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Absorption and diffusion of imported technology

Proceedings of a workshop held in Singapore, 26-30 January 1981

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Absorption and Diffusion of Imported Technology: A Case Study of Four Industries in Sri Lanka

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Industrial Development in Sri Lanka: A Brief Outline

Since the early 1930s, when the elected representatives of the people had a voice in the government of the country, the demand for industrialization has occupied a prominent place in the programs of the major political parties. The prevailing poverty and backwardness of Sri Lanka have been attributed to its colonial status as a supplier of cheap raw materials and agricultural produce to Britain and a captive market for manufactured goods from industrialized countries. Agitation for industrial development to reverse this trend and achieve balanced economic growth, thereby raising the standard of living of the people gained ground throughout the 1930s.

With the outbreak of World War II, Sri Lanka was cut off from its traditional sources of supply. In order to meet the widespread scarcity of all types of manufactured goods, a number of manufacturing units were set up. These included factories for the manufacture of plywood, rolled steel, cardboard, drugs and pharmaceuticals, acetic acid, glassware, etc. All of these units were small scale, with improvised machinery and a primitive level of technology that had been developed within the country or borrowed and adapted from neighbouring India. One of their salient features, however, was self-reliance.

The quality of the products from these local units was, understandably, poor and the prices relatively high in comparison with imported articles. In spite of this, however, there was a ready market due to the prevailing scarcity of goods. This wartime scarcity of manufactured goods and the success of the local ventures, hastily set up to meet this scarcity, gave an added impetus to the demand for industrialization. Plans, therefore, were prepared in earnest for setting up a number of large-scale industries after the war. In this regard, the government's postwar development plan, published in 1946, identified no less than 26 industrial projects for establishment.

Immediately after the war, a program for modernization and expansion of the wartime ventures and the establishment of a few large-scale units was initiated. The first generation of new industries that came into existence — all of them in the public sector — included a cement plant, pulp and paper mill, vegetable oil factory, caustic soda and chlorine plant, and plywood factory. Unlike earlier, when the small-scale wartime units were set up largely with local know-how, the establishment of the postwar large-scale units depended entirely upon foreign expertise, from the feasibility stages through to the operation of the factories. All plant and machinery and structural steel for buildings and structures were also imported.

By the early 1950s, substantial progress had been made in the implementation of the industrialization program. The cement factory was the first to go into production, while the other industries were at various stages of construction. In addition, feasibility studies for steel, textile, and fertilizer manufacture were under preparation. Meanwhile, there was another development that had an adverse affect on this program. After the war ended, all types of imported manufactured goods became freely available in Sri Lanka again and the products of the local wartime factories could not compete with these imports. Consequently, the government was compelled to adopt various protective measures, such as import controls, to give relief to local industry. This, in turn, prompted the powerful

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import lobby to mount a campaign against local industries. The arguments advanced during this campaign were that Sri Lanka had no comparative advantage in the manufacturing industry; the local market was very limited and could be met by a few days' or weeks' output from most modern manufacturing units in industrialized countries; and for the successful establishment of industrial enterprises, substantial capital investment and sophisticated technical and managerial skills — all very scarce in Sri Lanka — were needed.

It was also asserted that it was not the legitimate function of government to engage directly in manufacturing or commercial activities. To reinforce these arguments, various shortcomings in the public sector enterprises were frequently spotlighted in the press and in parliament. As a result, public opinion prejudicial to state ventures was gaining ground daily. It is against this background that one has to view the recommendations of the World Bank Mission, which was in Sri Lanka in 1952 to study and report on the economic development program.

The World Bank Mission, in its report, emphasized the need for the development of agricultural and infrastructural facilities. The mission strongly urged the government to leave commercial and industrial ventures in the hands of the private sector and, as far as industries were concerned, they favoured only small- and medium-scale units. With regard to the industrial projects already under construction or at various stages of planning, the mission recommended the virtual abandonment of almost all of the units except the cement factory, which had already been completed. The government, acting on the mission's report, promptly froze all of the funds for the pulp and paper, ceramics, oils and fats, and chemicals projects, on which work was in progress, and abandoned the steel project, on which work had just been initiated. After a reappraisal of the projects, however, work was resumed on all of the projects except steel.

The government at that time was fully committed to private enterprise and was not in favour of state industrial and commercial ventures. The local private sector, however, had neither the capacity nor the willingness to risk their capital in industry and the government, therefore, came to the conclusion that the key to the future of industrialization in Sri Lanka (particularly large-scale industry) lay in the hands of foreign capital investors and in order to attract foreign capital various attractive inducements were offered. At the same time, in order to ensure the efficiency of public sector enterprises, it was decided to hand over their management to autonomous corporations and at a later date sell shares in the enterprises to the public. What was envisaged at that time was that eventually the ownership of viable units would pass into private hands.

There was a major shift in the industrial policy of Sri Lanka when a government, pledged to a radical program of work and a strong bias in favour of the public sector, was swept into power in 1956. In industry, the importance of heavy and basic industries to the economy was emphasized and pride of place assigned to the public sector. As there had been very little response from private capital investors (both local and foreign), in spite of the attractive inducements offered by the previous government to invest in industry, the new government was forced to look elsewhere for assistance in implementing its policy on industrialization. The government found an ally in the USSR, with whom Sri Lanka had just established diplomatic relations. Negotiations on economic cooperation between the two countries, finalized in 1958, identified 17 projects, for which the USSR agreed to provide the necessary technical expertise and plant and machinery. Amongst the projects identified and implemented in the industrial field were a steel rolling mill, an automobile tire and tube plant, and a flour mill. These were all relatively large-scale projects and took several years to complete.

The role of the Soviet organizations in the implementation of these projects consisted of carrying out preliminary surveys and investigations; preparing designs; supplying plant and machinery and construction materials; and assisting in the construction and initial operation of the plants and in the training of local personnel, both at similar plants in the USSR and on the job in Sri Lanka. For all supplies and services from the USSR, a long-term loan with very generous repayment terms was granted.

Three noteworthy features from the point of view of technology transfer distinguish this technical assistance program from earlier experiences with project implementation in Sri Lanka. Firstly, at every stage, from preliminary surveys of the local market and raw materials through to the construction and operation of the plants, local counterparts were associated with Soviet specialists and decisions were arrived at, as far as practicable, on the basis of joint discussions. During the construction and initial operational stages, the Soviet specialists always insisted that their local counterparts be responsible for decision-making and they (the Soviet specialists) remained in the background, to step in if things went wrong. This arrangement helped build local expertise, in marked contrast to earlier experiences with foreign consultants and specialists.

Secondly, complete and comprehensive documentation of all aspects of the projects was furnished to enable the local organizations, if needed, to fabricate certain components and spare parts on their own. Training of local personnel in Soviet factories was also very thorough. The trainees were not given a "Cooks tour" as often happens when trainees are sent to developed countries, but were given a comprehensive course combining both practical and theoretical training and were subjected to a final test at the end of the training period.

Thirdly, prior to this technical assistance program from the USSR, foreign consultants had been responsible for the civil engineering design of industrial buildings and structures and their construction, particularly in the case of large-scale units entrusted to private foreign contractors. At the suggestion of the Soviet Aid Agency, however, a public sector enterprise was established to undertake the design and construction of buildings and structures for industrial projects in Sri Lanka, commencing with the first three Soviet-aid projects. With the experience gained in these projects, this particular organization subsequently developed sufficient capability to undertake detailed civil engineering designs as well as construction of several major industrial projects.

Industrialization continued throughout the 1960s and 1970s, large-scale industries being confined mostly to the public sector with bilateral aid, notably from the Federal Republic of Germany for the expansion of the cement and paper industries and from the German Democratic Republic and the People's Republic of China for textile industries. The import substitution program inaugurated in the early 1960s and the export promotion drive, which began toward the end of that decade, stimulated the private sector and led to the establishment of a large number of small- and medium-scale consumer goods and service industries.

The 20-year period from 1956–1976 was marked by a steady growth of industries in Sri Lanka. These industries covered a wide range of products including basic and essential goods to the economy, such as cement; rolled steel; refined petroleum products; paper; plywood; agricultural implements, tools, and chemicals (caustic soda and chlorine); and consumer goods, such as textiles, ceramics, glassware, ready-made garments, footwear, plastic goods, and food preserves. Most large-scale industries were in the public sector, with the exception of a few textile mills in private hands; whereas almost all consumer goods industries, with the exception of ceramics and textiles, were privately owned.

In the course of construction and operation of the numerous factories and workshops during the past 20–25 years, there came into existence a wide range of technical and managerial skills and considerable interaction between educational, training, and research institutions in the country. As a result of this generation of skill and expertise, by 1975, Sri Lanka was in a favourable position to undertake, on its own, with only marginal assistance from abroad, the design, construction, and operation of industrial enterprises involving, in some cases, sophisticated technologies. The absence of a capital goods sector, however, was no doubt a drawback in what was otherwise a major stride toward self-reliant growth.

This commendable achievement also had its own drawbacks, which, in turn, tended to inhibit further development of this growth process. Lack of competition due to a virtual ban on the import of all manufactured goods and strict licencing of industrial units; granting of complete monopoly to state corporations for a number of products such as cement, paper, and steel (not only for production but also for import and distribution); and strict enforcement of quotas for the import of raw materials, spare parts, etc., led to low levels of capacity utilization, lack of competition, poor-quality products, and the high cost of manufactured goods. The whole economy was restrictive and inward looking.

A major shift in policy occurred when a new government, with an unprecedented majority, assumed office in mid-1977. More reliance was placed on market forces than on the planning process to achieve the goal of economic development. Although the public sector still continued to dominate the industrial landscape, growth was now more marked in the private sector due to positive encouragement and a wide variety of incentives provided for both local and foreign entrepreneurs, including the establishment of free trade zones. All controls, virtually, were dismantled and local manufacturers had to compete with unrestricted imports. The full impact of the new policies is still to be assessed.

Summary of Industries

Pulp and Paper

The manufacture of pulp and paper in Sri Lanka is presently the exclusive monopoly of the state-owned National Paper Corporation (NPC), which currently operates two pulp and paper mills, one in the eastern part of Sri Lanka and the other in the south. Both mills are fully mechanized and equipped with modern machinery for

Table 1. Growth of the National Paper Corporation.

Period	Average annual imports (tons)	Average annual production (tons)	Average annual demand[a] (tons)	NPC's share of local paper market (%)
1950–54	21000	0	21000	0
1955–59	21000	1000	22000	5
1960–64	26000	5000	31000	16
1965–69	30000	9000	39000	23
1970–74	22000	14000	36000	39
1975–78	17000	20000	37000	54

[a]Demand is computed as the sum of imports and local production.

producing pulp from rice straw and manufacturing paper and paper boards utilizing straw pulp as the principal raw material, supplemented with imported long-fibre pulp.[2]

A feasibility study for a pulp and paper mill with a daily capacity of 12.5 tons[3] of paper was prepared in 1947, construction began in the early 1950s, and the mill went into production in 1957. Rice-straw pulp was the principal raw material and the output of the mill was confined to writing and printing paper. The capacity of this mill was increased to 35 tons per day in the mid-1960s, through modifications to the paper machine and the addition of balancing equipment, all involving a marginal investment. This was followed by the installation of a second paper machine and the necessary pulping facilities and auxiliary services in the early 1970s, thus increasing the total capacity of the mill to 75 tons per day. The output of the new paper machine included both printing and writing paper and paper boards.

A second pulp and paper mill, at a site in the southern part of Sri Lanka, with a daily capacity of 50 tons, and whose construction began in 1972, came into production in 1978. This mill was also designed to utilize rice-straw pulp as the principal raw material to produce printing and writing paper.

Over the years, the NPC's share of the local paper market gradually increased from approximately 5% in the 1950s to about 54% in the 1970s, as indicated in Table 1. Imports, at present, are confined largely to those grades of paper and paper boards that are outside the product range of NPC machinery.

The NPC has been dependent throughout on foreign consultants for the preparation of feasibility reports and for engineering services. All of the plant and machinery needed for the mills were imported and expatriate personnel employed for the installation of machinery and its testing, commissioning, and initial operation. During the second half of the 1940s, when the paper project was first considered, there was practically no one in Sri Lanka with any knowledge of or experience in the pulp and paper industry. Since then, through the establishment and operation of the paper mills, a large group of engineers, technologists and skilled workers, and managerial and administrative personnel have developed, numbering over 3000, who have eliminated the need to import foreign technology for new mills or expansion programs.

In the absence of a capital goods sector in Sri Lanka, there is little prospect of local manufacture of plant and machinery for pulp and paper or other industries. However, both in the repair workshops attached to the mills and in the engineering workshops in the country, about 50% of the spare parts required for the mills are fabricated.

Pulp from rice straw, due to its short fibre length, needs to be blended with approximately 35% long-fibre pulp, which is imported. Attempts to meet the entire needs for long-fibre pulp from indigenous sources have so far been only partially successful.

In addition to pulp, relatively large tonnages of other production supplies needed for making paper were all imported during the early stages. Over the years, the demand for these materials from pulp and paper and other industries has led to the establishment of plants for local manufacture of these items. The quantities of such major supplies required annually by the NPC and the extent of local substitution is tabulated in Table 2.

Cement

The manufacture of cement in Sri Lanka is presently the exclusive monopoly of the state-

[2]In addition to the NPC's two mills, there are a few small-scale paper-making units employing a low level of technology. Production from these units is confined to a few hundred tons of paper boards. Several paper-converting units manufacturing envelopes, paper bags, and cartons are also in existence.

[3]Refers to long tons throughout.

Table 2. Supplies required for pulp and paper production.

Material	Annual requirements (tons)	Percentage of local supply
Caustic soda	7000	25
Chlorine	1800	100
Kaolin	2250	100
Starch	260	80
Calcium hydrate	4000	100
Soda ash	2600	0
Alum	3400	0
Sodium sulphate	200	0
Rosin	1100	0

owned Ceylon Cement Corporation (CCC), which currently operates two cement plants: one on the peninsula in the north and the other about 80 mi (129 km) north of Colombo, and a clinker grinding plant about 75 mi (121 km) south of Colombo.

Investigations into the establishment of a cement industry in Sri Lanka began in 1945 and the first cement plant, on the peninsula in the north, with a rated capacity of 100 000 tons per annum, went into production in 1950. In the mid-1960s, this plant was modernized and expanded to 270 000 tons per annum. Part of the clinker output from this plant was transferred to a clinker grinding plant with a capacity of 100 000 tons per annum constructed around this period to feed the market in the south-western part of Sri Lanka. Construction on the second cement plant, with a capacity of 440 000 tons per annum, began in the late 1960s, and it was commissioned in the early 1970s.

Both cement plants utilize the dry process for cement manufacture; incorporate modern, sophisticated machinery; and are dependent upon indigenous limestone and clay and imported gypsum and fuel oils.

During the 1950s, when only the first cement plant was in operation, only slightly less than one-third of Sri Lanka's requirements for cement could be met. Once the expansion of the first plant was completed, the CCC's share of the market increased to about 68% and, by 1973, with the commissioning of the second plant, Sri Lanka became self-sufficient in cement, and even had an exportable surplus (Table 3). This situation underwent a major change when a large-scale construction program was inaugurated in 1978. Even near-capacity levels of production could not meet this increased demand and imports became necessary in 1979 and 1980. Due to the increasing gap between production and demand since 1978 and the potential for export, a major expansion program has recently been initiated.

The Ceylon Cement Corporation was entirely dependent upon foreign consultants for feasibility studies and engineering services for the establishment of the first cement plant. Although this dependence continued throughout expansion and new mill projects, there was a progressive increase in local participation in these activities, and in the expansion program now under way foreign participation is minimal. All plant and machinery were imported throughout this period and expatriate personnel engaged for machinery installation, testing, commissioning, and initial operation. As with the pulp and paper industry, the establishment and operation of cement plants resulted in the development of a large group of engineers, technologists and skilled workers, and managerial and administrative personnel, numbering over 2000, capable of future expansion or building new mills without relying on the import of foreign technology.

Unfortunately, the absence of a capital goods sector in Sri Lanka meant that plant and machinery for cement mills could not be manufactured locally. The CCC, however, is now planning to fabricate, at its own workshops and at outside engineering workshops, a sizeable volume of simple components and structures, which may amount to about 30% of the total volume of the machinery package required for the expansion program currently under way. At the same time, nearly 50% of the spare parts required will be fabricated locally.

Table 3. Growth of the Ceylon Cement Corporation.

Period	Average annual imports (tons)	Average annual production (tons)	Average annual demand[a] (tons)	CCC's share of local cement market (%)
1952–56	129354	72988	202342	36
1957–61	178250	76982	255232	30
1962–66	225207	78424	303631	26
1967–71	131169	276220	407389	68
1972–76	0	413848	413848	100

[a]Demand is computed as the sum of imports and local production.

Glass

The glass industry in Sri Lanka, entirely privately owned, is comprised of a single large-scale producer that manufactures bottles and nearly 20 small-scale units that produce domestic utility glassware such as tumblers, kerosene lamp chimneys, etc. Unlike the cement or paper industries, there is no monopoly in the manufacture of glass.

The first glass factory, established during World War II, came into production in 1943. This was a private sector medium-scale unit manufacturing utility glassware, with an output of about 1 ton per day. A short time later, a similar unit was set up in the public sector. When imports became freely available after the war, both units, in the absence of any protection and unable to withstand competition, were forced to close down. Thereafter, the Ceylon Glass Company, a private-sector enterprise with Japanese collaboration, took over the assets of the state-owned glass factory and implemented a program of modernization and expansion, raising its capacity to 15 tons per day. This factory came into production in 1957. Its capacity increased to 20 tons per day in 1961 and to 40 tons per day in 1963. Later, a second plant was built by the same company at a site closer to Colombo. The entire output of this company is confined to glass bottles. Both units are mechanized and are equipped to cover the entire process of glass-making, utilizing locally available silica and quartz.

In addition to the Ceylon Glass Company, which is the leader in the industry, there are about 20 private-sector units engaged in the manufacture of glassware. These units are all small scale, with practically no mechanization, and they utilize broken glass as their raw material. This, together with the low level of technology employed, has resulted in a poor quality product. All of these units, however, which came into existence in the 1960s and early 1970s, prospered because of the sheltered market. With increasing fuel prices and relaxation of imports since 1977, however, only a handful of these units are now surviving.

Almost the entire local requirement for glass bottles and containers and about 85% of utility glassware was produced locally until 1977, when imports were liberalized. In the absence of local manufacture, all plate and sheet glass was imported. An indication of the relative proportion of imports and local production and the sudden spurt in imports after liberalization in 1977 is given in Table 4.

Table 4. Proportion of local and imported glass products.

	Local production (thousand tons)				
Year	Bottles and containers	Mirrors	Others	Total	Imports
1977	18.203	3.313	3.986	25.502	17.176
1978	15.710	1.905	3.990	21.605	64.135

The first glass factory, established in the private sector in the early 1940s, obtained the necessary technical know-how and plant and machinery from an Indian firm. Operators from the same firm trained local personnel. The same procedure was also followed by the public sector unit that came into existence later. The expansion and modernization of the Government Glass Factory, taken over by the Ceylon Glass Company in the mid-1950s, depended to a large extent on expertise from its Japanese collaborator, both in terms of technical know-how and plant and machinery. This dependence on foreign technology was progressively reduced over the years through the various expansion programs of the company.

Dependence upon foreign technology varied in the case of the numerous small-scale units that came into existence in the late 1960s and early 1970s. In some instances the entire package — plant and machinery, foreign experts, and capital — came as part of a collaboration agreement. In other cases, former employees of the Ceylon Glass Company provided the necessary technical know-how and all requirements for plant and machinery were met locally — an indication of effective diffusion and assimilation of technology.

The total number of people employed in all of the units of the glass industry in 1979 was estimated to be about 1000. This included a few engineers and technologists and an adequate number of trained and experienced skilled workers.

Synthetic Textiles

With the exception of a single large-scale cotton textile mill, established in the private sector about 100 years ago, the manufacture of textiles in Sri Lanka until the 1950s was negligible and confined to a few handlooms. In spite of the substantial assistance provided by the government to the handloom sector in the 1940s and early 1950s, there was no appreciable increase in production, nor was there any private-sector initiative to undertake the manufacture of cotton textiles. This prompted the government,

in the latter part of the 1950s, to embark upon a major program of establishing a number of large-scale textile mills and decentralized powerloom projects, all in the public sector but confined to cotton textiles. Assistance to the handloom sector also continued without interruption. The manufacture of synthetic textiles was reserved for the private sector.

As a result of the government's initiative in the textile industry, there was a major increase in the number of looms installed, from 794 at the end of 1957 to 8029 by the end of 1977. Domestic production of textiles, which was approximately 1.54×10^7 yards (1.41×10^7 m) in 1957, increased to 1.164×10^8 yards (1.064×10^8 m) in 1977, and the share of domestic production in the local market registered a corresponding increase from 11.7–57.6% during this period.

With the drastic curtailment of imports after 1960, there was a ready market for both cotton and synthetic textiles in Sri Lanka. Although the manufacture of cotton textiles was reserved for the public sector, there was a profitable investment opportunity for the private sector in the synthetic textile industry. A ready market and liberal incentives for investment in the industry provided the impetus for a number of local entrepreneurs to establish synthetic textile mills. One such entrepreneur was already in the cotton textile manufacturing business. Four others, who were also pioneers in this field, were engaged in various trading activities: two of them in the textile trade itself.

The first five synthetic textile mills established in the early 1960s were large-scale units with facilities for printing and finishing. They were dependent upon imported technology for their establishment and operation. The package of imports was not uniform; it varied from a virtual turnkey project to a carefully selected list of items. Machinery in all cases was imported and with it a certain number of expatriate technical and managerial personnel. A number of these units recruited some of their skilled workers and most of their supervisory and managerial personnel from public sector cotton textile mills.

The success of the pioneering units attracted other investors and there was rapid growth in the synthetic textile manufacturing industry. Altogether, 10 synthetic textile mills came into existence between 1961 and 1965. Thirteen more mills were established during the next 5 years and two others since that time. Synthetic textile production, which was about 1.4×10^7 yards (1.28×10^7 m) in 1972, increased to about 2.0×10^7 yards (1.83×10^7 m) by 1978, which is approximately 16% of the total textile production and about 10% of the share of the total market.

The synthetic textile industry continues to be dominated by five large firms, which account for nearly 70% of the total output. Three of them are joint ventures with Japanese participation and two others with Indian participation. All other firms are locally owned. With the exception of two government-acquired undertakings (from the private sector) all other synthetic textile mills are privately owned.

The total work force employed in the synthetic textile industry is estimated to be about 5000. Over the years, there has been a great deal of diffusion of technology between the various units within the synthetic textiles sector as well as between this sector and the cotton textiles and ready-made garments sectors. The larger units, which employed qualified and experienced engineers and technologists, are now in a position to undertake major expansion or new mill projects without any foreign expertise. However, they are all dependent upon imported machinery.

Up until 1977, a protected market and repetitive operations enabled the synthetic textile factories to earn high levels of profits. With the liberalization of imports since that time, however, the industry is facing severe competition. Although the larger units, with their trained and experienced technologists, are able to innovate and bring out new products to compete with imports, the smaller units are being driven to the wall.

Methodology and Findings

In these case studies, the entire process of initiation and implementation of each major project in each of the four industries was first disaggregated into the generally recognized stages of feasibility study; engineering; procurement of plant and machinery; construction of buildings and structures; installation, testing, and commissioning of plant and machinery; operation of the enterprise; and subsequent development and expansion. Thereafter, the technology packages involved in each of these stages of initiation and implementation were identified and an attempt was made to determine the processes by which the transfer, absorption, diffusion, and assimilation took place.

Certain common features characterize three of the four industries that have been studied: they began in the 1940s; underwent expansion of capacity by replication at their original locations as well as at locations elsewhere, each expansion program constituting a well-defined major project; were dependent upon a wide range of imported technologies and techniques of pro-

duction with respect to the processes of manufacture, design, fabrication and installation of machinery, and management of production; and the ownership of each industry now rests with a single organization.

The studies focus on the human being as the principal medium for the transfer, absorption, diffusion, and accumulation of knowledge underlying imported technologies and techniques of production. It is the buildup of this human capital within the enterprise that enables the accumulation of technology within that enterprise, which in turn dispenses with or at least minimizes the need for repeated imports of the same technologies. It was found that it is the absorption and subsequent diffusion of these technologies from the individual enterprises, where the transfer first takes place, to other enterprises in related fields in the rest of the economy that enhances the scientific and technological infrastructure of a country. This technological spread and accumulation, in turn, enables the country as a whole to generate its own technologies and techniques of production on a self-sustained basis. The main indicator of the effectiveness of the transfer of technology, therefore, is the buildup of the trained and experienced technological, scientific, and managerial manpower resources of a country, on the one hand, and the entire cluster of manufacturing enterprises, consultancy firms, research and design organizations, and scientific and technical educational and training institutions, on the other.

One of the preconditions for the effective transfer of technology is that, before importing of a package of technologies and techniques of production, it is essential to assemble a group of persons adequate in numbers and with the entire spectrum of skills needed to absorb the knowledge underlying the imported technologies and techniques of production. This becomes possible only if there are within the country universities, technical colleges, and training institutions releasing to the economy a steady stream of engineers, scientists, supervisory and managerial personnel, and skilled workers. In Sri Lanka, it was only toward the latter half of the 1950s that skilled manpower needs for industry were met — and even then, not always fully — from indigenous sources. This was a major handicap faced during the earlier period by all four industries that have been studied. Consequently, they depended upon the services of several expatriate personnel whose experience gained on the job was lost to the country.

Knowledge can be absorbed only in small increments at any stage. If the recipients have some background knowledge — at least at the elementary level — of the technologies involved, absorption becomes easier. This was quite evident from the long time period required to bring the first pulp and paper and cement mills to their rated capacity levels and the shorter time intervals during which the expansion schemes were commissioned and production was again raised to capacity levels.

When there is already technological accumulation within an enterprise, subsequent absorption of related newer technologies becomes easier. This was evident in the case studies.

Absorption is heightened in the "learning-by-doing" process, i.e., by the active involvement of local personnel in all aspects of the work: feasibility studies, engineering, procurement of plant and machinery, installation, and initial operation. Involvement in solving initial setbacks, troubleshooting or problem solving, and research and development activities also heighten the learning and innovation processes.

Better opportunities for absorption of technology and its internalization exist in a large-scale enterprise involved in the entire range of operations from the procurement and processing of raw materials to the manufacture and sale of finished products. In such an enterprise, the knowledge structure is integrated and not piecemeal. Moreover, it is only a large-scale enterprise that can afford to provide adequate technical staff and research facilities for further development of technology.

Continuity of employment, particularly at managerial, technical, and skilled operative levels, strengthens the process of technological accumulation and its internalization within an enterprise and conversely, the external pulls — brain drain and piracy — militate against technological accumulation.

A well-conceived policy of self-reliance at the national level and effective programs at the enterprise level promote the absorption of technology, whereas indiscriminate dependence upon foreign aid and credits tied to technology packages are detrimental to the absorption process.

Assimilation

The existence of an extensive network of scientific and technological education and training facilities within a country is one of the essential prerequisites for the assimilation of imported techniques of production.

A capital goods sector and institutions devoted to the design of plant and machinery and research and development in the field of technology is

another major requirement for an effective process of assimilation.

An overall national policy on technology transfer and an information system relating to the country's technological capability, with special emphasis on its relevance to future industrial policy, should be developed and implemented for maximizing the assimilation process.

The foregoing findings are by no means new discoveries. Their value, however, lies in the fact that for the first time in Sri Lanka the establishment and growth of a few major industries have been sketched in detail, covering a period of about 30 years, and the processes of transfer, absorption, diffusion, and assimilation of technology have been subjected to a critical examination at the micro level. The study illustrates in practical terms, which policymakers at both plant and national levels can readily understand, the factors that facilitate and those that hinder the technology transfer processes. The framework developed in this study could also be refined further and utilized in the future to set standards — in quantitative terms — against which an evaluation of the effectiveness of technology transfer in any new industry or expansion program could be carried out.

Follow-Up Work

In view of the major importance of technology transfer, most countries have developed comprehensive policies on technology transfer and effective organizations for their implementation. Although Sri Lanka does not have an official policy devoted exclusively to technology transfer, the country's industrial and foreign investment policy statements make reference to technology transfer. As a follow-up to this study, it is proposed to trace the relationship between industrial policy and technology transfer.

This would require an analysis of the evolution of industrial policy in Sri Lanka since the 1930s, the development of the scientific and technological infrastructure within the country, and the transfer of technology in selected critical areas. The findings of such a research program would be of value in the formulation of policies for industrial development and technology transfer and for evolving an organization for the collection and dissemination of information on the technological capability of the country.

Comments: Quazi H. Ahmed

The Marga Institute has investigated the absorption and diffusion of imported technology in four industries in Sri Lanka. The industries are: (1) synthetic textiles, (2) paper and pulp, (3) glass, and (4) cement. All of the reports contain good accounts of the historical development of these industries. The reports also contain some information about changes in government policy from time to time and their impact upon the performance of the industries. The researchers have discussed the various issues of absorption and diffusion of technology for all of the industries.

The summary report, which has been prepared for this workshop, does not contain a "summary" of the four studies. It really does not reflect the contents of the reports mentioned above.

In all of the reports, "length of stay of the foreign expert in the mills" has been used as the only indicator of assimilation. In my opinion this is not sufficient and a few more appropriate indicators should be chosen to assess the degree of assimilation more reliably.

In discussing the absorption and diffusion of technology, an attempt has been made to decompose the skills and expertise required for this purpose. Based upon these decomposed factors, the degree of absorption and diffusion that has taken place within the respective industries has been assessed. In my opinion this is an approach that may be followed even though quantitative figures are absent. However, it is felt that there is scope for improving the organization and presentation of the material in this section.

By reading all four reports, one can observe some similarities and differences in the processes of absorption and diffusion. It is felt that it would be very useful if this section could be synthesized into tabular form for close observation and comparative analysis.

It is also observed that there is some scope for further analysis of the data presented in different sections of all of the reports.

With respect to the pulp and paper industry, one can observe that Sri Lanka is still importing the same kinds of investment-related services that it first imported during the early 1950s. It would be beneficial to elaborate on the reasons for such dependence.