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NEW INDUSTRIAL TECHNOLOGIES AND HUMAN RESOURCE DEVELOPMENT IN ASIA: SOME SELECTED ISSUES*

Prepared by the

Regional and Country Studies Branch

Division for Industrial Studies

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PREFACE

This paper has been prepared as a UNIDO contribution to the theme study of the Economic and Social Commission for Asia and the Pacific (ESCAP) for 1986 and 1987 on human resources development.

At the forty-second session of the Commission, to be held in Bangkok, 22 April to 2 May 1986, focus is to be given to the technological dimensions of human resources development. The present paper is to be presented at that session.

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1. THE CONTEXT

The ongoing process of industrial transformation in developing countries is accompanied by a corresponding change in skill requirements for this process. Human skills required at any one stage of industrial development in a country for planning, directing, promoting, operating and servicing industries will need to constantly be enhanced and adapted to enable the country's attainment of a higher degree of industrial development. Traditionally manpower planning in the 1960s and 1970s attempted to project requirement in terms of quantities of broad professional categories and could in many cases be based on trend developments and international comparative data. In most developing countries vast skill gaps existed in practically all professional categories relevant to manufacturing and human resource development for industry could thus be designed in an extensive form and on a very broad front pending, of course, availability of financial and institutional resources for training.

The recent world wide economic recession and the connected crisis in industry in the developing countries not only meant a break in past trends but also a revelation of the industrial production growth complexity and uncertainty of basic assumptions and parameters which were previously taken as stable and/or predictable.

A reassessment of the emerging industrial growth pattern, its driving forces, its preconditions and effects indicates that

- there is no automaticity in the industrial development and restructuring processes at the national and international levels;
- there is no clear growth pattern according to which developing countries can expect to autonomously move to a more or less defined next stage of industrial transformation;
- the skill content in manufacturing activities is undergoing significant changes due to rapid technology advancements and new forms of production organization;
- national policies in respect of industry, trade, labour and innovation have a significant impact on the competitive situation of companies both at national and international market.

Given these indications of new conditions for and new patterns of industrial development, the question of human resource development or skill creation and upgrading needs to be looked at in a way different from present methods of manpower planning.

First, human resource development is increasingly providing the competitive edge in industry. It needs to be seen as an investment in human capital complementary to the physical investment process.

Second, human resources for industrial development have to be seen not only in the narrow sense of resources in manufacturing companies but in the totality of the functions that are directly and indirectly concerned with industry such as

- research and development
- marketing including export marketing
- industrial and industry related services
- government policy making and planning
- engineering consultancy.

Third, manpower development has - like investment in physical assets - to be planned in advance and scrutinized as to the optimal efficiency of required inputs. This mean more targeted, economized training systems.

Fourth, skill creation is not a once-for-all investment. Drastically changing requirements call for re-training schemes and flexible curricula.

This means that human resource development has become an "economic activity" which constitutes an inherent part of any one industrial strategy and which needs to undergo the same scrutiny in terms of the precise type of skill development and the programme's benefits and costs as investment project formulation and evaluation.

Industrial strategies now being pursued in developing countries in Asia as in other developed and developing countries show an increasing reliance on the generation and application of new technologies. The issue of this note is to assess the implications of such strategic orientation of industry for the human resource development.

2. THE APPROACH

The introduction of new technologies in the developed market economies affects practically all productive sectors. Within that broad context this note focuses on a narrow subject viz. the impact of automation technologies on the conditions of competition in the manufacturing sector, including related services such as computer programming. In so doing the paper leaves aside new developments in biotechnology, new materials and other advances which are also greatly affecting industrial activity. The reasons for the choice are several. First, although information on the use and impact of automation changes is by no means adquate, it seems to be more amenable to quantitative analysis than are other areas of technological change, at least in the present state of knowledge. It is argued here that empirical evidence will be of the essence in assessing human resource requirements. Second, those technologies probably affect more the sectors of export interest to Asian countries than do the other technologies mentioned above. Third, they may also be the techniques which offer most opportunities, at least in the medium-term, for skilled Asians to develop themselves into successful producers and perhaps innovators.

The approach is to start from the possible impact of automation technology in the advanced countries on products and processes in their firms in terms of product quality, ease of switching output from one item to another, unit costs and marketing systems. The next step is to consider what these changes may mean for shares of Asian countries in the developed countries' markets. The third link in the chain of reasoning is to enquire what use Asian based enterprises might themselves make of these technologies in the competitive struggle. On this basis, the fourth phase is to consider possible effects on human resource use and capabilities.

Undoubdtedly this perspective has several difficulties and limitations. First, it is by no means clear just how quickly diffusion is taking place in the developed countries. Apart from the obvious point that appreciable variations most probably exist as between countries and industrial branches, there is the additional uncertainty relating to the impact on industrial concentration within the OECD member countries and what that might imply for competitivity there. Second, the technologies are themselves developing

quickly so even within the realm of the 'new', there are notable differences. Third, a priori reasoning would suggest that if one effect of new technology use is to be the recapture of domestic market shares by firms based in the industrial countries then that effect still has some way to go - were this not the case, the increased protectionism would be hard to understand. Fourth, this way of looking at things downplays possible impacts in other areas e.g. in non-export-oriented branches, in those activities where most Asian countries are primarily purchasers and not producers, and the possible creation of new industrial activities. Some reference is made to these areas in the following paragraphs, but it is only brief. The note is deliberately confined to a limited part of industrial activity only.

3. TECHNOLOGY CHALLENGES FOR ASIAN INDUSTRY

Asian countries are on the whole pursuing industrial strategies which are aimed at export markets in the OECD countries. Though a considerable part of that export has been associated with the activities of international firms in various countries of the region, there is nevertheless a sizeable proportion which emanates from locally controlled enterprises, whether public or private. In the developed market economies competition in practically all industrial product groups has become increasingly intense between companies based in the European and other industrialized regions and between these companies and Third World based producers. Predictions of continued economic growth of European countries at rather moderate levels indicate that these markets will not be expanding as in the past. A major way in which OECD firms are seeking to maintain market positions is through the employment of technological devices and whole new production systems which permit both cost savings for traditional products as well as the introduction of a greater range in products provided and tighter control over quality. Although the impact of such technologies remains, as of now, confined to a limited number of activities and industrial branches, there is a strong presumption that these developments will make substantial inroads into the competitive structure of developed country markets. As things now appear, the prospects of competing against production based on the new technologies through the use of current methods or minor modifications of them are not too promising. In other words, the situation which seems to be taking shape is one in which large segments of markets in which Asian countries have been obtaining export

earnings may come to be 'mono-technique', i.e. alternatives will be few. This, in turn, implies that Asian countries that wish to continue directing part of their output towards those markets will most probably have to start employing similar production processes themselves.

The argument just made has two aspects which should be underlined. First, the supposition that a range of alternative technologies (in the sense of different labour intensities etc.) is available may no longer be the case. Instead, exporting firms may gradually be forced to select technologies of the same vintage as the competitors in advanced countries. It will not, in many cases, be possible (even if it were desirable) to maintain a competitive position by reducing real wages in the export branches of industries since labour and the new machinery are not close substitutes. Second, the introduction of automation technology is, in these export-oriented branches, determined essentially by the demand requirements of markets in the OECD countries. The technologies were themselves introduced in part as a response to changing demand conditions and in particular to the prerogatives of industrial design and associated rapid shifts in production from one model to another - observations which are as true for engineering design in branches like automobiles, iron and steel and housing, as they are in consumer fashion products such as textiles and clothing. Consequently, although it is unlikely that developing countries would have concentrated on the particular technological changes made by firms based in the industrialized countries (whether in the automation business itself e.g. computer production, or in equipment supply firms e.g. braking systems for automobiles), those technologies are now beginning to demarcate the areas where developing countries will themselves have to introduce newer approaches.

The line of reasoning has thus proceeded from the premise that Asian developing countries intend to follow through their emphasis on directing exports to the markets of the OECD member countries and devoting appreciable shares of production to that purpose. From there, the next step has been to point out that competition in these markets is steadily becoming more and more influenced by automation technology which is changing both production processes and product qualities. It is argued that this competition from within the industrialized countries themselves cannot easily be met by modification to existing production methods in Asian countries; this is in

part because labour cannot manufacture some of the products with the same degree of precision as the new machinery, and in part because it would be a self defeating strategy to try and remain competitive through reducing real wages Under these circumstances the countries of the Asian region are more or less compelled to face the challenge of the new technologies and try to turn them to their advantage.

Undoubtedly, important segments of domestic industrial production in Asian developing countries are aimed at local consumption. To the extent that this production enjoys some natural protection, then those branches of the user industries may not have to employ the new technology so quickly. Even here, however, there may be potential for using the equipment in advantageous ways: the point is that the existence of a technology may represent as much an opportunity as a threat.

The remarks made in these paragraphs have concentrated on the impacts of the new technology on competition in user industries. At the moment this seems to be the appropriate focus for the majority of Asian developing countries. However, some of the industrially more advanced economies of the region e.g. India, the Republic of Korea, Singapore and Hong Kong, are or may soon be themselves in the position to produce some or many of the items made by the automation industry itself. It is, for instance, well known that India has begun to develop a flourishing business in the international sale of computer programming skills, this being an area where the availability of skilled people at internationally low wage levels does matter. Similarly, the production of some items in micro electronics has also been undertaken successfully by some of these countries.[1/] Where this situation is applicable, two possibilities may exist. First, domestic production of automation hardware and software may substitute imports and reduce foreign exchange outlays; this does not of itself alter the impacts on user industries though there may be some design changes which could be introduced to mesh more closely with local conditions. Second, if export opportunities could be generated, then of course the automation industry would itself provide additional foreign exchange and employment of quite skilled people.

1/ See e.g. "Small-scale electronics industry as subcontractor in Asia and the Pacific region" prepared by the Regional and Country Studies Branch, UNIDO (UNIDO/IS.549 of 7 August 1985).

The impacts in user industries and such possibilities as there may be to engage in local production of automation equipment do not exhaust the possibilities. There is an additional category of industrial activity which may be of considerable importance to Asian developing countries: it concerns those industries, of which the prime example is telecommunications, where the issue is not one of competing in international markets nor is there much prospect of local output except in the most advanced countries of the region. In this case the emphasis has to be on the elaboration of an effective purchasing policy. Mostly such purchases are undertaken by the public sector, either through government ministries or parastatal firms. Quite clearly a competence in at least selecting among alternative offers is required, and that in turn means that technical skills must be available. It is true that the transnational corporations (TNCs) which provide telecommunication systems normally sell a package which involves training of local staff. However, that training is provided only when the choice has been made and contracts are settled. The problem is for developing countries to establish a nucleus of project evaluation skills prior to any in-firm training. New technologies in automation are rapidly changing the nature of the telecommunication systems on offer and thus require some government investment in creating sufficiently skilled local project evaluation teams. Hence the human resource requirements do exist, but can probably be handled through relatively brief training of staff who are already qualified and experienced in electronic engineering and systems analysis.

4. THE IMPLICATIONS FOR SKILL FORMATION

The impact of new automation technologies on human resources thus arises first from their introduction of these technologies in the industrialized countries, and is felt primarily through changes in the patterns of international trade and investment. The second, and crucial, aspect is the extent and speed of diffusion of these technologies in the Asian region itself. The first question to pose in this context is whether or not these technologies should be freely imported. To the extent that some countries of the region may have domestic production capabilities in at least a few branches of automation, there may be arguments in favour of specific kinds of support for local producers and that support could include limitations on imports. The bigger question, nevertheless, concerns the import policy for

those countries the majority of which, in the foreseeable future, are unlikely to have any domestic production capabilities.

Potential demand in the region would seem to come from two main sources: industries including service activities which are part of automation itself, and those industrial branches whose production systems are being influenced by the new techniques. As noted above, the bias in areas such as telecommunications is certainly in the direction of purchasing the latest technologies. The reasons for this are not difficult to find. To begin with, the decisions on such matters as the renovation of telephone exchanges are made only at discrete intervals of several years while technology is changing fairly continuously. This means that obsolescence occurs more or less naturally; to purchase technologies which themselves are significantly behind the technological frontier at the time of purchase (and assuming, which is usually but not always the case, that such technologies are in fact available) would imply that the extent of technological gap would be still greater. This point acquires greater force when taken in conjunction with the next viz. that the current epoch is one where telecommunication systems are being drastically reorganized on a world scale. Given the immense value of up to the minute information and possibilities of international contact, the potential costs for export-oriented countries of staying out of the new global systems may be high. There is, moreover, a third reason why newer technologies may be preferred in this area. It is that the skill requirements for operating and maintaining such systems may not vary too much as function of the complexity of the equipment. More precisely, it seems likely that the core of electrical and electronic engineers needed will be much the same whatever the specific systems choice may be. Of course, the more complex equipment will require greater training but that would be undertaken with the same staff.

The conclusion from this line of reasoning is therefore that demand potential in the automation area itself is probably substantial, will often emanate from the public sector, and will require investment in training that normally will have to be financed by the state. The training requirements, nevertheless, are likely to be confined to a fairly limited group of technical staff which already has significant knowledge and may well have a good deal of experience. In the longer term, of course, the impact of these changes will affect the education system itself since university trained engineers must

learn the basics of the new technologies as part of their discipline. In the developed countries this impact has already been felt and indeed is not confined to university courses; pupils at secondary school stage (say between the ages of 12 to 18) are increasingly using small-scale computers in their studies. That type of impact is likely to come far more slowly in Asian countries simply because the costs of such training are prohibitive in situations where other education requirements have priority.

The obvious question to pose once it is accepted that training as described above is required is whether or not that training should be undertaken in the country itself. The alternative is to finance the further education of selected groups of students in developed countries; it is reported, for example, that 57 per cent of doctoral students in engineering fields at Stanford University (USA) come from abroad and that a considerable proportion of that number is Asian. The choice is not a simple one but the factors to take into consideration are well known i.e. the relative costs of domestic as against foreign training (taking into account foreign exchange expenditures), the quality of the training, and the risks of long-term brain drain of Asian students. It only requires emphasizing that this type of choice relates to the post graduate level as well as to the still more specific training for use of particular kinds of equipment mentioned earlier. In the medium- to long-term the alteration to university curricula within the region itself at the level of first degree will have to take place.

Demand potential in user industries is more difficult to assess. Following the approach sketched earlier, the initial hypothesis is that the demand will only be forthcoming when producers of e.g. textiles and clothing find their markets being eroded and conclude that the best way of meeting the competition is to employ the technologies coming into use in the developed countries. This hypothesis needs empirical information to ascertain whether or not the impacts are likely to come quickly, whether they are going to affect many exporting firms or not, and what the human resource requirements of a change in production methods are likely to be. This empirical task should certainly be on the agenda in the near future in those countries and for those industrial branches where the export markets are of major significance. As of now, it is possible only to set out some of the likely factors to keep in mind.

To begin with, the investment costs of a changeover in production methods can probably only be met by a limited number of enterprises. For the smaller firms it seems unlikely that substantial outlays on new equipment could be profitable and indeed these enterprises may well have been successful up till now through their ability to operate with low overheads and limited costs of labour. If this conjecture is correct, then these firms will come under severe pressure and several of them may in fact be forced to close down or be absorbed by other locally based companies. This would suggest a gradual increase in the degree of firm concentration in export-oriented branches and an increase in the average size of enterprise as measured by turnover (though not necessarily in terms of employment). Among the larger firms, a distinction may also be needed between those run by domestic capital and those which are affiliates of TNCs. The latter have usually been established to take advantage of relatively low real wages in the Asian countries; the technological changes are therefore operating against the rationale of that investment. The most dramatic response to the new conditions would obviously be for the TNC to close their affiliates and relocate the industrial activities concerned back to home countries. Tentative evidence on the clothing industry, which is obviously one of the branches most involved, suggests that this process of relocation is operating much more slowly than was perhaps suspected at the beginning of the 1980s. If this is the case, then the second possibility, i.e. that TNC affiliates themselves invest in the new technologies for their activities in Asia, has to be considered. So far there does not appear to be much information on this possibility. Certainly it could be true that labour cost saving even with the more limited use of labour would still make location in Asia the best decision. In this case it seems very plausible that the staff training would be conducted within the TNC system itself, probably by sending Asian staff to the production centres in the developed countries for limited periods of time.

The toughest issue to evaluate is the extent and speed of demand in the larger, locally-owned, enterprises. For them the probability of buying new technologies in order to maintain competitiveness seems higher than for the other two categories of firms. The reasons for this seem to be the following: first, they have more at stake in the sector and are probably better situated financially to meet new investment costs; second, they are generally interested in upgrading their technical capabilities (and hopefully reaching

the product design stage) and this will be difficult to achieve without intensive use of new technologies; and third, their prospects of obtaining bigger market shares may well be increased because of the pressures on local competing enterprises. In short, although the investments are a risk, the potential returns should be quite high. Under these circumstances the key point is: what will be the demand for human resources stemming from this type of enterprise and how is that demand likely to be met?

In the short- to medium-term (a time period that may vary according to the speed of technology diffusion among industrial branches) the chances are that these firms will try to have most of the training done through in-house and on the job activities. They will try to get equipment suppliers to take care of a good deal of the training and the rest will probably be done through learning within the firm or, at most, brief intensive technical courses conducted either at home or abroad. The point is that these firms may only have recourse to government training facilities after they have made full use of more industry specific and flexible options. Consequently the demand for public provision of training is only likely to become apparent at a later stage of the diffusion process.

The argument so far centres around the extent to which new technology is embodied in machines specific to a branch. Where this is so, then the arguments above may be a fair characterization of the human resource impacts. However, it is certainly the case that new technologies in the automation field possess a vital distinguishing feature viz. they tend to make production systems much more similar across industrial branches than they have been hitherto. Under these conditions, training for industrial activity that make use of the new technologies can clearly yield economies of scale in the sense that a general technical training can easily be adapted for use in specific industrial branches. This implies that sooner or later industry will obtain benefits in strict cost terms through participating in general training courses in the use of new technologies. The financing of such training could, of course, come both from industry associations and the public purse; the benefits for government would be those of supporting industry in its efforts to remain internationally competitive. Moreover, this type of training tends to maximize the mobility of semi-skilled and skilled staff and thus create more opportunities for dynamizing the industrial sector as a whole. This

point is especially relevant given the heavy emphasis in Asian industrial development towards the creation of ancillary industries and close networking of service and producing enterprises. For the most part the smaller firms which grow up to meet the needs of more complex industrial structures are created by people who previously acquire industrial experience through working in already established larger enterprises. It might be expected that this kind of pattern will be observed in relation to new technologies in the coming years.

5. EDUCATION PROFILES AND INDUSTRIAL OBJECTIVES

The perspective of this note is to work from the existing framework of industrial competition, beginning in the industrial countries as markets for Asian exports, and move back towards changes in production processes in the region and their probable effects on human resource requirements. This way of viewing the problem tends to downplay the role of formal training through the educational system. It also tends to place the Asian countries in the position of reactors and not controllers of the process. In the present circumstances of the international economy, that picture seems to correspond most closely to reality. But the expansion of Asian countries in the industrial sectors has been qualitative as well as quantitative during the past quarter century. Hence the analysis of impacts should take account of the changing competitive situation of Asian developing countries and in particular of their efforts to increase value added from the industrial activities they undertake. To put the point another way, the thrust of industrial policy in the more advanced countries of the region has definitely been towards making themselves less dependent on manufactured exports that rely on low wage costs and instead to look for more up market activities (even here, of course, wage payments in Asia are considerably below those for the corresponding skills in the developed market economy countries).

To the extent that this kind of longer term indicative planning for industrial development is taking place, then the educational profile will itself have to be modified. The still scanty information from industrialized countries suggests that the educational structure to encompass the whole range of technological capability (including research and innovation) would take on a pyramidal character. At the top would be a fairly small number of highly

qualified and internationally experienced staff capable of at least monitoring and perhaps themselves altering the technology frontier; below them would be a larger group of technically strong and organizationally powerful people involved in managing firms and institutes concerned both with automation and user industries; further down, a still larger number of semi-skilled operating staff. The main conclusion that can be drawn from experience in the industrialized countries is that the creation of this kind of skill mix can only be effected if a country has a considerable number of people with a good standard of technical and engineering training. In other words, the prospects for developing a highly specialized staff depend on the prior training of a number of people who possess the basic knowledge which permits them to undertake successfully the further training. To acquire that base obviously depends on important public investments in formal training. In the longer term the implication is that investment in education should at least try to create and maintain sizeable cohorts of well trained people from whom those interested in developing further can be drawn. Whether or not the further training is done in formal educational institutions or within firms, whether it is done at home or abroad, will depend on the specific cases.

At the moment it seems very difficult to judge what the actual costs and benefits of developing an educational system in this way would be. One consolation is that most investments in education share this characteristics of a large degree of uncertainty so the new technology problem is not unique. More specifically, however, the Asian countries that do decide to follow this path can at least draw a little on the experience of the industrialized countries. So far the latter group appears to be groping tentatively towards appropriate systems and in so doing is making a certain number of costly mistakes; Asian countries can and should look at those experiments before coming to their own decisions. Perhaps the main lesson that seems valid as of now pertains to the degree of linkage between public education and enterprise activities. They should be seen as reinforcing each other, with the former providing the basic context and knowledge for students and the latter bearing the responsibilities and costs of more specialized training aimed at generating profits for themselves.

6. THE REQUISITE EMPIRICAL INFORMATION

The arguments used here have started from the conditions of international industrial competition which are relevant to most Asian developing countries and suggested that those conditions are being altered by the introduction of new technologies in OECD countries. Uptil now there is a dearth of detailed information regarding the rate of diffusion of these technologies and their precise impacts on costs and on the overall organization of production. More specifically, it is not yet clear to what extent the new technologies have actually eroded the competitive position of Asian countries. Empirical evidence on this subject is badly needed, both because it would give a picture of just how much Asian countries might lose in export markets and because it would provide a time horizon for carrying out changes in Asian countries themselves.

Also on each subsequent point along the way of argument the empirical gaps are glaring; to assess just what the new technologies will mean in terms of financial outlays, number of persons requiring training, and the possible returns from these investments, implies the collection and processing of a series of figures. This note therefore concludes with a listing of some of these empirical matters. To fill in the gaps does not necessarily require large-scale research projects. What it does need, however, is the rapid mobilization of information which for the most part should be obtainable from or through industry associations that are made up of enterprises directly affected by the problems. At the moment, therefore, and to use standard terminology, Asian countries are in the stage of prefeasibility work in relation to assessing the human resource impacts of the new technologies. As is well known, the carrying out of such work depends more on getting a feel for the variables and parameters than on precise calculations; and to do this what matters most is contact with informed and interested groups. It may be worthwhile launching a pilot study for a specific branch.

Some of the empirical issues would be as follows:

- What are the losses of market share in OECD countries due to the application in that region of new automation technologies? This question should be posed in those industrial branches which are of main export interest to Asian countries.

- Has the introduction of these technologies led to cutbacks of investments by foreign firms in the Asian region?

- Could Asian firms recapture and/or strengthen their competitive position through employing these technologies at home?

- What would be the impact on industrial structure and in particular employment of such a move?

- What training requirements would there be in these user industries?

- To what extent could the training be undertaken in-house and on the job rather than through formal education courses?

- For those activities where formal courses are necessary, the costs and benefits of domestic as against foreign training would need assessment.

- Examination of the educational experience acquired in the industrialized countries would be a useful guide to investments in skill creation in Asia.

In conclusion it can be stressed that new technological application in Asian industries will call for an accentuation of the level of and shifts in the pattern of human resource development. Skill requirements in manufacturing industry, in servicing institutions and in governmental authorities responsible for industrial policies as well as financial, trade and technology policies will grow and need to be treated as a key prerequisite for and key element of the comparative advantages of the countries' prospective industrial development. Development of human resources cannot be treated as a residual of the industrialization process to be "tagged on" to the advancing technologies. It is a prerequisite for the advance of technology and the identification and pursuance of new opportunities which are made possible thereby.

A systematic, advance lifting of the skill levels according to perceived requirement profiles presupposes in turn a very active monitoring of international trends and of own capacities by the individual Asian countries with possible support by suitable regional mechanisms. Such monitoring and the timely use of the observed trends and driving force for human resource development programmes and re-training schemes may require the setting up of a national "brain-trust" composed of some top-level professionals of various disciplines.