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The Japanese Experience: The Problems and Attempted Solutions

1: Expectations from Outside

The United Nations University, in commissioning this project on the Japanese experience, observed that Japan, once an importer of modern technologies from the West, has now developed itself to the point of being an exporter of the latest technologies, and, further, that what it was that made such a transformation possible was a matter of great interest to developing countries.

At about the same time, a meeting of experts sponsored by the University released a document that concluded that theories of development were in a state of "disarray." Although it did not state explicitly reasons for the disarray, I would like to present some of my thoughts on the basis of experiences I had in sessions I attended at that function. First, developments invalidate theory; second, theories have long been questionable, but persuasive data to overthrow them have not been available; and third, though development needs have become diverse, theory has failed to keep up.

For these reasons, Japan has become the focus of attention among the developing countries, and I find this interest perhaps may have great practical value and, at the same time, it poses an exciting challenge: (1) Might the Japanese experience not be made useful in filling the information gap caused by the disarray of development theories? (2) Could it not provide practical suggestions to meet development needs?

Though their interests were too diverse for easy generalization, one thing seemed certain: too much attention was focused on Japan's "miraculous" post-war technological success; little interest was shown in the social and historical context in which transferred and domestic technology were able to flourish. Moreover, development in general tended to be discussed with technology in general, with no awareness of the particular and multifaceted relationship between them.

Technology can be discussed practically only on the basis of concrete data and for the purpose of discovering possible solutions to existing problems. Any discussion of technology that is too generalized tends to veer away from technology as such and slide into abstract arguments on policy and the international politics of technology transfer.

Such discussion may reflect their own national experiences, which are none too pleasant. Where technology transfer has already been more or less institutionalized through the ODA, the politics of technology may have proved both important and inevitable. In many of the aid-recipient countries, academic freedom to carry out scientific study of technology and development, which may reveal weaknesses and conflict in development policy, is restricted. Some intellectuals in these countries are calling for a moratorium on development.

Under these circumstances, the more urgent the development needs, the greater may be the danger of a political treatment of the problem and of neglecting to be alert to the inner mechanism of technology. In other words, by politicizing a problem that requires a technological solution, one might well be producing a result more harmful than beneficial.

As for the relationship between development and technology, just as there are different levels of development, ranging from the level of village or province to that of an entire country, even to the international level, so there are different levels of technology. This is an important fact to be considered when transferring technologies for the purpose of national development.

If technology is a means to development, it is undesirable that the end and the means exist in a one-to-one relation; it is preferable to have several means. Yet, a mature technology requires materials, processes, and equipment that are all standardized, and the methods, equipment, and technologies used in the manufacturing operations are also fixed. Thus, in the case of a transfer of a mature technology, the recipient country has little possibility of adapting or improving the technology. Here, then, the relation between the end (development) and its means (technology) must, in practice, be one to one. In other words, the end is restricted by its means.

That is where the problem of technology begins to emerge in a developing society. In order for a country to avoid the diseconomy of a technology transfer that would result from introducing a mature technology, it is important to (1) select a technology with a rich potential for expanding and upgrading the links among existing sectors of industry and (2) observe and gradually adjust the transferred technology to successfully meet the needs of country, region, and local community, both in quality and quantity. Technology modified in this manner to meet local conditions and needs is what we refer to as an intermediated technology, an alternative technology free from standardized pre-conditions and processes for operation.

In general, modern technologies are freely transferable but not always easily integrated. Therefore, the range of choice of technologies for transfer is usually limited. The possibility for a developing country to find a ready-to-transfer alternative or high technology suited to its own conditions is quite

limited. But a developing country often has no other way to solve its technology problems, hence the necessity for an extensive knowledge of technological science and technological history.

The view one often encounters of the general relationship between development and technology is too optimistic; it tends to exaggerate the diachronic and cross-cultural nature of technology and also to expect too much of technology's power of breakthrough. The impression is that the problem of development and technology has not been rightly grasped in all its implications. This seems also to be reflected in the way in which alternative technologies and intermediate technologies are frequently discussed. I believe a real understanding of the painful experiences of developing countries in the past 30 or so years is still not evident. There are gaps between expectations and realities and between wishes and capabilities with respect to development and technology, and therefore it is urgent a solution be found.

Because of the complexity of today's development problems, the information the Japanese experience might provide seems inadequate to meet the needs of developing countries. But because it is the experience of a late starter, it should enrich their knowledge.

As stated earlier, we will avoid here the politics of technology transfer as much as possible. The approach here is one free of non-technological values, and our aim is to present practical results from case-studies and avoid speculative and abstract reasoning. It is important to find opportunities for generalization, not the other way around.

Our hope is for a dialogue based on actual cases of technology transfer; it may not be possible to achieve all our expectations, as gaps in perception of the problem are bound to occur from country to country. But continual and multi-pronged efforts must be made to bridge these gaps.

Although the social sciences have working methods not bound by national borders, quite obviously, each social scientist has his or her own nationality. The way in which one investigates, constructs, and pursues work on a problem is to some degree rooted in the characteristics of one's native country. Therefore, in treating the theoretical handling of our problem, we must first determine what is common to the many diverse national characteristics.

Until now, however, efforts to do so do not seem to have met with success, at least not in the way we had expected. The present volume thus represents an attempt to cover the distance that separates us from this goal, a step that may be termed a methodological prelude to better dialogue. It is one of many possible methods that may be used to attack the problem and, consequently, is subject to correction and change. In any event, we do not advocate methodological exclusivity. Likewise, we do not wish to make the Japanese experience a dominant or universal model; but neither do we intend to minimize or ignore it.

Our methodological pluralism, therefore, does not exclude cross-national or diachronic analysis; both are necessary. But their descriptive powers concerning technological problems, even if not yet exhausted, have become increasingly unable to meet real needs and expectations. New problems that

can no longer be handled by earlier social science theories and new propositions have come to assume importance. This is why the Japanese experience seems to have attracted so much attention abroad as a case for study.

It should be understood that the social sciences, necessary and useful as they are, are not almighty. They can breed error, just as other sciences can. Unless it is realized that their validity is circumscribed by time and circumstance, whatever is scientific in them will be lost. The social sciences as discussed here denote an intellectual discipline based on the theorization of confirmed contemporary and historical reality and capable of making policy proposals.

Development problems can and should be solved finally and decisively only by each nation concerned. All we can do is to help other nations in their attempts to develop. Whether the Japanese experience is worth studying must be judged by third-world intellectuals themselves, and different nations may very well make different evaluations as a result of their different, often unique, development problems.

The results expected from a study of the Japanese experience tend to be exaggerated, and as knowledge of the experience accumulates, interest tends to diversify and demands to grow.

A gap may arise between what we can do to meet the demand for information and how much we want to release. Too little information may generate a too keen and unbalanced interest. A most important part of our effort, therefore, should be to prevent this from happening. It may be very difficult to acquire an accurate and deep understanding of another country, but the person who attains it will learn to know his own country better.

Our approach to the Japanese experience in technology and development began by classifying development problems on the basis of our own group's experiences in research tours to developing countries, in gathering scientific information, and, more important, in continued dialogue with intellectuals from these countries. We tried to elucidate how those problems were overcome in Japan or why some remain to be overcome. In a sense, our approach to development problems is provisional.

2: Japan's Response

Economy and Technology

Two views have characterized Japanese studies of the relationship between development and technology in Japan: (1) technology is a dependent variable of the economy; (2) technology possesses its own inner mechanisms that make it relatively independent of non-technological elements. I would like to expound the first view. As mentioned, in the middle of the nineteenth century, Japan was forced to open its doors to foreign trade and to establish diplomatic relations with the Western powers, which had already achieved their own industrial revolutions. Compelled to accept unequal treaties, Japan

was on the brink of being colonized. The Tokugawa regime, however, lacked the leadership necessary to surmount the crisis and preserve national independence. So it was up to the new Meiji government to build a strong modern state, through enhancement of the country's wealth and military power and through a series of political and social reforms. A popular slogan of the time was *Datsu-A Nyu-O*—"Withdrawal from Asia and Entry into Europe."

The Meiji government introduced modern technologies and spurred the nation's economic development, with the aim of building a capitalist economy at the hands of the state. The emphasis in industrialization was placed on a realization of self-reliance in weapons and arms supply, deemed necessary for both national defence and controlling domestic discontent. Because foreign currency was necessary to finance industrialization, the government established state-operated industries and factories, into which it introduced modern technology.

Although Japanese industrial technology was largely pre-modern in character until the end of the nineteenth century, a few state-operated factories were exceptionally equipped with imported modern technology and machinery, operating, however, to meet the needs of government, not of the general public. Economic rationality was belittled because domestically produced goods were higher in price and lower in quality and durability than imported goods. The state-run, bureaucratically managed factories proved unprofitable and were sold to the private sector. Because the change of hands involved not only equipment but also engineers and workers, the result was a large-scale secondary transfer of technology.

The military arsenals, which remained under state control, were better equipped and in possession of higher levels of technology compared to the other factories. The favouritism was also evident in the application of energy: the military had steam-power, while the private sector generally had access to only human power or water-power.

Thus, industrialization and the national formation of a modern technology network were brought to completion in Japan on the basis of a structural dualism—government vs. private; industry vs. agriculture; big enterprises vs. small; heavy industry vs. light industry and handicrafts; and central vs. provincial.

The view that technology is a dependent variable of the economy thus stresses the necessity of the modernization of Japan, for, without a modern economic system, technology could not have developed. It does not aver that the role of the government was of exclusive importance, because there was an active response from private interests. When, some 20 years after the Meiji Restoration, government enterprises were sold to the private sector, technology transfer ignited a great entrepreneurial boom. This centred on light industries, notably textiles and food processing, but paralleled or preceded the development of mines and railroads.

The Meiji government, nationalistic towards other countries, took an autocratic, "statist" position toward its own people. So what should have been regarded primarily as the economic evils of capitalism tended to be viewed as

political evils, and a chain of urban riots and peasant revolts resulted. It is worth noting, however, that antistatism did not necessarily mean a denial of nationalism among the Meiji Japanese.

Thus, Japanese industrialization, even if a capitalist development "from above," followed the historical path of light industry first, then heavy industry. However, the initial dualism between government and private enterprise in favour of the former remained in Japan's industrial structure. It favoured big business, which took over the government enterprises, and the gap between the big and the small came to be fixed not only in technology but also in the ability to develop technology.

Since the costs of a technology itself, and also of its development, are high, technology is subject to economic laws. Those who are late to enter a business are exposed to competition from those advanced in technology and in possession of the ability to develop it. Thus confronted both within and outside the country and in need of keeping abreast of technological innovation, the government and large private enterprises often separate parts of their technologies and manufacturing processes into new, independent companies to disperse risk and lessen fixed costs. Skilled workers also often become independent when business conditions are good, acting as producers and suppliers of goods required by the parent enterprises.

The diversity of smaller enterprises and their high technological standards are considered to have been the basis of Japan's strength in technology. Although some of the smaller enterprises failed to keep abreast of the parent companies in technology development and had to drop out from the ranks of subsidiaries or subcontractors, those that managed to secure a high-enough technological standard and the ability to enhance it were able to expand their transactions and stabilize their positions.

From the standpoint of the parent companies, this separation of processes enabled technological spin-offs that acted as buffers and a reorganization of manufacturing processes according to the logic of capital. In Japan, this kind of relationship has long been viewed critically as the source of wage dualism between larger and smaller enterprises and of the problem of the smaller being tyrannically dominated or exploited by the larger.

Although spin-offs have sometimes produced large, technologically advanced conglomerates that eventually succeeded in establishing world-class concerns, very many have, to the contrary, caused the parent company to fail in accumulating sufficient technological power when it was badly needed, resulting in bankruptcy. Both results have occurred in mining, which seems to indicate that mining demands two things to modernize: a complex system of technology and a careful study of how management should relate to that system.

Some economists maintain that dualism in management and in technology weakened during the period of rapid economic growth in post-war Japan. But I believe that dualism is evident in big factories even today; it can be found in the labour structure, that is, obvious gaps exist between the jobs, skills, wages, and welfare benefits of regular workers and those who are sub-

contracted or part-time. The latter do not have permanent employment, which results in a high percentage of job changing. The rapid progress of technological innovation and changes in the leading sectors have made it difficult to organize national unions in Japan. Labour unions have been overwhelmingly enterprise unions or in-house unions of mixed lots of workers.

In the sectors of technology that had achieved global maturity before 1960 and that have seen little change since, innovation has tended to take place only in such directions as enlarged scale and capacity of operation, increased speed of operation, and expanded automation in pursuit of merit of scale. This is particularly so where the technology has already been standardized. But in some areas, machine tools, for example, the ability to accumulate superskills and to develop technology is increasingly to be found in the smaller-scale enterprises. This is especially true in some of the most advanced technologies.

The dual structure, which an analysis from the first viewpoint would say characterizes the Japanese type of industrialization, thus may be said to persist even today, though its forms and dimensions have changed. However, the problem of dual structure in industry in the developing countries, subject as it is to both domestic and international industrial structures, must be treated as being qualitatively different from the problem in Japan.

A period of dualism may be inevitable for a country late in starting industrialization. When I accompanied a group of scholars from developing countries visiting factories in Japan, I noted they were impressed that the dual structure system encouraged competitive coexistence of the parent and subcontracting enterprises, not merely coexistence with little mutual contact. Further, at a factory making products for export, even though its scale was much smaller and the equipment used much older than at factories in the visitors' home countries, they saw immediately that good operational skills and high managerial capability more than offset any such disadvantages.

This was their "discovery of Japan." It should be kept in mind, however, that the Japanese approach—or the concerns prevailing among Japanese academics—cannot be applied to the developing countries without adjustments or revisions in the light of the existing conditions of these countries. What the Japanese take for granted is not always understood or accepted by other nations. This is due as much to differences in natural conditions, resource allocations, and production activities as it is to historical and cultural backgrounds, and the differences should not be reduced simply to development stages.

So, whether analyses based on the first view are applicable in treating the development problems of developing economies—and to what extent—must be re-examined through in-depth case-studies in each country and in each industry. This task can be accomplished only through international collaboration. Our study of the Japanese experience, therefore, for its conclusions and analysis to serve a useful purpose, must be supplemented. Though our work has benefited from co-operation with other countries, it has only just begun.

The Fixed Logic in Technology

The second view, that technology is independent of non-technological elements by virtue of its inner mechanisms, addresses directly the severe difficulties of technology transfer. This contrasts with the first view, which regards technology transfer as a natural historical process. While the first view addresses the aftermath of transfer, the second considers how the transfer begins and progresses and details of the practical and functional problems of technology at the shop-floor level. These aspects are supposed nearly independent of non-technological problems, of political and economic laws and customs.

Thus, the second position assumes that the inner mechanisms of technology, the laws firmly set in technology, cannot be arbitrarily changed or modified. Thus, when a technology is transferred with some political or other intention, this view facilitates the clarification of why it did or did not succeed, i.e., whether for technological or non-technological reasons.

For example, if a transferred technology encountered trouble after initial success, working on the basis of this second view, one would pin-point the trouble in raw materials, poor operation, maintenance and repairs, improper management or technology control, or in the general plan itself.

For example, before the Meiji Restoration, a commercial representative from the Netherlands, then the only Western country allowed access to Japan, stated in a secret report that the Saga clan in Kyushu was attempting to manufacture a steam-engine:

> The Japanese seem to simply assume that they can master this manufacturing technology, but the only equipment they have are poor furnaces and moulding factories. Iron of low quality is processed with poor machines and by unskilled workmen. They have a will to manufacture, but little means for it.

This brief report gives an idea of the technological picture of Japan at that time. Modelling their endeavour after a finished engine they had seen, members of the Saga clan set about to do nearly the impossible with the help only of a technical manual, but their supply of fire-brick was insufficient (because the Saga area had no natural resources), and they knew little about what the interior of a furnace should be and what temperatures were required. Further, they had little knowledge of what quality of iron to make and how to process it. What they did have was an immense desire; what they lacked was the means. There were too many obstacles: raw materials, fuel, instruments, machines, methods, to name those most prominent.

From what the Dutch representative observed (it remains unclear whether he was an engineer), it seems evident that a great gap in technology separated the West from Japan. Obstacles lay everywhere blocking Japanese efforts to adopt technology. Nevertheless, they remained convinced their goals could be achieved—no matter the problem—through mobilization of

all their traditional skills and abilities. Opinion may vary as to whether that was a mindless or an admirable position.

The second view recognizes that some technologies were already present in Japan, though of low standards, and attaches importance to them as the Japanese predecessors of modern technologies, even if they were of little direct use as they were then, and had to be wholly redesigned; their very existence made a great difference in the future of Japan and its development of modern technology.

In those pre-Meiji times, Japan was divided into some 240 large and small feudal domains, all variously endowed. Thus, it was politically impossible to bring together the empirical knowledge and skills that had been accumulated by carpenters, masons, builders, forgers, potters, and other craftsmen of different domains into a national technology plan. Moreover, Western scientific knowledge was regarded as serious political criticism of the system, and its students were in danger of conviction and execution for treason.

The rush to import Western science and technology began only about 30 years before the Meiji Restoration, when engineering experts armed with modern science were free to appraise and implement the empirical knowledge and skills of their predecessors without fear of conviction for political offence. The foreign experts later hired by the new Meiji government could not be expected to appraise and use traditional Japanese knowledge and skills, so all they could do was introduce their own technology as it was, a point we will discuss later in more detail.

Such was true even in the successful transfer of spinning technology. A foreign engineer, whenever and wherever he may serve, tends to be a believer in the transcultural and diachronic validity of technology. That is where his usefulness and his limits will be found. Regarding iron manufacturing in Japan, only the Japanese engineers were able to domesticate the transferred foreign technology. And, as is well understood, technology can spread only after it has stabilized.

Scholars holding the second viewpoint insist there is no leap in technology. They say that rapid progress in technology, whether vertical or horizontal, can be achieved only after proper and adequate operational and manufacturing skills have been accumulated. They are interested in the process in which accumulated technologies and skills come to be applied. Technologies concerning materials, processing, and design are developed individually before being integrated, and only after this process are theoretical levels of engineering and technology refined, and thus the applicability of the technologies is assured. Adherents of the second position grasp this process of technological development as one peculiar to each country, to each time, and to each enterprise or plant.

More important, this position is attentive to the role of labour as a factor of technology, especially to the indispensability of engineers and skilled workers. It has often been assumed that production and productivity gaps between countries, regions, and factories would be narrowed or altogether

removed if machines and equipment were standardized. The fact is, however, that conditions under which different factories operate vary widely, and the closing of the gaps may be far more difficult than imagined.

These differences should first of all be attributed to the human factor in technology. In the latter half of the nineteenth century, Japanese spinning factories adopted ring spinning, the most efficient spinning technology in the world at that time. The ring spinner was far easier to handle than the mule, and it was hoped that the new technology would raise production efficiency three to four times, as it had in Great Britain. In actuality, however, as an official report of 1903 declared, productivity in Japanese factories was as low as one-eighth of what it was in British factories, where even obsolete machines were in use.[9]

The report further describes the British spinning workers as professional soldiers and the Japanese as rabble, and attributes the Japanese weakness to the very short average terms of employment; most workers quit within two months of employment. Most obvious in the report is that, while in theory a farmer's labour is equivalent with that of an industrial worker, in reality, a farmer cannot easily make the transition from the soil to the factory.

A similar situation was evident in the watch and camera factories—where primarily originally agricultural labour was used—of some South-East Asian countries. In their first years of operation, the percentage of end products meeting standards was as low as a tenth what it was in Japan. What this shows is that farm skills and labour fall far short of the needs of industry and, not surprisingly, the work roles of factory workers and farmers are not easily exchanged. Because state-of-the-art machines require less skill from labour, the productivity gap between skilled and unskilled workers and between the new and old industrial nations has become narrower than when simpler machines and tools were in use. But the gap remains, and the apparent narrowing should not be misinterpreted; the latest machines, though efficient, are far more expensive than the ones they made obsolete. And throughout technology, the human factor, the skills and accumulated experience, are indispensable at any time, at any place, in any sector. As the machines and equipment change, so do the type and the substance of skills required to operate them.

In another example, there is a steel mill with the latest equipment which has an automated control centre that is notified of every activity in every process at the mill. If any process deviates from the programme, the centre is immediately informed. On one occasion, a process was found to be in trouble. The prescribed corrective measure was taken, but it had no effect and the trouble spread quickly downstream. Investigation determined that the other processes and the programme itself were functioning properly, and the trouble was found to be confined to the process that had shown misfunction.

Because the mill is wholly automated, the cause of a malfunction can usually be determined and remedied through an examination of records;

which, however, can be a two-week job. The search would mean suspended operations and perhaps customer demands for compensation for losses and delays. It could even mean having to remove some equipment for repairs.

So the mill in this case looked to veteran skilled workers for help, even to retirees. They were quickly brought in by chartered plane, and once there, closely checked the processes, paying close attention to sound, light, temperature, and the shapes of processed goods in order to determine the problems.[10]

Automated equipment is designed to fit the movements and judgements of skilled workers and will never favourably compare to human labour that is highly skilled and efficient. In a modern automated plant operated at a high degree of stability, the importance of human efficiency and skill may not be as great as it once was, but it remains a necessary ingredient of the manufacturing process, especially at the start-up of production and for maintenance checks. In the chemical industry, for instance, groups of skilled workers, now retired, have organized businesses to provide help when technology breaks down.

Needless to say, what is possible theoretically is not necessarily possible in practice. A manufacturing technology must be established under restrictions and conditions vastly different from those of an experiment, which usually can be stopped and resumed at any time. Science and technology differ greatly here, and thus a correct diagnosis will not necessarily lead to a cure.

3: Why Do We Begin with the Meiji Restoration?

The Sixty Years towards Self-Reliance in Technology

At the beginning of the present report, I presented my own thoughts on development and technology in post-war Japan, a theme not included in our project activities on the Japanese experience in technology transfer and development.

I included it because, during many of our discussions with collaborators from the developing countries, interest centred on that aspect of the Japanese experience.

But it must be kept in mind that the technological development in post-war Japan was possible only because of the nation's pre-war legacy of development in the technology network. This cannot be overemphasized because the favourable conditions for technology transfer did not exist only in Japan. In fact, Japan was unable to attain complete self-reliance in technology until after World War II, especially in the 1970s, but this was made possible only because it first progressed through the recovery of the pre-war level of technology development. The ability to absorb state-of-the-art foreign technology was ensured by the country's first regaining the pre-war levels in the technology-supporting sectors and services. This recovery was helped by technology transfers, but more important is that it took place along with

demilitarization. This differentiates the formation of the post-war technology network from that of the pre-war period.

The isolation and set-backs technology suffered during World War II caused Japan to lose much of its ability to develop technology, and the country fell drastically behind in this area after the war. Even today, Japan has much in common with many developing countries. The only difference is in the level and scope of national technology formation. That is why I have placed Japan as a front runner of the technologically less-developed group.

And yet, the Japanese experience differs from that of the presently industrializing countries in the method and time of technology network formation. In particular, the time difference has had much to do with whether technology transfer will prove easy or difficult.

Thus, our study of the Japanese experience in forming a national technology network through technology transfers should attend to the different phases of transfers, which corresponded with the changes in the level of technology in Japan. Consequently, initial attention must focus on the time when Japan began to absorb foreign technology, the Meiji Restoration, because this time factor influenced both the direction and the pace of the network formation.

The Meiji Restoration represented a political turning point. Though it was not a turning point of technology, it did pave the way for one. Only after the Meiji Restoration were there suitable conditions in terms of politics and socio-economics to domesticate and develop imported technologies. In the earlier cases of technology transfer, the Tokugawa regime had failed to create these conditions.

By the same token, the turning point in Japanese technological development after World War II would never have been reached without a series of reforms carried out as a result of another great political change, namely, the nation's defeat in the war.

The Meiji Restoration and the defeat in the war both clearly illustrate the relationship between technology and political and social factors. However, the political and social conditions of the restoration greatly differed from those of the defeat; the restoration was far more decisive for technology than the war as a turning point. That is, the Meiji Restoration represented an attempt by an agrarian society to turn itself into an industrial society, whereas the post-war development meant a change in direction and an upgrading of levels in a society that was already basically industrial. The latter experience thus was not primary, and as a secondary experience it was less painful and shorter than the first.

Technology Transfers Accelerated by Self-Reliance

Social and cultural conflict in Japan was far more serious at the start of industrialization in the Meiji period than after World War II. While the two periods are both characterized by a blind worship of foreign technology, and both experienced a flood of technology transfers, they differ in the way they

absorbed them. Regarding the post-war period, for example, the formation of a national technology had already been basically completed by the 1920s, and the technology transfer after World War II was completely in the hands of the private sector.

In the 1920s and again in the 1960s, the formation (and, in the 1960s, the recovery) of a national technology network did not lead to a rejection of foreign technology; rather, it made it easier to absorb higher-level foreign technologies; indeed, it accelerated the process.

In examining this historical background, let us first focus on the period from the Meiji Restoration (1868) to the 1920s. At this time, government involvement in technology and industry was relinquished in favour of business groups.

One thing the developing countries share with Japan is that, once having set forth on the road to industrialization, all have had to tackle social and technological problems common to once basically agrarian societies. On the other hand, some of today's developing countries could choose to reject industrialization, as some in fact have. This may be a commendable choice for some, but not for all. As for Japan, it resolved more than a century ago to abandon being an agrarian society, and the national consensus on this is worth special note. Although the nation had agreed on the transformation, there was no unanimity on how it should be accomplished. Even today there is debate regarding Japan's choice to industrialize. Obviously, however, Japan has gone too far to revert to being an agrarian society.

Nevertheless, rising agricultural productivity supported Japan's industrialization and its growing population. And now, agriculture has become increasingly dependent on industry for farm machines, fertilizer, and agricultural chemicals. Japanese agriculture today could not survive without industry. So the question arises as to whether countries that have chosen to remain agrarian can continue without facing insuperable difficulties.

This seems especially true for countries with rapidly increasing populations. Since the international environment when Japan struggled towards industrialization was quite different from that of today, the developing countries may never experience many of the difficulties and pains that confronted Japan, though they will likely face others. It is our hope in presenting the Japanese experience that they will learn whatever lessons might be helpful in steering them away from, or at least minimizing, those difficulties and pains.

In this study, particular attention has been paid to the view expressed by some of the participants in our project which says that a comprehensive study of the Japanese experience should begin with the Meiji Restoration as the primary experience of modernization in Japan, but that, in regard to technology, greater relevance (for the developing countries) is to be found in the period since the 1920s, when global technological monopolies came into being. We do not agree with this view, however, because, for one reason, monopolized technologies have always been the most advanced technologies, which are not always useful for developing countries. What is urgently needed now are intermediate or alternative technologies.

From Agrarian to Industrial Society

The transition from an agrarian to an industrial society undertaken beginning with the Meiji Restoration meant that farmers were now working in the manufacturing and service industries on a nation-wide scale. This transformation entailed a lifetime of effort in acquiring new skills and experiencing conditions that were entirely new.

In the initial stage of industrialization, farmers and workers can perhaps assume each other's tasks, but as industrialization progresses, the interchangeability of roles is gradually lost. A farmer can only hope to become an unskilled worker, and an industrial worker can only expect to perform well as a farm labourer, not as a farmer. For farmers, industrialization brought a process whereby they necessarily became principally farmers, agricultural specialists, no longer able to maintain sideline occupations. The change began with the Meiji Restoration and gradually spread throughout the country. Thus Japan became an industrial society, and it became impossible to return to what it had been.

During this period of social change, the role played by women from rural areas was great. In the textile-led transformation of Japan into an industrial society, females had begun to account for more than half the industrial labour force by around 1910. As light-industry development gradually gave way to the stage of heavy- and chemical-industry orientation, males began to exceed females in the labour market. Also, a little later in this period (late 1900s), more graduates of the imperial universities in Tokyo and Kyoto, who were expected to form an élite corps in the service of national interests, were choosing business careers in big *zaibatsu* corporations and banks rather than in the government bureaucracy.[11]

Nevertheless, juvenile female textile labourers, forced to work long hours under severe conditions, played a central role in Japan's development of self-reliance in technology. In families who had been squeezed out of their farm villages, the men's wages alone were not enough to support their families, and it was necessary for wives and children to earn what they could from odd jobs they could do at home. This phenomenon has been referred to as *zembu koyo* (whole-family employment), to be distinguished from full employment. This whole-family labour corresponded with the practice of young women labouring in the spinning mills, sending all their extremely low wages back to their home villages to support their parents.

This phenomenon and its related problems suggest the need to consider not only the economic aspects of technology transfer and development but also the social and historical changes that result. Thus, focusing on the technological development of Japan after World War II would not give an accurate and practical analysis of the Japanese experience. Such a study must begin with Meiji, when Japan was a late starter.

Part 2

Case-Studies