NEW TECHNOLOGY AND THE DEVELOPING COUNTRIES
THE IMPACT ON SOCIETY AND EDUCATION
THE ADVANTAGES OF THE LATE-COMER

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Just as there are many advantages in being the youngest child in a family, so, in many ways, the late-comer to industrialisation has it better. Japan, for example, starting in the late eighteen hundreds, was able to industrialise without creating slum cities quite as harshly degrading as those of Northern England in the first half of the nineteenth century described by Engels and Dickens. The technology of public health had made considerable advances by the time Japan was developing industrial cities -- and so had ideas about what it was appropriate for governments to do to combat epidemics, and so had the social technology of municipal government -- knowledge of how effectively to organise large cities -- something which Japanese officials came to Europe to study when Japan's local government system was being revised in the 1880s.

In production technology, too, Japan could move, in steel, say, straight into 1890s steel-making technology without going through all the painful, inefficient processes of trial and error through which that technology had been developed in Britain and Germany and the US. Japan never went through the canal age, but jumped straight into the railway age, just as many modern developing countries are going straight into the road transport age with hardly any experience of rail.

This learning from others' mistakes and development investments is only one of what the economic historian Gerschenkron once called the advantages of backwardness -- if quite possibly the most important. The other aspect on which Gerschenkron concentrated, was the way in which the intellectuals and political leaders of developing countries are afflicted by -- or stimulated by -- a sense of their own nation's backwardness -- which adds a national dimension, a dimension of central planning or collective effort, to the market forces which provided the main engines of growth in the countries which industrialised earlier. Industrialisation comes, not simply as the cumulative consequences of the
efforts of myriads of individual entrepreneurs and farmers, each pursuing his own profit -- a result of the working of the invisible hand -- but in part as the consequence of a deliberate drive to make Ritardania great, to enable its citizens to hold their heads high as members of one of the leading nations of the world. Nowadays, of course, now that free market ideologies have gained such hegemony -- at least in the Anglo-Saxon world that I come from -- no one will believe that the involvement of the state can make any contribution to the growth of the economy, but suffice it to say that, whatever the ideology they profess, most governments in the world today behave as if they believe otherwise.

It does seem, at any rate, that through the one mechanism or the other the rate of growth in late-developing countries is a good deal faster than it was in the early stages of industrialization of the pioneer developing countries. It seems that the later you start the faster you grow. France and the US grew in the nineteenth century faster than Britain. Germany grew faster than either of them two. And Japan faster than Germany. Then more recently, South Korea and Taiwan have grown faster than Japan. Economists speak of this phenomenon as the 'catch-up' effect. It is not an universal or inevitable process, not every developing country is a South Korea or Brazil. The size of the technology gap between the leading industrial countries and the developing countries represents only a potential source of fast growth. Whether that will or will not take place depends on many conditions, notably the nations intellectual and organisational resources. And it is here that the educational system becomes important.

A nation's schools have a lot to do in the first place with the level of national consciousness and sense of national cohesion. This is an important factor determining the ability of the state to mobilise the resources necessary for the drive to catch up. Without the sense of Koreans, shared by all the Koreans, the control of technology import, the selective credit system of the Korean government, the directions of certain kinds of productions towards exports necessary to maintain continuing import of capital goods, all that would have been much more difficult. And secondly and additional to creating a national consciousness, the education system also shapes the intellectual resources which a nation has available to absorb and master the technology which have been developed elsewhere. Because in the end it is the absorption and master that counts. We hear a good deal of talk of 'technology transfer'. It is common to think of this primarily in hardware terms. If I.G. Farben build an ethylene glycol plant in Indonesia which uses the latest chemical technology and is wholly owned by Indonesian capitalists, that is technology transfer. And
so it is, in a way, or at least the beginning of technology transfer. But it is only the beginning as long as there are German technicians there supervising the running of the plant, as long as crucial spare parts can only be imported from Germany and as long as German experts have to be called in when plant refurbishing and maintenance is required. Only when there are Indonesians who understand enough of the workings to deal with all production and maintenance difficulties; only when some of them have the underlying theoretical knowledge used in the plant processes and when that knowledge is incorporated into university chemical engineering courses so that it can begin to be locally reproduced; only when Indonesian firms become capable of building a similar plant -- only, in short, when the knowledge which went into the making and the maintaining of the plant is transferred fully from German heads to Indonesian heads -- can one say that technology transfer has taken place.

The phrase 'independent technological capability' has come into vogue amongst students of developing countries in recent years. It refers precisely to the capacity -- the intellectual and organisational capacity -- to accomplish this process of absorption and mastery which constitutes technology transfer. It is not, of course, an all-or-nothing thing. It would take a very long time for most European countries to master state-of-the-art space technology in the fields in which the US has a near-monopoly, for instance. In that sense 'technological capability' is a matter of more and less.

Catch-up getting harder

And the first thing to be said about the new technology is that the distance between more and less, the size of the technological capability gap between the leading nations and the developing nations, is growing all the time in ways that make the process of catching up, of absorption and mastery, increasingly difficult. The technology which Japanese engineers had to absorb in the 1890s in order to produce steel as good as the steel currently being produced in Germany was intelligible to people who had finished a secondary education plus, perhaps, a year or two's study of what then passed for the latest theoretical knowledge of metallurgy and chemistry. Today, understanding the theoretical knowledge embodied in a modern continuous casting plant would be the work of several specialists, metallurgists, chemists, electronics experts, each of whom had spent several years in systematic study.
We talk frequently nowadays of "the new technologies" and sometimes of the "microprocessor revolution", as if we were witnessing some discontinuous change in the technological sphere. There is perhaps something special about micro-electronics as a generic technology with implications for a wider range of spheres than almost anything since the development of electrical energy and electro-magnetic applications. But generally I see our current concern with technological change as the result not of any once-for-all discontinuous change in our technology, but rather as a sign of a general realisation of the fact that the pace of technical change has been slowly accelerating. With a steady increase in all the industrial nations in the percentage of national income which is spent on R & D -- combined with a steady increase in the national income of which it is a percentage -- it is not surprising that it should be so. The accumulation of scientific knowledge and of the stock of usable technology changed to a new gear in the nineteenth century when governments began giving funds to institutionalise the process of research in universities and again in the twentieth century when industrial corporations began hiring inventors and establishing research and development departments. Those processes of institutionalisation have allowed the rate of knowledge accumulation steadily to accelerate.

And, to revert to developing countries and their problems, the first general proposition which suggests itself is the obvious one: the more time goes by, the more advanced the world process of knowledge accumulation, the more daunting the developing country's task of catching up becomes, the greater the expectations placed on the education system becomes, the greater the strains to which it is subjected.

Education and Selection

The first source of strain is the intensification of the tension between the function of the school as an educational institution, a means of moulding the hearts and minds of future citizens, and its function as a mechanism of social selection -- the practice grounds in which members of the next generation compete with each other for the most desirable positions in society. I once wrote a book about this phenomenon and its particular consequences for developing countries under the title 'The Diploma Disease'. The argument, briefly, was that this tension between the two functions of schooling, has been present in every modern school system since the bureaucratisation of employment began -- since a majority of the population began to derive its
income, not from selling goods and services in the market but from an employee position -- often with secure tenure -- in a large organisation, a position gained in a competition in which educational qualifications play a decisive part. And that this tension had several consequences in all societies -- a tendency for school learning to become more and more examination-oriented as qualifications acquired more and more bread-and-butter value, with the result that learning became more instrumental and ritualised and less effective in forming productive work attitudes and work capacities; secondly, a tendency for the school system to become a univalent pyramid, for everybody to be trying to climb to the top of the same tertiary sector, with the consequence, for instance, that secondary-level technical education becomes devalued, seen simply as a second-best spill-over facility for people who do not qualify for the royal road to university -- and who often refuse to accept their fate, and neglect their vocational subjects in order to redouble their efforts at the academic subjects, preparing for second-chance exams which will take them back on to the main road again; thirdly, the tendency, when examination success is so highly valued, for educational resources and the attention of teachers to be concentrated on the able pupils, to the neglect of the needs of the slower learners.

All of these problems are exacerbated in developing countries by a number of circumstances. First, the social contrast between the conditions of employment in the bureaucratised diploma-requiring modern sector and those of the traditional, especially the agricultural traditional, sector of the economy -- the gap in wage levels and in levels of security and social prestige -- is much larger than any disparity in life-chances which exists in the industrial countries, and the incentives to succeed in the examination race are consequently that much greater.

Secondly, in the industrial countries, class differences in aspiration often damp down the examination competition -- large sections of the working class do not expect their children to reach the universities which are seen primarily as middle-class institutions. And much the same is true of Latin America. But such class differences are not present in many of the newer developing countries, especially the newer countries of Africa. The present, first-generation, elite if often made up of village boys who made good through the educational system, and every village boy in the nation sees himself as competing for the chance to follow in their footsteps.

Thirdly, the emotional and cognitive gap between home and school is a good deal greater in developing countries. The
disjunction between the values and the intellectual assumptions — the "common sense" — of the traditional society (often until very recently societies of primitive hand-hoe agriculture), and the values and intellectual assumptions of a school curriculum derived directly from what counts as common sense in Western societies, is often very large, and unsophisticated teachers are often much more in tune with folk common sense than they are with the common sense embodied in their curriculum. As a result, the tendency for the subject matter of the curriculum to be treated purely instrumentally, as having no meaning except as a means of social ascension through the examination ladder, is thereby exacerbated.

Finally, a fourth reason why diploma disease tendencies are so much stronger in developing countries is because of the unemployment problem — because it is cheaper and easier to expand the school system and even the university system, than it is to create economically viable factories and newspapers and hospitals and other service organisations. The pressure created by the graduate unemployment problem tends to skew educational expenditure towards the upper echelons of the system. At Stage 1 all the concern is with unemployed primary school leavers, and all the pressure is directed at building more secondary schools to accommodate them. At Stage 2, nobody any longer expects primary school leavers to be able to get wage jobs in the modern sector, and all the worry is about unemployed secondary school leavers, and the political campaigns are about more universities and polytechnics so that they can qualify for the jobs where demand and supply seem still to be in balance. But by the time they graduate, there is over-supply, and then there is talk of a need for more masters' courses. And with every step in the escalation, the primary schools which are educating the next generation of farmers — the men and women whose ability to raise farm output is often the make-or-break question for the economy — get more and more starved of funds.

The impact of new technology.

What effect will the new technologies have on these problems? In mineral-rich economies which have no very tight constraints on capital expenditure, there is no doubt that some of the new communications technologies, particularly the use of video cassettes, could help to make up for the deficiencies of teachers and improve the quality of education, particularly in rural areas — provided that there is manpower enough to write suitable material, or even to adapt foreign material to local languages and
circumstances. And given the difficulties many countries have in building up and keeping a vigorous and imaginative curriculum development unit, that remains a very big proviso.

An indirect effect of developments in technology, however, may well be to intensify the problems of what I called the diploma disease. A scientific education will be more and more at a premium. Already, in many developing countries, the most intense competition occurs at the point in the secondary cycle when pupils are divided between those who will follow the science courses and have a good chance to end up qualified as engineers or doctors — with almost guaranteed employment and high salaries — and those who are assigned to the arts courses. And in the univalent pyramid system I spoke of, this forking of the ways is usually perceived as a matter of "succeeding" in getting into the science courses or of "being relegated" to the less desirable fate of the arts — not as a moment of choice when each selects the course best suited to his aptitudes and abilities. As technological expertise becomes even more highly prized these tendencies can only be intensified, thereby reinforcing the univalence of the system. And thereby reinforcing also, perhaps, some of its other consequences. It is characteristic of an intensely instrumental attitude towards schooling, as primarily a means of gaining the diplomas which earn a desirable position in society, that it can fail to impart a genuine taste for the process of learning itself. The diplomaed man, particularly if he gets employment in a bureaucratic organisation and gets his foot on the bottom of a more-or-less automatic-promotion ladder, is likely to see himself as a complete man, who has done all the tedious learning he ever needs to do and can now sit back and enjoy the fruits of all his meritorious effort. It is an attitude in sharp contrast with the lifelong-learning ideal, and it is a platitude that the pace of technical change today makes lifelong learning, and an appetite for lifelong learning, a necessary prerequisite for doing most high-level jobs well.

But these are not the only ways in which the situation of developing countries is going to be complicated by the acceleration in the pace of technical change. There will be effects on the employment problem, and the brain-drain problem, there will be consequences for national integrity and for nationalism; consequences also for the difficult choices which all developing countries have to make between external dependency and self-reliance.
The employment problem

First of all, the employment problem. There is a vast literature of technology choice in developing countries, a lot of it variations on the theme that countries should choose the technology which is most suited to their factor endowments. If labour is abundant and capital is scarce, then they should be very hesitant about using labour-saving machinery, particularly if they have to import it. In practice, such advice is rarely followed because, quite apart from engineers' pride and insistence on the latest and the best, the choice of techniques is not simply a matter of relative costs. Machinery may be more reliable than a recalcitrant labour force. Even with no recalcitrance problem, even with the best will in the world, high product quality may be more easily attained with machines than by human agency, however skilled. The latest computer-numerically-controlled machine tools for instance can machine metal parts to much more complex shapes to much finer tolerances than human beings can. Add to this the fact that some forms of mechanisation represent such significant savings that not even the cheapest of human labour can compete with it -- a lot of computer operations now that microprocessors have become so cheap, for instance.

For all these reasons there is no doubt that the new generation of process innovations in machine tools and in communications and office work will rapidly find its way into developing countries too, as the preferred choice of technique whenever investment can be afforded.

We hear a lot today in the industrial countries about the problems of unemployment caused by the advent of new technology. Or, to be more precise, we hear a lot about it in Europe where the problem is more marked than it is in either the US or Japan. There is more than one reason for the difference, but one important factor lies in the different capacities in Europe, Japan and the US for product innovation as opposed to process innovation. Europe is not backward in adopting the new capital goods which lower costs and improve qualities by displacing labour. But all too often those new capital goods are the product of Japanese or of American industry. Societies which are equally capable of product as of process innovation create new jobs to replace the ones which machines make unnecessary. Societies which are not have trouble. And the troubles of the developing countries, with even lesser chances of sharing in the world production of high technology exports even than Europe, are likely to be many times more serious.
The brain drain

As for the brain-drain, the point is a simple one. The size of the brain-drain a country suffers depends partly on salary and quality of life differentials, but partly also on the intensity of contact with foreign countries, particularly of study overseas. Higher levels of technology — or rather an acceleration in the rate of accumulation of technological knowledge — mean that the process of localising the transmission of knowledge becomes tougher; study abroad remains indispensible, particularly, of course, for small countries.

Back in the nineteenth century, when new technology was accumulating more slowly, the Japanese could build up a university system which was capable of transmitting the stock of world knowledge in a pretty up-to-date form — as up-to-date and in touch with industrial practice as engineering education ever is — in the Japanese language. In the 1870s and 1880s a lot of the lectures in Tokyo University were given by foreigners and in English or German. The last English lectures, given by the last irreplaceable foreigner, were those in naval architecture, and they ceased in 1910. Today, a China with its size and manpower resources might hope eventually to do something similar — unlike, say, a Sri Lanka or even an Indonesia. But even China will need for a long time to have a high proportion of its technicians and scientists capable of using English, and will need to send a good number of students to study abroad.

In part this is simply a function of the knowledge explosion and of the increasing degree of specialisation in science and engineering. No country, not even the most advanced in technology, can hope to be the leader in every field. There will always be things that the Americans can learn in Japan and that the Japanese can learn in America. In fact, a growing interchange of doctoral and post-doctoral students between those countries is symptomatic of the process of internationalisation which is at work. And for countries which can hardly hope to be technological leaders in any important specialty, this process of internationalisation means, at the same time, increasing dependency. At best, it means dependence on foreign teachers to help one’s own nationals to acquire mastery over the computers and the agrobiology and the medical equipment one’s society uses. At next best, it requires occasional resort to foreign manufacturers for the repair of the equipment when it goes wrong. At worst, it requires resort to the services of foreigners simply for the effective use and routine maintenance of the equipment.
The dependency syndrome

Dependency is never a very healthy state of international relations. It is particularly irksome for poor countries and for the leaders and intellectuals of poor countries who are, among their fellow-countrymen, most frequently in contact with foreigners and may have most directly to experience the arrogance and off-handredness of people who are richer and more powerful than themselves -- or who simply wear an air of superiority by virtue of the fact that their country is richer and more powerful. So central a concern has this been in developing countries -- particularly among the university intellectuals of Latin America where resistance to the political dominance of the United States has always been a central theme of national politics -- that what was known as "dependency theory" came to occupy the centre stage for those who theorised about development in the English-speaking countries in the 1970s.

At its most developed, the theory involved a set of postulates about the relation between external dependency and internal class structures. The dominant bourgeoisie perpetuated external dependency basically because they were bought, because they were a comprador bourgeoisie which drew substantial rents from the mechanisms whereby the dominant metropolitan powers exploited the developing countries. The model clearly had a certain applicability, at least to Latin America or to Kenya, if not so obviously to India. It led to the prescription of an alternative strategy of self-reliance, of delinking from the world capitalist system, but usually only after a revolution to overthrow the compradors. So powerful and widespread was the sentiment, if not the doctrine, of rejection of dependency that, for instance, the Monrovia Declaration of the Organisation of African Unity, speaking in 1979 of the prospects for Africa in the Year 2000, and of the need for developing countries to develop their own technology, declared that "the term 'technology transfer' should be stricken from our vocabulary".

What that prescription overlooked, however, was the cost of self-reliance, the fact that of all the imbalances of power, the imbalance of technological sophistication remains the least easily cured in a short space of time and that if one does seek to avoid any kind of knowledge dependency on foreigners one might be condemning oneself to unnecessarily low levels of productivity and of growth.
The strategy of self-reliance

The acceleration of technological change and the appearance of the new technologies accentuates the dilemma. The history of India's development strategies since independence is symptomatic. If to a less extreme degree than China in the decade of the Cultural Revolution, India has adopted a strategy of maximal technological self-reliance. The development strategies of the economist Mahalanobis, which inspired the early economic plans, followed the Russian development strategy of first building up a technological capacity in the basic capital goods industries, thereby laying a foundation for subsequent industrial development. The indigenous industries were given tariff protection as they were built. There were strict controls on the import of foreign technologies and strong state backing for research institutes which were to cater for India's own technological needs -- developing a real Hindu technology as the Delhi wits had it. All these measures were designed to ensure that the political integrity and independence of the Indian nation was not compromised by any kind of technological dependency.

In a way it worked. India achieved a very high level of self-sufficiency. The cadre of home-trained engineers grew significantly, and so did their sophistication. India acquired a full range of modern industries -- but by and large industries which used, and were not able to upgrade, out-dated technology. The result was stagnation and an inability to compete in world export markets with goods of the quality which those markets required. The result was also a rate of economic growth much lower than a country with India's rates of population increase could afford, and much lower than countries like Korea and Taiwan were achieving with more open strategies.

Open strategies come in two kinds. There is the openness of a Guatemala, a weak state, minimal sense of nationalism, controls on the activities of foreigners and the import of technologies being imposed, if at all, primarily in order to extract bribes for the privilege of evading them. The other kind of open strategy is that of a strong state like those of Japan or South Korea or China or Taiwan, states animated by a very strong sense of nationalism which does find very irksome indeed any dependence on foreign governments, on foreign corporations and on foreign teachers. In this kind of openness, however, the nationalism is accompanied by a strong sense of realism, an acceptance that catching up requires the humility to accept the status of pupil, to invite the foreign firms which have something to teach into joint ventures and to be satisfied with the best terms one can
get. Behind that strategy lies a certain confidence, a confidence that in the end one will be able to catch up, that one's intellectual resources are capable of doing the job and that one's state of backwardness is only a temporary condition, product of the accident of history.

The relevance of this discussion to our theme is simply this: the more rapid the production of new technical and scientific knowledge in the industrial countries, the greater this tension between the two faces of nationalism -- on the one hand the rejection of dependency, and on the other the determination to make one's country strong and prosperous by learning, as rapidly as possible, the latest and best technology available.

The cultural sources of confidence and competence

The confidence that one can do it -- the confidence that one's own country can eventually join the ranks of the prosperous industrial countries -- the confidence which the Japanese had and which the other countries of the Confucian cultural sphere clearly have today -- a confidence shared, perhaps by Brazilians and Mexicans and intermittently by Indians -- is probably the crucial variable.

And, to come back finally to the educational system again, it is interesting to speculate on the meaning of the fact that the countries which have shown that confidence are, by and large, the countries which had some kind of formal school educational system well before the modern period -- peasant societies for the most part within the sphere of one of the great world religions. We generalise too easily about the developing countries, without attending as much as we should to the differences between them. UNESCO statistics count a year of schooling or of university study in Senegal and Tanzania as in every respect equivalent to years of schooling in Korea or Brazil. And so, in some respects they are: the curricula may be very similar. And yet we may be wrong in expecting a society's capacity to absorb technology, and to apply it to the task of economic improvement to be directly related to such indicators as the amount of schooling the population has received.

Differences between societies in what passes for folk knowledge, for proverbial wisdom and common sense, assumptions about causality and about morality, the standards of judgement applied to human action -- all those things which are the result of a slow cumulation of culture over centuries -- may be far more important.
We who are professionally involved with schools and who have a vested interest in emphasising their importance, should never forget that even the child who gets a pretty full schooling and spends, say, 14,000 hours of his childhood life in school, is still likely to spend 70,000 of his waking hours outside of school. Only as the first schooled generation begins to influence those 70,000 hours of its children, and they in turn the out-of-school hours of the third generation -- only through those processes of gradual cumulation does the effectiveness of the implantation of schools in a society begin to show itself. We should not expect too much too quickly.

And meanwhile, perhaps, as we become more and more preoccupied with the intensification of international competition in the world economy, more and more concerned with how we are doing in the three-horse race: Europe, US and Japan, we should think more often about the countries which are not able to compete in the same league but which have far more desperate needs than we have to harness new techniques to the mastery of their diseases and the husbandry of crops and to the effective utilisation of such resources as they happen to be endowed with. And we should recognise that even if we can persuade ourselves to be more generous, both in devoting some of our scientific manpower to their problems and in transferring already developed knowledge to them on better than commercial terms, the process of absorbing and mastering foreign technology and of dealing with all the social and ideological implications of that learning process, is not a simple problem. It never was a simple problem, and it gets worse as mankind's stock of knowledge accumulates and the knowledge gap between the rich and the poor countries continues to grow.