UNITED NATIONS

ECONOMIC AND SOCIAL COUNCIL

LIMITED

E/ECWA/NR/SEM.3/22
8 December 1981
Original: ENGLISH

ECONOMIC COMMISSION FOR WESTERN ASIA

Seminar on Technology Policies in the Arab States
Organized by ECWA with the Co-operation of UNESCO
14-18 December 1981
Paris, France.

SCIENTIFIC AND TECHNOLOGICAL RESEARCH STRATEGY: RELEVANCE OF THE JAPANESE EXPERIENCE

by

TAKESHI HAYASHI*
Project Co-ordinator

and

SHOJI ITO*
Associate Co-ordinator
The UN University Project
"Technology Transfer, Transformation, and Development: The Japanese Experience

* The opinions expressed in this document are those of the authors and do not necessarily reflect the views of the United Nations Economic Commission for Western Asia.

Japan shares many things with non-western cultures and at the same time it shares much with western industrial societies. This dualistic character of Japanese society enables us to understand the transcultural characteristics of technology and to transcend the conventional notion of the non-transferability of technology. However, care must be taken with respect to the role and function of international relations as well as domestic conditions (i.e., socio-economic and political structures) corresponding to each stage of technology transfer.

Japanese experience provides evidence that the growth-oriented strategy has been pushing aside problems concerning human rights, life-styles, the quality of life, and cultural and national identity. The lagging development in pollution control technology is also attributable to this strategy.

On the other hand, it should be emphasized that technology - broadly defined - is useful and, moreover, is inevitable for human and social development. In this connection, it is meaningful to re-evaluate the significant role of endogenous technology.

In this brief essay I will try to point out some of the main characteristics of the modernization process in Japan and to explain the relevance of the Japanese experience to present-day developing countries.

IRON AND STEEL INDUSTRY

These two sectors of industry are essentially separate from each other, but both were significantly transformed by imported technology.

The iron and steel industry, as typically observed in sword making, had maintained high technical standards since ancient days, amazingly high even by the criteria of present-day metallurgy, but neither its equipment nor its skills could directly meet the needs of modern industry. However, even before Meiji, there had already been a number of talented engineers whose knowledge, though as yet untheorized, had been advanced enough for understanding the modern western iron making process. The new Meiji Government repeated failures by listening less to those integrators of endogenous technology than to European engineers.

Considering the volume of steel demand in Japan of those days, large-scale local production would be uneconomical, but the government had taken note of the high price of steel and the economies of scale.

The government's policy at the same time was affected by the international situation then prevailing. As the threat of colonization was imminent and national defence was an urgent task, building of modern weapons, especially warships, was considered a national need. The failure at Kamaishi and the repeated ill successes at Yawata were due to mistakes in the very designs and sitings of the mills. Above all, the foreign engineers had ignored such major limiting factors as the resources available in Japan and the skills of Japanese workers. The failures accordingly were not corrected until Japanese engineers mastered modern science. The equipment could be designed and built, but not operated. It was none but Japanese who eventually were able to put the equipment into operation.

Not to be overlooked is the implication of this experience, which is a serious problem technology transfer can entail.

It was only as a fruit of endeavors by Japanese engineers that the Kamaishi Iron Works was reactivated in the meantime.

There is another thing to be added. It was after the Russo-Japanese War (1904-1905) that iron making established itself as an industry in Japan, more than half a century after it had marked its rudimentary start. The cost of iron making was imposed on taxpayers under the excuse of national defence needs. On the other hand, Japanese industralists in pursuit of economic rationality preferred not to have blast furnaces but to meet the steel demand of private industry by open hearth processing of scrap iron imported from the U.S. and India. By 1930, private steel companies came to outstrip state-run steel mills.

It is difficult to determine in general terms the relative advantage of private initiatives over government-guided development or vice versa, but anyhow the Japanese steel industry built up its technology and moved toward completion of a setup of most up-to-date large mills located in littoral cites and engaged in integrated steel production. It was over six decades after the founding of the state-run Yawata Iron Works.

A lesson we derive from this experience is that technology is inseparable from economy and from the training of endogenous engineers, scientists and skilled workers.

Highly automated steel mills of present-day Japan may appear to have no more work forces than are sufficient to perform control duties, but this is not true. The truth is merely that the various preliminary stages of work and jobs which previously were contained in the mills *per se* are now placed outside, and the mills cannot be as they are without the balanced systematic development of those related subsectors.

For a worker to sense promptly something different, if not quite unusual, in the working of a mechanical system which, to a layman's eye, seems to be regularly functioning, and to take an appropriate remedy (even if it is just pushing a switch button), he needs accumulated experience and skills.

While littoral siting of integrated steel mills is a uniquely Japanese invention in view of her dependence on imports for raw material supply, it presupposes the availability of both iron ore and coking coal of the world's highest quality at the most stable prices. We have to add that some observers doubt if the huge facilities so constituted to enjoy economies of scale can forever remain economically rational. This aspect seems to deserve close scrutiny in view of the problems of sovereignty over natural resources and new international economic order. Whereas it is well known that big steel mills in Japan at first depended on raw materials supply from China, iron ore from Malaya later came to have considerable significance.

TRANSPORTATION

Development of the transportation system was the area on which the Meiji Government placed the greatest stress in its industrialization policy and encouragement of technology transfer.

To reduce the financial burden on it, the government paid compensations to the former samurai class in public bonds, though they constituted a temporarily heavy burden, and those bonds played a major role in financing the construction of the railway system among other areas of industrialization and technology transfer.

Here again, the government's wisdom is found in its not granting railway concessions to foreign interests. Obviously, because the construction of Japan's first railway was financed with government bonds floated abroad, it was not totally immune from the danger of falling into foreign hands. However, as the operation of the Tokyo-Yokohama line demonstrated railways to be a good investment, idle capital came to be mobilized.

At that time, notably, the government spelled out its policy to nationalize and unify the gauge of railways for political and military reasons.

Although we can never overemphasize the important role played by the railway system in the modernization and industrialization process of Japan, stagecoach service was more important in the early days of privately-run railways. It heralded the expansion of the railway system and, after major cities were linked by a railway network, came to take charge of regional and local transportation. However, nationalization of railways could rather impede their development since the financial resources of the government were naturally limited, and the government could not help allowing local railways to remain under private management.

From a technological point of view, railway construction involved many areas in which endogenous technology coule be utilized or adapted, such as surveying, bridge spanning and tunnel excavation, and could capitalize on the existing store of skills except in the area of equipment, including locomotives, signal arrangements, rolling stock and rails. Moreover, Japanese became able rather early to design locomotives and other equipment for themselves, and Japanese engineers were so intellectually aggressive that, as soon as locomotives ordered from overseas were unloaded in a local port, they would disassemble one of them and copy its design. This is one of the reasons why local production of railway equipment became possible so early. According to an unconfirmed legend, diagramming of train schedules long remained a secret of foreign experts.

In this sector, again, success stories constitute only one aspect of the history. There were outright failures, too, including the case of the Port of Nobiru built as a part of the grand design to develop the Tohoku region. The failure perhaps was attributable, at least in part, to the difference in nationality, and accordingly in methodology, between the initial designer (who used the low water level method of Dutch origin) and another designer who subsequently checked the plan, but one thing that is certain is that the facilities of the new port, which had consumed an enormous sum of investments and a tremendously long period of time, did not function at all, buried in drifting sand. One of the major reasons might be that, after the completion of the first phase of the construction project, the second phase (there was a wide gap between two foreign engineers concerned in the evaluation and design philosophy) was not immediately started. Here again, however, the failure to absorb adequately the experience and knowledge of local residents seems obvious from the fact that the directions of the tide and wide were not accurately anticipated.

In marine transport, many foreign ships had visited Japan since the reopening of her door to the external world, and they revealed a conspicuous lag of the traditional shipbuilding technology, which permitted construction of only wooden vessels up to 100 tons, partly as a result of the Shogunate's ban on the construction of large oceangoing ships. For this reason, both the Tokugawa regime and the Meiji Government had to build up their navies by importing warships out of the national defence needs to cope with the new phase of foreign relations.

From 1870 on, the government encouraged construction of new western-style merchant ships with little success, and its plan to have a coastwise shippihg operator manage a joint veture with ships leased out by the government also proved unsuccessful. Thus it decided to foster a private shipping enterprise (the launching of Mitsubishi Company), because on the occasion of the dispatch of troops to Taiwan, as well as during the civil war, foreign vessels might refuse transport troops and war supplies for diplomatic and political reasons.

Mitsubishi Company, which would eventually undertake various ocean shipping services under a strong support from the government, took charge of the export of Japanese-made goods (mainly sundries) and the import of Indian raw cotton by opening a regular service to Bombay. This marked a major turning point for the Japanese cotton industry, which was thereby enabled to drive away Indian products from the

Chinese market.

Our research activities have also covered road construction. It was after World War II, when motorization made progress, that foreign technology came to be imported on a full scale. Thus road construction is an area where technology transfer began latest. This means that roads had reached a level of technical perfection before the progress of motorization imposed stricter requirements on them, and the extensive railway network had made up for the inadequacies in conventional roads.

Even after the Meiji Restoration, like under the Tokugawa rule, the construction and maintenance of roads was governed by the principle of local responsibility, under which the central government set forth the plan and the local authorities executed it as prescribed. This principle caused poor districts to remain poor indefinitely and, inviting devastation of many of the former post towns under the impact of the developing railway network ensuing from the progress of industrialization, kept interregional lags intact in spite of the limited area of the national territory. Of course, motorization did not help eliminate the lags, which instead have entered a new phase and are renewed at a different level from where they existed in the past. This development is pertinent to the problem of local autonomy. We are not unaware of the gravity of the problem, but it does not yet come into our field of vision.

SILK REELING AND COTTON TEXTILE INDUSTRIES

It may be well known that this was the national industry which most typically represented the early phase of the industrialization of Japan. Out of its two major sub-sectors, silk reeling was obliged to alter its traditional processing method to adapt itself to the needs of export to already established markets, and cotton spinning was intended to replace imports with domestic products. After the government's policy oscillated one way or the other and many technical and management difficulties were surmounted, silk eventually found for itself a domestic market as well, and cotton fabrics began to be exported, too. In the field of silk reeling and weaving, incessant technical improvements covered all stages of production from mulberry culture and silk worm raising to not only the details of reeling machines but also dyeing and quality control, and the peak of these activities came closely before te Second World War.

Both these subsectors constitute a notable aspect of the industrialization history of Japan in that they were supported by the hard and longtime labor of female workers, especially those recruited from poverty-stricken farm villages. Comparison of scales of business management (among the U.K., U.S. and Japan) attempted in the process of reviewing management history led to a number of interesting discoveries. The mechanisms of the improvement and dissemination of silk yarn production techniques were econometrically compared with the Chinese experience.

Between silk reeling and cotton spinning, a notable difference in the orientation of development has to be pointed out here. While, in silk reeling, the new technology introduced by the government by importing western equipment and hiring foreign engineers was disseminated and well established on a small scale in major production districts (providing a basis for subsequent development of medium and large-scale silk mills after the completion of technology transfer), the government's policy to foster medium and small-size spinning mills in differnet parts of the country ended up in a failure and only large-scale mills with up-to-date equipment proved profitable.

In disseminating the new reeling technology, to put it in extremely simplistic terms, improvements in equipment and skills had only to aim at conforming to uniform denier standards, and capital saving devices were therefore made in each production center.

In the case of spinning in contrast, the quality of raw cotton supplied from different parts of Western Japan was not uniform, and a mill with 2,000 spindles or so could enjoy no economies of scale. Certainly the gap between imported and endogenous technologies was too wide. This technology lag ensured the economies of a greater scale, but at the same time raw cotton available in Western Japan proved inadequate for large mills both qualitatively and quantitatively. The import of Indian raw cotton helped establish a modern spinning industry, but it also deprived farmers throughout Western Japan of an important source of their income.

Japanese spinners, like the Amirican,were able to pursue economies of scale, but the British were not. Because spinning in the U.K. had begun as cooperative undertakings of farmers, no factory could outgrow the site allocated for it by the village owning the factory. Further because it started in the form of cooperative movement, no managers of any level were renumerated for their services. This is why the British spinning industry, when it advanced into India, switched to the peculiarly colonial way of management known as the managing agency system.

Both large factories (including spinning mills) and small ones (reeling mills) are found characterized by thorough division of labor according to the sequence of processing, if one pays attention to the organization of labor therein. This characteristic helped accelerate learning of skills and sometimes afforded high efficiency. It was a painful process because it meant adaptation to a completely different principle from farmers' diligence, one of adjusting human labor to the motions of machinery.

In this respect, modern spinning mills in India, where skilled manpower was at first utilized according to the caste-wise specialization, were able to turn out products of higher quality at greater efficiency and accordingly to pay more generous wages than in Japan (some Japanese scholars disagree on this point). One of the reasons why Japan's spinning industry nevertheless surpassed India's in less than a decade is that the rationl division of the manufacturing process according to the function of machinery resulted in an increase in skilled workers mastering the procedures and skills of the related stages of work, and further in improvement, though gradual, of their remunerations. In India, on the other hand, the division of the production process had to be based on social segmentation called the caste structure rather on the function of machinery, and moreover annual events differed with the locality the workers came from, resulting in their irregular absences and accordingly in a fewer days of full operation per year than in Japan. Worst of all, workers tended to regard the particular stage of work in which they were engaged as something like their personal belonging, and this tendency prevented ready arrangements for personnel substitution. Here we can point out a relationship between technology and labor and one between labor and culture.

One thing not to be overlooked in this connection is the invention in 1898 by Sakichi Toyoda, a former carpenter, of an automatic loom. which was patented in many countries.

THE ROLE OF THE STATE

Japan's industrialization was an inevitable choice, forced upon her by the international situation then prevailing. Therefore, there was a rough consensus in the national society at large as to industrialization and technology transfer. Objections only concerned the way in which the transfer took place.

The government operated pilot plants in a number of areas of industry to introduce and disseminate western technology, and successively sold them to private interests when they became able to pay off. Not a few criticisms have been raised as to the way in which they were disposed of. Nevertheless, in the light of the role to be played by the state or the government in a developing nation, the Meiji Government's policy undoubtedly was in the direction of "self-reliance".

Further, it was a wise choice for the government not to permit foreign interests to participate in the exploitation of underground resources, construction of railways, large developmental project or infrastructure undertakings.

The hiring of many foreign engineers and experts cost a large expenditure and not a few of them were paid even higher salaries than cabinet ministers, but much was learned from them. We don't mean all their advices and proposals proved effective. We have already referred to a number of failures which resulted from excessive trust in their scientific or technical knowledge. Kageyoshi Noro who was a capable engineer and scientist said, although "technology transcends national boundaries", "In its specific application, each nation has to work out its own way, adapted to its peculiar conditions. Only when the recipient nation (of technology) shares this creative task, there is a possibility of success." Noro was the man who identified the cause of the trouble in the foreigner-designed Yawata Iron Works to be the wrong kind of fuel that was used, and devised his own coking method.

In this respect, the role of the government should also be sought in the training of men of talent like Noro. This aspect will be inquired into from the third year (1980) on as a matter of science and technology education in Japan. It is true that the government in those days had a broader range of technologies to choose from than today, but it certainly collected technological information in a clever way, partly because the government leaders had all come from the lower echelon of the samurai class and accordingly were familiar with the actual circumstances of the nation. It also was fortunate that efficient, pragmatist bureaucrats were recruited from the former samurai class.

Here again, we also have to touch on the negative role of the government. It was usual for many of the so-called samurai companies, capitalized with the public bonds paid to the former samurai, to state in their constitutions"... shall thereby contribute to the development of the nation." The expression suggests the enterprising fever prevalent in those days and testifies to the national consensus that had been formed in favor of industrialization, but here in fact was a pitfall. The rationale that they were serving national interest justified all business activities, and was apt to give rise to the notion that the sacrificing of individual citizens' interest could not be helped. This was a private industry counterpart of the authoritarianism of the pragmatist bureaucrats. They had in mind the state, but not the people. What is now considered a classical example of the consequence of their mentality is the pollution by the Ashio copper mine, as it were, an early predecessor to the case of the Minamata disease. Shozo Tanaka (1841-1913), a politician who untiringly denounced the unreasonable act of the mining company, resigned his seat in the National Diet and even directly appealed to the Emperor, but the government did nothing fundamentally to solve the problem. Its attitude could be better explained by its insensitiveness to farmers' sufferings than by its faith in the righteousness of the mining company. Presumably stung by conscience, the company donated equipment to a university. Similar incidents happened when a state-run factory was newly established or a new railway built. The Yawata Iron Works unabashedly rejected local citizens' protest against the pollution it had caused. Nor was there anything to prevent a railway project from destroying an irrigation canal. The government's policy to give top priority to industrialization was thus enforced in disregard of citizens' property rights and right to live safely.

Belittling of citizens' everyday life and environmental problems still persists. When a business enterprise develops in parallel with the development of the city in which it is located, citizens'resistance is susceptible from degeneration from inside, and frequently businesses rather increase their pollution damages by trying to cope with them in secret.

According to a certain scholar, as far as industrial facilities are concerned, the problems of environmental pollution can be completely solved technogically, but their solution is prevented by the enormous costs it would entail. Here, too, is one of the reasons why we have correlated technology and economy. It is exactly in such instances that we hope the Japanese Experience be utilized.

INSTITUTIONALIZATION OF SCIENCE

One important reply to the question why Japan's industrialization was so quickly achieved was proposed by Toru Hiroshige (1928-1979), a student of the history of science. According to him, the incorporation of science into the university curricula did not take place much earlier in Europe than in Japan. In various international scientific activities (including the International Conference on the Prime Meridian in 1884 and the publication of the International Catalogue of Scientific Literature from 1901 to 1914), Japan has participated from their very beginnings. Hiroshige pointed out that such international activities had begun during the final quarter of the 19th century, about the time Japan had started to take in modern western science. "Embarking on her modernization in such an epoch, Japan was able to import science in the process of institutionalization at its foremost," he wrote. (Kagaku no Shakai-shi (A sociological history of science), 1973, pp.40-41.)

Because of the evident development lag between the science of those days (when science and technology were not so far dissociated from each other as they are, although there still are some interactions between them) and today's, late starters' advantage is not so great as it used to be. Further, as far as technology is concerned, late starters'advantage is not necessarily great. Certainly, their disadvantage is greater now, because it is no longer universities (footholds of institutionalized science) but big businesses that lead in technology. In view of this point, we should rather say we are in an age when technology is insufficiently institutionalized.

Nevertheless, this only holds true with the highest level. One of our theses is that what is at the highest level is not necessarily the optimum., The criterion of whether or not something is the optimum, for this matter, is self-reliance. Let us give one example. The littoral integrated steel mills, which embody the foremost of Japan's steel making technology, could not be necessarily transferred elsewhere with benefits: simply because they conform to the most up-to-date and most advanced technological standards in the world, since they are designed on the premise that the world's top quality iron ore and coking can be freely purchased and steadily supplied. Moreover, as they represent maximum pursuit of economies of scale, their operating rates are difficult to adjust. In this respect, they are sophisticated facilities with many weakpoints. Therefore, there is no guarantee that transferring them to any other country would result in profitable production at a given level of steel price in the international market. As earlier pointed out, this kind of huge, modern equipment can be economically operated only if it is assisted by a large number of related enterprises (which even exceed 1,000 in the case of a littoral integrated steel mill) capable of constantly and punctually delivering to specified places supplies of goods satisfying the requirements both in quality and quantity. The "technology institutionalized" in this particular factory is supported by those peripheral units, without whose support no prompt remedies could be taken to an accident or a trouble that may occur. The greater a plant in dimensions, the more complex its operational control. Its operation can neither be readily suspended nor restarted. A trouble in only a segment of a huge plant may invite suspension of the whole production process or even destruction of the plant. In the past instances, accidents are often triggered by "simple, elementary errors". A fault in supplies from a Subcontractor can lead to such an accident.

Even if this technology is transferred at great risks to a location where no such peripheral requirements are met, the design will indispensably have to be modified to match the constraints on raw materials and fuel anticipated in that particular place in that particular country. Sufficient basic data needed for design modification are often unavailable locally. Then the foreign design engineer would have to substitute data from his own country for the local, inevitably to experience what was repeated in Japan in her early decades of industrialization.

After all these requirements are met, there will still remain the problem of manpower, whose training is so difficult that, in the case of Japan, more than half a century was taken to secure an adequate supply of qualified manpower. Although late starters are supposed to have advantage in this respect, too, manpower development should be sought in the direction of solving the employment problem. Today's big technology and big factory system have no backgrounds of nationality or culture unlike those in the last century. The big factory system is organized in huge groups or complexes of plants. As previously pointed out, its weakpoint consists in its very pursuit of maximum economies of scale, and it may be relevant here to mention that some scholars doubt if it will remain a rational factory system in the 21st century (see a series of treatises by Professor Tetsuro Nakaoka).

RELEVANCE OF JAPANESE EXPERIENCE

We have reached a tentative conclusion that, although developing nations may not have to start from the system of industrial production and technology based on the 19th century pattern of division of labor and collaboration, it seems they should not accept transfer of today's most advanced and biggest factory system and technology, but have to work out a third path to industrialization. For this purpose, it will be indispensable for them to mobilize the experience and wisdom of the populace latent in the traditional culture and society. This means discovery and utilization of the wealth of creativity dormant in the traditional culture. A problem is that the populace do not and cannot speak in the language of science. Developing their creativity, therefore, undoubtedly is the task of native scientists. Various attempts will have to be made at international cooperation for this purpose.

One of the difficult problems faced by developing nations in the process of their industrialization derives from the circumstance that, since they have imported various facilities and plants from more than one country, the intermediate product of one sector which could otherwise be used in the production process of another sector cannot be so utilized on account of disparity in standard.

Japan has also had a bitter experience in this respect, the difference in electric power frequency between the eastern and western halves of the country. As technology transfer is a costly undertaking, the choice tends to fall on a less expensive technology, inviting plural standards in a country, such as the railway gauges in India and the voltages in the city of Cairo.

Here is a case in China, which has come to our knowledge. At a locomotive factory, the staff produced a locomotive by themselves after going through many hardships, but one of the political leaders who looked at the product reportedly said it was not up to the specifications and refused to accept it.

The locomotive was not exactly as specified in the blueprint, but it did run satisfactorily. Here is the problem. Its success in running at all was the fruit of the ingenuity and endeavor of the workers at the factory, which certainly have to be appreciated. However, its failure to conform to the specification means that it did not satisfy the requirement of standardization, an indispensable mechanism for modern industry. Standardization makes possible simplification and minute segmentation of the production process and components, which constitute the very basis of any mass production system. Artisan-like perfection in unit-by-unit production is useless for horizontal development of technology, or integration of division of labor and collaboration on a national scale. This takes us back to the question, which we earlier touched on, of quality control through rational division of the production process and process control. In a huge country like China, perhapes they may not have to insist so much on standardization, as the Indian experience teaches us.

Therefore, in this respect, we have to inquire into the implications of the size of a national society. When she embarked on her nationalization, Japan had a population of 33 millions. England in 1851 had one of 20.8 millions. They were probably in an age when mesurements could be readily standardized, but one cannot totally deny the pertinence of standardization to the size and social integration of the population. In Japan, while international units of measurement are applied to industrial products, other units coexist with respect to land, housing, clothing and food. Their coexistence results in no inconvenience, but seems rather natural.

Although we can sympathize with the demand of peoples in pursuit of rapid industrialization for establishment of an internationally unified system of standardization, the only realistic way seems to be for each people to develop a system of its own, starting from where it is feasible. It is doubtful if unmediated introduction of international standards can immediately meet basic human needs in massive dimensions. Our knowledge and experience lack sufficient data and grounds on the basis of which to pass sensible judgment on this question. Hasty and easy pursuit of domestic standardization might only invite technological subordination, and we don't think this is a clever choice.

One of the conceivable approaches to solution of this problem may be to attempt, as a tentative step, supply of multiple types of components and products satisfying different standards. Indispensable for making it possible seems to be an industrial census. What embarrasses us in developing countries is that their elite, though well aware of their national problems, does not always have accurate knowledge of their current situation. Developing nations generally lack human resources to be assigned for collection of basic scientific data. For this very reason, it seems necessary to mobilize the knowledge and experience of the populace. This is what Japanese intellectuals have begun to take note of.

One of our major premises was that technology transfer was not just effective but indispensable for meeting developmental needs. To speak of the Japanese Experience in particular, there certainly is a tendency easily to attribute the "success" of Japan to the diligence and/or the dexterity of the Japanese. We have no grounds to deny this kind of argument outrightly. However, although dexterity or diligence in fact constitutes a precondition to the shift from agricultural to industrial society and ourselves we have stressed it, it has to be noted that "diligence" can mean different things to different societies. There must be widely different views as to whether there was no other alternative to this painful shift in value. As Max Weber said, man of our days dies tired with not of, life. Living in an industrialized society, or the high standard of livling it affords, does not automatically turn out the meaning of life. The reason why we raise this point here is nothing else than because we would like to ask if technology can assume responsibility for resolving all its consequences. In this respect, neither technologists nor scientists of Japan are so optimistic as their 19th century predecessors were.

Rather they are pessimistic, because industrialism has focused its attention exclusively on the mechanisms of machinery but almost completely ignored biological cycles and ecosystems.

Underlying there was a philosophy that the tyranny of nature had only to be overcome. Oriental philosophies and views of civilization are different, however. They have sought harmonization with nature. It is true that, in the East including Japan, this concept served to nip the buds of scientific thinking. We have to be wary of misevaluating the significance of modern western science and technology in the total history of mankind. There is no doubt about it. But it should not be allowed to develop into a science and technology cult. This is what the Japanese Experience tells us. The application of science and technology for technical solution of a given problem (in the sense it is solved by applying scientific principles) will eventually, if not immediately, give rise to another, more difficult problem.

The progress of science and technology always starts from one part of the whole, and never proceeds in a balanced manner. Because Tokyo was so much blessed with underground water that there was no urgent need for development of waterworks, not only industrial drainage but also sewage from households is now contaminating drinking water from wells, which once was abundant and clean. The unbalanced progress of science and technology goes on without relevance to the concern over the number of people who could be relieved of hunger with the sum of money spent for sending men to the moon.

This reminds us of the irony that the Zero fignters of the

Japanese Navy, which horrified the pilots of the U.S.Air Force during World War II, were carried from their factories to airfields on oxcarts. Technology in itself is always neutral, but the subject of its development does not have a neutral motive. Much less neutral is the result of technological development. Not so many scientists could give assuring answers today to the question if science and technology can always take responsibility for their consequences. In spite of all this, parts of science and technology useful for development should be picked out and utilized this is what the Japanese Experience teaches us as I see it.