Intermediate Technology in Ghana: The Experience of Kumasi University's Technology Consultancy Centre

by: Sally Holtermann

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Acknowledgments

During my stay in Ghana from August to October 1978 I was given generous assistance by the Technology Consultancy Centre (TCC) with the preparation of this report. Without their various forms of help - transport around Kumasi and out to the villages, office facilities at their headquarters, accommodation on the University campus, and, of course, large amounts of their time, I could not have written this report. My thanks are due especially to John Powell, Director of the TCC, Ben Ntim, Deputy Director, and their staff; also to John Russell of the Department of Economics and Industrial Management at Kumasi.

In London I was given considerable encouragement and support from Chris Perry, David Wright and Mark Sinclair of the Intermediate Technology Development Group. My warmest thanks go to Marilyn Carr, who undertook the unenviable task of editing this manuscript for publication.

Sally Holtermann

Preface

It is now widely accepted that the technologies appropriate to most developing country circumstances will be those which can operate on a small-scale, decentralised basis. So far, however, there has been less acceptance of the belief that the institutions required to support these technologies must also be decentralised and within easy reach of the people they purport to serve.

The arguments for local, decentralised centres for technology development are many; here, it is appropriate to mention three of these. First, only by creating a local indigenous capability will it be possible to respond quickly and efficiently to local needs and priorities at the village and small town levels. Second, local centres can more easily and effectively respond to the needs which accompany innovation such as training, maintenance and repair services and other delivery systems. Third, technology development is, in the final event, governed and constrained by national economic policies. Any centre for technology development must, therefore, be responsive to these policies and, where necessary, be in a position to suggest changes to policies which adversely affect the adoption of appropriate technologies within the national context.

It is for this reason that the Intermediate Technology Development Group (ITDG) has been emphasising the need to strengthen national appropriate technology centres in developing countries and has questioned the need for the creation of larger regional or international centres for the development and transfer of technology.

As part of its effort to publicise the importance of national AT centres and to show how their work can make a significant contribution to economic development, ITDG commissioned the services of Sally Holtermann to make a detailed study of the Technology Consultancy Centre (TCC) in Kumasi, Ghana. The impressive amount of data collected by Ms. Holtermann during

her three month visit to the TCC serves a number of valuable purposes. First, by outlining the way in which the TCC came into existence in the early 1970's and the way it has developed since then, the report will prove useful to people wishing to start similar AT centres in other countries. The detailed descriptions of the problems encountered by the TCC and the way in which these were tackled should also be useful to those who are already engaged in or about to embark on similar work elsewhere.

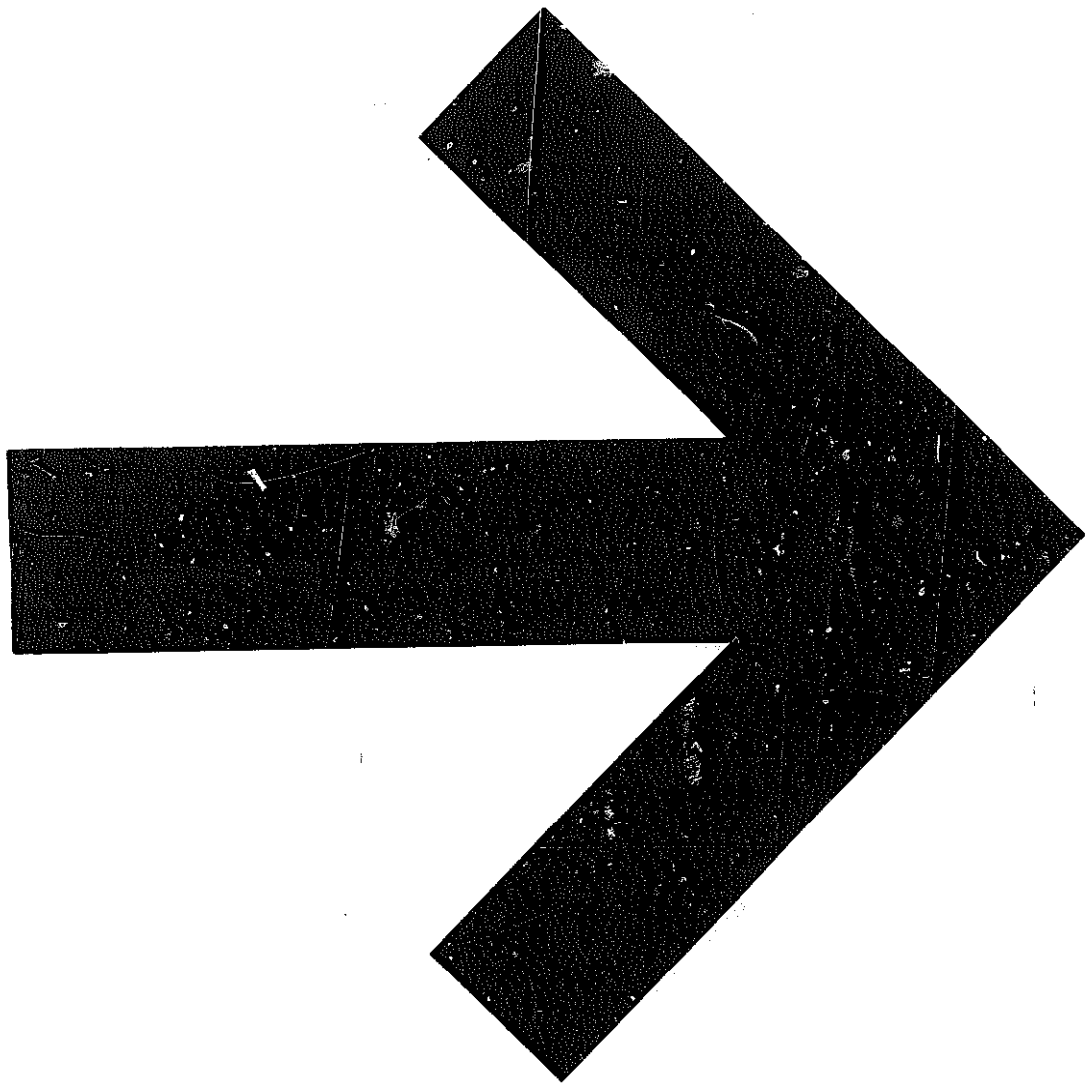
Second, by illustrating both the technical and economic feasibility of a number of the major technologies developed at the TCC, the report usefully responds to the growing number of requests for case studies which show that intermediate technology can and is working in practice. In addition, in those cases where enough data are available, comparisons are made between the intermediate and the 'high cost' technologies and show that the former are economically superior in terms of unit cost and employment generation.

Finally, by looking at the experience of the TCC within the context of the Ghanaian economy, the report clearly shows how various government policies including those related to credit, price control and import licensing can help or hinder the successful diffusion of intermediate technologies. This makes a valuable contribution to the understanding of the direct and indirect effects of economic policies on technology choice and illustrates the type of economic environment which is needed for the successful development and widespread use of intermediate technologies.

The work of the TCC provides a source of inspiration to all those involved in promoting the development and use of technologies appropriate to the needs and conditions of people in developing countries. The staff of TCC are to be admired for all they have achieved in the face of so many difficulties.

Ms. Holtermann's thorough and analytical treatment of TCC's experiences shows that an in-depth study of a national AT centre is an extremely worthwhile exercise. Hopefully, similar studies of other AT centres will be done in the near future.

Marilyn Carr
ITDG



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I Introduction

There is now a large literature analysing the problems brought about by the thoughtless transfer of advanced technology to developing countries. There is also an ever-growing body of work describing technical developments that should be capable of appropriate application in developing countries, but relatively little has been written on the problems facing those in the field who are actually seeking to promote the widespread introduction of intermediate technology. It is hoped that this report, by examining the experience of the Technology Consultancy Centre (TCC) of the University of Science and Technology, Kumasi, Ghana, will usefully swell the literature on the diffusion of intermediate technology in developing countries.

For seven years now the TCC has been engaged in the development and diffusion of small-scale technologies suitable for the conditions found in Ghana. The Centre has worked on the development of a wide variety of manufacturing processes and a wide variety of products, and this report indicates this variety by means of a set of eight case studies. These should be of interest in themselves to people in other countries working on the same products or processes, but the main purpose behind them is to extract from the TCC's experience some general lessons about the problems arising in the dissemination of intermediate technology, and the role of an agency such as the TCC.

Two particularly interesting features of the TCC warrant attention: first, its position as part of the country's technological university, and second, the development of its own production units, which it set up to develop intermediate technologies and to demonstrate the technical and economic viability of the technology to interested entrepreneurs and to the economy at large.

Accordingly, the case studies have been written with a number of key questions constantly in mind:

- What can account for the relative success or failure of this particular venture? Was it that the technology was especially well (or badly) chosen? Was there a vital external input in the way of, for instance, expatriate advice? Was there a special factor making for ready acceptance of the technology, or conversely for resistance? Were the economic conditions right? What is the scope for further diffusion?

- What was the interrelationship between the technology and the economic and social environment? Did the peculiar state of Ghana's economy make it more or less likely that the intermediate technology would be a commercial success?

- What was the role of the TCC? In particular, did the TCC's demonstration project substantially assist the process of diffusion?

The concept of intermediate technology

At the risk of repeating what so many others have already written, it may be worth while to set out briefly the ideas of intermediate technology as they apply in the context of the economic development of Third World countries.

Many of these countries have started their industrial development by the wholesale importation of advanced technologies embodied in advanced manufactured plant. Although these may have served their countries of origin well, and can sometimes be useful in developing countries, they have generally had a number of severe disadvantages for developing countries.

For example:

- The techniques are capital-intensive. This may be appropriate in developed countries where labour is expensive and capital is plentiful and cheap. But in developing countries where the reverse of these conditions applies (capital is scarce and expensive, especially in foreign exchange, and labour is relatively cheap) these techniques may be economically inefficient, in the sense that the same output could be produced at a lower unit cost by techniques using a higher ratio of labour to capital. Labour-intensive (and capital-saving techniques) will often be appropriate in developing countries given the relative prices obtaining there. A major consequence of copying capital-intensive western techniques is that industrialisation does not create many jobs. With more labour-intensive techniques the same amount of scarce capital can provide far more employment, which is a major need in developing countries.

- The plants are usually large-scale. This may be appropriate in western countries where the domestic markets are large and exports can be substantial. In developing countries the market is usually small, and export activities often not well-established. One of the harmful side-effects of establishing large-scale plants is that the factories are usually sited in a few urban areas (in Ghana, the Accra/Tema area contains 10% of the population and 50% of the country's total value added in manufacturing) and this concentration of employment increases the incentive for people to leave the villages and congregate in the already overcrowded cities.

- The factories are usually heavily dependent on imported plant and raw materials. Ghana has certainly suffered because of this. It is a country with substantial natural resources, but these will only bring wealth to its people if they are harnessed in the development of industry or agriculture. And this has not happened. The industries established during the Nkrumah period (and since) have relied largely on imported materials, even when the same materials (for instance palm oil for soap) could be grown in sufficient quantities in Ghana itself. Meanwhile, agricultural communities have not enjoyed the benefits that should have come through the increased demand for their products; the country staggers on with a chronic foreign exchange shortage; many of the western-style factories are almost at a standstill because they cannot import the raw materials they need and all kinds of activities are hampered because of the shortage of spare parts for imported vehicles and other machinery.

Intermediate technologies fall between the one extreme of advanced western technology, and the other extreme which is the tradional method of doing things. An intermediate technology will often be more efficient economically than either of the other alternatives, because it will produce more output from given expenditure on labour, capital and other inputs. It will therefore have lower unit production costs. It will generally involve a technique more complex, and requiring more capital, than traditonal methods, but will be simpler and less capital-intensive than the western technology. In many instances around the world, it has been found that an intermediate technology is more appropriate (in many senses) to the conditions of developing countries than the western alternative, primarily because it avoids the problems of western technologies mentioned above, and yet provides an economically viable (i.e. profitable) way of making things.

An intermediate technology generally has the following features:

- Small-scale - so that it can be replicated throughout the country, located near its market and its source of raw materials, and provide employment where the people live.

- Low capital cost - so that it can be set up within the country's capacity for saving for investment in productive enterprise, and so that a plant is not beyond the ability of small, indigenously-owned and run businesses and co-operatives to acquire the necessary capital.

- Labour-intensive (or capital-saving) - so that it conserves scarce capital and creates many jobs.

- Simple techniques - so that they are within the capacity of the local people, given their educational facilities, to master and develop for themselves.

- Reliance on local resources as far as possible - so that the country's natural resources are developed, the initial investment has a multiplicative effect on local employment and the country can escape financial and physical dependence on erratic and scarce imports.

- Profitable - so that it creates a surplus which is the source of the country's future income and investment, and so that entrepreneurs (or co-operatives, or whatever social arrangement the country has for organising productive activity) have an incentive to undertake the investment.

Section II of this report gives a brief account of Ghana's economy. This has a number of extreme factors which should be kept in mind when assessing the work of the TCC as related in the case studies.

Section III looks briefly at the history, organisation and objectives of the TCC, and Section IV described its work by means of eight case studies. Finally, in section V, the lessons to be learned from the experiences of the TCC are summarised.

1. Background

The population of Ghana was nearly 10 million in 1975 and growing at the rate of about 2.7% per annum. The country covers 92,000 square miles (about the size of the United Kingdom). The southern part is richly clothed rain forest-land, and the extensive northern area graduates from forest to low rainfall grassland. The population is largely rural, though about one-third live in towns of 5,000 inhabitants or more, and the country mainly agricultural, with more than one-half of those employed being involved in agriculture. Education has always been given considerable emphasis in public expenditure, and the country has a high level of general literacy. Higher education and technical training is now well served by three universities and a large number of technical schools.

Ghana used to be the richest country in West Africa, [1] but has recently been overtaken by Ivory Coast, Senegal and Liberia, and the country is currently suffering from extreme economic troubles which are described later. The economic organisation is capitalistic, although there is a large state element in production and a tradition of strongly interventionary government policy. The manufacturing industry accounts for about 12% of the Gross Domestic Product (GDP) and agriculture for about 40% (including 10% for cocoa). In the early 1960's, Nkrumah practised a policy of expanding industry and agriculture through state enterprise, and in 1970 roughly 16% of manufacturing output was through state corporations and another 17% through state partnerships

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1. GDP per head was $370 in 1976

with foreign firms (e.g. Lever Brothers, Firestone Tyre and Rubber and Sanyo). In 1965 about 5% of cultivated agricultural land was state owned. [2]

The size of the small-scale industrial sector is not known precisely, but (defined as firms employing up to 30 people) it is thought to account for approximately 3% of the GDP, 35% of manufacturing industry value added, and as much as 85% of total manufacturing employment. [3]

The transport system is largely based on roads, which on average are of reasonable quality, though the feeder roads tend to be poor. There is a perennial shortage of vehicles and spare parts and any vehicle which is functional tends to be overloaded with people and/or goods. Telephone communications are very bad, and the postal service takes about two weeks to deliver letters. Electrcity reaches about 17% of homes.

Most of the economy is monetarised to some degree, and it is estimated that about half the products of agriculture go through the money system. A conventional banking system with the full range of financial institutions exists at national level, and there is a network of commercial bank branches in all towns. Current interest rates for business loans are 15 - 18% which amounts to a negative real rate of interest when the very high inflation rate is taken into account.

2. The current economic situation

The key feature of the last few years is extremely high

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2. Killick T., Development Economics in Action: A Study of the Economic Policies of Ghana. (Heinemann 1978).

3. Small scale Industry Development in Ghana, Report prepared for the Government of Ghana by Checchi & Co., Washington, April 1977.

inflation despite widespread price controls, and there are frequent shortages of many everyday household goods and nearly all raw materials and equipment for industry. This general statement does not have much impact, and in order to realise what it means in practical terms it is necessary to imagine some of the consequences. Imagine going to the market and being uncertain whether you will find any flour or rice to buy. Imagine trying to buy enough for your family to eat when prices have doubled in the last year, your wages have not increased at all and you found it difficult to manage before. Imagine trying to run a soap factory when you are uncertain whether the state farm will allow you any palm oil this week even if you are prepared to offer a bribe, when the lorry for transporting the oil has a broken clutch and no-one can find a replacement and when the controlled price you are allowed to charge for the soap is less than you have to pay for the palm oil from which it is made. Inflation and shortages have been especially severe in the last three to four years. Problems which are equally serious, and of longer standing, are the decline in real income, and the low capacity utilisation in industry (thought to be currently below 30% in the large-scale manufacturing sector).

It is tradegy that Ghana is in this state because it is a country reasonably well-endowed with natural resources, which could, if properly utilised, give her people a good standard of living. How has this situation come about?

After independence in 1957, Nkrumah embarked on an ambitious programme of industrialisation, coupled with a massive improvement in the social and economic infrastructure (transport, education, hospitals, etc.) which was intended to create a favourable environment for attracting foreign

investment. Most of the industry that was established was in the event financed by government borrowing and re-investment of company profits since foreign capital did not enter in substantial amounts. The role of the state was considerable because of its own investment in industrial enterprises, and the improvements in the social infrastructure meant large programmes of public expenditure.

The programme of industrialisation was in some ways successful - manufacturing output as a percentage of the GDP rose from 4% in 1950-58 to 12% in 1962-65. However, the new industry was based mainly on imports of advanced western technology and had all the disadvantages mentioned previously. During the period 1953-65 employment in the manufacturing industry rose from 7% to only 8% [4], a clear indication of the high capital intensity of the new industry. Moreover, the new industries set up were often heavily reliant on imported raw materials - as much as 80% in some cases. In fact, the products of Ghana's agricultural sector, broadly defined to include fishing, forestry, livestock and cocoa, accounted for only 14% of the raw material inputs into the industrial sector in 1965.

The industrialisation effort was unfortunately accompanied by neglect of the agricultural sector, even though this accounted for a large part of the GDP (falling from 53% in 1953 to 46% in 1965), the majority of employment (60%) and an even larger share of exports (70% in mainly cocoa). Agricultural productivity has declined steadily in the last two decades, techniques have hardly changed at all, and soil productivity has fallen because of over-use and poor management.

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4. Krassowski A., Development and the Debt Trap. (Oxford 1977).

Cocoa has been badly negelcted, originally because of the uneasiness of being so dependent on one product, and because the future prospects for cocoa were not expected to be as good as they have turned out to be. Revenue from cocoa sales has always been the main source of government income, but the producer price allowed has generally been very low. The result has been inadequate levels of investment in new trees, so that there is now a very high proportion of mature trees that are past their most productive levels. Little government effort has gone into ensuring optimal use of fertilisers or the introduction of high-yielding, hybrid strains. The result of this neglect is that in volume terms Ghana's share of the world cocoa market has fallen from 36% in the early 1960's to 29% in the early 1970's, and although the recent large price rises of cocoa on the world market have increased Ghana's income from cocoa, its sales have fallen in volume by about 20% between 1967 and 1977.

At the time of independence Ghana possessed substantial reserves of foreign currency, but the ambitious expansion of industry and the emphasis on developing the social infrastructure soon exhausted those reserves. By 1965 the country had accummulated a substantial foreign debt, most of it accounted for by expenditure under suppliers' credits, much of which was on commodities that the country did not really need. Since 1965, the economy has continued to decline and is characterised by stagnating agricultural and industrial output, low exports, high imports and excessive government expenditure. This has resulted in zero income growth, rising prices and shortages of essential commodities.

Between 1957 and 1967 Ghana had an exchange rate that was fixed in terms of the pound sterling. From 1967 to 1978 it was fixed in terms of the dollar. In 1965 the old Ghanian pound was replaced by the new currency, the cedi (¢)

(dividend into 100 pesewas), which was initially equal to the old British 10 shillings, and thus had an exchange rate of ¢ = £0.50, or £1 = ¢2. The balance of payments crisis of 1965/6 forced a devaluation of the currency, and in July 1967 the new exchange rate was fixed at ¢ = ₵0.55 but revalued to ¢1 = ₵0.78 (or ¢1.15 = ₵1) in February 1972. It stayed at that rate until July 1978, when it was allowed to float for a short time. In August 1978 it was fixed again at ¢1 = ₵2.75 (or approximately £1 = ¢5.30). Despite this large devaluation, the currency is still overvalued[5].

Attempts to bring the balance of payments into equilibrium have failed for a variety of reasons. A complex structure of import controls has reduced imports to some extent, but the effects have been erratic and inclined to produce shortages. Although the currency has been devalued from time to time, the devaluation has never been sufficient, and the continuously overvalued currency and internal inflation has resulted in artificially cheap imports for which there is a correspondingly high demand. Relatively low import duties have not helped. Acquiring essential imports is a major headache for any business in Ghana. Even if an import license is obtained it is often then impossible to get the letters of credit because the Bank of Ghana simply does not have the foreign currency. A long term problem for Ghana is the poor performance of its exports, which are in the end what has to pay for the imports. Cocoa has flagged, as mentioned above, but other important exports (timber and minerals) also failed to expand significantly, even after efforts to increase the amount of processing done in Ghana, and new export industries have not emerged. The export sector of the economy, like agriculture, has been neglected by government policy.

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5. In this report the exchange rate ruling at the time has been used to translate cedis into pounds sterling.

Only recently have measures been taken to encourage exports. For instance, an export bonus scheme was introduced in 1971.

All governments in Ghana since 1957 have pursued policies of domestic expansion through heavy government expenditure on services and industrial investment. Laudable though the objectives were, government expenditure has consistently run a long way ahead of revenue resulting in balance of payments difficulties and internal inflation. Price inflation averaged 8% per annum in the 1960's but from 1972 the rate rose rapidly, reaching over 100% in 1977/78 as shown in Table 1.

Table 1

Consumer Price Index	March 1963 = 100	% change on previous year
1971	206	9.3
1972	227	10.0
1973	266	17.5
1974	315	18.4
1975	409	29.7
1976	639	56.3
1977	1361	112.9 (Jan-Nov) inc.

Source: Central Bureau of statistics: Accra

Price controls in their present form have existed since 1962, and cover a wide range of imported and locally manufactured goods. They are widely ignored except in large department stores where infringement would be easy to detect.

It has been argued [6] that the controls have been largely

6. Killick T., Development Economics in Action: A Study of the Economic Policies of Ghana. (Heinemann 1978).

ineffective in reducing the general level of prices, and that, since local foods are exempt, the poor do not benefit as much as high income people, who are more likely to buy the goods covered by the controls. An effect of having price controls that are not systematically enforced is that prices for the same item can vary substantially from place to place. Thus considerable time may be spent looking for the 'best buy' and prices are to some extent kept below equilibrium market clearing prices, so that shortages develop.

Wage controls also exist, but only cover the public sector. A minimum wage for unskilled manual workers applies to public employees, and wages in the private sector are often less. But at higher income levels the controls have in recent years operated against public sector employees, whose wages have been held to very low increases, so that they are now substantially below the wages for comparable positions in the private sector, and have lagged far behind the rising price level.

A consequence of all these problems is that real income per head has been falling in Ghana since around 1962. In 1969 the real value of private consumption per head was only 87% of the 1962 level. Figures for the most recent years are not available, but they must show a very gloomy picture as inflation has been running at more than 100% per annum for the last year or so. The group that has suffered most is probably the urban poor, who have little scope for reducing consumption of those goods inflating most rapidly.

The prospects are uncertain. The recent hyperinflation seems to have been caused mostly by uncontrolled public

expenditure. The magnitude of the changes needed to right the economy, and the reasonable resistance of the population to the further reduction in their living standards, which is unfortunately a pre-requisite of a successful return to an orderly economic existence, means that even a well-intentioned government will find it difficult to cure the country's massive economic ills. Certainly imports will continue to be rigidly controlled and/or extremely highly priced for the indefinite future, and price stability will be difficult to achieve quickly. A consequence may be increased unemployment, which is already high (thought to be about 15% in the wage sector in 1970), and continuing low capacity utilisation of manufacturing plant.

3. The Environment of the Small Firm

The small-scale industry sector accounts for about one-third of manufacturing value added, and a higher proportion of manufacturing employment. This sector includes small-scale rural industries, small firms in the informal urban areas, and a substantial number of larger, more organised firms in the towns. The main products of this sector are food products, beverages, garments, furniture, building materials and leather goods. The informal sector is also involved in the repair of motor vehicles, electrical machinery and other machine repair services. Very few linkages exist between the large-scale industrial sector and the small firms. They serve largely different markets and produce different kinds of goods. Large firms lack confidence in the quality and standardisation of goods produced by small firms.

A survey of small-scale industry carried out in 1976 [7]

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7. Small Scale Industry Development in Ghana, Report prepared for the Government of Ghana by Checchi & Co. Washington, April 1977.

found that the main problems being faced were shortages of imported raw materials, spare parts and machinery, difficulties for the smallest size of firm (less than seven employees) in obtaining credit, lack of technical assistance for accounting, control and production methods, and the complexity of the procedures required for starting businesses. However, small businesses seem to have weathered the difficulties quite successfully, and they have managed to maintain a higher capacity utilisation than large concerns. In some ways they are less vulnerable than large-scale industry - they use more local raw materials (but virtually all need some imports), informal networks keep up supplies (though at a high price), much of the imported plant and equipment likely to be needed by small firms attracts a low or zero import duty and lower taxes are paid (interfirm sales are subject to sales tax, but sales to final consumers are not, and corporate income tax is on a progressive scale) [8]. However, these factors are unlikely to give small firms much compensation for their relative disadvantage in, for instance, obtaining import licenses or credit.

The government largely ignored the small-scale sector in the 1950's and '60s, but more effort is now being made to assist it. The Bank of Ghana operates a credit guarantee scheme for small business loans, and the commercial banks had lent ¢20 million to small businesses under this guarantee by 1975. The Ghana Enterprises Development Corporation also has a small business loans scheme and ¢2.5 million had been lent to small-scale industry by 1975. A Small-Scale Industries Development and Training Centre has been set up in Tema, but apparently has only a nominal staff and is not functioning.

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8. ibid

More useful is the Management Development and Productivity Institute, which helps small firms with training in finance and accountancy, and gives advice on the preparation of applications for bank loans and other matters. These efforts are, however, small in comparison with what could be done, and they probably do more to help fairly large and well-established firms than the very small ones, or people wanting to start a business from scratch.

Entrepreneurs who are willing to go into manufacturing are very scarce in Ghana. One key factor is that the economic circumstances that make it difficult to make money in manufacturing are precisely the ones that make it easy to earn money in trading. Inflation and price controls enable some people to make small fortunes. Between the person who initially imports or produces for sale at around the controlled price and the person who sells to the final customer at a much higher price on the open market, there is a chain of intermediaries, who all take their cut. An investment in a productive enterprise has to promise a very high rate of return on capital, and a very high absolute profit, before it will entice an entrepreneur away from the lucrative opportunities in trading. As will be seen in the following sections, this is one of the main reasons why the TCC has found it difficult to find capable and enthusiastic entrepreneurs.

III The Technology Consultancy Centre

In the words of the Director in his five-year development plan for the TCC:
"The Centre was established to make available the expertise and resources of the University in the promotion of the industrial development of Ghana. Through it, government departments established industries and individual entrepreneurs can draw upon the services of the professionally qualified senior staff of the faculties of the University. Moreover, the Centre has become an agency for the stimulation of grass roots development through the means of 'intermediate' or 'appropriate' technology. It is seeking to upgrade existing craft industries and to start new ones by developing new products, introducing improved methods and utilising locally produced raw materials in place of imported ones." 9

Although the TCC is concerned with all kinds of industrial development, its main emphasis is on the promotion of small-scale industry using intermediate technologies. Indeed the origin of the Centre was the Suami Product Development Group formed in 1971 by a group of lecturers from the University of Science and Technology, Kumasi. This group aimed to help the small entrepreneurs of the large informal industrial area of Suami, just outside Kumasi, to improve their skills and resources.

In Janaury 1972 the TCC came into existence with a staff consisting of an acting director, a secretary, a messenger, and funds of ¢5000 (£1700) granted by the University for the

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9. Powell J.W., 5 Year Development Plan 1976-1980 (TCC October 1975)

period to September 1972. During the first year several agencies were successfully approached for funds, the seeds of several of the projects described in the case studies were sown, and many other activities were explored, often with the continuing help of members of the Suami Product Development Group. In 1973 there was a substantial increase in the University's subvention and this, with the first of the overseas grants, enabled the real project work to begin, helped by the opening of the Centre's workshop.

During the next few years the staff expanded considerably, and by 1977 it consisted of a director, a deputy director, five technical assistants/research fellows plus support staff [10]. Through its production units, the Centre became a substantial employer of local people in unskilled and semi-skilled positions, and the units employed over 50 people by 1976/7. Transport needs are barely served by four vehicles - an old Landrover, a Bedford five ton truck, a Ford pick-up truck and a saloon car.

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10. Dr. J. Powell, Director
Dr. B. Ntim, Deputy Director
Mr. S. Buatsi, Research Fellow - metal products
Mr. P. Donkor, Research Fellow - Soap
Mr. K. Opoku-Debrah, Asst Research Fellow - village craft work, spent grain
Mr. S. Adjare, Asst Research Fellow - Weaving
Mr. J. Quansah, Rice Thresher Project Evaluator
Secretary, Accountant, Clerks, Typists
The five technical assistants/research fellows are all graduates of the University in relevant disciplines such as engineering, science or agriculture. Each is assigned to a project, and has responsibility for maintaining contacts with entrepreneurs and craftsmen, undertaking development work on techniques, helping with the establishment of off-campus activities and in some cases with the work of the Centre's production units. At the same time they are gaining experience for the overall responsibility and administration of projects at a later date. Mr. Buatsi and Mr. Donkor have both had a year off for full-time study for their Diplomas in Business Administration.

The Centre raises funds for individual projects as the need arises. In the past, grants have been received from overseas donors, a few small grants from local donors, grants and loans from government ministries, and loans from national and commercial banks. In a number of cases where grants have been received to cover plant or equipment for entrepreneurs or craftsmen, the Centre has in fact sold the goods at cost price, so that the entrepreneurs value them properly and demonstrate financial independence; then the Centre uses the proceeds to set up a loan fund for further related projects.

The Centre's income since its formation is shown in Table 2 below:

Table 2

Academic Year	UST Subvention	Local Grants	Consultancy Earnings (Cedis)	Production Unit Earnings	Overseas Grants	Total
1971/2	5,000	-	-	-	-	5,000
1972/3	35,000	29,703	6,466	1,812	40,000	112,981
1973/4	31,600	25,000	3,400	35,011	26,404	121,415
1974/5	42,300	-	49,556	81,737	64,000	237,593
1975/6	62,680	-	34,175	158,267	7,000	262,122
1976/7	68,748	-	25,220	118,678	34,456	248,501
1977/8	82,794	-	7,512	216,451	190,551	497,308

It can be seen that sales from the production units have contributed a growing share to the Centre's income, but of course they have attendant costs, and it was not until 1975/6 that sales income exceeded expenditure. It is also clear that although total income has grown in money terms, inflation means that it has actually fallen in real terms.

The methods by which the Centre seeks to achieve its objectives are well-illustrated by the case studies presented in the following section. For many projects the Centre acts primarily as adviser to entrepreneurs who have ideas for investment or who have money to invest and are looking for lucrative ventures (e.g. paper glue, animal feed from spent grain).

Frequently the Centre puts the entrepreneur into contact with a specialist from one of the University faculties, who advises on product or process development on a consultancy basis. Much of the technical work is done by the Centre's own staff, utilising the facilities of its workshop to construct prototypes of plant or equipment needed by the various projects. Examples are the development of the pyrolytic converter, the caustic soda plant, rice threshers and oil presses. Most of the work involves metal or wood-working, and the TCC workshop is equipped with a range of basic machine tools suitable for this work.

A vital part of the Centre's work consists of establishing contact with entrepreneurs who are seeking new opportunities and would be interested in investing in an intermediate technology. Many of these have heard of the TCC and visit to ask for assistance, but the Centre feels that its location on the University campus, four miles outside Kumasi and away from the industrial areas, creates a barrier between itself and the would-be entrepreneurs. This would be overcome by establishing a physical presence in their midst. The Centre plans to achieve this through Intermediate Technology Transfer Units [11], but so far lack of funds has prevented this.

The other main group of people that the Centre seeks to reach are the village craftsmen working in industries such as textiles, pottery and woodworking. The Centre's aim is to upgrade existing craft industries by the introduction of new products and improved manufacturing techniques. It recognises that this can only be done when the craftsmen themselves appreciate the need for taking a step forward in technology, and can anticipate the rewards. The Centre's relationship with the craftsmen is therfore a delicate one to be carefully nurtured, and taken at a pace no faster than is demanded by the craftsmen.

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11. These are discussed in Section V of the report.

The case studies of weaving, bead-making and brass casting illustrate the Centre's activities of this kind.

Finally, an important role is played by the Centre's own production units (case studies on weaving, nut and bolt manufacture, and the plant construction unit). In these units, production methods can be refined after the initial development of the technology, markets for the products identified, raw material sources located, managerial problems sorted out and the technical and commercial viability of the technologies demonstrated to would-be entrepreneurs.

Of course, the case studies do not cover all of the TCC's work. The Centre is very well known throughout Ghana, and especially in and around Kumasi, and the daily life of the Centre's office sees a constant stream of visitors coming for advice, enquiring about TCC projects, or simply keeping contact after earlier involvement.

The type of request varies considerably. Many small manufacturers seek testing or chemical analysis of their products before starting production. Some seek reassurance that their product will meet the requirements of the Ghana National Standards Board. Others need to know if their product is safe to use or can be improved. Some are directed to consult the Centre by a commercial bank or other organisation from which they have requested a loan to start or expand their business. Many manufacturers have problems concerning the availability of raw materials. Others require advice on the selection and importation of machines and equipment. As a result of the Centre's assistance, people can often make immediate improvements in their techniques or organisation.

Many of the requests are passed on to expert consultants elsewhere in the University. For instance, during 1974/5

consultants in the Faculty of Engineering dealt with problems concerning the installation and commissioning of a carbon dioxide welding machine, the design and manufacture of cheap feeder tubes for rabbit farming, the design of metal stamping dyes, the repair of a laundry steam press and the repair of a large wood-fired steam boiler at a plywood factory.

IV Case Studies

Each of the following case studies is divided into three parts. The first part gives a background which relates the product(s) to the economic situation in Ghana. The second part describes the history of TCC involvement in developing the particular intermediate technology. In the final part, the case study is briefly analysed in terms of success or failure.

1. GLUE [12]

Background

In 1972 almost all paper glue used in Ghana was imported. As a result of the TCC's assistance to a local entrepreneur it is now all made in Ghana. The development of the local glue industry has saved considerable foreign exchange (imports of paper glue were worth about ¢170,000 in 1970) and provided employment for unskilled workers in Ghana. The TCC assisted with the perfection of the glue formula, and helped the entrepreneur to obtain a bank loan to set up production. Thereafter the TCC has only to put in occasional work, as the venture has spread on its own momentum.

History

In 1971 Mr. Baffoe was a small manufacturer of cassava starch, which he sold to local laundries. He operated from his home in Ayigya, which is a scruffy village with a population of about 5,000, just across the main road from the Kumasi University Campus.

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12. Reference materials for this study are:
    - TCC Annual Reports No. 1 to No. 5 (1972/3 to 1976/7).
    - Powell J. W., A Review of Experience Gained from Three Projects, 1972, in Appropriate Technology in Economic Development, Proceedings of Seminar, Edinburgh University, September 1973.
    - Powell J. W. and Ntim B.A., Appropriate Technology in Ghana: The Experience of Kumasi University's Technology Consultancy Centre in Appropriate Technology, Problems and Promises, Jequier N. (ed) OECD, Paris, 1976.

In March 1972 Mr. Baffoe came to the TCC with a request to be taught how to make good quality paper glue. Paper glue is traditionally made in Ghana from cassava starch and the ash from plantain peel - both readily available raw materials. Some schools make enough for their own needs. The problem with this glue is that it has a short life and is not waterproof.

The technical problems were solved by the University's Department of Chemistry and Chemical Technology, and consisted of the addition of a non-toxic fungicide as a preservative, and chemicals to confer the waterproof property. A formula was developed that resulted in a glue of a quality comparable to the imported products.

The Centre assisted Mr. Baffoe in securing a loan of ¢3,000 from Barclays Bank to cover the purchase of materials (cassava, chemicals, etc.) and equipment (aluminium basins, plastic bottles, packing boxes, etc.). The Centre advised him to back his application to the Bank with a complete list of requirements, to have a cash flow estimate prepared, to design and print labels, and to try out the market by taking sample bottles to stores and collecting trial orders. The overdraft was obtained in August 1972, and Mr. Baffoe started making the new glue soon after.

The simple equipment needed was made to Mr. Baffoe's order in the TCC workshop. When production started, a market was easily found and 'Spider' glue was soon being sold in stores in Kumasi and Accra. At that time the price at the factory gate was 60 pesewas for a 10 ounce bottle, which compared very favourably with a retail price of 95 pesewas for a 5 ounce bottle of imported glue. In February 1973 a certificate of the Ghana National Standards Board was obtained, and later that year an agreement was signed with the Ghana Publishing Corporation, the largest distributors of stationery in the country, to supply them with not less than ¢20,000 worth of Spider glue a month. Mr. Baffoe had already paid off his overdraft by March 1973 and was then granted a further loan so that he could expand his output. By mid-1974 he was making 30,000 bottles a month; he

was employing 30 people from the village, many of them women, and was making a profit of ¢70,000 on a turnover of ¢240,000. He was still operating from his home in Ayigya, having decided that the expense of establishing special premises was unnecessary.

It is common practice in Ghana for the government to protect indigenous import substituting industries by banning the import of the commodities concerned. This was applied in the case of glue, and imports ceased in 1974/75, by which time Mr. Baffoe was supplying virtually all of Ghana's needs, and achieving foreign exchange savings of around ¢120,000. The savings would have been greater if the bottle and spreader top (accounting for over half the value of the selling price) could have been made in Ghana.

The TCC charged Mr. Baffoe a small fee of ¢350 for the development of the original formula and payment was deferred for six months to give him a chance to pay from the sales of his product. The charging of fees is at the discretion of the director of the Centre. Many free services are provided to small businessmen and craftsmen. However, when a project requires the lengthy study of a consultant and leads to a significant increase in profitability, it is the policy of the Centre to charge fees. By this means the co-operation of consultants is encouraged and the entrepreneur takes a serious view of the advice given.

In 1975 Mr. Baffoe's fortunes turned. His success had attracted others to the possibilities of profit from making glue, and at least two competitors started up, the first being his previous foreman, who had left equipped with the formula. Of course, the emergence of competitors is a healthy sign, and proof of the commercial success of the product, but the consequences were unfortunate for Mr. Baffoe as he lost sales to his competitors. He suffered another setback in that year. While he was in Abidjan, Ivory Coast, trying to set up a plant there to manufacture glue, a bad batch of glue was sent out from his factory at Ayigya. The National Standards Board insisted on changing the formula, which actually ensured that all the glue produced was defective; eventually the Board withdrew its Certificate of Approval and Mr. Baffoe then lost the contract with the Ghana Publishing Corporation, and his sales fell

to almost nothing.

Now the troubles are over and he is starting up with a new brand name, Nadom glue, which has a Standard Board certificate, and he is making about 8,000 bottles a month with a workforce of seven labourers and one supervisor. He hopes to expand again from this base. During the lean years he diversified into glue for envelopes, and attempted without success to develop a glue for book-binding. At no point has he made a serious attempt to export, apart from the venture in Abidjan which was abandoned when the trouble in Ghana started. The main reason for not making export sales was that in 1975 he was still not really ready to undertake the complex and hazardous task of exporting, and since then he has not been in a sufficiently favourable position. It is not known whether any of the other glue manufacturers are exporting.

Discussion of case

Although the fortunes of the entrepreneur described here have been variable, the TCC's intervention has been successful in making Ghana self-sufficient in the manufacture of paper glue, saving a significant amount of foreign currency and creating a modest but useful amount of local employment.

This case was particularly satisfactory from the Centre's point of view because its input was relatively low compared with some of the other developments undertaken. After the initial work the entrepreneur took full responsibility for production and marketing, and the TCC's subsequent contact has been only for occasional advice. The Centre would be relieved if all their cases were as easy!

Three factors probably contributed to the success of this venture:

- The entrepreneur was a serious and experienced person, who pursued the venture with energy and initiative.

- There was already an established market for imported glue, and the new process developed by the entrepreneur allowed a new product of comparable quality to be produced at a low cost and sold at a price considerably below that of the imported alternative.

- Most of the raw materials used were locally produced, and processing them for making starch and glue was already a familiar practice.

2. SOAP [13]

Background

The TCC's involvement in the manufacture of soap and caustic soda has also led to the successful transfer of an intermediate technology. It does, however, have rather interestingly different features from the glue case study: the technical development took longer and extended some way back into the production process; the product has not been so obviously successful commercially and the experimentation and initial production were undertaken by a TCC demonstration project, which served to show the technical and commercial viability of the operation. The demonstration project has over the years taken up a large amount of TCC staff time, and even now that transfer has successfully taken place, a TCC research fellow has been engaged full-time since 1976 on further development work on related soap-making activities.

Although Ghana grows large quantities of one of the basic ingredients of many kinds of soap - palm oil - it is heavily dependent on imported soap to meet the current demand. Between January and May 1975, Ghana imported 14.68 tons of medicated soap valued at ¢374,355, 3.3 tons of toilet soaps valued at ¢7,673, and 815 kilos of washing soap in bars or cakes valued at ¢875. This is a heavy burden on the balance of payments, which could be reduced by greater home production.

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13. Reference materials for this study are:
    - TCC Annual Reports Nos. 1-5
    - Powell J.W., Soap Pilot Plant - Review of Progress in 1975 (TCC March 1976)
    - Powell J.W., Soap Pilot Plant - Review of Progress in 1976 (TCC Jan 1977)
    - Donkor P. and Sorviant G., Progress Report on Local Manufacture of Caustic Soda (TCC June 1974)
    - Donkor P., Extraction of palm oil using appropriate technology hand screw press (TCC July 1978)
    - Donkor P., Finding an economic non-edible oil substitute (for palm oil) for soap making, with particular interest in the neem oil: Thesis for Post-graduate Diploma in Industrial Management, Kumasi, 1976.
    - Prakesh G., Report of Work done for Soap Pilot Plant Kwamo for TCC (Jan 1976)

Local producers can use home-grown palm oil, but caustic soda - the other main ingredient - still has to be imported. Foreign exchange difficulties have meant that there has been a shortage of caustic soda, which has now reached a very high price when available. So domestic producers have been unable to produce as much soap as they want.

Palm oil is also in short supply. Local production cannot satisfy the whole of the country's needs - only about 20% of the estimated total requirements for household and industrial use is domestically produced; much is imported, most in the form of processed goods. Industrial uses, such as soap-making, are in competition with direct consumption in the home, and preference given to cooking uses seems to have led to erratic supplies being available to the soap-makers. The price of edible palm oil sold by the state farms is now ¢875 per 44 gallon drum, but the same quantity bought in the market place would cost ¢1,600. State farms are one of the main sources of palm oil and they operate a quota system to ration supplies, but it breaks down. The reason is thought to be that the market women bribe the factory officials into selling to them for resale at a high mark-up. Soap-makers frequently have to go back time and again before they obtain any oil, and their output has been severely curtailed in this way during the last three to four years.

The government is encouraging the expansion of oil palm production, which gives a very high rate of return on capital to the grower (higher than cocoa at the current fixed price of cocoa received by the farmer) but progress is slow. Palm oil grows best in the intensively cultivated forest region, so that even if expansion is achieved it will be at the expense of other crops such as cocoa, which gives a very high return to the economy as a whole in terms of export earnings and revenue for financing government expenditure. In the long run it would be desirable to develop the production of other suitable oils for soap-making, especially ones that could be grown in currently uncultivated parts of the savannah areas or the Accra plain.

In the villages of Ghana there is a large number of traditional soap-makers operating on a very small scale, typically producing about 80 one-kilo bars a day using a 44 gallon drum for boiling the oil and alkali mixture. The bars are set in a box and cut with a steel wire. The oil used is usually palm oil, but during times of shortage of palm oil, shea butter may be used instead even though it does not give a good lather except in combination with other oils. Coconut oil and palm kernel oil are sometimes used to produce toilet soap by a cold process which requires no boiling. The source of alkali is usually imported caustic soda, but in the rural areas soap-makers sometimes use locally available materials - caustic potash, obtained from the ash of plantain or banana peel or cocoa pods, and the soap is sold in small balls shaped by hand. This method produces a soap of a dirty colour, which dissolves quickly in use. The quality achieved by the local soap-makers with caustic soda is better but still poor - it is sometimes too soft so that it shrinks before reaching the market, it gives a poor lather and contains too much free caustic soda. It is also extremely variable because the soap-makers do not adhere to a consistent formula.

There are three soap manufacturers in Ghana using automated processes. One is a fairly small operation and is thought to have ceased production because of raw material shortages. Another is medium-scale, but production is also currently very low because of shortages. The third is a very large-scale plant operated by Lever Brothers, who are partly government owned. Their factory in Tema has been producing a variety of soaps - toilet, medicated and pale bar soap (which is the one in greatest demand) - since 1963. The capital value in present day prices is about ¢6 million (excluding the plant for making detergents and margarine at the same factory). It would employ about 750 people in soap-making if working at full capacity with three shifts and produce 30,000 tons of soap a year. At present the factory is running at about only 20% capacity, owing mostly to shortages of imported raw materials, and employs 500 people. This low level of work has persisted for two to three years, and Lever Brothers' soaps are rarely seen in the shops. Lever Brothers could produce only about half of Ghana's demand for soap even in full production, so there is still a need to expand

local manufacturing capacity. They are also entirely dependent on imported raw materials (the palm oil comes mostly from Malaysia and some from Ivory Coast and Togo) so local manufacture of soap from locally grown materials could achieve substantial import savings.

Soap was one of the 'essential' commodities, which under the regulations operating until very recently were available only in officially 'designated' supermarkets and were subject to price controls at both the factory gate and retail outlets. Even at the official retail outlets Lever Brothers soap (and any other kind) are rarely in stock, and it is thought that before it reaches the counter much of it is resold to the market women, who sell it at a large mark-up in the open market.

The price of Lever Brothers' soap is controlled at ¢1.25 for a bar weighing 1.36 kilos, but the controlled price has fallen below the production cost during recent years as costs have increased two to three times but the controlled price has only been raised by about 30%. Lever Brothers manage to sell at the controlled price by means of a government subsidy, but even so, at the present low levels of capacity utilisation they are running at a loss. Other soap-makers usually disregard the price control, which is little enforced partly because soap is such an important commodity and partly because it is actually difficult to enforce; sometimes they reduce the bar size.

It can be seen that there is a considerable need to expand the production of soap in Ghana, relying as much as possible on locally grown materials, and ideally using a non-edible oil that can be grown in regions with low agricultural productivity. Even if the current shortages were eased there would still be a long-term need to produce a soap in Ghana that was comparable in quality to that of Lever Brothers, and was produced by methods that were more efficient (i.e. lower cost) than those of the traditional soap-makers and achieved a better quality product at a similar price.

History

The TCC originally became involved in the problems of soap manufacture during 1972 in response to enquiries from local traditional manufacturers who wanted a chemical analysis of their soap, and advice on how to improve its quality which, as mentioned above, was somewhat unsatisfactory. Experimentation started in the TCC's workshop, with technologists from various faculties of the University working with one of the local soap-makers.

The TCC made a successful application for a grant from the Ministry for Industries to construct a prototype soap plant on the campus for experimentation and ultimately for the production of soap. During 1972/3 experimentation was carried out with various combinations of ingredients, the resulting soap being tested for moisture content (which was often too high in local soaps), the percentage of fatty matter (which was often too low), retention of free caustic soda, and physical properties such as colour, hardness, smell and lathering ability. Formulae that achieved reasonable results were offered to the local soap manufacturers, though they did not always abide by them and still obtained variable results.

A satisfactory formula was eventually evolved and the prototype soap plant installed at the TCC's workshop started production for sale in September 1973. The prototype boiling tank had a capacity of 500 one-kilo bars per day, and was electrically heated, with an outer tank for clarifying the oil and an inner tank for boiling the soap. Average daily production during the first year was only 160 bars (much less than capacity), because of a combination of problems arising from the inexperience of the soap-makers, technical difficulties needing continuing experimentation and fluctuating market demand. Monthly output varied from 420 to 6,870 bars during this period. The product was a basic pale soap, suitable for both washing and cleaning. Sales fluctuated according to the availability of other brands of soap. When Lever products were available they were bought in preference to Anchor soap - mainly because they had the advantage

of familiarity and were also being sold at a slightly lower price. In April 1974 a second plant was installed and started production. This also had a capacity of 500 bars a day.

Plans had already been made to construct a soap pilot plant near Kumasi, the purpose being to produce soap for sale, to serve as a demonstration project showing the technical and commercial viability of the intermediate technology, and to continue research and development. Construction of the plant started at Kwamo in January 1974.

As caustic soda had become increasingly scarce and expensive it was decided to begin caustic soda manufacture so that, as far as possible, the supply to the proposed soap pilot plant could be guaranteed. A caustic soda plant was designed by a member of the Department of Chemistry and Chemical Technology and production started in early 1974. Caustic soda was produced at a cost of ¢35.00 per 50 kgs, which was only a third of the prevailing market price. The plant proved to be adaptable for other purposes: one was produced at the TCC workshop for the manufacture of insecticide and two more for domestic bleaching fluid.

The prototype soap and caustic soda plants attracted a good deal of favourable attention from manufacturers and entrepreneurs and, during 1974/75, orders were placed with the Centre by entrepreneurs located in Ho, Sekondi, Akim-Oda, Sunyani, and Tarkwa. During this year, plant operators were trained at the prototype plant for transfer to these entrepreneurs and also for the soap pilot plant, where production began in June 1975. Later in the year, the prototype on the campus was renovated and sold.

At this stage, in response to an earlier request made to the Intermediate Technology Development Group, London, for assistance to improve the quality of the product, a consultant on small-scale soap-making from the Appropriate Technology Development Association, Lucknow, India, was seconded to the TCC for a three month period, financed by the Commonwealth Foundation.

The consultant was asked to improve on the quality of the soap in respect of consistency of colour, hardness and total fatty

matter content. He was also asked to advise on lowering costs through finding suitable locally available fillers which might be an improvement on the sodium carbonate and sodium silicate currently being used.

The consultant suggested that wood-fired saponification tanks should be used instead of electrically-heated ones. Besides producing better soap, these are also cheaper to construct, cheaper to run and faster in operation.[14] In addition, people can be trained to operate them more quickly and they are more suitable for use in remote rural areas. Three wood-fired saponification tanks were made during the consultant's visit and 12 more were made and sold during the following year.

Other improvements made by the consultant were:

- the process time was reduced by using a smaller initial quantity of water;
- clotting was avoided by the gradual addition of caustic soda in three stages during saponification;
- cassava starch and kaolin were introduced as fillers for the soap - ten per cent white kaoline, which is locally available, was finally chosen as the best;
- neem oil was suggested as an alternative to palm oil.

During the following years, the soap pilot plant and the entrepreneurs who had bought soap plants faced difficulties relating to shortages of palm oil and rising costs of this and other raw materials.[15] In 1976, production averaged only 30%

14.

	Electric Plant	Wood-fired Plant
Initial cost	¢2,000	¢550
Fuel cost/month	¢ 150	¢ 65
Process time	8 hours	7 hours

Note that no allowance is made for differences in the buildings required (higher for electric plant) or labour (higher for wood-fired plant).

15 The controlled retailed price of soap had stayed at 95 pesewas per bar since October 1973, but since then the costs of raw materials had risen dramatically. Palm oil had increased from ¢90 per 44 gallon oil drum in October 1973 to ¢210 per drum at the beginning of 1976 and ¢350-¢400 at the end of 1976. It is now ¢875. In the last half of 1976, the recurrent cost of producing a bar of soap at Kwamo was around ¢1.05, which was more than the control price. In May 1976 the bar size was reduced in order to attempt to cover costs. In July 1977 the controlled price was increased to ¢1.25 per 1 Kilo bar but this was insufficient to compensate for increases in the price of raw materials.

capacity at the pilot plant and fell even further during 1977/78 because of raw materials shortages. Some of the entrepreneurs who bought soap plants have closed down operation because of supply and cost problems, but some keep going, and orders for new plant have continued to arrive. Twenty soap-boiling tanks and associated equipment were supplied to six entrepreneurs in 1976. Most also bought caustic soda plants to ease their importation problems.

It is worth looking in a little detail at four of the entrepreneurs who are known to be still producing soap, as it illustrates the variety of types who are likely to become interested in intermediate technologies. One man was a trader before he became involved in soap-making and he also had a textile shop. Another was a farmer. The third soap-maker is a lady in Accra who has a variety of other interests - transport, oil pressing and the manufacture of hair preparations. It is said that there is an increasing number of female entrepreneurs, and it is thought that they find it easier to obtain bank loans than men. The fourth soap-maker has been a problem case. There was on one occasion a bad fire in his factory caused by soap overboiling and igniting. On another occasion he distributed a batch of poor quality soap and was then unable to refund the money paid. Both these situations were thought to have been due to poor supervision of the soap-making, but the entrepreneur had a history of similar mishaps. On a previous occasion, 5,000 chickens in his poultry farm all died in a week.

The entrepreneurs buying soap and caustic soda plants have to find the capital funds, which they usually obtain from private resources or a bank loan. The TCC requires a deposit of 50 per cent cash payment when the order is made. On several occasions the Centre has helped the entrepreneur to obtain a bank loan by preparing an appraisal of the project and helping the entrepreneur submit this to the bank. The TCC thinks that without this assistance some entrepreneurs would not have secured their loans. The interest rate charged on loans is usually 12½ per cent per annum, and the repayment period varies from two to five years with new entrepreneurs usually being given a period of grace of two years before any repayments of principal are required.

Other assistance given to entrepreneurs includes the training of their soap-makers at Kwamo for a period of up to three months before installation of the plant. This serves two purposes. First it ensures that the venture will be successfully operated technically, and secondly it tests the seriousness of the entrepreneur. The plant is then installed under the supervision of a technician from Kwamo, who stays on for one to two months to see the venture through initial teething difficulties. Thereafter, the entrepreneur is on his own.

Despite current conditions, interest continues to be high and new orders for soap plants have been received in the last year. However, with the present shortages of raw materials, the Centre is actually counselling caution to some people who enquire about the plant.

Further developments by the TCC of intermediate technologies in the soap-making field include the search for alternative raw materials. Soap has been made, and tested for suitable properties, from oil extracted from a number of local plants - shea butter, cocoa butter, castor oil (all edible) and physic nut, neem and monkey cola. Of these, neem gave the best soap, but the costs of collection were found to be very high. The Centre is now examining the potential of castor oil and physic nut, and has established experimental plantations of these plants. Technical developments include the construction of a prototype perfume distiller, which would extract perfume from local plants to replace the imported fragrances currently used. Another is the development of a hand-operated screw press for the extraction of oil from palm and other fruits. Several have been made and are being used successfully. If adopted more widely the presses could enable farmers to increase their incomes by extracting the oil from their own fruit.

Discussion of case

The establishment of a small-scale industry for producing caustic soda and soap in Ghana has to be counted as a success for intermediate technology. The current state of the industry is somewhat shaky, but this is attributable to the dilemma of the Ghanaian economy rather than to any fault in the technology.

It satisfies all the criteria by which one might judge an intermediate technology venture. The plants are small-scale, employing a workforce of between three and 15 people; the products can serve local markets; the plants have been established in all parts of the country; the processes used are simple and can be mastered after a short training period and many people in the country will already be familiar with them because of the tradition of local soap manufacture. The amount of organisation and supervision, although important, is not excessive. The product has found widespread customer acceptance in a time of shortage. It may prove more difficult to maintain sales if and when imported supplies of higher quality products or Lever Brothers' soap again become available, and more effort will then have to be put into marketing. However, with the recent devaluation of the cedi, import prices will probably increase and it should be possible for the soap produced from locally grown oil to maintain a price advantage. The capital cost is low, and well within the capacity of small entrepreneurs to obtain finance. The capital/labour ratio (cost per work place), of about ¢3,600 (allowing for a building more modest than Kwamo's) is only one-tenth of that of the large-scale Lever Brothers enterprise, whose capital/labour ratio is about ¢36,000. Nearly all of the raw materials used are locally produced. Local manufacture results in savings on imported finished products, and the development of caustic soda manufacture also saves on the import of this chemical.

The only reservations one can have about the apparent success concern the commercial performance of soap-making and the future maintenance of a good sales record.[16] Profitability has been low, partly because rapid inflation in raw material costs has not been matched by increases in the controlled selling price, and partly because shortages of raw materials have held production at very low levels relative to capacity output.

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16. For details on the profitability of Kwamotech Industries and financial returns to soap manufacture see Annex I.

During much of the five-year period of soap-making, imported soap and Lever Brothers soap has been extremely scarce, and the product of the intermediate technology has not really been tested in a situation of free choice.

It is difficult to speculate on what will happen to the Ghanian economy, and what might happen to the local soap manufacturer accordingly. Although local soap should have a price advantage over imported soaps, it is more doubtful that it can compete against the Lever Brothers' products made in Ghana. However, since that firm does not have the capacity to serve more than half the total market, a demand for locally made soap should be assured, and foreign exchange scarcity is likely to continue for many years in Ghana.

It is worth trying to identify the crucial features that can account for the success of this intermediate technology. One can only guess at this, but it seems likely that the following are important:

- the processes are very simple;
- they use locally available materials that people are used to working with;
- the product is a basic consumption good needed by every housewife;
- the financial return is high enough to attract entrepreneurs.

Development of the technology and its diffusion were given considerable attention by the TCC, and of their many activities the following have perhaps done most to ensure the success of the venture.

- the existence of the soap pilot plant, which could demonstrate technical and commercial feasibility;
- the facilities of the TCC workshop where the prototypes could be made, experimentation carried out, and plants made to order for the entrepreneurs;
- the technical assistance provided by the TCC to the entrepreneurs before, during and after installation of plant;
- the advice of a consultant in soap-making, which resulted in significant improvements in product and process;

- the development of the caustic soda plant which reduced reliance on imported materials to a minimum.

This amounts to a considerable back-up, but is probably essential in an economy where there is a scarcity of entrepreneurs and an unwillingness to go into productive enterprise.

3. Animal Feed From Brewers' Spent Grain[17]

Background

This is an interesting TCC involvement with a local entrepreneur which has led to the establishment of a highly profitable and self-sustaining small-scale productive enterprise, with prospects for expansion and replication elsewhere.

The venture consists of small-scale drying of spent grain from the local brewery for use as animal feed. The Kumasi brewery produces over 100 tons a week of spent barley, which until recently they were paying contractors to transport away and dump in the bush. In most countries this protein-rich material is dried and turned into animal feed, but in Kumasi, although some of the wet grain was fed directly to pigs, the majority was wasted.

Now a local entrepreneur is taking about 14 tons a week of the wet spent grain from Kumasi brewery and drying it for sale to local farmers. The intermediate technology developed with the help of the TCC involes a screw press for extracting the major part of the water, and sun-drying in a large concrete yard to complete the process. A local market for the new product was easily established and the production costs were so favourable that the entrepreneur could both make a handsome profit and sell the grain at a price that compared favourably with that of other animal feeds.

History

An unusual feature of this case is that the TCC was originally approached by an entrepreneur for its suggestions as to a suitable productive activity in which he could invest his funds.

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17. Reference materials for this study are:
    - TCC Annual Reports Nos. 4 and 5.

The Centre had already considered the possibility of drying spent brewers' grain and had already had samples of dried grain analysed. The Centre suggested this to the entrepreneur, who took it up eagerly apart from some anxiety as to whether he would find a market for this unfamiliar product.

The TCC designed and constructed the first press, which was made from a perforated oil drum. This was later found to be insufficiently strong and was replaced by a drum made from galvanised sheet steel, a material readily available locally. The entrepreneur found a suitable site, the main requirement being a large concreted compound with white walls and some sheds. The Centre supplied the press and other equipment on a three month trial basis. The entrepreneur had the option of returning it after three months if he was unsatisfied, or buying it. In the event, the process worked well, a market was established, the entrepreneur bought the press and soon commissioned a second one.

The Centre thought that a mechanical dryer would be needed during the rainy season and a prototype kerosene-fired blower-dryer, based on a design tried by the International Rice Research Institute, was constructed by a final degree student at the Mechanical Engineering workshop under the supervision of TCC staff. Completion of the work was actually delayed, and by the time it was ready the rainy season had already started. However, the entrepreneur found that he could continue solar drying to his satisfaction, and he has never, in fact, taken the dryer.

Experimentation by the Centre revealed that the kerosene gave a smell to the dried grain, which made it unacceptable to the livestock. The dryer was converted to electricity, but there was concern that the rising cost of electricity would make it an uneconomic proposition. It has now been converted back to kerosene and is in use at the TCC workshop to dry sawdust before its introduction into the pyrolytic converter being developed by the Centre.

Sales of spent grain were slow at first but soon expanded to the point where the entrepreneur could easily sell all his output and raise his price too. In March 1977 he bought two more presses. The TCC helped him to negotiate an agreement with the Kumasi Brewery to guarantee his supply of wet grain.

In June 1976, the Guinness Brewery (also located in Kumasi) started its own production, and it was feared that the competition would reduce the entrepreneur's sales. This did not happen because the Guinness product was more expensive,[18] the demand for dried grain expanded considerably as other feedstuffs became more scarce and expensive, and Guinness sold mainly to animal feedstuff manufacturers, who mix the brewers' grain with other feedstuffs to make a balanced product. The small-scale entrepreneur was advised to go into animal feedstuff manufacture to reduce his risks and diversify his activities, but he has never taken up this suggestion.

The future of the venture is now uncertain because, although it would be possible to expand the entrepreneur's venture or replicate it through other entrepreneurs, the Kumasi Brewery has plans to introduce an automated drying plant. For some years they have been trying without success to get an import license for the plant, and are now negotiating with an independent company that is planning to set up a large-scale plant drying cassava and giner as well as brewers' spent grain. In view of Ghana's chronic foreign exchange shortage, it seems absurd to try to import a capital-intensive plant when a tried alternative using entirely locally-made equipment and solar energy already exists. This is especially so given the experience of the Guinness Brewery plant which is operating below capacity and which, despite a high selling price for the spent grain, is running at a loss.

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18. ¢6.25 for a 25 kilo bag compared to ¢4.00 for the same quantity from the small entrepreneur.

    High production costs relate mainly to the fact that the steam for drying is produced in electrically-fired boilers and the electricity tariff paid by the company increased by 600 per cent in an 18 month period. It is interesting to note that the capital labour ratio of the Guinness plant is 34 times that of the intermediate technology.

Discussion of case

Like Spider glue, this is a relatively simple success story. From a situation where a valuable feedstuff was being wasted, we now have a flourishing small industry which is providing local employment and producing at low cost a valuable feedstuff that can be substituted at least in part for imported alternatives. The raw materials are all domestically produced (including the solar energy), and the plant and equipment is made entirely from readily available materials (apart from the concrete).

Another similarity with the glue is that the demands on the Centre's resources were slight after the initial essential help with the technology and marketing arrangements. The research and development effort was low in comparison to the success of the venture.

Opportunities like this are perhaps rare but the Centre continues its efforts to find more of them. Even where they exist, they would not prosper without the commitment of a competent entrepreneur and such people are even rarer in Ghana than the technological and commercial opportunities. The glue and spent grain projects both succeeded because of the combination of an appropriate (and profitable)[19] technology and a serious entrepreneur.

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19. For details of the profitability of small-scale drying of spent grain see Annex II.

4. BROADLOOM WEAVING[20]

Background

The TCC has involved itself in several ways with the traditional craft industries of the villages in the Kumasi area. The crafts include Kente weaving, Adinkra cloth printing, glass bead-making, wood-carving and the manufacture of brass figures using the lost wax process.

Each craft is centred on a group of villages, where almost the whole village may be engaged in the craft, while many people in surrounding villages will also earn their living in this way. Most of the craftsmen are also subsistence farmers, and may also earn some income by cutting firewood for sale. The craft products are sold in the villages to passing traders and tourists, and some are also sold in the market places of Kumasi and other towns. The market served is therefore mostly a local one, although Kente cloth is sold all over Ghana and sometimes abroad. At present there is no export market worth mentioning for any of the products (apart from Kente cloth).

The TCC's activities in this field started soon after its inception in 1972 with the introduction of English broadlooms into the weaving villages, and expanded into glass bead-making and brass-casting in 1974/5. The objectives of all the activities are to increase the income of the craft workers and to increase employment in the villages. This is to be achieved in a variety of ways - by increasing the productivity of the craftwork through imporvements in technique and materials; by expanding demand through stabilisation of the local markets and the establishment

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20. Reference materials for this study are:
    - TCC Annual Reports Nos. 1 - 5
    - Powell J.W., First Annual Report on the Handloom Weaving Production Unit. (TCC, July 1975)
    - Powell J.W., Second Annual Report on the Handloom Weaving Production Unit. (TCC, October 1976)
    - Powell J.W., Appropriate Technology in India: Report of a Study Leave - August to December 1977. (TCC 1978)

of export markets and by widening employment opportunities through the adaptation of traditional techniques to new products.

The existing weaving industry in Ghana is represented by two extremes: in the towns there are textile mills making cloth using processes and equipment that are replicas of those found in factories in developed countries, and in the villages there are weavers making traditional-style cloth on handlooms no more than seven inches wide.

In several villages near Kumasi the traditional weaving of Kente cloth, a beautifully decorated handwoven cloth, is a highly developed craft. Apart from subsistence farming, weaving is the main occupation of most of the men and boys in these villages. There is a taboo against women weaving as it is thought to cause infertility.

Kente cloth has a very distinctive appearance created by the bright colours, mainly blues and yellows, and the intricate geometric patterns woven into the cloth. The most striking product of the Kente weavers is the man's cloth, which measures 9ft by 12ft and is made from many four-inch strips of cloth sewn together. Every Ghanaian man aspires to possess one of these cloths, but they are beyond the means of most, and their use is reserved for special occasions.

The cloth is often sold directly to customers who visit the weaving villages, but more often it is bought by traders and sold in the towns. The prices are high - a good quality man's cloth with elaborate design can cost between ¢1,000 and ¢3,000 in the Kumasi market (i.e., between £200 and £600!). These prices reflect considerable scarcity value. The traders are able to sell at very high mark-ups, while the village weavers may only receive ¢400. However, this is still quite high because the yarn is very expensive and the labour content of the cloth is very high. Some weavers (including the youths) can, however, make quite high incomes, which do not show up in the villages as it seems that the money is invested in safe ventures such as housing in the towns.

Not all the Kente cloth is in the patterned geometric style. Much of it is plain weave with a simple striped pattern, sometimes adorned with a lurex thread. This sells in the market at prices between ¢250 and ¢300 for a man's cloth of 12 sq. yards. Although this fabric is much more ordinary than grand Kente, it still carries a premium: a man's cloth made from factory-woven material could be bought in the market for between ¢150 and ¢200.

All finished fabrics on sale in Ghana are now made in the country as the industry has been protected by a ban on finished imports for the last two years. As with many other goods there are two sets of prices, the controlled price and the open market price. The controlled price of factory-woven cloth is ¢80 for 12 sq. yards, but it sells at upwards of ¢150.

Nearly all of the cotton used in making fabrics in Ghana is imported. Some enters the country in the form of yarn, but much of it arrives ginned and batched and is spun in mills in Ghana. At the spinning stage locally grown cotton is mixed in with imported cotton. As with all other imported goods, cotton has become extremely scarce. All three of the large spinning mills are working at a very low level of output, and sales by the mills are only made to preferred customers. Established customers, including the textile factories, can buy at the spinning mill prices, but those less fortunate, including the Kente weavers, have to pay the open market prices, which are more than double the factory prices.

History

The TCC's interest and involvement in broadloom weaving started in 1972. Observation of the Kente weavers suggested that productivity could be much increased by using the broadloom instead of the Kente loom, which is only four to seven inches wide. Without wishing to replace the traditional craft, the TCC thought that some weavers might like to learn to operate a broadloom, and that weaving on the broadloom might be an acceptable occupation for women.

For the first few years the Centre worked in collaboration with the Department of Industrial Art in the University's College of Art.

The Textile Section of the College of Art was already using English broadlooms to teach students pattern analysis and design, and TCC staff suggested that the college might try to establish a link with the Kente weavers so that those who were interested could learn to use the broadloom. Discussions were held between the TCC and the College of Art to explore the types of looms that would be suitable for the development of a rural textile industry in Ghana and to identify some positive steps that could be taken at the University to expedite their adoption in the villages.

The Hattersley pedal-operated loom, which is still used by cottage weavers in Scotland, seemed the most promising, and the College of Art acquired one of these. However, they have never seriously tested it in use, and the TCC's work has been entirely with the 40 inch English broadloom. The version used is based on the Dryad model. Modified copies had already been made in the College of Art and the TCC subsequently introduced further minor modifications after experience with them.

In August 1972 the first loom went out to a village weaver in Ntonso, one of the Kente weaving villages. The weaver had heard of the broadloom and came to the TCC to enquire whether he could buy one. The arrangement made was that he should take a loom with an option to buy it or return it after three months if he found that he could not make a satisfactory income from it.

He bought the loom for ¢40 and a supply of yarn for ¢60 with an interest free loan of ¢100 from the TCC, which he undertook to pay off over a period of 20 months. The loom was successfully used by his son, who wove attractive men's clothes in the Kente style to his own design. The option to purchase was taken up and a second loom was bought the next year. He easily sold his products and paid off the initial loan in much less than the specified period.

In May 1973 a further four looms were bought by the White Sisters Vocational Training School at Nandom in the Upper Region, after four of the sisters had received instruction at the College of Art. These looms were to be used to train young women who would thereby gain employment during the long dry season. The price of the four looms with accessories was ¢520. The looms were delivered and successfully used at the school.

These encouraging results led the TCC to undertake the construction of 20 more broadlooms in the expectation that other weavers would come forward. The looms were all made by SISS Enterprises, a local woodworking firm that had been set up with the main purpose of making school science equipment with the active help of a lecturer at the University. All of the wooden parts were made from local hardwoods, and the metal parts were supplied by the TCC workshop. The only imported item was the reed, which the Centre obtained with a grant from Christian Aid.

Also during 1973, the College of Art started a training course in broadloom weaving, which was intended to show village weavers how to operate the loom. The course took place on one morning a week and lasted for six months. It was hoped that at the end of the course the weavers would purchase their own looms on a loan scheme and return to their villages to form the nucleus of a new style village weaving industry. Fifteen young weavers attended the course, but at the end, although they were very keen to be employed as weavers by the University, none of them was prepared to take the risk of setting up with their own looms. At that time the TCC could not provide these jobs, but the attitude of the weavers suggested that a weaving production unit on the campus would be a useful and possibly essential intermediate step in the establishment of broadloom weaving.

This step was taken in early 1974, and a Weaving Production Unit was instituted as a joint venture between the TCC and the Department of Industrial Art of the College of Art. It was intended that the unit would be run by the University only temporarily, and would in due course be taken over by a co-operative or independent entrepreneur. The aims of the unit were:

- To test the reliability and performance of the broadloom under realistic production conditions;

- To assess the economic factors determining the viability of a hand-weaving industry, including considerations of labour productivity, cost and availability of raw materials, and the market potential for various products of both modern and traditional designs;
- To offer training facilities for the local weavers in a commercial environment;
- To serve as a demonstration project, showing potential entrepreneurs or self-employed weavers the scope for setting up their own weaving operation.

The unit was set up in a part of the College of Art Building. The TCC provided the looms and associated equipment and was responsible for marketing, purchase of raw materials, payment of wages and accounting control. The College of Art provided a technical manager to instruct the weavers, determine the design of products and advise on all technical matters. The unit started in March 1974 with two looms and two trainee weavers, and by January 1975 had eight weavers and five looms in use.

The looms performed satisfactorily and the training of the weavers progressed smoothly, but the commercial performance of the unit gave cause for concern, and during the first 14 months of operation the unit made a substantial loss.

A number of factors explain this poor performance:

- Product price. The unit intially concentrated on napkins and tea towels but found that they would not sell except at prices below those of competing imports. At those prices unit costs were not covered. In subsequent years the emphasis has switched to men's cloth, which the experience of the broadloom weaver at Ntonso suggested would sell at a better price.
- High cost of yarn. It can be seen that yarn accounted for half of the production costs, and the product prices achieved were barely enough to cover raw material costs.
- Low productivity. The speed of weaving was very slow, even allowing for the fact that some of the weavers were in training. Attendance and time-keeping was also poor.

A major problem identified was inadequate supervision and an unrealistic working environment. The technical manager made only occasional visits to the unit, and the weavers were probably influenced in their work habits by the researchers and students with whom they were working. A productivity bonus scheme was introduced for a three-month period to see whether this would make an impact, but only one out of the four weavers responded to it.

- Quality. This was generally poor with uneven sizing and numerous faults in the weave.

The year did, however, see some achievements. Several more schools and training centres were supplied with broadlooms for teaching purposes. Two ex-employees of the unit were engaged as weaving teachers in village schools in Ashanti. In each case the Centre made the looms available through its loan scheme. A few weavers were trained at the unit for employers in Kumasi and Accra who wished to establish broadloom weaving businesses. One man, formerly employed at the College of Art, secured a loan of ¢20,000 from the National Investment Bank, and purchased 23 looms and accessories from SISS Enterprises in order to set up a broadloom weaving business in Kumasi.

During the next 16-month period the commercial performance hardly improved and a substantial loss was again made. Sales were still slow because of high product prices compated to other goods available in the market, but towards the end of the period they picked up because of increasing shortages of imported goods. Productivity remained low but there were signs of improvement in the last three months when 'supervision' by the College of Art ceased, and full-time day-to-day responsibility for management was given to a trainee weaver who was promoted to supervisor. Four more weavers left to take up posts as weaving teachers in schools. One was taken by an entrepreneur intending to set up a broadloom weaving business (which never materialised) in Wonoo, one of the traditional Kente weaving villages. A notable innovation of the year was the arrival of two women trainees, weaving having been hitherto an exclusively masculine domain.

During the first years of the weaving production unit's operation all the looms were made by SISS Enterprises, who also made a

number of looms for other customers. Certain modifications were made after construction of the first few looms to make them more suitable for local materials and local manufacturing capability, and to incorporate alterations that seemed to suit the weavers better. These included strengthening the frame, raising the height of the loom frame, widening the gap between the tool treadle arms, making the breast rail higher and smaller, and making the beater lighter. Apart from the reeds, the looms and all accessories (warping mills, raddles, bobbin winders, skeiners, shuttles, reed hooks, heddle hooks and beaming sticks) were made from locally available materials. In 1976 the National Cultural Centre at Kumasi designed a highly effective reed made from bamboo, and these have now replaced the imported metal reeds.

Over the years considerable effort has been put into trying to secure regular supplies of yarn at reasonable prices, both for the weaving unit and other weavers, including the Kente weaving villages, who pay very high prices in the open market. To obtain yarns direct from the spinning mills it is a great help to be a registered enterprise, or a prestige institution such as the University, or a co-operative. Although the TCC has often urged the Kente weavers to form a co-operative for the purpose of buying yarn (among other things) they have never taken up the suggestion.[21]

An indirect method of helping the weavers has been found. The Centre has negotiated a University allocation with one of the spinning mills. A condition of the agreement is that the University should take all the yarn offered even though only some of it is wanted. The rest is sold to weavers at a relatively low mark-up price.

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21. Co-operatives have a long history of failure in Ghana. People are now reluctant to form them because they are not prepared to trust the officials with their money.

In 1977 a new weaving unit was successfully set up a few miles from the TCC with four looms and four trainee weavers, one of whom acted as supervisor. The step was taken in order to move the weaving operation back into the village context, since it was felt that the University setting was artificial and people became too dependent on it.

In early 1978, the unit on the University campus moved to a new building where it was hoped to provide a better simulation of a commercial environment than had been obtained in the College of Art. There are now 11 trainee weavers (six of them women) and seven looms in operation. Production is now predominantly of fine cloth suitable for making into a man's cloth, or for garments for women. Many of the designs are extremely attractive, and the quality and appearance compare very favourably with that of the cloth produced in the Kente weaving villages. The products are sold easily, usually directly to customers on the University campus. That prices could probably be raised without losing sales is indicated by the recent applications made by some market traders to act as agents in the sale of the cloth.

It is extremely difficult to assess the economic performance of the TCC's weaving unit. Although the financial position has improved since 1976, the unit is still not making a profit. The financial performance of the unit should indicate whether a private entrepreneur could expect to make a profit if he set up independently, or whether a self-employed broadloom weaver could make an adequate income.

Of the broadlooms that are operating outside the University, the majority are being used for teaching purposes in schools. Relatively few looms have gone to people who are attempting to make a living by broadloom weaving. The weavers who have trained at the TCC's unit have preferred to go into teaching jobs rather than set up their own businesses. One weaver on the University campus, who set up with the assistance of the University lecturer, is known to be doing quite well. The weaver who was doing so well at Ntonso had to stop weaving when his father died and a relative inherited the looms. He has not taken up the suggestion that he should buy a new loom.

A lady from Kumasi has recently bought two looms and her weavers are being trained by the TCC. The man in Kumasi who bought 23 looms is the only person known to have set up on any scale, and his history is not very informative. He seems to have spent only a small part of the original loan on weaving, the rest having gone on a car and a house. He has been out of the country for the last two years, and left his wife in charge of the weaving operation. Five looms are in use - producing tea towels only. The quality is inferior to those made by the TCC and the price higher. About 10 people are employed. The weavers (two of them are women) are paid piece rates, and certainly weave very much faster than the weavers in the TCC unit. The supporting workers who do bobbin winding and warping are paid a fixed wage. The owners maintain that the operation is profitable, but this is hard to check independently. However, one can probably assume that the continuation of the activity is proof of its profitability. An outfit of this kind should be easily replicable, but so far no other units have been set up.

Discussion of case

The TCC's attempt to establish a broadloom weaving industry in Ghana has met with only limited success so far. The first objective - to increase the productivity of traditional weavers by use of the broadloom instead of the narrow Kente loom - has not been realised because few weavers have actually changed to the broadloom, although many have expressed an interest in it. The reasons for this are not clear, but the most likely explanation is a reluctance to depart from the well-known methods that they have been using since childhood, a reluctance perhaps understandable since the traditional methods can with certainty provide them with an income that they may regard as satisfactory.

The second objective - to train people in broadloom weaving so that they can become self-employed weavers or set up small businesses - has only been partially successful. The training part has certainly turned out well and as a result many people have gained employment as weavers, but the qualified weavers have generally preferred to take paid employment as instructors rather than set up weaving businesses. Only two or three

private entrepreneurs have established weaving businesses.

The broadloom weaving unit has generated a considerable amount of interest. As a result many schools have started teaching broadloom weaving as part of their vocational training programmes. And many young people have expressed enthusiasm for taking employment as weavers - at both the TCC unit and the new unit at Kwamo there are people queueing to join the units and some of these help out on a voluntary basis. The Centre's unit has certainly been successful in its training role and in demonstrating the technical viability of broadloom weaving, but it has so far failed to generate widespread diffusion of broadloom weaving into the economy at large.

The explanation may simply be that it is still too early to expect widespread diffusion, but an important factor is probably the poor economic performance of broadloom weaving. Even allowing for the low productivity of the TCC's unit and prices that are probably less than the market will bear, the TCC's experience suggests that the profit from broadloom weaving is likely to be low, and unlikely to be high enough to attract entrepreneurs in the current climate in Ghana, which discourages investment in anything other than operations with a very high return.

It is hard to see how the economic performance could be significantly improved. A pedal-operated loom would probably be successful in increasing potential productivity, but this has not been seriously tried out and to start now would mean embarking on another possible lengthy development period. Moreover the loom would inevitably be more expensive than the wooden handloom. A reduction in the cost of yarn would certainly be a great help, but given that most of the cotton is imported, its price is most unlikely to fall, and is in fact more likely to rise. The next step in terms of advancing the technology would be towards some kind of powered loom, but this would be inadvisable in Ghana because the capacity for local manufacture would be lost, and the activity would become dependent on imported motors. Moreover the high cost of yarn would still be a barrier.

So, although the Centre has gained very valuable lessons from the operation of its weaving unit, and there are now 50 - 60 broadlooms in use in Ghana, one must conclude that it has not yet achieved a great success in establishing this particular intermediate technology.

5. GLASS BEADS[22]

Background

The strings of glass beads made in the villages near Kumasi are traditionally worn by all Ghanaian women and some men. Short lengths are worn around the wrist and long ones around the waist. The beads come in 60 attractive designs, they are about half an inch long, and slightly oval in shape. Each design has a basic colour, usually yellow or pale blue, with a simple but appealing coloured pattern. Each type has a different meaning and is worn on the appropriate occasion.[23]

The main bead-making village is Darbaa, about 10 miles North-west of Kumasi. Here and in the four neighbouring villages almost the entire adult male population from about 260 families, and some boys are engaged in bead-making. These villages have an average family income probably slightly above the average for rural Ghana. Another 17 or so villages have some bead-makers, and there are thought to be about 2,000 in the Ashanti region. Few women actually make the beads, but they help by taking them to the market where they are sold at more or less fixed prices. The scarcity and high cost of materials has induced many crafts-men to leave the industry, but there is obviously scope for expansion because all the beads made can easily be sold.

The beads are made from recycled bottle glass - soft drink, beer medicine bottles and so on. The colour is introduced either by powdered glass obtained from coloured bottles (e.g. Milk of Magnesia for blue) or from powdered glass beads. The coloured bottles do not give a good result because the colour is too

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22. Reference materials for this study are:
    - TCC Annual Reports Nos. 1 - 5.

23. Examples of their meanings are: 'Meet me at 5 o'clock', 'One head does not decide', 'Stop fighting with your

dilute, and the coloured beads are preferred. However, these are very scarce and are often smuggled into Ghana from neighbouring countries at exorbitant prices.

The bottles are first pounded into a fine powder using a pestle and mortar, and the powder is then packed into clay moulds using a short length of cassava stick to form the central hole. The round moulds are made from local clay; each one contains 40-50 cylindrical pockets to take the glass powder. The coloured patterns are made by adding layers and pockets of the powdered coloured glass beads or bottles. The moulds are fired for about an hour in a wood-fired kiln, which reaches a temperature of only 700-750^{o}C, enough to sinter but not melt the glass. When cool, the beads are tapped out of the moulds. They are then shaped on a grinding stone, which produces a somewhat rough finish, and strung on raffia.

The beads are sold in strings of about 20 (for wrists) and about 80 (for the waist) and sold at prices between ¢5 for the short lengths and ¢12.20 for the long lengths, the price depending on the quality of colour, design and finish.

At present the beads are not exported, except on a limited scale to neighbouring countries such as Togo and Ivory Coast, although the higher quality ones are probably sufficiently attractive to command a foreign market. Before the devaluation of the cedi their price was prohibitive, but now it should be possible to offer them at a more acceptable price, and the possibility of exporting is to be further explored.

History

The TCC has attempted to upgrade bead-making work in the following ways:

- importation of colouring, to improve colour, to reduce costs and to eliminate dependence on smuggled glass beads;
- formation of a co-operative of bead-makers, so that they can apply for their own import license to buy colouring, and to co-ordinate marketing;

- training women to become bead-makers;
- introducing a mechanical polisher to improve the finish of the beads;
- exploring export possibilities.

The TCC's involvement with the bead-makers started in 1975 and was initiated by a request from the chief of the Darbaa bead-makers for help in negotiating a better site for their stall in the Kumasi market. This has still not been achieved (partly because of changes in the management of the market), but the initial contact led to innovations that have helped the bead-makers in other ways.

The first contribution was to enable the bead-makers to improve the colouring in the beads. Samples of glass-colouring materials were requested from various firms in the U.K., and these were tested by the bead-makers. The best was an amorphous ceramic colouring obtained from Blythe Colours Ltd. It produced excellent results when mixed with the powdered white glass.

In December 1975 a grant of ¢7,000 (worth £2,700 then) was obtained from Oxfam-Quebec for the importation of seven colours from Blythe totalling 810 kgs. By the time the colours arrived in October 1976 the bead-makers had formed the Darbaa Co-operative, and the TCC sold the co-operative half of the colouring in small packets at prices that were calculated to realise ¢20,000 when all the colouring was sold. It was decided not to release all of the colouring at once because the TCC wanted to ensure that the co-operative would apply for its own license the following year. It was also thought that this measure would strengthen the incentive for new members to join the co-operative, and would avoid the development of a secondary black market in the colouring. The purpose of selling the colouring (rather than giving it away) was to create a fund that could be used for further assistance, such as the provision of a loan to the bead-makers for their import license and the construction of higher temperature kilns, and to ensure the seriousness of the recipients.

As a result of using the imported colouring the quality of the beads was much improved. The cost of the colouring was reduced

by about 80%, and the total cost of producing a bead was reduced by about 25%. Some productivity gain was also noted. The villagers were very pleased.

In June 1977 a request for a further grant of ¢20,000 was made to Oxfam-Quebec (and approved) because the co-operative had not yet received its import license.

The Darbaa Co-op Beads Manufacturing and Marketing Society was formed with TCC encouragement and help during 1975/6 and registered in July 1976. By the end of 1975, 52 out of the 260 bead-making families in the Darbaa area had already signed the agreement to form a co-operative and by August 1977 it had 110 members. Three other co-operatives have now started up in other villages, and it is hoped to form a union of co-operatives, with the help of Ghana's Department of Co-operatives.

The purpose of the Darbaa Co-operative was:

- To obtain space in the various markets to widen the distribution of beads;
- To obtain import licenses for colouring;
- To promote exports;
- To obtain industrial credits for further expansion.

Only the second objective has had much success, and even so the co-operative only applied for its import license in August 1977 after the fright caused when Oxfam-Quebec nearly refused to make a grant for the second lot of imported colourings.

Both bead-making and Kente weaving are traditionally occupations for men only, so in the craft villages there is a need for more employment for women. With the assistance of the National Council for Women in Development, two women were sent to Darbaa from one of the Kente weaving villages to learn the craft of bead-making. However, one did not take it very seriously, and the other, although initially progressing well, then married and did not continue the work. The Centre is persevering though, and has now given the National Council assistance in funding a bead-maker to teach bead-making to women in Koforidua in Eastern Ghana.

In exploring the export potential of traditional beads, the TCC asked the advice of ITDG on their prospects. After consulting some retailers, ITDG advised that the prospects were slight, partly because of their high price, and partly because the quality of finish was not good enough. The main problem with the finish (once the colouring problem had been solved) was roughness of texture. The grinding wheels used by the craftsmen produced a rather rough texture with no sheen. The TCC consulted the Department of Ceramics at the University and were advised that the finish could probably be improved in a number of ways - by mechanical polishing, by firing at a higher temperature, or by using moulds from a different clay - and all of these are being explored at the Centre.

The TCC enquired of many British companies for details of mechanical polishing equipment, and after finding one that seemed suitable sent a sample of the beads to ITDG for them to arrange experimental polishing with the selected machine. This was done with good results, and a small Tumblemaster polisher was imported by the TCC. Experimentation by the bead-makers shows that they produce a good finish but take 21 days to polish 200 beads. Enquiries are now being made through ITDG about a larger polisher capable of polishing approximately 200,000 beads in the same period.

Development of different moulds and improved kilns has now started. If these innovations succeed in making a good quality bead, with a good finish, at a reasonable price, the recent devaluation of the Cedi provides the opportunity to enquire further into the prospects for export markets.

Discussion of case

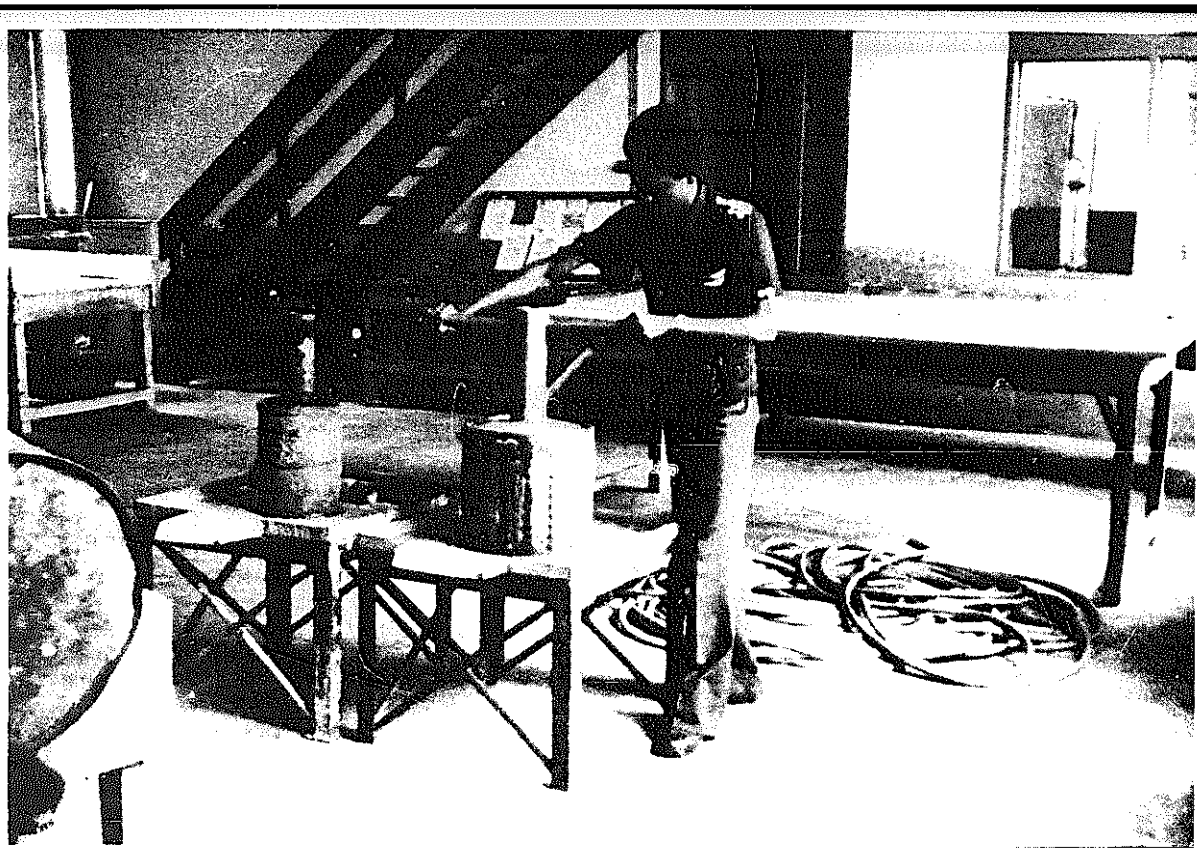
It appears that the TCC's efforts are going to prove successful in reviving a traditional industry involving perhaps as many as 2000 bead-makers in the Ashanti region, providing greater income and more employment.

The key features leading to this success appear to be:

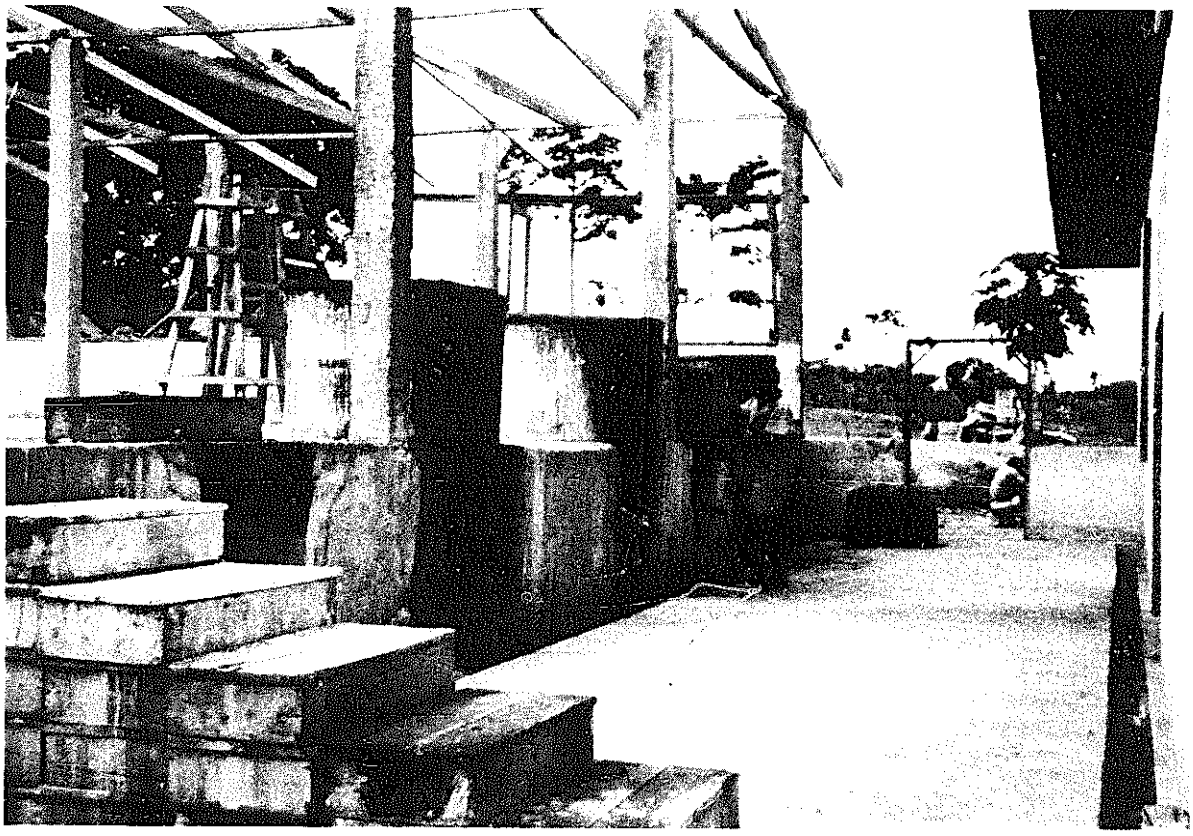
- Early establishment of good contacts with the village craftsmen, which have continued throughout the period. Since 1975 about 350 enquiries for assistance from different bead-makers in the region have been received.

- Successful formation of co-operatives, which seem to have worked because of the obvious gain that could be made by working together, especially in the matter of the import license.

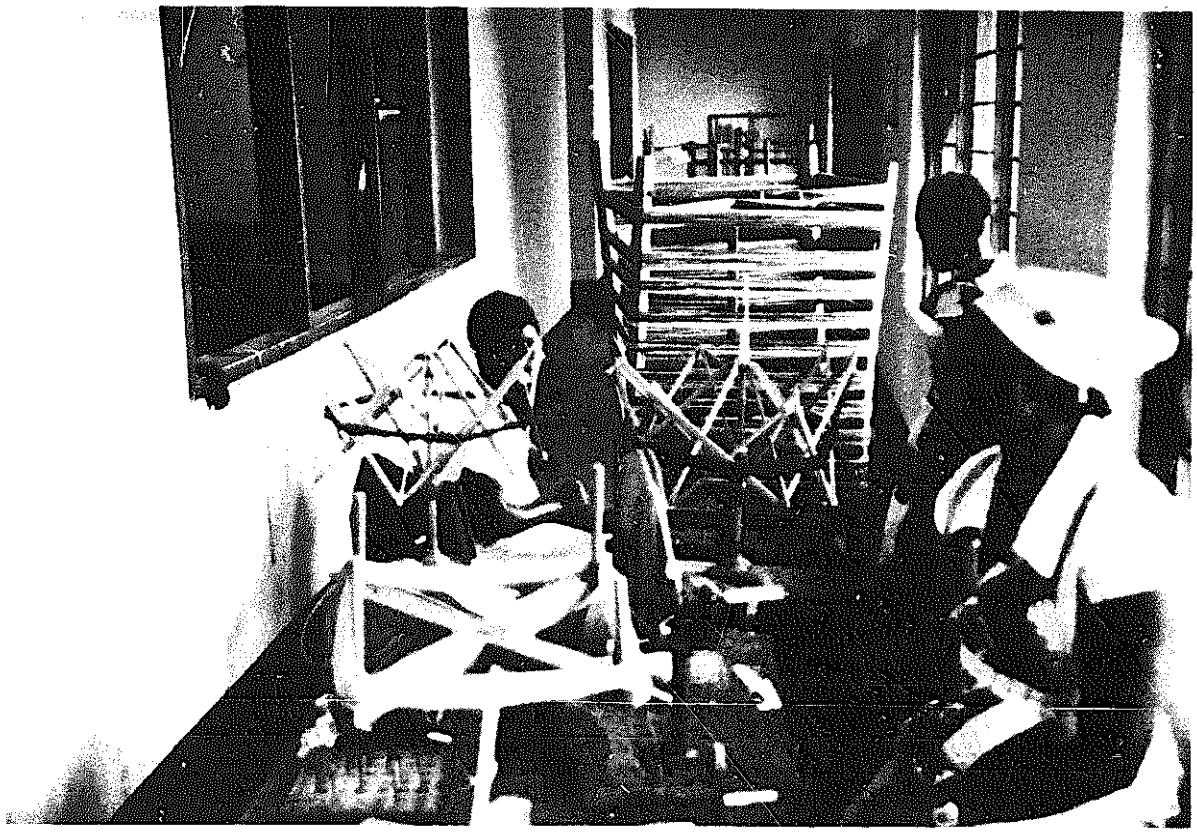
- Energetic search by the TCC and ITDG for suitable materials and machines for improving the quality of the product.



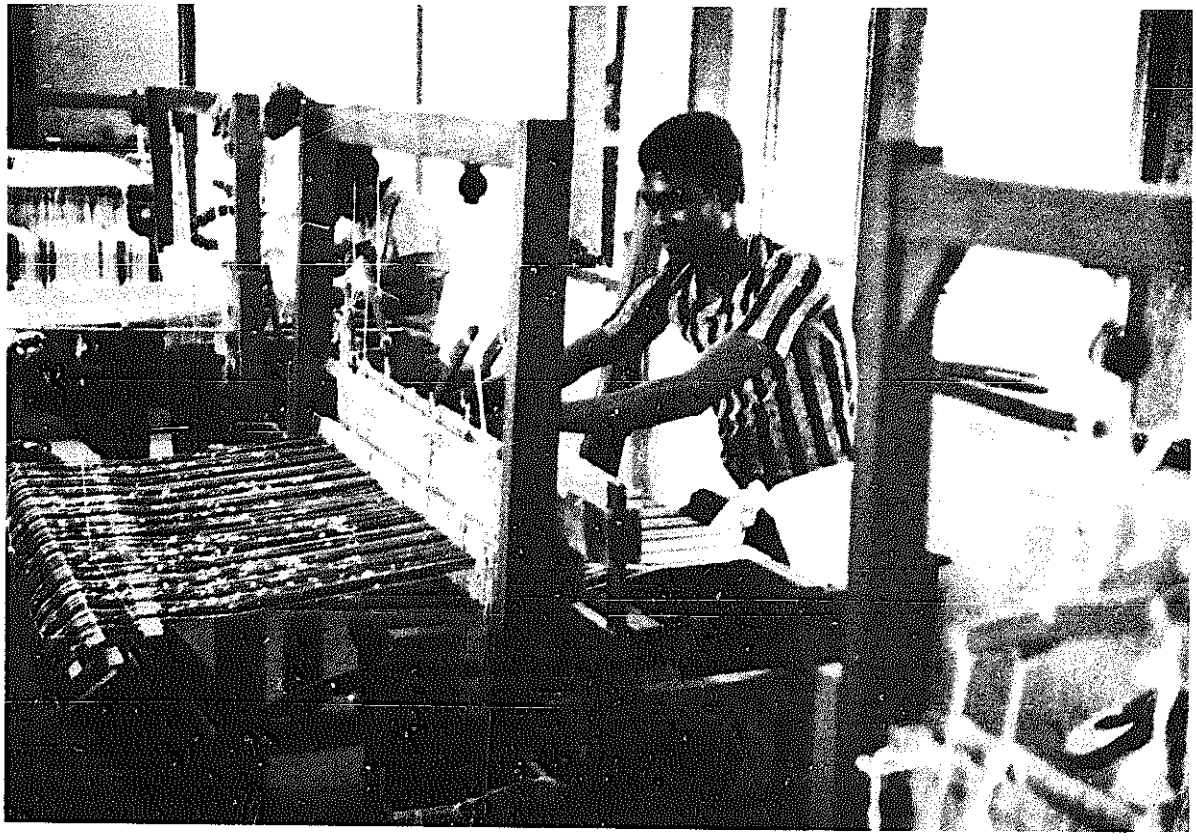
A hand-operated screw press developed by the TCC for the extraction of oil from palm and other fruits for use in soap-making (see p. 29)



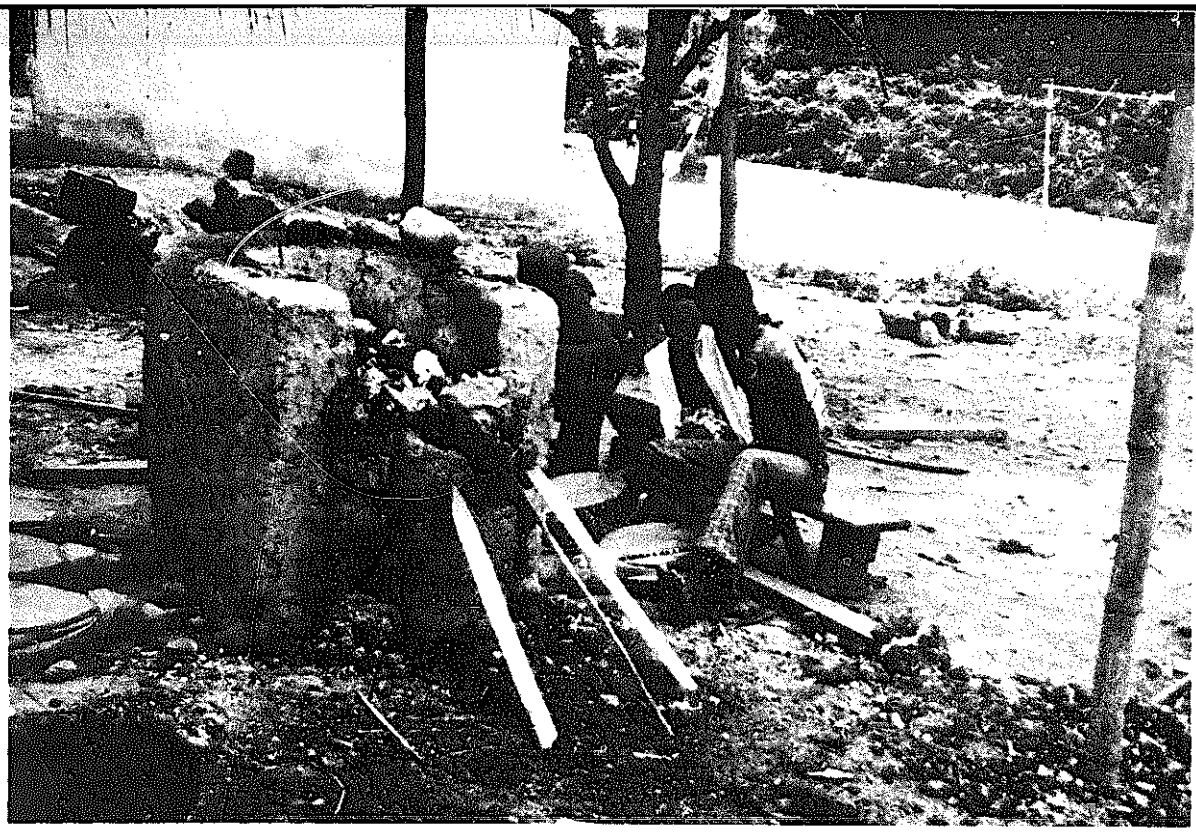
Prototype boiling tank developed by the TCC for soap-making (see p. 29)



Preparing the yarn for weaving on the new broadloom (see p. 45)



Weaving on the modified broadloom constructed at the TCC (see p. 45)



Charcoal-fired kiln developed by the TCC
for melting the brass (see p. 63)

Working on an elaborate tableau of brass figures (see p. 63)

6. BRASS CASTING AND METAL WORK[24]

Background

In several villages centred on Kurofofuron, eight miles south of Kumasi, most of the adult male population is engaged in another craft industry - making brass figures by the lost wax process. The ornamental figures vary in size from single figures no more than three inches high to large urns and elaborate tableaux portraying chief and attendants. Each figure has some symbolic significance.[25]

Prices vary from ¢3 for the small figures to ¢100 for the large ones, which may contain several pounds weight of brass. The figures are sold in the villages to passing traders, and in craft stalls in the towns. The raw material is recycled scrap brass, obtained from traders in the towns.

The lost wax process has been in use in some parts of the world for 3,000 years. It has several stages:

- The figure is first modelled in beeswax, exactly as it should be when finished in brass.
- The beeswax image is covered with a wet mixture of powdered charcoal and local clay, built up in layers until a nearly convex object is formed. A final thick layer of clay reinforced with palm fibre is added to strengthen the block.
- The third stage is to heat the block gently over a small wooden fire so that the wax runs out.

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24. Reference materials for this study are:
    - TCC Annual Reports Nos. 1-5
    - Buatsi S., Design Based Metal Products Project 1973-4. (TCC September 1974)
    - Buatsi S., The Local Manufacture of Household Metal Products, A Commercial Viability Study of Three Products Developed at the TCC (TCC September 1976).
    - Powell J.W., Appropriate Technology in India (TCC 1978).
25. An example is a man holding a pawpaw and a knife, which says 'A head is not a pawpaw to be cut in half to see what's inside'.

- Pieces of scrap brass are packed on top of the mould and enclosed in another layer of clay and palm fibre, making one large block with the mould for the figure at one end and the brass at the other, connected by a passage through which the molten brass is to run.
- The block is then put into the kiln with the brass at the bottom and heated until the brass is molten. The charcoal-fired kiln is open at the top so that the craftsman can judge whether the brass is molten by the changed colour of the rising smoke. It is open at the side to allow the mould to be tightly packed among the charcoal. Up to six hand-operated bellows blow air through holes in the base of the kiln. As a result of this design, consumption of fuel is very high, and the temperature needed to melt the brass is reached only with difficulty.
- The block is removed and upturned so that the molten brass runs into the mould.
- When somewhat cooled the mould is broken and the brass figure is taken out. About 10 per cent of the figures are faulty and the brass is reused.
- Finally, some simple hand polishing is done.

This skill has been handed down from generation to generation, but the market for the artifacts is insufficient to provide a good living for all of the population, so there has been the usual migration of young people in search of greater opportunities.

In contrast to glass bead-making where the TCC initially concentrated on improving the livelihood of the craftsmen by opening up opportunities for new markets for the improved but traditional product, in the case of brass the Centre has attempted to expand the range of activities open to the craftsmen by showing them how to turn their skills to the manufacture of different objects, such as valve parts for water pumps.

History

The Centre was originally approached in 1975 by the chief of the main brass-making village, Kurofofurom. He asked for help in securing cheaper and more reliable supplies of scrap brass. The Centre was able to provide some temporary help with this but there is only a limited amount of scrap brass in the country and it has become increasingly scarce and expensive.

It occurred to the TCC staff that the craftsmen's skill in the lost wax process could be applied to new products, thus enlarging the employment opportunities in the villages and giving the artisans a new source of income. An experiment was undertaken by the chief brass-maker of Kurofofurom to see whether he could turn his skills to making brass parts for engineering use. The first products made were valve parts for water pumps being made by the Faculty of Engineering, and bushes for rice threshers made in the TCC workshop

The Centre provided the patterns and the brass-makers copied them in wax and made brass castings using the usual lost wax process described above. Because of inexperience they had some difficulty in adapting to the geometric shapes but the parts were successfully made. Turning on a centre lathe to achieve precise dimensions, turning of the thread and the polishing were done at the University's Mechanical Engineering Workshop.

A problem with the traditional method is that for each item produced the wax image has to be made individually, and, of course, this is time-consuming and limits the scope for applying the technique to the production of a large number of identical objects. The TCC are now working on the development of a method of making large quantities of identical wax images which can then be cast by the lost wax process. For example, a plaster of Paris split mould for making door handles has been developed. The wax used in the villages is too soft for this and shrinks during the casting, but successful results have been obtained by mixing some candle wax with the beeswax and lining the mould with a light machine oil to prevent sticking.

Now that some of the technical problems have been solved, it is hoped that a range of products can be developed for manufacture by the lost wax process from wax images made in plaster of Paris moulds. Apart from the door handles and similar domestic fittings, there could be considerable scope for the development of engineering components, such as the pump valves, for use in plumbing and vehicle repair work. Virtually all parts of this kind are currently imported into Ghana, and consequently are in very short supply. Many of them are suitable for the lost wax process which is still used in developed countries for highly intricate objects. Many would be made in a developed country by an automated sand-casting process, but little of this is at present undertaken in manufacturing industry in Ghana. It is therefore appropriate in the Ghanaian context to make them by the lost wax process, as the skills already exist there. It would be possible to achieve import saving and provide extra local employment.

As this work is still at the development stage, it remains to be seen whether the craftsmen will be able to adapt their skills and produce objects of the required quality at a price that is both competitive and gives them a large enough return on their costs. Experience so far suggests that the artisans will respond favourably to the idea of producing non-traditional objects, but it is clear that further training will be needed.

The TCC is developing this work in several ways. A prototype charcoal-fired kiln has been constructed at the workshop, which should produce a higher and better regulated temperature (and use less fuel) than the traditional kilns. A boy from Kurofofurom is employed at the TCC workshop to be trained in the use of the new kiln, and he is helping with the experimental work. It is hoped that he will return to his village to pass on his new skills and knowledge.

In addition, the Centre is also going to experiment with different materials, such as aluminium and light non-ferrous alloys, which are more readily available in Ghana than brass.

The TCC's work with brass-casting is part of its effort to upgrade local craft industries building on existing skills, but it is also part of its work to develop the manufacture of metal products more generally. In collaboration with the University's College of Art, the TCC has been working on the design of a range of domestic fittings which could be produced from locally available materials. The long term aim is to establish the local manufacture of items in this kind either by interesting an entrepreneur or by setting up a production unit on the campus.

Discussion of case

The TCC does not claim to have made great advances yet in promoting small-scale metal-working industries in Ghana. The successful trial by the village craftsmen in making engineering components has laid the foundation for further collaborative work, and good contact is maintained with the villagers through visits by TCC staff and the link with the boy training at the workshop.

The main reason for the slow progress is that the venture is, in fact, ambitious, and inevitably needs a long development time. Moreover, the Centre has had only one professional person engaged in the work, and there was a break of a year while he was studying for his Diploma in Industrial Management. With greater input it is thought that the field offers considerable potential.

7. NUTS AND BOLTS[26]

Background

Ghana has no mechanical engineering industry worth mentioning. Its industries, of course, use many of the products of other countries' engineering sectors, ranging from nuts and bolts at the simplest level to highly sophisticated plants. Nearly all of these are imported from developed countries as they cannot be made in Ghana. And yet the country needs them desperately in order to develop and maintain its industry and transport sectors.

Ghana's Universities and Technical Colleges train many engineers and skilled technicians, and these mostly find employment in the industrial sector, operating, maintaining and managing the imported equipment. But none of them, unless they work abroad (and many do) can give experience in the design of engineering components or the manufacture of machines and machine tools because Ghana's industry does not have this capacity.

The purpose of the TCC's involvement in this field was to move the country a step towards an indigenous mechanical engineering industry starting with the manufacture of nuts and bolts.

History

The need for nuts and bolts was brought to the attention of the TCC in 1971 when a shortage of coach bolts was discovered among the wooden lorry builders of Suame Magazine, an informal

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26. Reference materials for this case study (other than those specifically quoted in the text) are:
    - TCC Annual Reports Nos. 1 - 5
    - Powell J.W. and West T.D., The Promotion of a Steel Bolt Industry in Kumasi, Ghana, Review of Progress to April 1973 (TCC April 1973)
    - Powell J.W., Second Annual Report on the Steel Bolt Production Unit, to April 1974 (TCC May 1974)
    - Powell J.W., Third Annual Report on the Steel Bolt Production Unit (TCC July 1975)
    - Powell J.W., Fourth Annual Report on the Steel Bolt Production Unit (TCC May 1976).

industrial area of Kumasi specialising in vehicle repair work. Further enquiry revealed that at that time almost all of the highly quality nuts and bolts used in Ghana were imported at a foreign exchange cost of around ¢300,000 per annum (1970 prices). Although some are made by local blacksmiths, the quality is inferior to the imported products and often inadequate for requirements.

The Centre's first step in exploring the feasibility of a nut and bolt industry was to look for local raw materials. Imported mild steel was expensive, so Tema steel was considered. This is made from remelted scrap steel, and is formed into rods and sold primarily for use as concrete reinforcement. It is not ideal engineering material as it is hard to machine and the shape of the section is poor. However it had the major advantage of being only one-third of the price of imported steel.

Mechanical and metallurgical tests showed that it is harder, stronger and more brittle than the mild steel usually used for making bolts, but the differences were small enough for its use to be satisfactory.

Initial attempts at bolt production with Tema steel were undertaken in the Mechanical Engineering Workshop of the Faculty of Engineering using a small Capstan lathe and a milling machine. It was established that with good quality tooling, bolts of acceptable quality could be produced. Tests showed that corresponding to the characteristics of the steel used, the bolts made had greater tensile strength than the imported ones. They were more brittle, but this would only matter for certain specialised purposes.

The next step was to find machine tools to set up a separate production unit. The facilities of the Faculty of Engineering were unsuitable as the machines were often in use by students and staff and proper supervision and instruction could not have been maintained.

The original idea was a unit equipped with two Capstan lathes, one to produce bolts and the other nuts, a milling machine to produce hexagonal bar, forging equipment to produce the heads of coach bolts, a centre lathe for finishing and for jigging and general work, and a bench grinding machine for tool sharpening. A survey of workshops operating in the informal industrial sector of Kumasi found a number of centre lathes in use, but no capstan lathes. This is a machine suitable for producing a moderate quantity of identical objects. It does not have the flexibility of the centre lathe, but has the advantage of rapid output of a standard item. It therefore seemed appropriate to centre the bolt unit round this basic machine.

The production unit was established with a grant of £5,000 provided by Barclays Overseas Development Corporation, and an interest free loan of £350 from Scottish War on Want. The two Ward 2A Capstan lathes and the milling machine with their associated tooling were purchased from Meggitt Machine Tools and Equipment of Poole, Dorset, England for £1,700. Used machines in good condition were carefully selected to ensure reliability and a long life. They arrived at the University in January 1973 and were immediately installed in a large workshop made avilable by the University. The other machines and equipment were purchased locally, and the total capital outlay at that time was ¢10,800 (about £3,600).

The initial staffing was five operatives, two of whom had already been employed on the work in the Mechanical Engineering Workshop, plus a senior technician who acted as supervisor and instructor.

The unit was a joint venture between the Department of Mechanical Engineering and the TCC. It has been directed throughout by a management committee consisting of two members from each department, which meets about three times a year, but the daily management was the responsibility of the TCC.

Production started immediately and sales and orders quickly built up. Initially the unit supplied departments of the University, such as the Stores and Supplies Department, the Transport Section, and the Faculty of Agriculture, each of which used thousands of nuts and bolts annually. Large numbers were also sold to local industrialists, who soon learnt of the availability of the products and found that they compared favourably with imported items in terms of both price and delivery. Prices were initially set rather low (half the price of imports) and the profit margin was very low, but it was hoped that future improvements in productivity would enable prices to be kept at this level. Rising costs meant that this hope was not realised, and prices had to rise until they were close to those of equivalent imports.

The unit expanded steadily between 1973 and 1976, and the stock of machine tools was further enlarged. In 1973/4 a third Ward 2A Capstan lathe and a drilling machine was purchased. 1974/5 saw the addition of a powered hacksaw, a universal milling machine, a tool cutter grinding machine, an indexing head for the milling machine, a machine vice and a blacksmith's forge. All of these were new apart from the milling machine, which was a good used machine. All were imported from Britain. In 1975/6 the Centre purchased two more Capstan lathes and a centre lathe (though the latter was mainly for use in the plant construction unit). These expenditures amounted to ¢21,000, and were funded by grants from the World Council of Churches, Oxfam-Quebec, and a further grant from Barclays Overseas Development Corporation.

Thus by the end of April 1976 the unit was operating the following machines:

Ward 2A Capstan lathe	5
Denbeigh Milling Machine	2
Colchester student centre lathe (6")	1
Colchester Triumph centre lathe (8")	1 (allocated to plant construction unit)

Tool and cutter grinders	2
Pedestal drilling machine	1
Powered hacksaw	1
Blacksmith's forge	1

With this set of equipment the production technique is as follows. Three to four Capstan lathes continually produce bolts from round bar. Hexagon heads are milled individually on a horizontal drilling machine with an indexing head. Coach bolt heads are hand forged using appropriate dies. Nuts are made from three to four foot lengths of round bar which are milled to hexagonal form on the horizontal milling machine. These are fed into another Capstan lathe for drilling and parting as nut blanks. Nuts are tapped on a pedestal drilling machine using a tapping attachment.

Staffing also increased. Throughout 1974 and 1975 there were 12 operatives and one senior technician. In June 1976 three additional operatives were taken on to work the new machines.

Since 1974 Tema steel has become increasingly scarce and imported steel rod must now frequently be used in order to maintain production levels. The unit is now operating with only four Capstan lathes as one has been sold to an independent entrepreneur, and there are now 11 operatives.

During 1974/5, the unit showed a small gross profit, but in 1975/6 there was a substantial loss.[27] Part of the loss in the second of these years is accounted for by heavy expenditure to build up stocks of Tema steel which was becoming increasingly scarce, but in neither year was there sufficient margin to cover depreciation or other overhead expenses - rent for premises, interest and repayment of loans - which the unit did not have to pay but would be faced by a private entrepreneur.

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27. For statistics on the profitability of the Steel Bolt Production Unit see Annex III.

Concern over the very poor financial performance in 1975/6 led the Centre to ask a member of the Department of Economics and Industrial Management to undertake a study of productivity in the steel bolt production unit, and make recommendations for its improvement. The consultant[28] found that the main reason for the poor performance in 1975/6 was that earnings had increased by 60% during the year while productivity declined by 38%, and he suggested a number of factors that could account for the low productivity which had averaged only 40 per cent of potential during the period 1975/6. These included loss of product through waste and pilfering; low machine utilisation time because of lateness, poor attendance, protracted machine setting and material preparation; and low effort indicated by slow machine speeds and protracted operation. Of these he found that low effort was by far the most important factor. In explaining this finding he identified a number of failings in management and supervision, and attributed part of the problem to the existing incentive bonus scheme. This was a group scheme based on a target value of output. If the value of output exceeded a certain level the operatives and the supervisor received a fixed share of the marginal value added above the target of production value. This scheme meant that there was no clear relationship between individual effort and individual reward. Moreover the scheme was hard to understand and workers could not accurately anticipate the extra earnings they would receive for extra work. As a result they preferred to work slowly and raise their incomes in a more certain way by working overtime, of which a considerable amount was undertaken at that time.[29]

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28. The Consultant was Mr. J. Russell.

29. Russell J., Productivity in the Steel Bolt Production Unit, April 1973 - June 1976. Typescript, September 1976. This and other papers by Mr. Russell referred to in this case study are working papers for his Ph.D. Thesis to be submitted to the University of Birmingham. The papers are not available, but Mr. Russell may give further details on request. The author acknowledges Mr. Russell's help in preparing this case study and his permission to summarise selections of his original findings.

In the light of his findings, the consultant made a number of recommendations, including:

- Better management control by setting monthly and annual targets for output and return on capital;
- More frequent management visits to the unit, and greater shopfloor activity by the supervisor, to be achieved by transferring some of his record-keeping duties to other personnel;
- Greater delegation of authority to the supervisor in matters such as disciplinary action;
- More detailed supervision of tool and machine adjustment;
- Increasing the prices charged for special orders to reflect their true cost, and encouraging orders requiring long production runs;
- Introduction of an individual output-based productivity bonus scheme.

As a result, the Centre made some innovations, including the introduction of a productivity bonus scheme designed and supervised by the consultant, who was invited to join the management committee of the steel bolt production unit. The new productivity bonus scheme started in March 1977 for a 3 month trial period and produced very encouraging results with both productivity and profit targets being exceeded. Output did fall back after May, but stayed at a level very much higher than had been obtained during the period before the introduction of the scheme.[30] Preliminary statistics for 1977/78 suggest a definite improvement over earlier years, largely attributed to the productivity bonus scheme.

The TCC's steel bolt production unit demonstrated the technical feasibility of this intermediate technology by producing high quality products at reasonable prices using largely locally produced raw materials. It employed a production technique which was acceptable to operatives and technicians and which was capital-saving (and employment generating) in comparison with

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30. Russell J., An Appraisal of the Performance of the Steel Bolt Production Unit between February and May 1977. Typescript June 1977.

the highly automated mass production techniques used in developed countries. Experience showed that with proper utilisation of the equipment and careful effort to ensure a reasonably high level of worker productivity, the operation could achieve an adequate rate of return on capital invested.

It seemed reasonable to assume, as the Centre did, that the activity could be replicated as long as it was possible to obtain the imported machine tools and to find entrepreneurs with sufficient seriousness and technical competence to run the business. However, before 1977 only three other firms attempted to enter the field.

The first was an entrepreneur in Kumasi, who imported about a dozen second hand machine tools from Britain in 1973. He came to the TCC for help will all aspects of the business - installation of machine tools, choice of materials, products and production methods, and recruitment and training of personnel. One of his lathes was used at the TCC workshop for a while, and three of his apprentices were given some training in Capstan lathe operations and milling. The value of the effort was, however, limited by the very poor condition of the machines, and the entrepreneur has now closed down his business.

A second company, Agricultural Engineers Limited of Accra, sought help in establishing steel bolt manufacturing facilities to meet their own needs. The Centre advised on the importation of suitable machines, and offered training for operators. In the event, the firm did not obtain an import license. A third firm in Kumasi planned to install equipment capable of producing 30,000 bolts a month, which is about 30% of the estimated national demand, [31] but again the firm could not obtain the necessary import license. This was despite the government's

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31. Powell J.W., Steel Bolt Industry Feasibility Study (TCC April 1975)

concern at that time to promote the manufacture of vehicle and other spare parts in Ghana, and its request to the TCC to draw up plans for an expanded steel bolt industry.[32]

There was no progress until the Centre decided to sell one of its own lathes, thus getting round the importation problem. The Centre was very keen to see the transfer of its bolt production technique to the economy, and to compare the approach and performance of a private entrepreneur with that of its own unit, which was felt to be affected by its operation in the rather artificial commercial and managerial position within the University. An experiment was carried out by selling one of the unit's five Capstan lathes to SISS Enterprises, a small firm making wooden and metal products and located in one of the informal industrial areas of Kumasi. The machine was sold at historic cost under a hire purchase agreement on condition that all data concerning production, sales, raw materials and equipment purchases, and all related overheads were recorded and made available to the TCC's consultant so that he could make a comparative assessment of SISS and the TCC's unit. Coach bolt manufacture began at SISS in January 1977.

It was found that the pace of work at SISS was slower than in the TCC unit.[33] The lathe was only used for 50% of the available time, and the rate of output per machine hour was only 70% of potential, giving an effective productivity of 35% of potential, which compared with 70% achieved at the TCC during the same period, January-May 1977. The entrepreneur adopted a policy of allowing the machine to stand idle for much of the time and concentrating on products on which he could place a high mark-up. The high mark-up policy is standard in Ghana, but SISS was lucky to recieve a substantial order during the period for a very simple product (it could, in fact, have been made adequately by the blacksmiths) on which it secured an excessive

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32. TCC Annual Report No. 4

33. Russell J., The Performance of the SISS Bolt Unit, December 1976 to May 1977. Typescript June 1977.

mark-up. The entrepreneur claimed that the low rate of machine utilisation was motivated by a desire to conserve the life of the equipment. This may be optimal policy given the importation difficulties. It is found elsewhere in Ghana - Guinness Brewery for instance have reduced operations from three to two shifts a day for exactly the same reason.

During the six months to the end of May 1977 SISS first made some losses, but cancelled these out later, and ended with a small operating surplus over costs (including depreciation). Thus, although the outcome was a little different from what the Centre had anticipated, the entrepreneur who bought the machine was pleased with the results.

The second transfer took place in late 1977 when the Centre sold another Capstan lathe to the senior technician of the Centre's nut and bolt unit, who built a small workshop and employed one operative, supervising the work himself on a part-time basis. The machine was sold to him under a hire purchase agreement, and during the nine months to May 1978 the workshop made a modest profit.

In his study of this venture, the TCC consultant concluded that a set-up with only one Capstan lathe could not give an adequate financial return because the lathe had to perform a number of operations, such as making the hexagon bar and bolt head, for which it was not well-suited, and this reduced productivity. He recommmended that a unit consisting of two Capstan lathes, a milling machine and a drilling machine was required to make the best use of the equipment and to yield an adequate return.[34] In fact, this set-up is very close to what had originally been intended for the Centre's nut and bolt unit.

The Centre has been encouraged by these two experiments in the transfer of the nut and bolt technology to the economy, and in view of the importance that it attaches to the establishment of

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34. Russell J., Performance and Future Viability of the Workshop of General Technology.

an engineering industry in Ghana, has decided to make further efforts in the field. At present the problem facing small enterprises in gaining import licenses for the necessary machine tools seems insuperable, so the Centre intends to continue for the time being with its policy of using its own ability as part of the University to import, and sell to interested entrepreneurs, recycling the proceeds for other TCC projects. A grant of £20,000 has recently been obtained from the Intermediate Technology Development Group for this purpose. Letters have been sent by the Centre to a number of entrepreneurs, who already have some capability in the use of machine tools, inviting them to discuss their needs. The Centre will then assess the proposals made to them and decide what machines to obtain. It is hoped that by nurturing the infant industry under the wing of the University until it is better established, it will gain strength and ultimately be self-sustaining.

Discussion of case

There are two reservations one might have about the probable success of trying to promote the diffusion of a small-scale engineering industry in Ghana. The first is the dependence on imported machine tools. But the venture is impossible without them. The second is the low profitability of making nuts and bolts experienced by the TCC's own production unit and the two entrepreneurs to whom they have transferred lathes. However the profit can certainly be made, as demonstrated by all three of these concerns, and is probably high enough to attract entrepreneurs who are already engaged in a similar activity, and want to expand by taking on slightly more sophisticated equipment.

The notable achievement is the successful production of a high quality product which has proved acceptable to a large number of customers in terms of price, quality and delivery. Another success is the transfer of second hand machine tools, about which the Centre had some initial worries in case of unreliability or unacceptability. The decision has been proved

right, however, as the used machines imported by the Centre have given good service with little maintenance, and still have a long life ahead of them. Maintenance and spares problems have been minimised by purchasing machines from the same manufacturer. Acceptability has been demonstrated by the two entrepreneurs who have bought TCC machines, and by the interest now being shown in the Centre's proposal to import more used machines for sale. However, the experience of the entrepreneur who bought poor quality second-hand machines and now finds them unusable stands as a warning reminder of the importance of following the Centre's policy of carefully choosing the optimum machines from a reliable company.

8. PLANT CONSTRUCTION UNIT[35]

Background

The TCC's steel bolt production unit shares the same building as its plant construction unit. They have frequently been referred to collectively in this report simply as the 'workshop'. The plant construction unit has played an important role in the TCC's work and is worth writing about in its own right. It was not originally a separate project, but grew in response to the demands made on it. It is here that the construction of almost all the prototype plants developed by the TCC has taken place, and the unit has also made to order a large quantity of plant and equipment for outside organisations.

Most of the unit's activity is in metal-working - welding, forging and so on. The unit works very closely with the steel bolt production unit, where most of the bolts and nuts needed for the plant construction are made. It also is the site of development work on the brass and iron foundries, which have been constructed just outside the workshop.

Locally produced materials are used when available, but most of the requirements are not made in Ghana and have to be imported. The unit uses large quantities of galvanised sheet steel and mild steel plate, and although they can be bought locally they are generally imported. Quantities of steel rod are used and Tema steel is purchased when possible, but if it is not available, imported mild steel rod has to be used.

The plant construction unit and the steel bolt production unit are supervised by the same senior technician, but they have separate equipment, and independent accounting and production records.

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35. Reference materials for this study are:
    - TCC Annual Reports, Nos. 1 - 5
    - Ntim, B.A., Establishing the Capability within the TCC to produce Agricultural Implements for use in Rice Cultivation, Harvesting and Processing (TCC 1975).

Employees at the workshop consist of six operatives, one electrician, and a qualified technician, who shares the supervisory role with the senior technician. Until recently the labour force of the workshop was separate from that of the steel bolt production unit, but earlier this year a new system was started whereby operatives switched at four monthly intervals between six well-defined activities (two in the workshop, four in nuts and bolts) so that they gain experience of all of them over a two-year period.

History

The plant construction unit has been in existence since 1973. The stock of equipment has been built up gradually, and now consists of:

Colchester Triumph centre lathe (8")	1
Sheet metal guillotine	1
Sheet metal box and fan folding machine	1
Sheet metal bending roll	1
Electric welding sets	3
Hand drilling machines	2
Blacksmith's forge	1
Oxyacetylene cutting/welding machine	1

The plant construction unit has made a large variety of items of plant and equipment for TCC projects, many of which have already been mentioned elsewhere in this report. Much of the work not mentioned so far has been the manufacture of agricultural implements. Throughout its existence the Centre has been concerned with promoting the introduction of appropriate agricultural implements and food processing plant into Ghana's agricultural sector.

Very little food processing is done in Ghana by the farmers themselves; most is undertaken by large-scale concerns. Development of local processing by the farmers would increase their income and reduce their dependence on the few large buyers. The development of small-scale oil pressing described in the section on soap-making is an example of a TCC project in the area of food processing.

Agriculture in Ghana is dominated by small farms, but there is quite a large number of large farms (holdings over 25 hectares account for about 30% of all farmland). The large farms often use imported tractors and combine harvesters etc., but the small farms generally use only the primitive traditional methods. Productivity has been growing very slowly, if at all, and there is a great need for improvement through the use of better implements (and also fertilisers, new seed varieties, etc.). The Centre expected resistance to intermediate technologies from the large farmers, even though such techniques have the potential to liberate them from dependence on imported machinery, which is scarce and expensive, and for which spare parts are always a problem. It was thought that in the Upper Region, where there has been much less exposure to western technology, there could be more success. In this region, a recent development is the introduction of animal-drawn implements, such as the bullock plough, but the major change in recent years is the development of rice-growing. This is very new to Ghana, and since 1970 it has grown rapidly in the Northern and Upper Regions where conditions are most suitable. About 40% of the rice is grown on large farms, but the rest is grown by small farmers with noldings typically in the region of one to three hectares.

Equipment made at the unit includes:

1. Hoes and cutlasses. More than 2,000 hoes were made in 1977 for farmers in the Upper Region. None will be made this year as a large number of hoes have been imported into Ghana under a West German grant.

2. Rice threshers. Twelve threshers, including two prototypes, have been made for the Ministry of Agriculture for use in its irrigated rice project at Dawhenya in the south of Ghana. In addition, there are 10 undergoing testing in the Upper Region, and a further five being tested in the Volta Region. The prototype pedal-operated rice threshers were made at the TCC's workshop in late 1975 following the deputy director's visit

to the International Rice Research Institute in the Philippines, where he studied designs for the indigenous production of agricultural machinery. The design is similar to the Chinese machine, some examples of which were already in Ghana. A defect of the Chinese machines was that the thresher hooks, made from steel wire, wore very quickly and could not be repaired because the imported steel wire was not available. In its design based on the IRRI model, the Centre replaced these with steel pegs, which work effectively and are long-lasting. The pegs are fixed on to the threshing drum which is driven by a system of bicycle chain and sprockets. The materials used are galvanised or mild steel plate and mild steel rod (Tema steel). The bicycle parts - free wheel, chain and sprockets - have to be imported. The machine is operated by one, or preferably two people, and can reach speeds of 3-4000 rpm. One machine could process 800-1000 kgs of paddy in an eight-hour day, giving it a capacity of about one acre per day. Some modifications to the design have been made following experience with the early machines made for the Dawhenya project. The purpose of the project in the Upper Region is to test further the reliability of the machines, to examine their acceptability by the farmers, to assess their cost in relation to their performance and to compare this with that of other methods. It is hoped that when they are established their manufacture can be transferred to Northern Ghana. The project is being financed by a grant of $25,000 from the International Development Research Centre in Canada.

3. Bullock carts. A prototype was made in the plant construction unit, with wooden parts supplied to order by SISS Enterprises. This is in use in the Upper Region. Ten more carts are being made, but the TCC is supplying only the metal parts. These will be in the form of a kit. The wooden parts will be made and the cart assembled in the Upper Region. A prototype donkey cart has also been made.

4. Water pump. This is a foot-operated bellows pump for use in lifting water into, for instance, paddy fields. Two have been made and one is in use in the Upper Region.

5. Water tanks. These have been made in large numbers in a variety of sizes. The main customer has been the University, which has bought at least nine tanks.

6. Spent grain presses. Four presses have been made for the small firm described in the case study on animal feed from spent grain.

7. Dryers. A dryer was made to dry brewers' spent grain (or other grains such as rice) but never bought. It is now in use in the TCC's workshop drying sawdust for the pyrolytic converter. Another much larger dryer has now been made in the workshop for this purpose, and the fuel to be used is the gas produced in the converter.

8. Oil presses. Two presses for extracting oil from palm fruits have been made for the TCC's soap pilot plant and four for private entrepreneurs.

9. Perfume distiller. One prototype for producing perfume from lemon grass oil has been made and is in use in the Soap Pilot Plant.

10. Soap boiling tanks. Approximately 40 tanks have been made, as described in the section on soap-making.

11. Caustic soda plants. Eight tanks have been completed so far and three more have been made for the National Council of Women in Development, but are waiting for the motor and drive belts, which have to be imported.

12. Gate hinges. These have been made to a variety of specifications for a number of customers, including the University and some State farms. Quantities of other similar pieces of ironmongery are made from time to time.

13. Brass foundry. This is as described in the section on brass-casting.

14. Iron foundry. A prototype small-scale foundry is under construction outside the workshop. The purpose is to make agricultural implements and spare parts using scrap steel. Construction of the foundry will be entirely from local materials, including burnt bricks from the local small-scale brickworks. An important technological development was first required - the manufacture of refractory bricks from local clays - and this has been achieved by staff of the Department of Ceramics, using sawdust and kaolin.

15. Pyrolytic converters. One prototype has been made and three more are under construction. This is a major TCC project, which is being financed by grants of $100,000 from USAID and $36,000 in local currency from the Government of Ghana. It is being carried out in collaboration with Georgia Institute of Technology. The pyrolytic converter takes sawdust, a commodity in plentiful supply in Ghana, and converts it into three valuable products - char, gas (mostly methane) and a combustible oil. The char will be made into briquettes for use in domestic coal pots. The gas is being used in the dryer in which the sawdust must first be dried. The initial use of the oil will be in firing the Building and Road Research Institute's brickworks near Kumasi, but other uses will be found as well.

When the plant construction unit makes things to order for outsiders a commercial pricing policy is adopted, namely the estimated cost of raw materials plus a 10% handling charge, plus labour costs, plus 200% of labour costs to cover overheads, plus 15% of the overall sum. These prices have almost always been acceptable to customers. When items are made that are financed by grants the unit is credited with their value as if they were a sale.

The plant construction unit has always been the most profitable of the Centre's production units and demonstrates that it is possible to make a very respectable profit from a general purpose metal workshop making small-scale plant and equipment for local industry and agriculture. In fact, the unit is similar to the

many small welding and fitting shops that operate successfully in the informal industrial sector of Ghana, but unlike these its products are mainly innovative.

The workshop facilities of the plant construction unit have been essential to the TCC's work, and a similar workshop is incorporated in the proposal for the Intermediate Technology Transfer Units which are described in the next section.

V Summary and Conclusions

The case studies illustrate a number of different ways in which technology can be transferred. Glue, soap-making and brewers' spent grain are cases where a simple product was made using simple methods. Transfer was easy. Once the initial technical difficulties were solved the entrepreneurs found no difficulty in adopting the production method, organising the production process and selling the products. Glue and soap were already familiar goods, but brewers' spent grain was a little different because the product was unfamiliar and a market had to be established; however, there was a great need for the product and customers were easily found. Soap is a case where the Centre successfully initiated the transfer by means of its own production unit.

Glass bead-making, brass-casting and to some extent broadloom weaving represent attempts to upgrade existing craft industries by improving techniques or expanding the range of products. In the case of bead-making the first step in this development was very successful be ause the Centre identified the problem of colouring for the beads as an area where the craftsmen had a strongly felt need for change, and they readily adopted the new colouring materials made available by the Centre. Brass-casting has made little progress so far primarily because the Centre has not yet made any significant advance in the technology of a kind that the craftsmen can recognise as offering a major improvement in their way of doing things, and broadloom weaving, despite the example of the Centre's own production unit, does not yet seem to have convinced the craftsmen that there are great gains to be made from changing their long practised ways. Thus these efforts have had limited success; however, many contacts with the craftsmen have been established and the foundations laid for acceptance of new ideas in time.

Nut and bolt manufacture is different again, primarily in respect of its dependence on imported machinery, which is unavoidable if

any progress is to be made in this field, but also as it is an example of a technology which though still 'intermediate' in the context, is more advanced than any of the other cases. Transfer has been slow because of import difficulties, but if these could be overcome there seems every reason to believe that the potential for diffusion is high. The TCC's own production unit has been completely successful technically, and there have been no difficulties with process or product acceptance. Commercial performance has been modest, but it is thought to be good enough to be of interest to entrepreneurs who are already engaged in related activities.

1. Characteristics of the technology

All of the technologies established by the Centre satisfy most of the criteria considered desirable in an intermediate technology. The only significant exception to this generalisation is that some are dependent on imported machines or raw materials. However in Ghana's current situation this is unavoidable because some things simply cannot be made in the country itself. The TCC's projects have only used imported goods when absolutely necessary, and it is hoped that this will be recognised by the government so that its allocation of foreign exchange will concentrate on such goods.

Thus the technologies have the following characteristics:

- Processes are simple. Some, such as weaving and the manufacture of nuts and bolts require skilled or semi-skilled workmanship but these can easily be mastered and the Centre has already established training facilities in its own workshop.

- Materials are mostly already familiar ones and locally available, although some do have to be imported. Thus, the projects have the potential between them to achieve considerable import savings.

- The enterprises can all be small-scale, employing between one and 20 people each.

- The capital cost is low, and is within the capacity of interested entrepreneurs to raise funds for the required investment.

- Much of the plant required can be manufactured locally. Many items have been made in the Centre's workshop, but most could also be made in the small-scale workshops in the informal industrial sector, and transfer could easily take place when development work on the designs is complete, as it already is in many cases. The manufacture of some equipment, such as broadlooms, has already been transferred.

- The profitability of the enterprises has been demonstrated, while the reservation about broadloom weaving has been discussed in that case study.

- The technologies are all capital-saving. In comparison with the techniques that would be used in developed countries, where capital is cheap and labour expensive, the intermediate technologies require less capital, which is relatively scarce, and labour which is cheap and readily available. As a consequence the potential for employment generation per unit of capital expenditure is very much greater than would be the case with western technologies.

2. Cost per workplace

This last point can be examined in greater detail by looking at the cost per workplace and the value added per employee in a number of projects undertaken by the TCC or with its direct assistance. To do this properly is actually a fairly tricky exercise because of the difficulty of valuing capital. Buildings are particularly difficult. Sometimes they are purpose-built and count as part of the capital invested in the enterprise. Sometimes they are rented, and the rent counts as a recurrent cost. Strictly speaking one should either include the value of

the buildings in the cost per workplace or deduct rent when calculating value added. In the case of the TCC projects, neither could be done with any accuracy so all building costs have been omitted, and the figures given below for cost per workplace include only plant, equipment and working capital. The exception is the brewers' spent grain case, where the buildings (notably the concrete drying area) form an essential part of the processing equipment. Value added is calculated without deduction of fuel costs and some items such as consumables. In other words, it represents the value of sales less the cost of raw materials. All figures except those for spent grain are in mid-1978 prices, and are based on the actual production and cost records for the year ending mid-1978, and the capital value at that time. Figures for spent grain are for mid-1976.

As can be seen in Table 3, there is considerable variation in capital investment in plant and equipment per worker, although none is higher than ¢4,580 (£860), which compares with, for instance, the ¢13,000 required per additional employee for the Guiness Brewery's grain drying plant in Kumasi, a classic example for an imported western technology.

From the table it can be seen that the seven projects fall into three groups. The traditional industry (soap-making) has the lowest cost per workplace at ¢109. This is similar to the capital outlay required for other traditional crafts such as Kente weaving, wood-carving, etc., which would not need more than ¢100 per person.

Broadloom weaving and spent grain require a cost per workplace of less than ¢1,000. These activities introduce a modest advance in technology, but all equipment is human-powered and manufactured locally.

The remaining four industries have a cost per workplace between ¢1,000 and ¢4,500. These all involve some use of mechanical power and need some imported equipment and/or materials. In terms of organisation and management skills they have more in common

Table 3

CAPITAL INVESTED AND VALUE ADDED PER EMPLOYEE IN 7 TCC PROJECTS 1977/8

All values in cedis (mid-1978 prices) (1)

Industry	No. employed	Total investment in plant equipment & working cap.	Capital investment in plant equipment and working capital per employee	Materials used per employee per annum	Average annual wage	Output per employee per annum	Value added per employee per annum
el bolt duction	10.6	28,280	2,830	1,994	1,209	3,657	1,663
nt construction	5.7	23,000	4,386	4,582	1,625	8,951	4,369
adloom, ving (2)	15.7	7,000	446	823	576(8)	1,471	648
o pilot plant	13.0	34,000	2,615	4,025	1,672	8,556	4,531
n Oil raction (3)	7.0	2,150	3,109	1,299	731	3,429	2,130
ditional o-making (4)	3.0(6)	326	109	848	na	1,440	592
wers' spent in (5)	9.0	6,900	770(7)	12	750	1,760	1,625

(1) In July 1978 the exchange rate of the cedi was £1 = ¢2.12. In August 1978 it was devalued to £1=¢5
(2) Data based on 3 best months of 1977/8 when there was no materials supply constraint.
(3) As described in Ref.3
(4) Data based on 32 weeks production a year (the fruiting season for oil palm)
(5) 1976 prices
(6) Self employed
(7) Including buildings
(8) Low because trainees paid low wages

with large industry than with traditional industry. However, they all employ an intermediate technology that is labour-intensive compared with large-scale industry. Two of them are basic engineering activities which support many other industries and it would be difficult to devise an industrial development strategy that avoided them. On the other hand, machine tools, even used ones, are expensive and it is not easy to see any means of significantly reducing the cost per workplace. In fact the figures in the table, which are based on the current cost of purchasing machine tools of the type (and age) acquired for the nut and bolt and plant construction units, translated at today's exchange rate of ¢5.30 to the pound sterling understates the true cost to the Ghanaian economy of importing these goods. A premium placed on the foreign exchange component of costs to reflect the true opportunity cost of rationed foreign exchange, might raise the cost per workplace of the industries by a factor of around three.

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The soap pilot plant (including caustic soda manufacture) is between the two intermediate groups, reflecting a technology which can largely be made in Ghana, being dependent only on a few imported components (and materials). Capital investment includes a large portion for working capital, needed when supplies are uncertain.

Of the industries described the soap pilot plant has the highest value added per head, followed closely by the plant construction unit. Traditional soap-making has the lowest, but it must be noted that this is only a part-time activity for the three women concerned. Two of the low-cost industries have value added per head greater than ¢1,500. Broadloom weaving has a low value added per head, and this level must really be regarded as inadequate when considering that the technical innovation was intended to raise labour productivity above that of traditional industries.

3. Factors in success - and problems

The entrepreneur

Many of the case studies reveal a fairly slow rate of diffusion of intermediate technologies, and the Centre attributes this primarily to a shortage of entrepreneurs willing to enter the field. A number of projects have lain dormant because the Centre could not locate entrepreneurs who were sufficiently interested to undertake them. Some have been taken up by people who were not really willing to make a serious commitment and the projects have flagged or folded. Even where the Centre has set up its own demonstration projects the rate at which entrepreneurs have come forward has been slower than the Centre had hoped for.

There seem to be two dominant reasons for the shortage of entrepreneurs. First, it is very easy in Ghana to make high profits from trading, and manufacturing can rarely offer as high a return on capital or effort. The trading activity may also be more enjoyable: trips and chats are a necessary part of the work, while the steady application of effort and the comparatively onerous

organisational element required in manufacturing is less appealing. Moreover, in the strong sellers' market existing in Ghana, little effort has to be put into persuading people to buy the goods.

Second, it is not easy to gain acceptance for intermediate technologies. Ghanaians have been familiar for a long time with western technologies and imported goods, and prestige is associated with these things. A not uncommon pattern is exemplified by a small-scale brickworks near Obuasi which was built to a design by John Parry, the chairman of ITDG's Building Materials Panel. It was built by the Ghana government's Building and Road Research Institute, Kumasi, with the intention of developing the technology, setting up a going concern and then selling it. This programme was successfully followed (although with some problems including breakdown of the mechanical mixer, high fuel requirements of the kiln and difficulty in achieving high quality workmanship).

It has recently been sold to the chief of the village of Asokwa in which it is located, in partnership with his brother, who is a businessman in Accra, and a Danish firm. Even though they could make good bricks and sell them easily at a price that compares favourably with alternative materials, the new owners seem rather to despise the concern they have acquired, apparently because of its small-scale and what they see as a primitive technology. They have plans for massive development, importing machinery to do the moulding, and expanding the size of the kiln and changing its design so that it can be fired by either electricity or oil (the present kiln uses wood, which can be cut from the forest all around). These plans are already going wrong. The tractor imported to cart firewood was stolen at Tema, and the enormous wheeled loader imported from Gloucestershire at a cost that exceeded that of the entire brickworks, has had to be adapted for carting firewood (it was bought to transport the clay).

A common characteristic of many of the entrepreneurs who have successfully adopted TCC ideas is previous experience in a closely related field of manufacturing. However, more important qualities are commitment and determination to see things through, a degree of competence in organisation and management, and a willingness to play the role. The Centre has a policy of only helping people who make a fairly formal request for assistance, and who also demonstrate by their actions that they are prepared to do something on their own behalf.

Economic factors

The projects where transfer has taken place most easily or diffusion has been most successful are those where the financial return to the entrepreneur has prospects of being reasonably high - glue, soap and spent grain are examples. Unless an activity is to be taken up by a government organisation or subsidised by the State (either of which might happen if social benefits that cannot be captured in the market price are derived from the goods) a prerequisite of successful diffusion is that the technology should be capable of operation at a profit. In an economy where the activity is to be carried out by private enterprise, entrepreneurs are not going to invest in plant and equipment that is not going to yield them a profit. That is why the case studies give so much emphasis to the question of profitability. It is not enough for the technology to be right - the economics must also be right. This means that manufacturing costs must be sufficiently low so that, at a price mark-up that will yield a decent profit, the price is still low enough in comparison to competing products for all the output to be sold.

As mentioned before, trading offers a lucrative alternative to manufacturing in Ghana, and manufacturing needs to offer a much higher prospective rate of return than would be the case in a developed country. A new technology is likely to be seen as more risky than well-tried alternatives, which is another reason for a high expected rate of return being required.

Although the profitability of some of the TCC projects has been assessed in the report, the assessment will not be an absolutely reliable guide to the profitability of the same activities in the hands of the private sector. In Ghana there are often two sets of prices for goods - the official controlled price, and the open market price. The Centre tries to buy and sell as near control prices as possible, and pays its employees at least as much as the official minimum wage (which is only binding in the public sector). Small-scale private entrepreneurs are likely to have to buy materials at prices above control prices, and they will sell their goods at correspondingly higher prices. They are also likely to pay their employees less than the Centre would for equivalent personnel. This means that the profit and loss account for a private entrepreneur could look very different from the Centre's. Unfortunately it was not possible to assess whether the outcome was likely to be higher profits for the private entrepreneur or lower, other things being equal.

In many cases the marketing of the product of an intermediate technology would need considerable attention to aspects such as appearance and packaging, as well as price, because the goods will have to compete with factory-made or imported goods. This has not applied in Ghana recently because the severe controls on imports, and the low level of output of local factories, mean that virtually anything can be sold. To some extent the products of intermediate technologies may be protected from proper competition by the existence of shortages, and it is always wise to compare the prices with those of the factory goods or imported goods, supposing they were available. If the shortages are expected to last for a number of years, and this is quite possibly true of Ghana, then the protection does not matter.

In some countries finance for investment is also a problem. But the Centre has found that in Ghana this is generally not so. If an entrepreneur has a sound project, and can offer some security, then he will usually obtain a loan on reasonable terms from one of the commercial banks or other agencies. In fact, with money interest rates at 15-18% and a high rate of inflation, real interest rates are negative. The entrepreneur will often need help in

preparing an application for the bank, and the Centre has frequently provided this assistance by preparing a project appraisal or advising on how to do this. With TCC support applications are usually accepted. In fact, the Centre is worried about the opposite problem - that the banks have so much money available for lending that they are not too careful to whom they lend or how much. The Centre can quote a number of examples of people who have been lent far more than they need, and a lax policy towards demanding repayment means that the money is often squandered on consumer items, such as cars, that are not essential to the project. The TCC has been able to give direct help in the form of interest-free loans to small entrepreneurs who cannot offer security acceptable to the bank.

Technology

So much has already been written about this elsewhere that it hardly needs restating. The Centre has found that the easiest projects to transfer have been the profitable ones employing a simple technology and simple processing using locally familiar skills and locally available materials, and relying only on human and solar energy. In choosing the technology the Centre has often found that it pays to select a technique that is going to suit the interests and temperament of the entrepreneur concerned.

Throughout its existence the Centre has found it invaluable to draw on the expertise of specialists throughout the rest of the University for help in solving a variety of technical problems. They have also found it very helpful on occasions to have technical assistance from expatriates who have spent time in Kumasi. An example is a German welder, Mr Jurgen Wende, who spent a period in the plant construction unit in 1973/4, and apparently astonished the other workers by his energy and skill. Another is Mr Prakash from Lucknow, who helped develop the soap-making technique in 1975. The Centre receives visitors from all over the world, who have come to see for themselves the work they have read about. The Centre welcomes them all cordially, but there is an especially warm greeting for those who are prepared to get

their hands dirty, and help the work of the Centre along in some way.

Also useful from time to time are the many contacts that the Centre maintains with organisations such as the Intermediate Technology Development Group in London and the Georgia Institute of Technology. Sometimes these organisations can be useful primarily because their location enables them to pursue enquiries with, for instance, equipment suppliers or potential customers for Ghanaian exports. Sometimes they can offer specialist technical information or advice.

Human

Some of the technologies demand a fair amount of skill and offer the satisfaction that can come from exercising skill and creativity in making things. Examples are weaving, nut and bolt manufacture and plant construction. Yet persistent application, often involving long hours of repetitive work, are necessary to achieve levels of productivity that make the operations viable. It is interesting that although some workers do have obvious enthusiasm for their work, the Centre's units are dogged by problems of low productivity due to low effort, and have at times been affected by poor attendance, poor workmanship and pilfering. As a result all these units have needed far more management and supervision than the Centre would welcome if small units are to offer a significantly different working environment from large-scale industry - one where individuals have more pride in and responsibility for their own work.

Another point to emerge from the Centre's experience is that many of the people with whom they have had contact have preferred to take paid employment with the University or other organisations, rather than set up on their own account. Self-employment has the obvious disadvantage of riskiness, and may also provide less social contact than wage employment. But an additional factor in explaining the desire for paid employment may be that employers in Ghana often provide considerable benefits for their employees

on top of a guaranteed wage, such as lunch allowances, housing allowances, holiday pay and in a few cases medical services. These must give paid employment a powerful attraction.

Co-operatives do not seem to take root easily in Ghana either. On several occasions the Centre has encouraged people to form co-operatives, but there has been very little response. The only reasonably successful co-operative set up as a result of the Centre's initiative has been amongst the glass bead-makers of Darbaa, and the key factor there seems to be the clear economic gain to be made by collectively importing the colouring material. The reasons for the lack of enthusiasm for co-operatives must be complex. Some of the reasons are probably common to those facing co-operatives in any market economy - they are unstable because there will generally be ways for individual members to do better for themselves by working outside the co-operative. They always require more organisational effort than they ought, and this tends to fall on a few committed people. In Ghana an extra factor may be that they cut across the ties of the extended family system. However, these superficial remarks go no way towards an explanation, which would require a thorough study.

The role of the TCC

To function effectively the Centre has to have large numbers of contacts in various directions - with the University of which it is a part, with the Ghana government and international agencies for funds and support, with other organisations promoting intermediate technology who are useful for ideas and further contacts, and lastly, but not the least important, with the farmers, craftsmen and industrialists, potential and established, who are the target of the Centre's work, and who will ultimately do most of the work of spreading intermediate technology.

With all of these there are successes and problems. The easiest links are probably those with sister organisations in other countries and with promotional organisations such as the Intermediate Technology Development Group in London, and its Intermediate Technology-Industrial Services in Rugby. Relations

with the Ghana government are good, but somewhat remote, possibly because of the Centre's location 150 miles from the capital, and the Centre would like more tangible support (especially financial) from that source.

Many contacts have been established with craftsmen and industrialists, but more must be forged. The Centre's location on the University campus does not help this and plans for setting up Intermediate Technology Transfer Units in the informal industrial areas are discussed below.

The Centre's own production units have been very important in establishing links with potential entrepreneurs, and in many of the cases discussed earlier in this report they have been a key element in the diffusion of the intermediate technology. One lesson that emerges clearly from the Centre's experience with its production units is that these are extremely time-consuming activities for an agency such as the TCC. They require a substantial input of managerial time, even after the initial work to set them up and sort out the major production problems has been completed. As the units are commercial operations, continuous responsibility for all the decisions about purchasing materials and plant, accepting orders, deciding prices, finding customers, making product or process innovations etc. has to be exercised by someone in the appropriate position, and much of this work falls on the small professional staff of the Centre. With over 50 people directly employed in its various units, the task of personnel management alone is an onerous one. A second major lesson is that it will often be necessary to keep the demonstration projects going for substantially longer than the two to three years originally envisaged.

The TCC production units have played a vital role as demonstration projects for the Centre's work, serving as the place where technical problems are solved, and showing that the technologies are feasible and profitable. Without the units it is hard to see what kind of substitute would fulfill these functions with anything like the same degree of success. It seems that demonstration

projects will be indispensable for some technologies, but it must then be recognised that transferance of these technologies requires a considerable input of organisational effort over a number of years. It is not enough just to point out a good idea - it has to be demonstrated in practice.

Because of its position as part of Ghana's Technological University, the Centre has been able to draw on the University's large pool of experts in various fields of technology, and without this supplementation of its own resources it would have been unable to do what it has. This emerges in several of the case studies, where faculty members have played a key role in the development of a TCC project, or a project has been undertaken jointly with a particular faculty.

One of the Centre's prime objectives is to see a much greater diversion of the skills and research resources of the University into efforts to promote small-scale industrial development in Ghana. Of course, the University plays a major role in training technologists, but most of these go into large-scale industry. The staff carry out numerous consultancy jobs for industry, but again this is mainly for the large-scale sector. In the Centre's five-year development plan (October 1975) the director set out his aims for increasing the involvement of the rest of the University. At that time only about 10 per cent of the staff were involved in TCC projects, but the director hoped to increase this to 50 per cent, which would mean that 30-40 members of the academic staff would regard a TCC project as their major non-teaching activity, while perhaps another 100 would devote some of their research and consulting time to TCC projects.

An increase on this scale has not in fact happened, and when considering the achievements of the Centre over the period of its existence one has to remember that this has been done with only a very small permanent professional staff. Although at various times the Centre has had valuable help from expatriates on short assignments, it has carried out all its projects with only a very small core of professional staff. If one bears in mind

that all industrial research and development work is highly demanding of professional time, and that the staff have also set up and run several of their own production units, the Centre's performance in relation to its resources seems impressive. However, in absolute terms the achievements may seem disappointing. As the director himself points out, the Centre cannot claim to approach the achievements of Sri Garg in India, whose work in the field of small-scale sugar refining has been responsible for perhaps 2500 small-scale sugar factories in India. This was the sort of result the Centre hoped for, but it has not reached it yet. Perhaps the time period is too short - six years is not long. Perhaps special difficulties in Ghana - the deeply established admiration for the products and methods of western technology, the lack of entrepreneurs, the distortions of the economy that reward trading so much more highly than production, the absence of a tradition of exploiting local resources for manufacturing, the long-term reliance on imported materials and equipment, and so on - mean that diffusion will inevitably be slow and successes will be hard won.

4. Future Directions

Intermediate Technology Transfer Units

Recognising that it faces an upnill struggle in Ghana, the Centre nevertheless has every intention of continuing its efforts and numerous new projects are in progress. One of the ways in which the Centre hopes to extend its reach and increase its effectiveness is through the medium of Intermediate Technology Transfer Units. The idea is to take the Centre's services out into the informal industrial area, where it will be able to make much closer contact with the craftsmen and industrialists that it exists to help. The Centre's location on the University campus places it in an environment unfamiliar and offputting to the informal industrialists, and the Centre feels that its impact could be much greater if it had a permanent presence in their midst.

An Intermediate Technology Transfer Unit (ITTU) will consist of four to five workshops and production units demonstrating products and processes developed or adapted to local conditions by the University. The workshops will include blacksmithing, carpentry and welding/sheet metal working. It is expected that the local industrialists and craftsmen will observe that the methods and tools are a little better than their own, and will want to adopt them themselves. An ITTU would be able to offer machines on hire and supply initial stocks of raw materials. It would train people who want to adopt new methods, or their employees. It would be able to offer technical and economic advice on all aspects of running a proposed business, help in drawing up the feasibility studies and cash flow projections necessary to secure loans, offer some interest-free loans to those with no security, import items for which small entrepreneurs would not be able to obtain import licenses, and perhaps assist with raw material supplies through bulk buying, and also to establish their sales by placing the initial orders or passing on orders received itself.

Through the ITTUs the Centre could expand its own production units, making much needed products and providing valued employment in areas where unemployment is high, but more importantly its presence among the people to whom it is trying to transfer intermediate technologies should ensure that the diffusion of those technologies takes place more rapidly than before.

The first two ITTUs are planned for Suami Magazine and Tamale. The one at Suami, which is an enormous informal industrial area in Kumasi, will specialise in vehicle maintenance and body building, and the manufacture of items of general household and industrial use. The one in Tamale, which is in the Northern region, will be primarily concerned with the manufacture and repair of agricultural equipment and machinery, including items needed for irrigation and food storage and processing.

The Ghana government has expressed its support for the ITTUs and the Centre is now, after two years spent in promoting the idea, close to agreeing financial support from an external agency. It is

hoped that this agreement can now be finalised so that the Centre can extend its work in promoting the transfer of intermediate technology in Ghana.

5. Conclusions

In drawing conclusions from the experience of the Technology Consultancy Centre one has to avoid making generalisations that would not apply to other countries. However, despite the extremity of Ghana's economic situation, there are probably other African countries, and possibly developing countries outside Africa, that have enough in common with those aspects of Ghana's cultural and economic conditions that influence the diffusion of intermediate technology for conclusions based on the Ghana experience to be applicable to those countries too.

The first conclusion seems to be that those expecting rapid diffusion might well be disappointed. It takes time to establish a presence, time to find willing and capable entrepreneurs, and time to overcome the resistance to new technologies from traditional craftsmen. Success will not be achieved by methods that do not strike chords of sympathy in the industrialists and craftsmen who could take up the ideas offered by intermediate technology.

The second is that the products and processes must be carefully selected, with an eye not just to their technical performance and acceptability, but also to the profitability of the venture. This is likely to be the case as long as the country has a capitalist economic system where an entrepreneur will only be interested in investment if he is reasonably well-assured of a financial return that compares favourably with what he could earn through other activities.

The third is that demonstration projects such as the Technology Consultancy Centre's production units can play a very important role in the diffusion of intermediate technologies, and may well be indispensable for some. However, they require a sustained input of effort over a fairly long period of time before they have their full effect.

The fourth is that an agency such as the Technology Consultancy Centre needs to have a physical presence in the midst of the people with whom it is trying to work. The TCC's task is not helped by its location on the University campus. An organisation such as that of the Centre's proposed Intermediate Technology Transfer Units seems a promising way of achieving good contacts and a satisfactory adoption of its ideas and the experiment will be watched with considerable interest.

Finally, the successful and widespread diffusion of intermediate technology needs the persistent and well-judged efforts of people such as the director and the staff at the Technology Consultancy Centre, and the developing world needs far more of them practising in the field.

Annex I

Financial return to soap manufacture

In this Annex the profitability of Kwamotech Industries Ltd. (formerly the soap pilot plant) in the financial year July 1975 to June 1976 is presented. In that year Kwamo produced 113,525 bars of soap, which is about 45% of the maximum possible. In the next financial year to June 1977 the factory produced only 43,764 bars, which is only 17% of potential, and the labour force was not reduced. The following table details the sales and cost figures for 1975/6. The return on capital in that year was 20% and the return on sales was 12%. In the following year performance was worse because output was lower: return on capital was only 4% and return on sales 6%. These results are poor but the company was glad to have made any profit at all.

Profitability of Kwamotech Industries - June 1975 to June 1976

		In cedis	
Sales			107,726
Less cost of sales:			
Raw materials		62,147	
Wages (inc social security)		13,713	
Maintenance of equipment	195		
Small tools	30		
Fuel, power, lighting	1,913		
Transport charges	8,359		
Materials and consumables	2,389		
Water charges	360		
Depreciation - vehicles	2,277		
- equipment & fittings	611		
Fire and tornado insurance	385		
Vehicle insurance	370	16,889	
		92,749	
Less stock of finished goods		2,054	
		90,695	
Less selling, general and admin.expenses:			
Salaries (inc. social security)		3,747	
Bank charges		29	
Audit fees		400	
Printing and stationery		68	
		4,244	
Total costs			94,939
Profit			12,787
Assets (30 June 1976)			
Total			64,065
Current assets (net)			2,373
Fixed assets:			
Leasehold land		900	
Factory building		53,228	
Factory equipment		3,323	
Furniture and fittings		617	
Motor vehicle		3,624	
			61,692

For a number of reasons it is difficult to draw conclusions from the Kwamo experience about the profit and return on capital that one could expect to be achieved by an entrepreneur investing in soap-making. The dominant reason is uncertainty about the future of the economy, but other factors are:

- the low utilisation of capacity in the years considered;
- the omission of payment of interest and repayment of capital from the Kwamo accounts;
- the over-capitalisation of the Kwamo factory;
- inflation;
- variations in prices of raw materials and product price.

It is worth attempting to assess the impact of low utilisation on Kwamo's profitability, by considering what profits might have been with a higher output. If production in the order of 180,000 bars had been achieved in 1975/6 (70% of potential) revenue from sales would have been around ¢171,000 and costs might have been ¢141,000, giving a return of capital of 47% and a return on sales of 17.5% - a considerably better result.

The return would have been lower if the company had had to pay interest and principle repayments on loans made for the capital investment. As it is Kwamotech has taken over the grant of ¢24,300 made to the TCC by the Ministry of Industries, and has not yet started to pay interest or repayments on the rest of the capital, which is being counted as a loan by the University and will attract an interest rate of 10%. Deducting the full cost of capital, assuming a seven-year repayment period, would have turned Kwamo's profit into a ¢6,000 loss in 1975/6.

However, capital expenditure at Kwamo was considerably higher than most entrepreneurs would choose to undertake. First, the factory building is a high quality durable structure and was designed to house the electrically-heated soap tanks, which have since been replaced by the wood-fired tanks used outside. Many other entrepreneurs have not erected permanent buildings to house the plant. Secondly, some of the expenditure went on things that could properly be attributed to research and development rather than soap production. This means that other entrepreneurs with the same recurrent costs and revenue would have a higher measure rate of return on capital. For instance, if the capital had been half, the

return on capital in 1975/6 would have been 40% (instead of 20%).

Kwamo's assets have been valued at historic cost rather than current or replacement cost, which would have been higher because of inflation. An entrepreneur contemplating investment has to pay current costs, so he is interested in the return on capital at current values. Inflation between 1974/5 and 1975/6 was 43%, so Kwamo's return on capital would have been 14% (instead of 20%) recalculated with the 1975/6 value of capital.

Kwamo only makes soap when oil is available from the State farms at the current price of ¢875, and the soap is sold near to the control price. However, some soap-makers keep going (and achieve a higher rate of output) by buying their oil in the market place, where they may pay up to ¢1600, and then sell substantially above the control price. Profit calculations would look rather different for these soap-makers, but we were unable to get figures for such a case.

All these considerations mean that it is difficult to assess the profitability of soap-making by the TCC's intermediate technology, but the results of this section do indicate that investment in soap-making is capable of providing a return sufficient to attract entrepreneurs who want to invest in productive activity. Perhaps the proof of their enthusiasm is that during the last year orders for soap plants have continued to arrive.

Annex II

Profitability of small-scale drying of spent grain.

(All values in cedis)

Capital costs (late 1975 prices)

Presses (2) and table	650
Signboard	160
Cementing 10,000 sq.ft, roofing and improvements to sheds	1880
Initial stock of sacks (1200)	1300
Rakes	12
Storage drums (6)	12
Tarpaulins (2)	600
Approximate value of premises before improvement (walls, some concreted area, 1 storage shed, some shed without roofs)	2000
Site value - say -	300
Hats	15
	6929

Running costs per month (mid 1976 prices)

7 workers (2 men, 5 girls)	420
1 foreman	80
Miscellaneous	21
Depreciation (equipment - 2 years buildings - 5 years)	175
Transport (2 trucks per week)	80
Allowance for Manager	200
	976

8 deliveries per month of 5 tons wet grain, giving 10 tons of dried grain.

Selling at ¢3.00 per 50 lb bag,

Revenue per month = ¢1320

Profit per month = ¢344

Profit per annum = ¢4128

This is a 59 per cent return on capital, and a 26 per cent return on sales.

Annex III

Profitability of Steel Bolt Production Unit

(all values in cedis)

	May 74-April 75	May 75-April 76
Sales	12,191	16,815
Basic wages	3,749	8,330
Bonus	774	663
Social Security	214	246
Materials	3,284	10,579*
Small tools	306	701
Electricity	55	253
Supervision	2,050	2,140
Total costs	10,432	22,912
Gross profit	1,759	- 6,097

*including 5,070 for building up raw material stocks

	July 77-June 78
Labour	12,820
Supervision	3,600
Materials	21,132
Fuel, small tools	2,500
Depreciation	3,000
Total costs	43,052
Value of production (including ¢15,000 of unsold stock)	53,809
Profit	10,757

Source: 3rd and 4th Annual Reports of Steel Bolt Production Unit.