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Background paper

Progressive Industrial Technology for Developing Countries

Prepared by the International Labour Office

Presented by the Executive Director
of the United Nations Industrial Development Organization

Contents

Introduction

1. The "technology" of an industry, for the purposes of this paper, means the processes, plant, machinery, equipment and tools used in that industry. There are some industries in which, for practical reasons, there is little choice of technology, or in which the superiority of one technology over all alternatives is so great that it remains superior throughout the whole range of variations in the size of markets, in wage rates and in interest rates prevailing in the world. Such a state of affairs, however, is exceptional. In most branches of industry, there is a range of choice of technology; even where this is not true of certain central production processes, it is usually true of a wide range of ancillary processes, such as materials-handling, internal transport and packaging.

2. Those concerned with the industrialization of developing countries - private industrialists, the directors or managers of public industrial establishments and officials in ministries of economic development, planning, industry or finance who guide industrial development by issuing or withholding licences, permits or loans - are anxious to choose or encourage the choice of the technology most suited to the needs of the country concerned. In the first part of this paper, certain considerations affecting the choice of industrial technology are discussed; sources of appropriate technology and ways of increasing its availability are considered in the second part; and in the final section, measures that can be taken to promote the introduction of progressive technology through action on the part of industrialists, Governments and international organizations are examined.

I. SOME FACTORS AFFECTING THE CHOICE OF INDUSTRIAL TECHNOLOGY

3. There has been much controversy over the relative merits of "capital-intensive" and "labour-intensive" technology in developing countries. On the one hand, it may be felt :

(a) That the building up of an industrial sector employing the most modern and advanced technology is the hallmark of an economically developed country, and of a country determined to take its place as rapidly as possible among the developed countries.

(b) That it is necessary to invest with the future in mind, and that machines and equipment, not of the latest design will rapidly become obsolete.

(c) That advanced technology exposes all who come in contact with it to the forces of change and development, thus exerting a pervasive influence on the ways of life throughout the society and, in particular, enabling managements and workers to acquire the technical skill and knowledge that are indispensable to a modern economy.

(d) That industries with the greatest growth potential are those employing advanced technology.

(e) That a high degree of capital intensity permits large profits to be made and a large proportion of these profits to be ploughed back to promote faster growth.

4. On the other hand, it may be felt:

(a) That advanced industrial technology has delevoped in response to the needs, and is designed to operate under the conditions, of industrially advanced countries with large markets, a relative abundance of capital and entrepreneurial and managerial skills, and a shortage of labour.

(b) That transplanting industrial technology to countries where it will operate under conditions for which it was not designed can be an expensive mistake.

(c) That countries should not seek to make a sudden, sharp break with their past, but should build on the existing foundations, thus developing and adapting traditional skills, knowledge and techniques.

(d) That where capital is scarce, capital-intensive technology means concentrating it in a few large plants while keeping the rest of the economy starved of capital, and that this accentuates the

dualism characteristic of developing economies and societies, sharpening the contrast in living standards, opportunities and outlook between the modern and the traditional sectors and limiting the number which can be absorbed into the modern sector and exposed to its modernizing influnces.

(e) That is, indeed, capital-intensive technology does enable a few large, modern plants to make big profits, this does not mean that the total profits, both public and private, for the economy as a whole are necessarily greater. Nor is it necessarily the case that more resources will be invested than if capital had been spread widely.

5. These arguments cannot be examined in detail in this paper, but comments will be made on some of them. 1/

6. It is sometimes thought that anyone who advocates the selection of labour-intensive products and methods in developing countries is trying to "fob them off" with something inferior. Indeed, it is quite likely that industrial processes in the future will come to be carried out increasingly by machines rather than by men. When one considers the comparative advantages of men and machines, most of the advantages in industrial processes seem to lie with machines. 2/ Where fabrication is concerned, men can shape and combine materials with simple hand tools by such actions as cutting, striking, twisting, rubbing and stirring. However, men cannot attain great speed or great precision, and they can work only within certain temperature ranges and in the absence of poisonous fumes. Machines can perform all of these jobs and more; they can also do the work with greater speed and precision, under various conditions. With respect to transport, men can move limited weights rather slowly for rather short distances; machines can move heavy weights speedily for long distances. As far as control is concerned, men can look, listen, feel, smell and taste.

1/ The arguments are reviewed in "Some Problems of Investment Policy in Under-developed Countries", International Labour Review, vol. LXXVII, No.5, May 1958. (The arguments have not changed much in the years since that publication.)

2/ The points in the following passage have been made by P. Strassmann in Technological Change and Economic Development (forthcoming), Cornell University Press, Ithaca, N.Y.

Their speed and accuracy, however, is limited. Men do not respond directly to changes in voltage, humidity or chemical states. Machines do all of these things. Men still have an advantage over machines in the field of analysis - breaking down information into components for selective recombination with other data. And human beings have a monopoly in connexion with personal services - in situations where the impact of one personality on another is important. In industry, types of work other than those just cited seem likely to pass increasingly into the hands of machines.

7. This has not, however, happened yet even in the developed countries. The transition to more or less complete automation of industry, if it ever comes to pass, may take several generations. During the transition period, it is reasonable and necessary, in selecting industrial products and processes, to take account of differences between countries in factor proportions, factor prices and size of markets.

8. This suggests that countries in which capital is scarce and expensive and labour cheap and abundant, would do well, in planning their industrial development, to look for ways of using more labour and less capital. This is not a matter of being content with inferior, old-fashioned ways of doing things. It is rather a matter of making use of the assets of abundant cheap labour which developed countries do not have, an asset which gives developing countries an advantage or a potential advantage in many lines of production. It seems likely that the least-cost combination of labour and capital in an industrial process in a developing country will often be one which provides more employment per unit of output than the least-cost combination for the corresponding process in a developed country. This is especially likely to be the case if the developing country has a comparatively small market - and, of course, the size of a market depends not so much on the size of a population as on its purchasing power.

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9. Interesting work on the optimum combination of labour and capital at different interest rates and wage rates has been carried out by the Netherlands Economic Institute.3/ Among these studies, there are three which compare:

(a) Hand files with small electric grinders;

(b) Centre, turret and automatic lathes; and

(c) Production of window frames with planing and moulding or tenoning processes.

10. The choice of a process depends both on the relation between wage rates and interest rates and on the size of the market, which determines the length of the production runs. With short production runs, it is profitable even for developed countries with a high ratio of wages to interest to use the most labour-intensive methods. In developing countries with a low ratio of wages to interest, the most labour-intensive methods will be the cheapest except in cases where there is a volume of production substantially greater (from 1.7 to 15 times greater in the above-mentioned studies) than in the developed countries.

11. The full strength of the case for using abundant labour where possible to save scarce capital in developing countries may, however, not be reflected in comparative cost figures alone. Often the costs of leaving human resources idle are not brought into, or are not accurately reflected in, the calculations of planners. A pricing system will promote economically rational decisions if, but only if, money costs accurately measure real costs, so that what an employer has to pay to employ labour, or to borrow capital, reflects its true scarcity or abundance.

3/ See a series of reports on Alternative Techniques of Production, (Rotterdam).

12. It is clear that money costs and prices in developing countries often do not accurately reflect real costs. In particular, capital frequently appears cheaper than it really is (finance may be made available from public sources or with a government guarantee for some types of investment in the modern sector at rates of interest lower than would have had to be paid in an open market) while labour often appears more costly than it really is. (The real cost of employing a hitherto unemployed or greatly underemployed worker, in the sense of the production foregone by withdrawing him from what he was previously doing, may be almost nil.) 4/ In addition, the cost of foreign exchange often appears less than it really is. (If countries have over-valued currencies, but do not want to devalue, foreign exchange has to be rationed and is allotted to successful applicants at a price below what they would have been willing to pay rather than go without.) These cost distortions make it rational for private enterprise, and the managers of public enterprises insofar as they think primarily in terms of maximising the profits or returns of their own undertakings, to choose a product-mix and a type of technology that use more capital and foreign exchange and less labour than would be in the best interests of the country as a whole. This has led to the suggestion that Governments, for planning purposes, should use not market prices but rather "shadow prices", reflecting the best estimates they can make of the real costs of different resources from the social point of view; and that Governments might also wish, through appropiate fiscal measures, to give inducements to private enterprise to act as though capital and foreign exchange were dearer and labour cheaper than the market prices actually prevailing. 5/

4/ For details on this subject, see another paper prepared by the International Labour Office, entitled "Employment Aspects of Industrialization", especially paragraph 26 (document ID/CONF. 1/B.18).

5/ Cf. "Employment Aspects of Industrialisation", loc. cit. para. 29 (f).

13. The case for making sure of the employment of all the labour that can be economically employed in the industrial and other sectors is strengthened by the human and social costs of unemployment and under-employment, which have been stressed in the ILO paper on "Employment Aspects of Industrialization". This would mean, as suggested in that paper, that it would contribute to the general economic and social welfare if private enterprise, and Governments, both in their own operations and in their policy towards private enterprise, attached more weight than at present to employment considerations when they take or guide decisions regarding the choice of industrial technology. This does not mean, of course, that labour-intensive technology should always be preferred to capital-intensive technology. The following fourfold classification may be helpful as a guide to policy. Industrial and other projects may be grouped in principle in four categories:

(a) Category A projects: These are projects in which labour-intensive, capital-saving technology, with existing methods and prices, yields money economies in production. In all such projects, there is a clear case for choosing labour-intensive technology; the selection of capital-intensive technology for non-economic reasons, such as prestige, would involve an evident misuse of resources.

(b) Category B projects: These are the projects in which labour-intensive techniques, when used carelessly or in traditional fashion or without adequate supervision, involve rather higher money costs than would more capital-intensive techniques, but in which at the same time there are opportunities (through better management, work study, better design of simple tools etc.) to adapt labour-intensive techniques in order to produce at equal or lower cost than with more capital-intensive techniques. There is a clear case for doing all that can be done at reasonable costs to change category B projects into category A projects and then to carry them out by labour-intensive methods.

(c) Category C projects: Even when all feasible measures to improve the efficiency of labour-intensive techniques have been taken, these are projects in which the techniques will still involve higher money costs of production than would more capital-intensive methods, but not higher real costs (i.e. they would be cheaper if shadow prices, accurately reflecting real costs, could be used instead of market prices). The simplest way of counteracting the cost distortion would probably be to raise interest rates, or at least to make sure that finance is not available on subsidized terms. 6/ It might also be possible to operate something in the nature of a negative employment tax or a subsidy for the employment of labour though this would present obvious possibilities of abuse, making such a system difficult for developing countries to administer, and Governments would have to decide where the money was to come from. 7/

(d) Category D projects: The difference between Category D and Category C projects is that the cost differential in favour of advanced technology is greater than the cost distortion produced by the use of market prices instead of shadow prices. On economic grounds there is no case for using anything but capital-intensive technology in Category D projects. A question may arise as to whether a country in which capital is very scarce should have any projects of this kind, but a certain number of such projects, even in very primitive economics, may be conducive to economic and social welfare, for example, by permitting the exploitation of natural resources such as oil or deep-level minerals accessible only by capital-intensive methods.

This classification in four categories may seem to be somewhat theoretical and schematic, but an attempt to classify industrial and other projects included or competing for inclusion in a development plan in these categories, and to treat them accordingly may well be useful for planners, private as well as public.

6/ This is not to suggest that Governments should pay a higher rate of interest on funds they borrow from advanced countries or through international agencies, but rather that if they lend such funds to private enterprise, they might maintain a profitable margin between their borrowing rates and their lending rates, while if they use such funds in the public sector, they might for planning purposes use a shadow rate of interest. It is recognized that raising interest rates on loans to private industrialists might conflict, or appear to conflict, with a policy of encouraging rapid industrial development; but funds no longer used to subsidize the capital costs of certain industrialists could be used to promote industrial development in other ways.

7/ See also some suggestions in ILO Employment Objectives in Economic Development, Geneva, 1961, page 72.

14. A country that chooses to confine highly capital-intensive technology to category D projects may thereby save much capital, which can be used to provide more jobs and/or to raise the productivity of labour in A, B and C category projects. This could result in a more even spread of capital throughout the economy and a progressive adaptation of technology to growing markets, knowledge, skill and availability of capital - hence, the use of the word "progressive" in the title of this paper.

15. The following are examples drawn from the experience of ILO in management development and small-scale industry, of cases in which the transplanting of advanced industrial technology to conditions for which it was not designed does not seem to have given good results.

(a) Plastic shoe manufacture

One country imported two plastic injection moulding machines costing $100,000 with the moulds. Working three shifts, and with a total labour force of 40 workers, they produced 1.5 million pairs of plastic sandals and shoes per year. At $2 per pair, these were a better value than the leather footwear at the same price. But it is doubtful whether the country as a whole benefited. The result has been that 5,000 artisan shoe makers have lost their livelihood and the markets for the suppliers and tanners of leather, hand tools, cotton thread, tacks, glues, wax and polish, eyelets, fabric linings, laces, wooden lasts and cardboard boxes have been reduced, since none of these is required for plastic footwear. As all the machinery and the material (P.V.C.) has to be imported, while the leather footwear was based almost wholly on indigenous materials and industries, the net result has been a decline in employment and in real income within the country.

(b) Ceramic plant

A ceramic factory making floor and wall tiles previously imported its hand-operated presses. As a result of close co-operation with local small engineering workshops, it was able to have replacement presses made locally, using castings moulded from scrap metal in small foundries and machined on general-purpose lathes and drilling machines. The tiles themselves were made from indigenous clay deposits, and fired in kilns composed mostly of local refractory bricks. Thus, output, income and employment were stimulated in a number of other industries and trades, e.g. scrap metal, foundry, carbon, refractory, engineering, quarrying.

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This multiplier effect was just beginning to make itself felt when it was decided to build a modern large-scale ceramic plant in place of the existing one, with fully automatic presses, continuous tunnel kilns etc. This equipment required special steels and engineering skills, refractories with a high aluminium oxide content and technical know-how, which were not available locally (and were not likely to be for many years). Therefore, they had to be imported. Because of the high speed of operation, very malleable clays were required and these also had to be imported. In the end, the consumer received a poorer quality, dearer product because the breakage rate was higher as result of: (a) inadequate temperature control in the tunnel kilns (technological inexperience); (b) clumsy handling during glazing operations (inadequate supervision in the new factory). Employment and net output declined in the ceramic and allied industries listed above and the country's trading deficit widened.

(c) Tanning industry

A tanning industry project in one country envisaged building a small model tannery to act as a training centre and to demonstrate new techniques, together with a number of new buildings to rehouse existing tanneries, thus improving working conditions and separating the industry (with its obnoxious smells) from the living quarters. The total capital costs were projected as $2.5 million for an output of $15 million per annum (a high capital productivity). The buildings and some of the machinery could be made locally, so the import content was small. Demand for leather was growing at 5 per cent per annum and labour productivity was expected to rise at this rate as result of improved methods and conditions; thus, the total labour force in the industry of 3,000 would remain the same.

This project was rejected on the ground that it was not modern enough. In its place was substituted a scheme for a large government-owned tannery estate, costing $15 million, equipped with the latest imported machinery and with a total capacity 50 per cent in excess of the existing firms. Labour productivity would be doubled, but the savings in wages would be more than offset by higher capital (interest and depreciation) costs if a shadow interest rate were used. The productivity of the capital employed would only be 25 per cent of the anticipated level in the first project. Employment in the industry would be halved, the existing equipment made obsolete and the import bill increased by more than $8 million. The present firms would be broken up and experienced owners made redundant. Little improvement in quality could be expected because further foreign exchange to buy better hides and tanning materials (this and technical know-how were the primary determinants of quality) could not be afforded. In international terms, they would end up, not with the most up-to-date process, but with an expensive "white elephant", because heavy sole leather and even some upper leathers were being replaced rapidly in world markets by synthetic materials.

The more modest scheme was not only more appropriate for the particular internal circumstances of this country, but also gave it greater flexibility to take advantage of world technological developments when it had the necessary resources (e.g. a petrochemical industry).

16. Finally, two examples may be given of the successful use of technology in industrial projects (in one case, advanced technology) well adapted to the needs and conditions prevailing in the developing countries concerned.

(a) Manufacture of sewing machines

An Asian country which had formerly imported sewing machines decided to promote its own sewing machine industry. A nucleus already existed in small workshops manufacturing replacement parts for imported models. Profiting from the temporary protection afforded by import restrictions, local entrepreneurial initiative quickly appeared to co-ordinate and expand the activities of these specialized workshops and to set up assembly units. In a few years the industry, equipped with general-purpose lathes and drills, was turning out models at 60 per cent of the price of previous imports. The local sewing machines had a more limited range of operations, and were less accurate, but because of their lower price, they had opened up a new market among small-scale clothing and footwear establishments, thus increasing their efficiency. By 1966, import restrictions could be relaxed and the industry was strong enough to have established a thriving export trade to neighbouring countries.

(b) Fibre board plant

A fibre board plant was set up in an African country. This cost $2 million and employed only 120 workers directly, because the higher pressures and great bulk involved required very heavy machinery. However, it processed the residue of sugar-cane and maize stalks that would otherwise have gone to waste. Thus the value added during the process was high and it provided additional incomes to the farmers. The finished product was a good, cheap substitute for certain kinds of wood for furniture and housing. This wood had previously been imported, so foreign currency was also saved. This project therefore served the national interest in several respects.

II. SOURCES OF APPROPRIATE TECHNOLOGY AND WAYS OF INCREASING ITS AVAILABILITY

17. Various economic and social objectives of technical progress have been indicated, and some general guidelines have been suggested which might be borne in mind by those who frame economic policy affecting public and private investment decisions. The problem does not cease there. The optimum choice of technology can only be made if a full range of alternatives is available. Unsuitable

techniques are often applied because there is nothing else on the market except machinery which has been designed to meet other needs. The full spectrum of scientific and technical knowledge must be brought to bear. The brand new, the present-day and the past are all potential sources which should be tapped. Some sources are examined below in more detail and some ideas put forward as to how their yield can be increased by international action.

New designs

18. The most effective means of overcoming economic underdevelopment would be to apply accumulated scientific knowledge to solution of the particular problems of the developing countries. There is undoubtedly a great need for original designs which will incorporate recent inventions but will at the same time take account of the scarcity of capital and of certain managerial and operative skills in the developing world. Innovation is required so that local raw material can be substituted in certain processes for the different types which are imported at present. Varying climatic conditions may require new solutions to familiar problems. Working parties have been formed in India and the United Kingdom to undertake this research and the United Nations Advisory Committee on Science and Technology is keenly interested in the problems of adaptation of designs and methods. Much valuable pioneer work has been done by specialist institutes such as the Tropical Products Research Institute in London.

19. Technological research institutes are now being set up in some countries with assistance from the Special Fund component of the United Nations Development Programme. The ILO technical training and development centre in Turin, Italy, is expected to contribute in this field, as have the productivity centres and small industry institutes which the ILO is assisting in various parts of the world. But only the surface of the problem is being scratched. More research of this kind is urgently needed; preferably within the developing countries themselves so that the research would be based on first-hand knowledge of the local

situation. Techniques on which further research is needed include:

(a) Capturing the heat of the sun by means of reflecting mirrors to distil fresh water from salt water, and to serve as an energy source for industrial purposes.

(b) The processing of date-palm fibres to replace wool and hair in upholstery stuffing.

(c) The extraction of creosote and charcoal from the husks and shells of coconuts, and of biological insecticides from coconut oil.

Modern technologies

20. As emphasized previously, modern technology has a role to play. Not to use such techniques at all would be as wasteful as to use them indiscriminately. What types are likely to pass through the screening that has been proposed? Four main groups can be distinguished. The first consists of technical know-how with little or no capital element. Improved ways of making or growing things as a result of deeper understanding of the chemical, physical and biological properties of products and materials fall into this category. The more quickly this knowledge is incorporated into current practice the better, and extension services and demonstration units have vital roles to play in this dissemination of knowledge. There appear to be no major economic obstacles to this effort, though social resistance may be encountered.

21. The second group consists of technology where the tool element can be easily separated from the labour element. One particular process in a series of operations may have to be performed by a particular machine if consistent quality and precision in the final product are to be maintained. The ancillary operations could be carried out by hand methods if labour were abundant and cheap.

22. The third category covers machines which replace non-existent human skills, or skills which would be very expensive to develop through the provision of educational facilities.

23. The fourth category embraces those modern technologies which may be the only effective means of exploiting a country's physical resources, which would otherwise lie idle, and which form the basis of other indigneous industries.

An example might include the use of colour charts, penetrometers and triaxial compression testing machines for measuring the proportion of soil and clays, leading among others to the manufacture of improved ceramic products.

Long-established designs

24. There may still be very great scope for the use of equipment which has been superseded in industrially advanced countries because it is no longer economic under present conditions in such countries. Such equipment may, however, be employed profitably in the small industries and craft workshops which provide the bulk of consumer goods and services in developing countries. In the latter countries, the most primitive production methods still exist, even in countries with large modern industries. In some countries, the potter's wheel is still unkown. Wood-turning lathes are turned by hand with a bow. Bricks are fired in kilns which have to be dismantled after every firing. Many designs exist in industrially developed countries which are not to be found in catalogues and which may have to be dug out of the archives of patent offices and of long-established machinery manufacturers. Trade associations could carry out the work of sifting and collating such designs, with the help of United Nations or bilateral aid funds. The designs could be sent to research institutes in developing countries, which would disseminate the specifications and drawings to workshops and manufacturing firms and assist them with development.

25. Major international companies that are setting up subsidiaries in developing countries could contribute considerably to this effort. The Philips Electrical Group has shown the way by establishing, at Utrecht in the Netherlands, a pilot radio assembly plant for training future managers and technicians to man their overseas factories. In that plant, only simple and commonly available tools are used and the complete process is "packaged" for reproduction abroad. Some twenty countries are now producing radios using techniques developed at Utrecht.

26. The Intermediate Technology Development Group in the United Kingdom, formed in 1965, is gaining substantial support and has already provided assistance and advice to a number of countries in Africa, so far mainly in connexion with rural activities. It is currently producing an illustrated buyer's guide to British tools and equipment, entitled "Tools for Progress", which lists thirty-one categories of inexpensive equipment and tools under the main headings of agriculture; metal working and machine maintenance; power and water supply. Sub-headings include handicrafts and small-scale industries, and transport and handling.

27. The examples given above are indications of what may be appropriate "new" technologies to replace existing ones. These should be regarded as steps, and not platforms. In each industry, improved techniques should be introduced successively over the years so that productivity is raised progressively. Concrete examples of such processes and techniques are given below:

(a) Bakery industry: Steam pipe ovens which ensure an even dispersion of heat by means of coiled steam pipes; drawplate ovens in which the loading and unloading are speeded up by putting the plate of the oven on wheels and rollers; T-arm kneaders in which a single reciprocating arm kneads the dough in a rotating mixing bowl. This equipment is more advanced and efficient than bricklined, open-frame ovens and hand mixing, but is much less capital-intensive than turbo.radiant travelling ovens or continuous mixers.

(b) Ceramic industry: Hand-operated jiggers for forming plates, semi-automatic presses for tiles, gravity-fed extruders for pipes. These are all superior to traditional methods but less expensive than tunnel kilns and fully automatic equipment.

(c) Shoe industry: Simple sewing machines (first introduced in 1859) for stitching the sole to the upper and insole. This is quicker than hand stitching but may be more appropriate than vulcanising or injection moulding equipment for soling in some countries.

Second-hand machinery

28. Second-hand machinery is really a special case of the discussed above. Second-hand machinery is often less complex than present-day machinery, so that it is easier to operate and maintain where certain skills or experience are lacking. It is usually much cheaper than new equipment. Thus, a given investment fund may go further and the output in relation to the capital input will be high. Second-hand machinery can usually be adapted and reproduced more readily in the indigenous engineering industries. There seems to be little doubt that imported second-hand machinery would find a ready market and if selected judiciously, it could raise productivity and efficiency over a wide area.

29. Some of the widespread resistance to second-hand equipment stems from a fear of being saddled with worn-out, obsolete machines, as well as from a rejection of what seems to be "second-best". These inhibitions may weaken if it is realized that a large market exists in the most advanced countries for this surplus equipment. Indeed, in certain countries, the sale of second-hand equipment exceeds that of new. For example, while in

the United States "the dollar value of new metal-cutting and metal-forming machines sold exceeds that of the second-hand, the annual turnover in number of units sold is greater for the latter than for the former: the ratio is currently about 2:1". 8/ All in all, it would seem better to avoid abuse and disappointment by more rigorous inspection and by dealing only through reputable specialist import/export agencies in this field, rather than forego the potential advantages of second-hand plant altogether. An example of comparative costs when using a second-hand and a similar new machine tool is given below:

Table 1: Costs and output of alternative sole-stitching machines

	Second-hand model	New model
Price	$1,000	$5,000
Depreciation period	5 years	10 years
Interest rate on loans	15 per cent	15 per cent
Yearly output	50,000 pairs	70,000 pairs
Number of operatives	1	1
Annual wage cost	$500	$500
Fuel and power costs	$50	$50
Light and floor space and insurance	$50	$50
Repairs and maintenance	$75	$100 a/

a/ Servicing costs are higher for the new model because foreign engineers and spare parts are required, whereas the older, simple machine can be repaired by local personnel.

8/ United Nations. Centre for Industrial Development. Report of Expert Group on Second-hand Equipment for Developing Countries, 7-22 December 1965, New York, p. 5. 1966. (Sales No: 66.II.B.9).

Table 2: Analysis of direct labour, fuel and capital costs

	Second-hand model	New model
	$	$
Depreciation and interest	275	875
Fuel	50	50
Light, floor space etc.	50	50
Servicing	75	100
Labour costs	500	500
Total	950	1,575
Cost per pair	$0.0190	$0.0225

This example is based on actual costs which have been rounded off for simplicity. Thus, despite the fact that the new sole-stitching machine has a 40 per cent greater productivity and double the anticipated working life of the older model, its cost per pair is 18 per cent higher. The reason for this is that capital costs are high and wages low. In this exercise, material costs are assumed to be constant.

III. MEASURES TO PROMOTE THE EFFECTIVE INTRODUCTION OF PROGRESSIVE TECHNOLOGY

30. This final section is concerned with measures which can be taken by industrialists, Governments and international organizations to ensure an optimum selection.

Industrialists and employers' organizations

31. Many industrialists in developing countries and elsewhere have set up industries without having had previous industrial experience and without formal management knowledge. Except in the most advanced companies, costing and accounting systems rarely are sufficiently developed to provide accurate cost breakdowns on which the economic performance of existing or proposed investments can be judged. Many industrialists, who also lack technical knowledge and information about alternative processes or plant, buy their equipment on recommendation of machinery manufacturers or their salesmen, who may not be concerned to ensure that it is the most suitable equipment for the conditions in which it will operate. As a result, these industrialists may find themselves saddled with a plant that is uneconomic, even from the point of view of the firm. This may also happen in the case of public undertakings.

32. It is therefore in the interests of industrialists themselves to ensure that:

(a) They fully understand the conditions in which they have to operate, including the relative costs of the factors of production. This is best ensured by sound management development and training at all levels.

(b) They obtain full information on the choice of processes and plant available to them and expert advice on its selection.

Employers' organizations and trade associations might set up documentation centres to provide technical information likely to be of interest to their members, and might arrange for the provision of expert services, to be paid for by the users when major purchases are involved.2/

2/ In Iran, the Industrial Management Institute supplies experts to accompany industrialists going abroad to purchase plant and machinery. Substantial savings have been effected in this way. See ILO: Regional Seminar on Marketing, Employment and Management Problems of Industrialisation in Countries of the Near and Middle East and North Africa - Conclusions and Papers. Management Development Series No. 2, Geneva, 1965.

Governments

33. It has been stated earlier that it lies in the hands of those responsible for economic planning to ensure that the real social costs of investment decisions are known and understood. Training courses for planners, in feasibility studies and cost/benefit analysis techniques to increase the rationality of investment decisions, are being provided by the United Nations Industrial Development Organization (UNIDO). It must also be ensured, by legislative, fiscal and other measures, that those responsible have the means of enforcing decisions which are in the broad national interest. Measures might include:

(a) The formulation and publication of industrialization policy statements.

(b) Higher official interest rates on capital investment to raise the price of capital vis-a-vis labour costs. This would tend to bring more labour into productive employment and increase the propensity to save.10/

(c) Measures to ensure that importers have to pay the real cost of foreign machinery and materials and that a proper evaluation is made in feasibility studies.

(d) State-financed hire purchase and rental schemes with lower interest rates for locally made equipment and imported second-hand machinery.

(e) Encouragement of the setting up or expansion of indigenous machine building industries, initially to provide capital equipment of a simple type which can later be developed and diversified into the manufacture of more advanced equipment. Associated with this might be rewards for local inventions and patent protection for adaptations of foreign designs.

(f) The formation of customs unions with other States at similar stages of development and with complementary resources.11/ These would encourage a new international division of labour and a competitive stimulus for efficiency, while avoiding one-sided encounters between rich and poor nations in the fields of international trade and technology.

10/ It is in no way suggested that Governments should pay a higher interest rate on loans from international or bilateral sources.

11/ See ILO: Baghdad Meeting Report, op. cit. Conclusions No. 52 - 55.

(g) The setting up of central documentation and information centres to keep track of past and current technical developments throughout the world, working in liaison with international and other national services.

(h) Subsidizing of research institutes attached to industry associations, especially for development of appropriate technologies.

(i) The provision of service institutes and common facility services, possibly on co-operative lines, for small industries and artisan workshops, which would provide extension services and technical training in the use of new equipment.

(j) The provision of vocational and technical education and training at all levels in conformity with the planned needs for manual, technical and managerial skills. Firms setting up their own training facilities might be given financial assistance.

Action by international organizations

34. A few developing countries have the resources to undertake the steps necessary to ensure the optimization of their industrial technology without assistance from outside. Several international agencies within the United Nations system are concerned with the provision of technical co-operation services in most of the fields mentioned above as being suitable for government action. Proposals for action will be confined to those directly concerned with the promotion of progressive technology:

(a) The setting up by UNIDO of a central documentation and information centre on industrial processes, plant and equipment, providing for each industry information on the range available to suit different conditions of operation and levels of industrial development. Advice on selection could be provided to government centres and industry associations. 12/

12/ See ILO: Baghdad Meeting Report, op. cit. Conclusion No. 69.

/...

(b) Assistance to industrial research institutes in the development of suitable processes and plant. UNIDO is already active in this field.

(c) Assistance in the establishment of service institutes, common facility services and co-operatives for small and artisan industries. The ILO is providing this kind of assistance.

(d) Assistance in vocational and technical education and training and management development. UNESCO and ILO are providing such assistance.

Conclusion

35. Whether action along the above lines will be taken depends in the final analysis on how convincing a case can be established for the arguments which have been advanced in this paper. Where they have been applied in the field, the results are promising. They appear to open up new avenues for a dynamic attack on poverty in the developing countries, in which the progressive and widespread introduction of new methods (new in comparison with the traditional ones) could lead to a better use of their current resources and so achieve a more rapid and sustained growth to be shared by the whole people.


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