market developments for some multinational firms in the electronics industry leading up to current conditions are discussed in the following.

Canon, Inc., the large Japanese maker of business machines, cameras, and optical equipment, apportioned its 1994 global revenues of $19.3 billion among three principal regions: Japan with 32.8%, North America with 32.6%, and Europe with 26.8%. Its employees were distributed throughout the world with 54.7% in Japan, 17.2% in other areas, 15.6% in Europe, and 12.4% in North America (6). Canon's much larger competitor Matsushita Electric, had incorporated its North American operations into the Matsushita Electric Corporation of America (*MECA*) with headquarters in New Jersey and an American national as president and chief operating officer. In 1994, MECA had $7 billion in total sales and 16,000 employees in 150 business locations and 21 manufacturing sites, most of them in the United States. The subsidiary began operations in 1953 with a three-person sales office located in New York City (7).

The outward flow of business investments to global markets by U.S. electronics firms has similarly expanded due to technological advances made by American companies in high-growth semiconductor, computer, and communication fields. At the end of 1996, for example, Intel had 42% of its sales from the Americas, 28% from Europe, 18% from the Asia-Pacific area, and 12% from Japan (8). This growth of global markets and foreign direct investments has greatly added to the responsibilities of the HRM department in multinational staffing requirements with distance, language, cultural, and legal obstacles complicating its tasks.

Major increases in labor mobility and science and engineering employment complement the global trade and investment flows. Figure 2 depicts science and engineering employment per 10,000 labor force for seven industrialized countries with strong gains made in six of them from 1981 to 1993. In the early 1990s, moreover, Japan edged past the United States even with the U.S. work force augmented by immigration of scientists and engineers. In 1992, for example, a large 62% increase in U.S. border admissions was recorded. And at the universities, over 40% of U.S. resident Ph.D.s in engineering are foreign born as are 33.6% of doctorates in computer/math sciences. Thirty-three percent of engineering doctoral degrees is earned at U.S. schools, while 7.2% comes from foreign ones (9). These statistics illustrate important trends in higher education and employment that are increasing the diversity of the American work force. Outside the seven industrialized countries, strong gains in employment of scientists and engineers are also being made in East Asia accompanying the large international trade and investment activity in the region. Higher educational institutions in Singapore and South Korea, in particular, are being established or upgraded to supply the technical personnel needs of their booming economies.

For the ASEAN area, the extent of foreign direct investment and new manufacturing capacity in nine key electronic product categories are plotted in Fig. 3. The data for 1989 to 1993 show that Malaysia, Singapore, and Thailand were sites for the bulk of new production facilities with investment and technology frequently coming from the industrialized countries of the West and Japan as their markets mature and slow. In the products affected, sharp increases in capacity are apparent for color TVs, VCRs, hard disk drives, facsimile machines, printers, and resistors. The magnitude of output by certain nations is impressive with color TVs approaching 10 million sets per year in Malaysia alone. VCR production there was close to 8 million in 1993, while Singapore's output of hard disk drives was 20 million units. The two countries' individual production of integrated circuits, in monetary terms, stood between $3 and $4 billion in 1993.

Significant percentages of off-shore production capacity in Southeast Asia migrated from Japan as the high yen exchange rate made operations in the home archipelago prohibitively expensive. Production shares or Japanese corporations, as a result, rose to 75% in air conditioners, 78% in VCRs, and 70% in color TVs of total

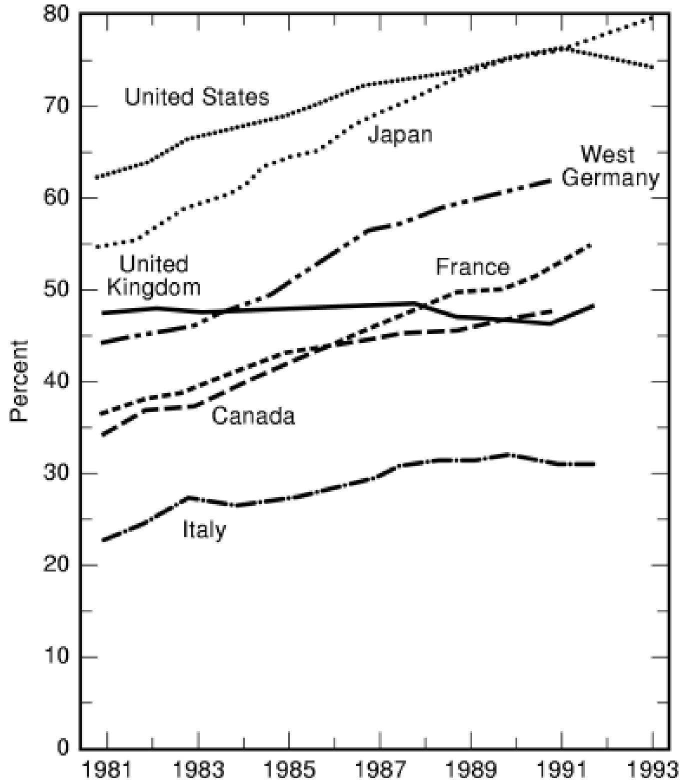

Fig. 2. Scientists and engineers engaged in R&D per 10,000 labor force, by country. Source: National Science Board, *Science & Engineering Indicators—1996.* Washington, DC: U.S. Government Printing Office, 1996 (NSB 96-21), Figure 3-15, p. 3-25.

regional output per product category (10). Investing MNEs also seek to enter the growing consumer markets in Asia as well as reduce production costs, which for Japanese companies can be 10% to 40% lower than those at home. Four factors account for the savings in ASEAN manufacturing: (1) lower labor rates, (2) cheaper prices paid for locally produced parts, (3) incentives given by the host country for new manufacturing, which can include tax reductions or exemptions and the waiving of duties on equipment or parts imported by the MNE, and (4) lower infrastructural operating costs such as reduced payments for energy and communication services (10). The investing MNE also has a powerful negotiating position vis-à-vis local suppliers and utility companies simply by the magnitude of business it is proposing. In addition, the foreign corporation is bolstered by the strength of its currency such as the US dollar or Japanese yen, the backing from national and local governments in the form of incentives, its potent legal and professional expertise, and the technology transfer, training of employees, and jobs it is offering the host country. If business conditions deteriorate because of political and economic instability such as terrorist attacks or high inflation, the MNE can quickly move its facilities as in the past. MNE investments began in the industrialized, affluent areas of the West and moved to Japan and rapidly developing, smaller economies of South Korea, Taiwan, Hong Kong, and Singapore. As costs rose in these countries, MNEs moved to less-developed areas in Southeast Asia such as Malaysia, Thailand, Indonesia, and the Philippines. With immense markets and improved conditions for doing business, India, China, and a much smaller Vietnam are currently attracting foreign direct investments. The fall of the Berlin Wall has also opened markets in Eastern Europe, namely, Russia, Poland, Hungary, and the Czech Republic.

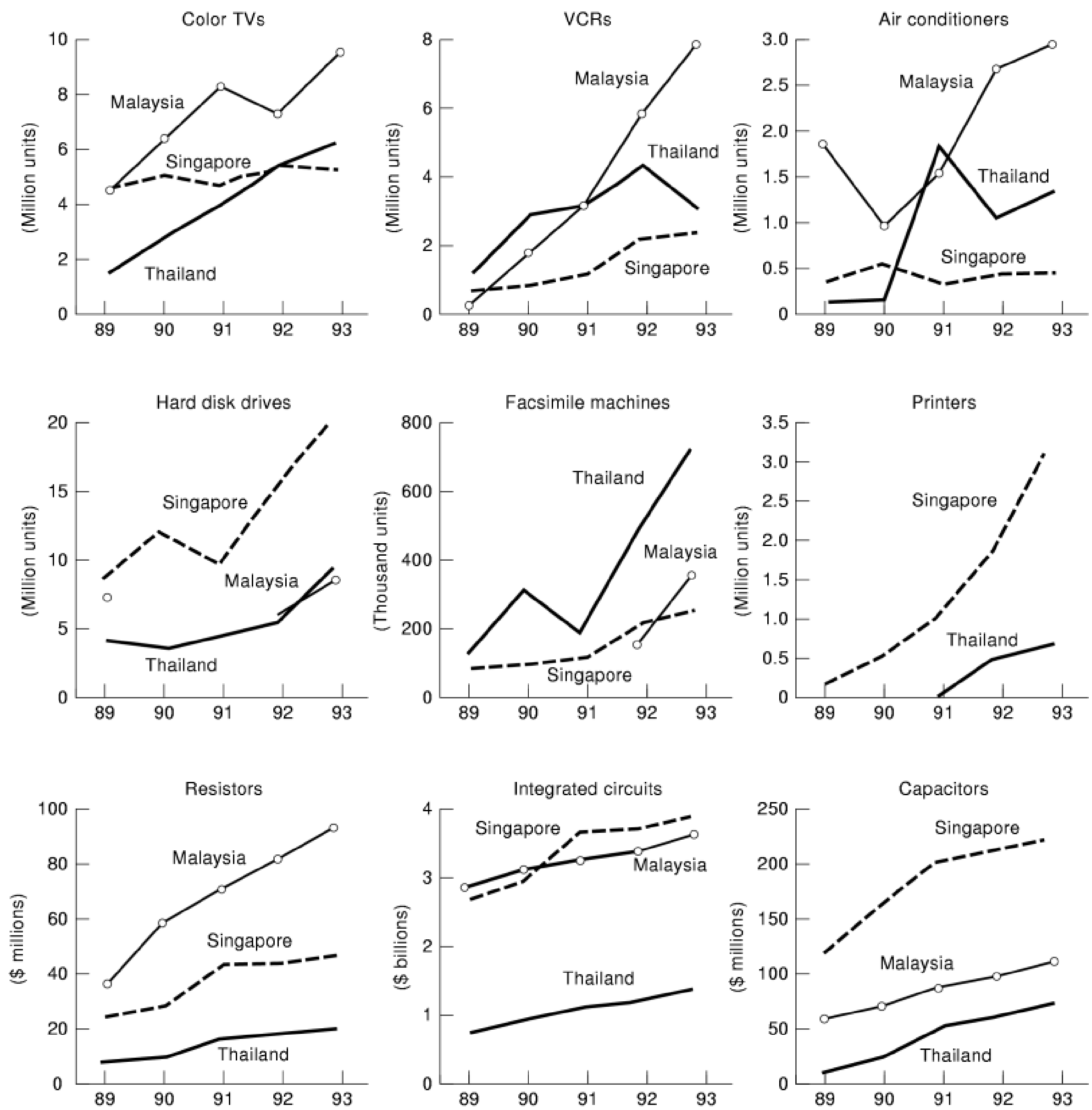

Fig. 3. Production trends in ASEAN countries. Source: Booming electronic and electrical machinery industry in ASEAN countries. *Quart. Survey Industrial Bank Jpn.,* No. 99, 1994III, Figure 16, p. 15.

The HRM department is at the vanguard of corporate moves to operate abroad with its heavy responsibility for staffing foreign marketing departments, manufacturing plants, and R&D laboratories. How does a multinational corporation like Hewlett-Packard hire for its needs in more than 40 countries? Figure 4 is an Internet listing of the countries in which HP has facilities and is particularly helpful in hiring because it can be viewed around the world and in areas where the company has operations. Technically competent people can access the Web site, which is the audience the company is targeting. Applications and correspondence

The Americas	Europe		Asia-Pacific
• Argentina*	• Austria*	• Netherlands*	• Australia*
• Brazil*	• Belgium	• Norway*	• China
• Canada*	• Czech Republic	• Poland	• Hong Kong
• Chile*	• Denmark*	• Portugal	• India
• Colombia*	• Finland	• Russia*	• Japan*
• Mexico*	• France*	• Spain*	• Korea
• United States	• Germany*	• Sweden	• Malaysia
• Venezuela*	• Greece	• Switzerland*	• New Zealand
	• Hungary	• Turkey	• Philippines
	• Ireland	• United Kingdom	• Singapore*
	• Italy*		• Taiwan*
			• Thailand
• HP in Latin America*		• HP in Europe*	• Vietnam

*These countries have Web sites in the language of the country.

Fig. 4. Countries in which Hewlett-Packard has facilities. Source: Hewlett-Packard Company, Santa Clara, CA, HP Worldwide, http://hpcc920.external.hp.com/abouthp/World/html. Downloaded on May 4, 1997. Used by permission.

can promptly and inexpensively be handled by e-mail, thus bypassing lethargic, national postal systems and the vagaries of international mail. Fax transmissions, which proceed over the same networks as e-mail, are just as quick but cost more than electronic mail. Fax is, however, more efficient when sending long printed copies like resumes and application forms because paper copies can be processed immediately while e-mail messages must be typed into a terminal. Both modes are playing integral roles in the Information Revolution and surging growth of international business. Because they also facilitate personal interaction, their use in HRM and technology transfer is proceeding at a corresponding rate.

International Technology Transfer

Prior to the rise of foreign direct investments, international business focused on manufacturing in the industrialized countries with in-house or purchased technology, and output sold at home or abroad. Product technology was uniform among competitors and centered on economies of scale for mass marketing as in the United States. Industry was oligopolistically structured with one or two dominant leaders. Foreign competition and markets in underdeveloped economies were generally of secondary concerns. Per capita income in these nations was comparatively low, giving rise to sparse demand, and the supply of international goods was severely restricted by high protectionist trade barriers. Government policy nurtured infant industries with subsidies and restrictions on foreign competition in the domestic market. Economic exploitation by large MNEs was constantly suspected by political leaders, resulting in state-run or sanctioned monopolies providing vital goods and services, albeit in a highly inefficient, bureaucratic, and frequently corrupt manner.

Structural changes in both affluent and developing nations resulted from maturing markets in the industrialized countries and the debilitating lack of economic and technological progress in most third world countries. The latter was juxtaposed against the rapid industrialized recovery of defeated Axis powers following World War II and the economic stagnation in the Communist bloc of nations. Official development assistance, international trade, and technology transfer from the United States undergirded much of the recovery in Western Europe and Japan. The blueprint for economic advancement was subsequently adopted by East Asian countries such as Taiwan and South Korea with the rest of the world following. In the global transformation, government obstacles to technology transfer and foreign investments were lowered, allowing MNEs to establish plants abroad to take advantage of lower operating costs. Their pursuit of new markets heightened international competition, while, simultaneously, government regulatory bodies demanded the transfer of process and product technologies to upgrade human resource capabilities of the domestic work force.

Such transfers are hardly simple, linear transactions since process technology encompasses a diverse body of knowlege, capital, labor, and managerial expertise used in the production of goods or services. Because of numerous interactions, technology can be viewed as a complex system with a specific application. The capitalized part of process technology is embedded in the familiar equipment, plant, tools, fixtures, connections, and conduits—the fixed assets of an operating site. These are installed, operated, maintained, and depreciated. The layout, engineering, and design of a process system is also an integral part of operating technology with planning and development done in-house in technical departments, licensed, transferred from a parent MNE, or supplied by a joint-venture partner or independent contractor. Product technology relates to an item's specific design and use as opposed to its manufacture, given the understanding that a product's design has important engineering ramifications for how it is made. In foreign direct investment, technology transfer revolves around the construction or modification of an operating site together with its startup and continued management with the surmounting of cultural and language barriers an immediate task.

Alliances and Technology Transfer. Principal modes of international technology transfer have occurred among private firms seeking profitable arrangements within the legal constraints of technology-exporting and -importing countries. The technology is usually owned by a MNE in an industrialized country in the form of product or process patents, trade secrets, or professional know-how. Negotiations produce an arrangement in which technology is provided with the payment of royalties and fees for patent rights, licensing, franchising, or contract manufacturing.

Licensing and franchising are contractual arrangements covering intellectual property such as patents, trademarks, brand names, or trade secrets, which are transferred by a MNE that prefers not to involve itself actively in the foreign market and operations of the recipient firm. Royalties are paid to the licensor as a percentage of scales, and for the recipient firm, licensing represents one of the fastest means for obtaining technology and proprietary information. It is also a highly efficient method for entering a new business provided the licensee has the requisite know-how for rapidly commercializing the technology. Management and consulting fees may have to be paid if this is not the case. If the transfer proceeds smoothly, the licensee sidesteps large R&D and marketing costs because the technology is a proven one and demand exists for the product or service. The drawbacks for the licensee include little if any built-up expertise in product or market development, which could be a serious disadvantage in the electronics industry. The licensee, in effect, remains beholden to others for new products and risks losing sales and entire markets to technically superior competitors. While government protectionist policies may prevent such competition from entering the home market, these barriers to trade and investment are being eroded by the growing influence of the World Trade Organization, the successor to GATT, and other regional economic cooperation and trade blocs.

Franchising and contract manufacturing are also expedient modes of technology transfer that obviate the need for risky investments in operating facilities or marketing outlets. Franchising allows a local operator to conduct business using a well-known brand name like McDonald's, Coca-Cola, or Holiday Inn. The franchisee pays royalties and fees, operates under strict, uniform guidelines of cleanliness, quality of service, and general attractiveness of facilities, and buys parts, materials, and equipment, if sold by the franchisor. The local operator owns and manages the franchise, thereby assuming most of the business risk and garnering the greater share of any profits. This results in a major drawback for licensing or franchising by MNEs whose profits are restricted to a certain percentage even when the foreign unit is highly successful. Moreover, the franchisor is precluded by the contract from establishing a competing unit within a certain area surrounding the first site.

Contract manufacturing is similar to technology licensing whereby a local manufacturer produces the product according to specifications set by the MNE. The important difference is that part or all of the output is marketed by the MNE in the export trade or local market. This gives the MNE greater control over its technology monitored by its continuing involvement with the local plant. Competitive moves by the local partner can be met by the MNE, which can dissolve the ties and subcontract production to other firms. Contract manufacturing can also include parts specialization in the multifaceted assembly of a product like an automobile. In small European or Southeast Asian countries, economies of scale can be achieved by assigning parts manufacturing to plants in different nations with assembly in a central location. The product is then marketed in all participating countries. Free-trade blocs that lower or eliminate tariffs on imported parts or assembled units are abetting the specialization movement. As an example, the North American Free Trade Agreement (*NAFTA*) between the United States and Mexico has made the latter the largest nation for TV assembly and export (to the United States) in the world. Duties are not placed on TV parts imported into Mexico provided the assembled sets are all exported. Domestic makers and markets thus remain protected while large, foreign investors provide capital, technology, and jobs to the Mexican economy and target their output across the border to the nearby, large U.S. market after taking advantage of lower-paid Mexican labor. Under NAFTA, no U.S. duties are assessed on sets imported from Mexico.

Joint Ventures

In contrast to the contractual or free-trade arrangements in which one firm exclusively handles operations mentioned previously, a joint venture between foreign and domestic companies involves both firms in the ownership of the daughter firm according to the percentage of equity investment made in the created company. While investment risks for the MNE are greater, it now shares in all profits of the joint venture through dividends declared and paid to the stockholders by the board of directors, which is selected by the parent companies. Technology is usually supplied and overseen by the MNE, and management of the new company, which can be shared, is probably best provided by the local firm because of its familiarity with the business environment and markets. Technology transfer is further abetted by continuous, personal training of the work force by engineers detailed to the foreign site by the MNE, which is more inclined to do this to ensure the success of its investment. In simple, contractual relationships like licensing, the technology is embedded in manuals, patents, and written instructions, the understanding of which is problematic for employees unfamiliar with the contents and language of the documents. Future technological advances, furthermore, are more likely to be shared in a joint venture and held back in a contractual arrangement unless additional royalties are paid. In the former, disagreements between the partners arising out of the new venture can grow and eventually stifle the project in the process, jeopardizing the lengthy time and investments expended by both sides in forming the joint venture. This is the principal reason why risks are high in an international joint venture.

Globalization of Manufacturing and R&D. Internationalization of business technology has prompted MNEs to move not only production facilities but research and market development activities abroad to tap foreign resources and advance competitiveness. In these latter-day moves, the transfer of technology differs from earlier arrangements whereby know-how was obtained from the West and Japan by developing countries. The new alliances are frequently between firms from industrialized nations with strong in-house R&D that are forced to cooperate in order to keep abreast of advances especially in the electronics field. Based on postwar experiences in seeking advanced technology and markets overseas, Japanese MNEs have extended these internationalization moves with foreign direct investments, mergers and aquisitions, alliances, and strategic networking with other multinational companies as detailed by Bowonder and Miyake (12). These corporate moves to enhance competitiveness are formed to get market information, increase technical, design, and manufacturing expertise, and develop improved channels of distribution and communication. Design centers and R&D facilities are thus established in major foreign markets to assist in new product development and design and to detect shifting consumer tastes. This imposes another 180° turn on technology transfer with know-how now being absorbed from overseas alliances and operations just as it did during Japan's earlier industrialization. Following catch-up with the West, the country's private sector transplanted much of its manufacturing base overseas and technology transfer turned outward. With commercial advances now occurring throughout the world, MNEs, to remain competitive, are forced to extend core competencies into newly expanding, related fields with partner firms having the desired expertise. In theory, this could lead to a convergence of competencies among MNEs. In reality, internalizing skill accumulation by allied MNEs can lead in various directions, with failure to profit from the alliance frequently a result. In the effort, the HRM department plays a central role because the firm's corporate culture and human resources—not physical capital—determine whether the company successfully absorbs important new know-how.

To illustrate these moves Table 3 lists the globalization activities of the Japanese firm, NEC, during the period 1988 to 1993. Most of the alliances are with companies from the West or Japan with the greatest number of participations with U.S. firms. Joint product development in the advanced fields of chip design, software, and computers is a frequent business objective as is the more usual joint ventures for manufacturing using NEC's technology in lesser-developed nations. The extent of NEC's globalization moves is in sharp contrast to an earlier period, up to the 1980s, when the insular corporate mentality of MNEs kept foreign know-how out of the company and by their home governments, out of the country as well.

Coordinated Technology Transfer. Prior to the lowering of protectionist barriers, alliances between foreign and local firms were limited by the MNE's desire to control the business and technology—thus assuming all risks—and retaining the profits from a foreign investment. A wholly owned subsidiary was usually formed to capitalize on low-cost foreign labor and natural resources such as petroleum with sophisticated processing plants, R&D facilities, corporate headquarters, and markets located in the home or industrialized countries. Little technology transfer to the host country occurred, and profits were repatriated by the MNE. In reaction to what was perceived as foreign exploitation, parliaments and ministries in developing countries adopted regulations and laws restricting investments and operations deemed inimical to their national interests. Japan's MITI was particularly effective, during the country's rapid industrialization in the 1950s and 1960s, in coordinating the transfer of foreign technology to its private sector. With advice from the petitioning firms, MITI allocated scarce foreign exchange for the purchase of advanced technology (mainly from the United States) only to those industries such as steel, chemicals, electronics, and motor vehicles, which were selected to spearhead the nation's industrialization. The allocations were augmented with commercial and government bank loans, frequently obtained at concessionary interest rates because of the Ministry's endorsement. Domestic companies would subsequently dispatch teams of managers and engineers to foreign locations to analyze the extant technology for use back home. Negotiations for its purchase would then ensue with foreign counterparts. The government, banks, and trading companies provided technical and financial guidance with MITI vetoing deals that were judged too costly. The Ministry also set restrictions on foreign MNEs desiring to operate in Japan. Texas Instruments, for example, had to form a 50-50 joint venture with Japanese interests and even license its technology to local competitors before it was permitted to manufacture integrated circuits in Japan. IBM also had to license its patent rights to Japanese firms for modest royalties if it wanted to continue operating in the country. The American companies were ultimately amenable to such ministerial interference because the Japanese market had been deemed too important to stay out of. Control of the technology was also problematic, which, in time, would be made obsolete by rapid advances. Both companies also chose to be near and thus keep abreast of the considerable Japanese progress in electronics.

Official Development Assistance. With the maturing of its economy as signaled by the powerful yen, Japan's industrial policy shifted to the outward migration of private investments with a coordinated flow of foreign aid (and later, private funds) to assist recipient countries with infrastructural developments of ports, roads, communications networks, and educational institutions. These were preparatory to the attraction of outside commercial investments and effective employment of advanced technology as Japan had learned during its own recovery period. The fundamental relationships—government to government, government and industry,

Table 3. Globalization Alliances of NEC

Country of Alliance	Activity	Firm with which Linkage is Established	Objective
USA	Joint venture	MIPS Computer System	Joint development of software and RISC (reduced instruction set computing) microprocessors
USA	Manufacturing	NEC America	Manufacture cellular mobile and fax machines
USA	Design	Subsidiary	Technology development for semiconductors
USA	Joint development	AT&T	Design of fast SRAM (static random access memory) chips
USA	R&D	NEC Research Institute	Basic research in computer science
USA	OEM arrangement	NCR	Supply PCs for sale in USA
USA	Manufacturing	Subsidiary	Manufacture of 4-Mbyte DRAM (dynamic random access memory) chips
USA	Alliance	Crosscheck Technology	Transfer of failure detection technology
USA	Alliance	Control Data	Market NEC supercomputers in USA
USA	Communication networking	Mark-Net of General Electric	Provide network information (international exchange packet service)
USA	Cross licensing	Micron Technology	Market each other's computer chips
USA	OEM agreement	Texas Instruments	DRAM chips to Europe
USA	Information exchange	AT&T Microelectronics	Transfer of ASIC (application-specific integrated circuit) technologies
USA	Joint development	Apple Computer	Develop image processing technology
England	Manufacturing	NEC	Manufacture 4-Mbyte DRAM chips
England	Subcontracting	British Aerospace	Satellite manufacturing
Ireland	Manufacturing	Subsidiary	Semiconductor manufacturing
Scotland	Manufacturing	Subsidiary	Manufacture 4-Mbyte DRAM chips
Scotland	Manufacturing	Subsidiary	Wafer fabrication plant
France	Distribution	Matra Datavision	Distribution of Matra computer-aided design system in Japan
France	Joint development	Matra Harris Semiconductors	Joint technology development for single-chip processors
France	Subsidiary	NEC France	Market information processing equipment
France	Joint development	Bull	Codevelopment of mainframe computers
Germany	Technology development	European Technology Centre	Design chips for mobile communication
Chile	Manufacturing	Subsidiary	Manufacture communication and information processing equipment
Taiwan	Joint development	ACER	Design of fast microprocessors
China	Joint venture		Manufacture telephone exchange equipment
China	Joint venture	Shondow	LSI (large scale integration) for consumer electronics
Indonesia	Manufacturing	Subsidiary	Production of linear integrated chips
Thailand	Manufacturing	NEC Technologies	Manufacture electronic components
Thailand	Manufacturing	Subsidiary	Manufacture color TVs
Hong Kong	Manufacturing	NEC Technologies	Manufacturing facility for PCs, matrix printers, floppy disk drives
Korea	OEM arrangement	Daewoo	Supply color TVs
Philippines	Manufacturing	NEC Technologies	Data communication and equipment manufacture
Singapore	Manufacturing	Subsidiary	Manufacture 16-Mbyte DRAM devices
Singapore	Design	Subsidiary	Design of microcomputers, ASICs
Malaysia	Manufacturing	Subsidiary	Manufacture remote control ICs
Japan	Joint venture	AT&T Microelectronics	Market AT&T chips in Japan
Japan	Joint venture	Toshiba	NEC Toshiba Information Centre for marketing ACOS computer systems
Japan	Alliance	Sanyo	NEC will supply VCRs manufactured by Sanyo
Japan	Joint development	AT&T Microelectronics	Development of SRAM chips
Japan	Joint development	Nomura Research	Joint software development for communication
Japan	Marketing	NTT	Market and service ISDN (integrated services digital network) terminals

Source: Reference 12, Table 1, pp. 164–166, published by Inderscience Enterprises Ltd., World Trade Centre Building, C.P. 896, CH-1215 Geneva 15, Switzerland. Used by permission.

foreign and domestic industries—were established with personal communications, visits, and extended stays for the detailed planning of large and small projects by officials from the ministry, industry, and consulting firms. Major funding for these preliminary activities came from loans and grants of Japan's official development assistance (*ODA*) program, which has become the largest foreign aid program in the world for the fourth consecutive year with the most recent year's amount in 1994 reaching $13.24 billion. Bilateral (government-to-government) aid is the largest part of the ODA budget, and it is broken down into grants, which require no repayment obligation, and loans, which require repayment on concessionary terms. ODA activities as well as intergovernmental negotiations are conducted by officials of the Ministry of Foreign Affairs with advice and participation from other offices such as the Ministry of Finance in lending and MITI on technical assistance, which is part of the nonrepayment grants program. In addition to technical cooperation, grant aid includes emergency disaster relief funds and assistance, financing for cultural programs, food donations, and grants to increase food production and establish a fishing industry, with the latter corresponding to official technical transfer given Japan's considerable expertise in fisheries. Grant aid goes to countries with very low per capita income that are not expected to repay the loans that are denominated in yen—an international, hard currency difficult to accumulate and repay loans in. Moreover, technical cooperation focuses on nation-building and developing human resources, important activities that defy quantification in monetary repayment terms.

The official giving and lending alert the private sector to those countries that are eager to cooperate with Japanese MNEs and receive investments and technology. With high operating costs in Japan, partly due to the strong yen, the government's planning and efforts, in turn, unleashed a torrent of direct foreign investments that dwarfed the sizable ODA outflow. A major portion of these private funds were used to construct manufacturing facilities as given in Table 3 with financing assisted by (1) the strong home currency, (2) Japan's robust stock market during the 1980s, and (3) considerable corporate profits derived from the export trade. The coordinated private/public funding and technology transfer became the building blocks that assisted much of Asia in its rapid industrialization drive (13) with similar coordination currently scheduled for other underdeveloped areas.

Japan Information Cooperation Agency. The technical cooperation aspects of Japan's ODA program has been administered by the Japan International Cooperation Agency (*JICA*), established by the government in 1974 (14). One of its primary functions is the dispatching of survey teams of experts to countries requesting government grant aid or loans for the construction of infrastructural facilities. The teams determine if the projects meet the development needs of the requesting country and the implementation guidelines of Japan's ODA program. A basic design of the project is then formulated together with a working plan detailing the amount of cooperation expected by each government in the project's implementation.

Technical personnel and government officials from developing nations are also trained by JICA in Japan in such areas as computers and electronics, agriculture, medicine, environmental protection, business administration, production scheduling, and quality control. This type of human resource development is integral to technical cooperation because the foreign trainees learn the basic mechanics of Japan's ODA program and meet many of the experts who will be conducting surveys and dispensing advice to their respective governments. Some trainees return to leadership positions at home. Long-term relationships are thus begun that foster technology transfer and pave the way for dispute resolutions that tend to arise in many international aid programs.

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