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Programme Document

The Japanese Experience Project:

A Résumé of Activities in 1979

Takeshi Hayashi

THE UNITED NATIONS UNIVERSITY

From the CHARTER OF THE UNITED NATIONS UNIVERSITY

ARTICLE I

Purposes and structure

1. The United Nations University shall be an international community of scholars, engaged in research, post-graduate training and dissemination of knowledge in furtherance of the purposes and principles of the Charter of the United Nations. In achieving its stated objectives, it shall function under the joint sponsorship of the United Nations and the United Nations Educational, Scientific and Cultural Organization (hereinafter referred to as UNESCO), through a central programming and co-ordinating body and a network of research and post-graduate training centres and programmes located in the developed and developing countries.

2. The University shall devote its work to research into the pressing global problems of human survival, development and welfare that are the concern of the United Nations and its agencies, with due attention to the social sciences and the humanities as well as natural sciences, pure and applied.

3. The research programmes of the institutions of the University shall include, among other subjects, coexistence between peoples having different cultures, languages and social systems; peaceful relations between States and the maintenance of peace and security; human rights; economic and social change and development; the environment and the proper use of resources; basic scientific research and the application of the results of science and technology in the interests of development; and universal human values related to the improvement of the quality of life.

4. The University shall disseminate the knowledge gained in its activities to the United Nations and its agencies, to scholars and to the public, in order to increase dynamic interaction in the world-wide community of learning and research.

5. The University and all those who work in it shall act in accordance with the spirit of the provisions of the Charter of the United Nations and the Constitution of UNESCO and with the fundamental principles of contemporary international law.

6. The University shall have as a central objective of its research and training centres and programmes the continuing growth of vigorous academic and scientific communities everywhere and particularly in the developing countries, devoted to their vital needs in the fields of learning and research within the framework of the aims assigned to those centres and programmes in the present Charter. It shall endeavour to alleviate the intellectual isolation of persons in such communities in the developing countries which might otherwise become a reason for their moving to developed countries.

7. In its post-graduate training the University shall assist scholars, especially young scholars, to participate in research in order to increase their capability to contribute to the extension, application and diffusion of knowledge. The University may also undertake the training of persons who will serve in international or national technical assistance programmes, particularly in regard to an interdisciplinary approach to the problems with which they will be called upon to deal.

ARTICLE II

Academic freedom and autonomy

1. The University shall enjoy autonomy within the framework of the United Nations. It shall also enjoy the academic freedom required for the achievement of its objectives, with particular reference to the choice of subjects and methods of research and training, the selection of persons and institutions to share in its tasks, and freedom of expression. The University shall decide freely on the use of the financial resources allocated for the execution of its functions. . . .

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THE JAPANESE EXPERIENCE PROJECT: A RESUME OF ACTIVITIES IN 1979

Takeshi Hayashi

THE UNITED NATIONS UNIVERSITY

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The United Nations University
Toho Seimei Building, 15-1 Shibuya 2-chome, Shibuya-ku, Tokyo 150, Japan
Tel: (03) 499-2811 Telex: J25442 Cable: UNATUNIV TOKYO

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1. Composition of the Report

This report summarizing the activities of the Japanese Experience (JE) Project during its second year comprises an interim résumé of the activities during the first two years and summaries of research findings by the leaders of individual sub-projects. This format has been adopted for the following reasons.

a. In view of the fact that past reports on the activities of the JE Project generally were scholastic documents presupposing very large amounts of background knowledge on the part of their readers, we became confident, through the various conferences sponsored by the United Nations University and other occasions for the exchange of research experience, that it was indispensable for the 1978 annual report, if it was to be truly useful for its readers, to include a historical sketch of the experience of modern Japan covering nearly a century. (*Japanese Experience,* no. 2, October 1979, issued by the UNU project team, Institute of Developing Economies, Tokyo.)

b. Therefore, the report did not outline the activities in 1978, and accordingly the résumé by the co-ordinator had to be read in conjunction with the reports on the individual sub-projects.

c. However, the sub-project reports were written in Japanese, and not all of them were translated into English or any other official language of the United Nations. In spite of keen demand for more extensive translation, English versions available at the end of 1979 number only 15. Therefore, we have no objection to their translation into any other language, as long as it is accurate. We should be very glad, however, if the translated versions bore credit references to the United Nations University and a few copies of each were supplied to us.

If, moreover, they were accompanied by comments on our work, based on specific

cases and experience, we should be even more grateful, because we regard our past activities as the first step in our "dialogue as a method," and we are ready to modify the focuses and problem aspects of our work through such dialogue.

2. Outline of Activities in 1979

Basic Character of the Project

2.1. The overall scheme of the JE Project is mapped out in the proposal I submitted to the United Nations University: for details please refer to our newsletter, *Japanese Experience,* no. 1, September 1979, copies of which are available upon request.

2.2. The JE Project has a five-year research agenda, of which the first two years were devoted to study in the areas of hard technology, and the second two to the realms of soft technology. The research intends to concentrate primarily on technologies transferred to Japan.

2.3. I stated above that we would use dialogue as a method, and two different levels of dialogue were assumed.

The first level of dialogue would be achieved through research conferences and seminars held both in and out of Japan, including such occasions jointly sponsored with sister projects of the UN University's Human and Social Development (HSD) Programme.

The second would consist of studies on specific areas of exported technology or industry for which the JE Project is responsible. If, for instance, Japan has exported the same technology to two different countries, a mixed team of scholars, researchers, practitioners, and engineers from the three countries will be organized to conduct field surveys in each country, and the findings will be transferred to the first level.

This plan is considered to be of a pioneering character as a study on the question of technology transfer. Although on various occasions the exchange of research findings at the first level has been provided since 1978, none of these exchanges has been sponsored by the JE Project, which is scheduled to hold the first such meeting of its own early in 1980, to which researchers mainly in South-East Asia will be invited. Its success would promise expansion of the range of participants, both geographically and in areas of specialization.

2.4. We are further aiming at formation of a new international consortium which would embrace foreign Japanologists (perhaps not the most accurate term) having

research experience in the tasks and subjects of this project and which is expected to facilitate collaboration by such new types of researchers.

2.5. We also intend to establish international forums on a bilateral basis for discussing, from multiple points of view and in specific terms, and exchanging information on problems involved in the relationship between technology and development.

2.6. The Japanese experience, if taken and studied in isolation, could have only specific and limited significance. However, the experience of any nation can only be specific and limited. Scholastic work would consist in examining whether or not something common can be extracted and generalizations made on many instances of such specific and limited experience. Certainly the Japanese experience seems to be a "successful" example of the transfer, transformation, and development of the technology of modern Western Europe, and this must be the reason so much importance is attached to this project.

a. To limit our frame of reference to industrialization, the case of Japan, as an addition to the "successful" cases of Western nations, the Soviet Union, and East European nations, will play a role in relativizing the instances in the so-called "North."

b. However, we had better be wary of taking industrialization as a synonym for "development," exactly because the concept of development is different from, though closely related to, that of growth. This is what the Japanese experience has taught the Japanese people.

2.7. When we launched this project to outline the Japanese experience, we pointed out that our attention would be focused on "labour and organization of labour." This may appear to be a peculiar, unusual approach, but we don't think it is, because, generally speaking, technology and labour are inseparable from each other; or because, in other words, one of the most important problems in developing countries today is that of employment and labour.

If technology transfer is accomplished for the sole purpose of facilitating growth, no employment-creating effect can be expected from it. "The sole purpose of facilitating growth" can be rephrased as "the sole purpose of utilizing resources." The rephrased expression implies that those who transfer technology are attracted by cheap labour alone.

2.8. This point draws our attention to the question of who attempts technology transfer or resources utilization, how, and for whom. Different combinations of "who, how, and for whom" can provide completely different effects of the technology transfer.

2.9. If the transferred technology fails to be linked to the endogenous, or if the gap between the transferred and endogenous technologies is too great (and the gap in equipment, i.e., the capital invested, is unsurmountable), there will take place neither accumulation of skills nor naturalization of technology, which are important elements to mediate between the transferred and the endogenous, and moreover the former will drive away the latter. In this event, the impact on society will be heavy. Although we know by experience that every culture has built-in mechanisms to absorb and adjust itself to shocks, if the transferred technology is designed, installed, and operated by people having a different cultural background, the function of absorbing and adjusting to shocks may be destroyed at the very roots.

The first and basic premise of our project is that all cultures are equal in value. Every culture is different from any other, but the difference never is the superiority or inferiority of one to another. To view the matter from the other side, the relationship between big and small cultures, or between central and local cultures, should not be the encroachment of one upon the other. Technology transfer should preferably contribute to easing tension and enhancing harmony between big and small or central and local culture. This, however, is relevant to political (or policy) problems involved in technology transfer. If, for the sole reason of the size of the population living in a given endogenous culture, the minority is subdued by the formalistic logic of majority rule, the wisdom that has been accumulated in that culture through long residence in its territory but cannot be readily appreciated by people with any other cultural background will be disregarded, and the disregarded endogenous wisdom will subsequently prove costly, sometimes too costly for anyone to pay for. This is particularly true with natural cycles and ecosystems.

This is the reason why the Japanese always place "the success of Japan" in quotation marks.

2.10. Certainly modern industrial technology was born in the natural, cultural, and social environments of Western Europe. Each of the constituent elements of modern technology put together and integrated there could also, obviously, be located elsewhere than Western Europe. However, the West European combination of those elements developed into something entirely apart from the origins of the individual elements, different from a mere array of them. To put it simply as the completion of the Industrial Revolution would not be incorrect in the present context.

Yet we would not agree to a view that for this reason modern technology cannot be transferred or developed elsewhere. Because its transfer to Japan did take place, though only through a painful process, it can be transferred to any other country, any other nation. This is the second major premise of the JE Project.

2.11. Nevertheless, as each national society greatly differs from others in natural

environment and cultural background, it may have to anticipate a different process of transfer with different kinds of pain from that experienced by Japan. To reduce the accompanying pains and accelerate the transfer, common points should be recognized in spite of differences in other respects. Yet what poses a problem here is that our knowledge of other nations and states does not necessarily have the same even level and depth that our knowledge of Japan has, and these differences prevent us from authentically evaluating the effectiveness and propriety of the way we epitomize the Japanese experience to the peoples who wish to draw lessons from it. Therefore, the results of our work to date can not be easily theorized.

Since their theorization is strongly urged, we nevertheless must attempt tentative epitomization. What we are attempting here is something much less ambitious than theorization, because what we have dealt with is confined to what we judged more important on account of the limitations of available financial resources and time. Moreover, only Japanese researchers have taken part in our work. To researchers specializing in Japanese affairs, the aim of this project seems to have been full of intellectual, moral, and inner challenges, but they had no sufficient experience with the realities of developing nations, reflecting the tradition of the academic community in Japan. It was for this very reason that they actively participated in this project, and we have been greatly helped by their intellectual sincerity.

Similar assistance will be rendered us at the next stage through multilateral intercourse with scholars from various foreign countries.

Before attempting theorization, we would like to list the areas of our activities.

Scope of the Activities of the Projects

2.12. The proposal (September 1977) was composed as shown below.

a. Identification of Problems

   i. Introduction of Foreign Technology
      — Imported technology and endogenous technology
      — Technology and society
   ii. Social Impact of Technology Transfer
      — Impact on way of life
   iii. Problems of Conceptual and Theoretical Frameworks
      — Diversification of concept of development
      — Social development at regional and national levels
      — Theory, classification, and characterization of technologies
      — Technological development and ecology

b. Themes of Work and Objects of Inquiry

i. Consortium Formation
ii. Themes of Work
- Leading technologies in the early development stage of Japan and their characteristics
- Lineage of imported technology, and social and cultural reactions to technology transfer
- Impact of technology and how it was, or failed to be, coped with
- Public and private utilization of technology
- Characteristics of technological development peculiar to Japan
- Problem of technology transfer from Japan
- International environment of technology transfer and economic sovereignty

iii. Case Studies
- Urban society and technology
- Rural society and technology
- Peculiarities of technology transfer in the industrial sector
- Ecological changes observed in the combination of resources and technology (regional case studies)
- Education and the dissemination of technology
- Technical training ensuing from technology export

c. Summary of Themes

2.13. Among the themes of work listed above, those of "urban society and technology" and "rural society and technology" will remain on the research agenda throughout the five-year duration of the project because of their particular importance and close correlation. Therefore, what is characteristic of the range of activities during the past two years is found in the theme "peculiarities of technology transfer in the industrial sector."

Reflecting our own evaluation that the assertion of methodological pluralism, which logically derives from the very nature of the project, is best realized in the inquiry into the relationship between industry and local community made in the regional case studies, so far a preliminary study on the case of Hokkaido (1978) and a case study on the Sanjo-Tsubame area of Niigata Prefecture (1979) have been made. The case of Hokkaido indeed is a typical example of the Japanese experience in that the introduction of foreign technologies, such as railway construction, mine development, and new areas of agriculture (livestock farming and cultivation of wheat and potatoes), was carried out under the guidance of foreign experts and at the initiative of the central government. However, the findings of the preliminary study made us consider it wiser to postpone the start of the main part of our study, and the case of Hokkaido was partially taken up in the regional case studies as a technology-transfer problem in

the mining industry (1979). Research in this direction will be developed on the opportune theme of the introduction of new agricultural activities (the cases of their failure and of their established success deriving lessons from the cases of failure, which led to the change in Japanese eating habits and the formation of dairy farming and the food-processing industry).

The case study on the cities of Niigata was intended to analyse the formation process of the biggest centre in Japan of hardware manufacturing, mainly concentrating on carpentry tools, and the world-renowned base of tableware making.

These local industries have one characteristic typical of Japanese industry at large in that they depend on other localities for the supply of raw materials other than fuel. It should be noted, however, that this area was once directly ruled by the Tokugawa Shogunate and prospered from the production during the farmers' slack winter season of Japanese nails out of iron brought back by river boats that carried textiles and grain on their outbound voyages. The main consumption centre of Japanese nails was Edo (the city now called Tokyo). Here one could find a link between industrial location and politics.

However, they were easily outstripped by Western nails. What the nail makers discovered after groping for a way out of the shock of this defeat was the production of Western-style tableware in Tsubame. Tableware from Tsubame is now faced with intense competition from Korean and Taiwanese products, and some of the manufacturers have sought relief by exporting their products to a West European manufacturer of a well-known brand. The case of Tsubame suggests what consumers' trust means to marketing, and at the same time illustrates joint activities of geographically clustered small-scale producers (the difficulty and importance of unifying quality and standards and of establishing trust in a local brand).

Sanjo excelled Tsubame in sales activities, which were undertaken along with and based on its experience in production activities, i.e., development of commercial marketing channels. However, the sharp-edged-tool industry of this city is losing the dominant position it once enjoyed – a consequence of its hesitation to introduce electric tools and relay them to other markets.

Okinawa ought to provide valuable data for a similar area study, but for a number of reasons nothing more than the possibility of a preliminary study on the region may be assessed in 1980.

2.14. The areas of work by the individual sub-project groups will be sketched below. However, as "summaries" by the sub-project leaders will constitute the latter part of this report, my sketches will mainly concentrate on what the individual summaries fail to cover sufficiently.

Urban Society and Technology

2.15. The transformation of Edo into Tokyo was an epitome of the changes that took place in modern Japanese society. Tokyo re-emerged with the unified presence of both authority and power as a result of the move of the Emperor from Kyoto to this seat of the new Meiji government. Previously, the power of the Tokugawa government and the authority of the Emperor had been geographically separated, the former located in Edo and the latter in Kyoto. They were integrated in a single capital city as a consequence of the political upheaval in 1868, the Meiji Restoration. The integration at the same time constituted politicization of the Emperor system as a symbol of authority.

The Meiji era was the period during which a new political power, replacing the Tokugawa government, which had lost governing capabilities in a dilemma between external and internal pressures, just succeeded in solidifying the basis of independence for Japan as a nation-state, though only through a zigzag path. In other words, like many other nations, Japan was faced with the threat of colonization. Reluctant to open Edo (Tokyo) to aliens, the Shogunate forced on Yokohama the role of Japan's gate to the external world. Yokohama, only a poor fishermen's village until then, was quickly urbanized after the end of the feudal system. The same was true of Kobe. We did not take up the new, quick development of the two harbour cities as a subject of study during the first two years.

Only Tokyo was taken up, for no other reason than the existence of the primate-city problem in developing countries. This problem, which certainly is a legacy of colonial rule, at the same time derives from the tendency of industralization to concentrate in localities where prerequisites are better met, to put it in rather simplistic terms. External economies or the development of infrastructure stimulate concentration and accumulation of technology. This tendency will stay on until the advantages of concentration come into an equlibrium with its disadvantages. However, it has to be pointed out in this connection that Japan under the rule of the Tokugawas had already been divided into over 240 administrative units, large and small, each with its own core city, and had a very well-integrated inter-urban relationship and urban hierarchy because the feudal clans, as administrative units, had been placed under the strict control of the central Tokugawa government. The Meiji government reorganized the clans into about 40 large provinces for the sake of more rationalized and efficient administration, which was one of the objectives of the new rulers.

Tokyo thus became the bridgehead of modernization on the Western European pattern, the base of bureaucratization and industrialization (importation of foreign technology).

There were two vectors at work. One worked in the centripetal direction opposed to feudalism and provincialism, and the other in the direction of Westernizing Tokyo to establish national sovereignty. In the latter context, the political élite of those days

believed that remodelling Tokyo after the pattern of London by erecting modern stone buildings was first of all indispensable for revision of the unequal treaty forced upon Japan by gunboat diplomacy. From there derived the plan to array Ginza Street in brick and the conception of a new civic centre. The former was like modern urban planning found in any developing country today, which is undertaken at the sacrifice of the poor and executed under loose control, resulting in the accumulation of accomplished facts working against the execution of, and crippling, the plan. That is to say, the plan itself was only an unrealistic dream. The same can be said of the plan for a new civic centre. The area where Western-style office buildings were supposed to be concentrated was found to have ground too soft to bear the weight of modern buildings. The failure obviously involved the problems of technological standards and financial resources, but one thing that is certain is that the plan was pushed ahead without a preliminary survey.

The "urban society and technology" group, which has inquired into this gap between planning and execution by incorporating analyses from the viewpoint of socio-economic history, has not yet sufficiently studied the relationship between urban planning and municipal finance. In designing modern buildings for Japan, foreign architects did not fully take into account the big earthquakes that occur in Japan and simply applied their own technology (for fireproof stone buildings). As a consequence, the Nobi Earthquake in 1891 revealed the weakness of stone and brick buildings, and the time-consuming and costly traditional technique of warehouse construction came to be reappreciated instead. The group has not touched, either, on the question of how modern Western architectural techniques were domesticated. In respect of materials, ferro-concrete had not yet been invented, and the field of basic (i.e., non-commercial but highly beneficial to the nation and society) scientific research which constitutes a part of geophysics (in which Japan is among the world leaders today) was still undeveloped in this country. Basic, non-commercial research was the task of national universities in the Japan of those days.

To demonstrate the prestige of the new government both domestically and externally, Tokyo contemplated a variety of urban remodelling plans. The model was taken from London at one time, and from Paris at another. One of the plans envisaged arrangement of central government offices, an exposition site, Rokumeikan (a building for social gatherings for ranking government officials, foreign diplomats, and other members of high society), the National Diet, the Ministry of Foreign Affairs, and the Ministry of Justice along the street running from the central station to the new Imperial Palace.

On account of the inadequate geological survey which preceded it, the plan was only partially materialized; and the urban planning carried out by German engineers ended in failure.

A similar instance was the plan for a model urban district of fireproof housing,

patterned after Regent Street in London, to be laid out in the area, including Ginza, Kyobashi, and Tsukiji (where a concession for foreign residents, completed in 1868, was located), that had burnt down in a great fire in 1872 (involving 3,000 houses and 50,000 people).

The urban poor who had inhabited a large part of the area were forced out so that brick buildings could be constructed in the vacated district, but, within a year of the start of their construction, some began to build permanent wooden houses there, obliging the remodelling plan to be modified. The enormously high prices of the new buildings, entailing rather stringent payment conditions, compelled previous dwellers of the area to leave.

Western architectural techniques were introduced and established for the construction of individual buildings (especially in the form of colonial-style wooden houses), but not as elements of urban planning. Other than in a few exceptional instances, including that of Sapporo (Hokkaido), it was not until the reconstruction of Tokyo after the Great Earthquake in 1923 that they began to be extensively used in urban buildings, and their full blooming had to wait until after the Second World War, which reduced many Japanese cities to ashes.

I would like to stress here that the successive failures of urban remodelling plans for Tokyo were the result of endeavours to demonstrate Japan's achievement in Westernization with an eye to facilitating revision of the unequal treaty which had been forced on Japan.

Upon reopening her doors to the rest of the world, Japan suffered from a new imported epidemic: cholera, which resulted in annual casualties of over 100,000 for successive years. The reluctance of foreign missions in Japan to co-operate in the establishment of a quarantine system was referred to in the annual report for the preceding year. On the other hand, the same foreign missions were strongly urging introduction of urban sanitary facilities. Recalling that "highways, bridges, and rivers are the root; water service, housing, and sewerage are the branches and twigs" expressed the fundamental ideology of the pragmatic bureaucrats of the new government, one can see how earnestly the government, placed in a semi-colonial state, tried to comply with foreign demands for fireproof urban remodelling and for water service, to cite but a few examples.

The one million residents of Edo had been served by a number of water service lines completed under Tokugawa rule. Their maintenance had been inhibited by the political instability prevailing since the last days of the Shogunate and the administrative disturbance that followed it. This circumstance had seriously affected the sanitary environment of Tokyo. Fortunately the topography of Tokyo made available well-water of good quality in many parts of the city. This very advantage, however, made it impossible for the "city" of Tokyo to be developed into an

artificially designed social space and instead invited its amorphous expansion. Furthermore, excessive pumping of underground water to meet the needs of developing industry invited subsidence in some areas, and the contamination of drinking water (from wells) by sewage from households increased with the expansion of the population, resulting in the coupled emergence of sewerage and waterworks problems.

In Yokohama, where Japan's first waterworks system was built, the British engineer in charge, well aware of the straitened finances of the municipal authorities, did not include in its service area the district known as the Bluff, where the foreign community was located, because pumping water up to that height would have required expensive equipment and, moreover, good well-water was available there. It would be unfair to neglect reference to the presence of a man of such capability and foresight among the hired foreign engineers.

Urban management, including the control of waterworks and sewerage systems, can never effectively function if it is unilaterally enforced by the administration. This is especially true where the urban area is quickly expanding. The urban management of Tokyo was propped up from underneath by the unique urban community organizations known as *chonaikai*. These are multi-purpose organizations, each deliberately formed by all the households inhabiting an urban block or a ward. Complementing official administration and aiming at the common welfare of and amity among the community members, they have served as effective units to make proposals and demands to the administration. Viewed from another angle, they constitute substructures contributing to the saving of administrative costs, which would otherwise have to be borne by the citizens, and to improvement in the efficiency of administration. Incidentally, many Japanese intellectuals today are critical of *chonaikai*, because the community organizations served as terminal monitoring mechanisms subordinate to the fascist administration during the Second World War and, after the war, as vote-gathering machines for conservative parties. Viewed in the light of urban problems in developing nations, however, not all of their functions seem to be plainly negative.

Since the stratification that the urban community intensifies in a new direction with the progress of industrialization is inevitably reflected in dwelling areas – even if it is not of sufficient intensity to induce the definite organization of *chonaikai* – urban riots are often mediated by such community consciousness shared by the dwellers of a ward. As a typical instance of this trend, the "rice riot," regarded as the peak of urban riots in modern Japan, has been analysed with particular reference to the case of Kanazawa, a provincial city.

An important question is how provincial cities, especially those linked by rail to Tokyo, were affected by the major political changes that took place. After the more than 200 feudal clans, big and small, that had existed under the Tokugawa regime

were reorganized into 40-odd administrative units, the urban hierarchy of clan capitals, connected by highways and waterways, underwent a drastic reshuffling. Urban studies so far undertaken in Japan are not necessarily compatible with the orientation and level of the JE Project in addressing this question.

We have arrived at a point where the pre-modern history of at least one provincial city – Kanazawa – can be confirmed in its relationship to Tokyo and from where its adaptability to modernization (i.e., industrialization), together with the limit of this adaptability, can be assessed. Traditional artisans of the city, who previously had the samurai class as their customers and therefore mostly suffered a decline, were able to revive their skills at a higher level by trying their hands at new materials, new designs, and new products, and by doing so they succeeded in making Kanazawa one of the foremost centres of traditional artisanship in present-day Japan. We have traced their personal histories.

Generally speaking, traditional provincial cities were more sensitive to the impact of foreign technology – to which the JE Project attaches particular importance – and less capable of absorbing such technology than the newly developed cities like Yokohama, Kobe, and Sapporo. Research on those provincial cities is scheduled for the third and subsequent years.

Rural Society and Technology

2.16. Those who have borne the burden of Japan's industrialization, in reality, are the farmers. Japanese industry has especially relied on farm villages for the supply of its labour needs.

As the process of industrialization after the Meiji Restoration extended over a wide range, including both light and heavy industries, what is the implication of the fact that rural Japan was able to provide all these sectors with work forces? To put it in a few words, it implies the multi-faceted character of Japanese farm villages, or that Japanese farmers could not have survived unless they had laid their hands on tremendously diverse areas of work, even though still undifferentiated and unsophisticated. This was due to the peculiarity of Japan's natural features whereby some parts of the country, which ranges from subtropical to subarctic zones, permit 12-months-a-year farming while others are too cold for more than one crop a year. Rural villages are broadly classified into mountain villages, flatland (*sato*) villages, and seaside (riverside) villages. It would inevitably have been disadvantageous for a village of any category to specialize in any single area of production, given the underdeveloped stage of marketing and traffic facilities in those days. Therefore, villagers could survive only by engaging in many other lines of production besides agriculture. Thus any farmer, to accomplish his task as a farmer, had to employ himself in at least five or six other vocations at the same time, such as hunting (or

fishing), raising livestock for use in farm work, smithery, carpentry, irrigation, earthwork, dyeing, and food processing. For a female villager, spinning and weaving were added to this list. The skills required to facilitate farming could not satisfy the needs of modern industry by themselves; but it cannot be over-emphasized that they did provide a foundation for the needed skills. When the farmers were employed by industry as workers, or when they were faced with the diversification of vocations and jobs accompanying the development of industry, the areas of work in which they had to engage were not entirely new to them, apart from the level of vocational skills they had attained. What were new to them were the methods by which work was done and the ways of life and labour.

In Japan, where rice culture constitutes a predominant part of agriculture, irrigation is of decisive significance to production. Accordingly there was an institutionalized accumulation of hard and soft technologies, built up over centuries. Therefore, in spite of a need for new technology, modification of the established practices to admit it was almost hopelessly difficult in regard to adjusting the conflicts of interest between farming households or between farm villages. As a consequence, there were constant disputes over the water rights, which were established as private rights (with villages as superior proprietors) through those disputes.

The Tokugawa regime was scrupulous in the handling of irrigation issues, and individual clans spared no technological efforts, investing enormous amounts of funds in successive irrigation projects. The irrigation practices established on that foundation remain basically unchanged even today.This does not mean that the government since the Meiji Restoration has belittled the importance of river improvement and of irrigation. Rather the contrary is true. The government did, and still does, make enormous investments in farm improvement. I would by no means claim all these investments have proved effective. To industrialization, agriculture always poses a new and important problem. The population of Japan has trebled since the early Meiji years, and having to maintain agricultural productivity to adequately feed this expanding population has constantly presented new problems to the government.

The Meiji government tried to promote sheep breeding in Japan with the goal of replacing imported wool with local products. During the early Meiji years, Western-style suits and uniforms were very expensive and provided by the government to civil servants, so that they became status symbols. The attempt to produce wool locally ended in complete failure, because of the uncompetitiveness of Japanese-made wool in the world market. This, moreover, was an area unknown to Japanese farmers.

Similar failures, though not so conspicuous, have been experienced in almost all areas of Japanese agriculture since the Meiji Restoration, including the introduction of new varieties, improvement of seeds and soil, and research on fertilizers, to cite but a few

examples. In spite of our awareness that experimental cultures and dissemination activities by agricultural experiment stations have played truly important roles, we have stayed away from these subjects so far, because we have focused our attention on hard technologies, typical of which is imported irrigation technology.

Irrigation systems in Japan use as sources of water supply, besides rivers as in many instances, reservoirs (as in Shikoku) and creeks (as in Kyushu). We have already done case studies on the introduction of a new technology in the basin of the Azusa River, a small stream between mountains, and on the experience of a village in Nishi Akashi, Hyogo Prefecture. Whereas creek-based irrigation, cases of which are found in Saga Prefecture and elsewhere, has yet to be studied, individual instances are too complex and diverse to permit easy outlining, and in the case of reservoirs the scale factor determines the outcome to a substantial extent. The difference between the presence of many small reservoirs and that of a single big one is reflected not only in rural communities (the relationship between villages) but also in individual farm management and home economy.

The introduction of a large-scale irrigation system inevitably accelerates integration of existing farms for physical reasons. This process is determined to a great extent by the state of leadership prior to the introduction of the new technology. Here we cannot generalize on how able leaders come into being and grow up: but the difference is obvious between villages that have such leaders and those that do not.

Whereas the qualification of a leader is evaluated by such criteria as knowledge of local circumstances, experience, and the capability of negotiating with local and central governments, the absence of big landlords in this particular area of the mountainous prefecture of Nagano made it rather difficult for large-scale irrigation-drainage and farmland consolidation projects to be proposed at the farmers' own initiative. Instead they were planned by and in accordance with guidance "from above" by the prefectural government and its local outpost, and modified and adjusted by the administration. Hastening to draw a conclusion, one cannot deny that this circumstance subsequently made the farmers individualists and markedly dependent on the government in their mentality. In this respect, the case of Nagano presents a sharp contrast to that of Hyogo Prefecture, in which farmers are so independent that the New Year's Day meeting of all in the village determines by mutual consent the restrictions on the scale of cultivation for the rest of the year on the basis of the water level of their reservoir.

Comparison of these instances where technology was implanted in endogenous industries with those, like the case of the Ishikari basin in Hokkaido, where new technology was introduced to help cultivate undeveloped land would provide an interesting contrast, but this is not our immediate task. At this moment, we are concerned with the problem of water, because it is pertinent to developmental needs (especially food production) in many countries.

One thing we would like to draw attention to is that in no area of technology transfer was greater importance attached to the participation and views of local inhabitants than in that of agriculture. In the case of the Azusa basin, for example, their empirical knowledge of rainfall, topography, geography, water volume, and floods was fully utilized to ease the age-old tension between the farm villages in the basin, and large-scale technology (including geographically extensive preliminary surveys which it entailed, and modified and complemented by local farmers' wisdom and experience) was indispensable for the development of electric power which accompanied the irrigation project. Large-scale technology only became feasible when it was combined with smaller-scale appropriate technologies. This process took more than a decade to complete, but the farmers' experience had been built up over a period of more than a century.

Our next question is how to evaluate the fact that these developmental projects have resulted in a reduced number of households specializing in agriculture. While it is in part due to the progress of mechanization of farming, this trend also advanced side by side with urbanization. Agricultural administrators were preoccupied with filling the income gap between agriculture and industry, but they did not expect to accomplish this task by increasing the number of part-time farmers.

In suburban farm villages dependent on massive inputs of fertilizers and energy, non-food agriculture is expanding to meet new needs among the increasing urban population. Rising land prices (and the resultant increase in the assets of suburban farmers) induced by the progress of urbanization are further tempting farmers to seek non-agricultural use of their land.

Industrialization is the starting point of urbanization, while agriculture is the mother of industry, but it has to be noted that industrialization can transform agriculture in this way. Japan is self-sufficient neither in industrial raw materials nor in food. This is the paradox of Japan as a highly industrialized nation.

Whereas the two sub-projects so far referred to will continue their dialogue, mediated by their past fruits, the following paragraphs will touch on other sub-projects which came to a tentative end in the first two years of the JE Project.

Iron and Steel Industry and Transportation

2.17. The iron and steel and transportation sectors of industry are essentially separate from each other, but both were significantly transformed by imported technology.

The iron and steel industry, as exemplified by sword making, had maintained since

ancient times high technical standards, 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 the Meiji Restoration, there had already been a number of talented engineers whose knowledge, though still based on practice rather than theory, had been advanced enough to enable them to understand 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 the Japan of those days, large-scale local production would have been uneconomical, but the government had taken note of the high price of steel and economies of scale.

The government's policy was at the same time affected by the international situation then prevailing. As the threat of colonization was imminent and national defence was an urgent task, the building of modern weapons, especially warships, was considered a national need. The failure at Kamaishi and the repeated ones at Yawata were due to mistakes in the very design and siting of the mills. Above all, the foreign engineers had ignored such major limiting factors as the scarcity of resources in Japan and the level of 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 the Japanese themselves 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 endeavours 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 industrialists 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 US 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 the Japanese steel industry certainly built up its technology, moved toward completion of the most up-to-date large mills located on littoral sites, and engaged in integrated steel production.

This was more than 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 the economy and from the training of endogenous engineers, scientists, and skilled workers. The highly automated steel mills of present-day Japan may appear to have work forces no larger than are necessary to perform production 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 function without the balanced systematic development of those related subsectors.

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 action (even if it is just pushing a switch), a worker 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 the New International Economic Order. Whereas it is well known that big steel mills in Japan at first depended on raw materials supplied from China, iron ore from Malaya later came to have considerable significance. Our research activities cover these cases of resources development as well.

We are also dealing in this sub-project with the question of the reorganization of labour necessitated by the introduction of a technology irrelevant to the past accumulation of skills.

In the fourth year, after preparatory work in the third (1980), we will undertake a four-way comparison between Japan and importers of steel-making technology from Japan – i.e., Brazil (the USIMINAS steel works), Malaysia, and Qatar.

We stated in our report of last year that "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 compensation to the former samurai class in public bonds, though this 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 the railways and unify their gauge for political and military reasons.

Although we can never over-emphasize the important role played by the railway system in the modernization and industrialization process of Japan, the 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 was likely to impede rail development, since the financial resources of the government were naturally limited; the government therefore had to allow local railways to remain under private management.

From a technological point of view, railway construction involved many areas in which endogenous technology could be utilized or adapted, such as surveying, bridge spanning, and tunnel excavation; and it could capitalize on the existing store of skills except in the area of equipment, including locomotives, signal arrangements, rolling stock, and rails. Moreover, Japanese gained the ability quite early on 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, however, the planning of train timetables 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: 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 wind were not accurately anticipated.

As for marine transport, many foreign ships had visited Japan since the reopening of her doors to the world outside, and they revealed a conspicuous lag in 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 ocean-going 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 need 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 shipping operator manage a joint venture with ships leased out by the government also proved unsuccessful. Thus it decided to foster a private shipping enterprise (the launching of the Mitsubishi Company), because on the occasion of the dispatch of troops to Taiwan, as well as during civil war, foreign vessels might refuse to transport troops and war supplies for diplomatic and political reasons.

The Mitsubishi Company, which would eventually undertake various ocean-shipping services with 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 able to drive away Indian products from the Chinese market. For the intensity of the impact of this development on farmers in western Japan (whose main side crop was cotton), refer to the report on the shell-button industry by the sub-group responsible for small-scale industries.

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 large scale. Thus road construction is an area to which technology transfer came late. 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, as under 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 those at which 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.

Mining Industry and Technology Transfer

2.18. In no area has the transfer of foreign technology attained such directly visible successes as in that of mining industries. It has brought about new groups of high-performance machines for drainage, ventilation, and conveyance, facilitating the replacement of human labour with steam power. Viewed the other way around, however, the successes meant that workers' skills had reached their limit, and the transfer of drainage, ventilation, and conveyance techniques enabled their accumulated skills to be fully utilized. As major mines had been placed under the direct administration of the Shogunate, free domestic movement of the work force had been guaranteed, which, along with the organization of mining works having a specific subculture, in turn had assured uniform skill standards throughout the country.

The fact that Japanese mastered the new techniques in a matter of a few years, even though the technology transfer and the installation and start-up of machinery and equipment were accomplished by foreign engineers, testifies to the high level of endogenous skills. Furthermore, as foreign technology was imported on a large scale, some mining machinery items began to be locally manufactured in a little over ten years.

This sequence of developments has so many implications: (i) the technological gap between Japan and Europe was very narrow; (ii) the imported mechanisms were sufficiently close to the endogenous know-how for Japanese smiths and other skilled craftsmen to master them by observing real examples without knowledge of underlying scientific theory or engineering principles; (iii) the imported machines were so expensive that Japanese products, even though inferior in quality and performance, could adequately replace them for practical purposes; and (iv) although large and heavy machinery still had to be imported, the technical standards of local products were steadily improved until their manufacturers became fully able to stand on their own.

The export of mining technology from Japan started with the establishment of the South Manchuria Railway Company early in the twentieth century. Backed up by an abundant supply of funds, the technology domesticated in Japan was combined with the most up-to-date and most advanced technology in the world, resulting in the development of a number of original techniques.

In those days, both in Japan and in Manchuria (the present-day north-east region of China), a problem was posed by the conflict between, on the one hand, autonomous working units of workers having advanced skills and safety know-how integrated into unique internal organizations and, on the other, a "free" labour system which the development of mining technology in itself demanded as a mechanism to facilitate it. The workers, for their part, formed something like a Japanese version of the Luddite movement, which took place in Britain between 1811 and 1817. The conflict arose

because the traditional system – whereby each small group of workers contracted a certain assignment – had, from the management's point of view, become a hindrance to the expansion of production, as the mechanization and sophistication of facilities within mines had advanced and, further, because the mine owners' expansionist policy tended to be pursued with little regard for safety and sanitation. In Manchuria, no sufficient supply of mining workers was locally available, and labourers were brought over from the far-away Shantung province of China. The recruiters of workers became subcontractors, but a very high separation rate prevented fostering of a sufficiently large skilled work force, and this circumstance served to accelerate the mechanization and rationalization of the production process. Eventually, after more than 20 years, the job-contract system was partially taken over by a personnel-management-contract system and production became stabilized at a high level; but then Japan was defeated in the war and withdrew from Manchuria.

We have already pointed out that mining is the sector of industry where the effect of technology transfer was most significant. It also is an area where the conflict of transferred technology with the traditional labour organization occurred most early and, as the Japanese experience in China revealed, where systems of work and management incompatible with a modern organization of labour had to be coupled with modern equipment if no steady supply of free labour was available. The fact that this awkward coupling was formed in a colony has many implications, but we have been obliged to refrain, for the time being, from analysing all of them. The many problems we have had to leave untackled could be properly handled only through joint research with Chinese scholars.

Worthy of note here is the fact that the Meiji government legally prohibited foreign interests from developing or redeveloping metal or coal mines in spite of the urgency of the task. It may be too hasty to refer to this policy as an early example of claiming national sovereignty over natural resources, but at least one thing is certain: had Japanese mines been developed by foreign entrepreneurs, the Japanese mining machinery industry (and consequently the later development of the mechanical industry) would have presented an entirely different outlook. Further, as this undoubtedly would have invited an inflow of good-quality but inexpensive labour from China, where coal-mining work based on Western technology had established itself, an element of ethnic conflict between the endogenous work force of Japan and the Chinese would have been built into the industry. This is only a supposition, from which we should refrain so as to be faithful to academic propriety, but it does not represent too wild an exercise of the imagination. Of course, we are not presenting it here out of any moral or political motive.

Textile Industry and Technology Transfer

2.19. It may be well known that the national textile industry was the one that most

typically represented the early phase of the industrialization of Japan. Out of its two major subsectors, 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 then the other and many technical and management difficulties were surmounted, silk eventually found for itself a domestic market, and cotton fabrics began to be exported. In the field of silk reeling and weaving, incessant technical improvements covered all stages of production from mulberry culture and silkworm raising to not only the details of reeling machines but also dyeing and quality control, and the peak of these activities came closely before the 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 long-time labour of female workers, especially those recruited from poverty-stricken farm villages.

The sub-project team responsible for these industries was divided into two small teams working in parallel by different methods. Comparison of scales of business management (between the UK, the US, and Japan) attempted in the process of reviewing management history led to a number of interesting discoveries. The mechanisms for the improvement and dissemination of silk yarn production techniques were econometrically compared with the Chinese experience. Thus one team concentrated on multilateral comparison, while the other traced the process of development from traditional to modern spinning, with respect to equipment and technology and to the specific aspects of the recruitment and on-the-job training of the work force. The latter represents the orthodox approach of Japanese academism.

Here again, our adherence to methodological pluralism is definitely maintained.

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 different parts of the country ended in 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 centre.

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 economies of 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 income.

Japanese spinners, like the American ones, were able to pursue economies of scale, but the British were not. Because spinning in the UK had begun as a co-operative undertaking by farmers, no factory could outgrow the site allocated for it by the village owning the factory. Further, because it started in the form of a co-operative movement, no managers at any level were remunerated 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.

What is stated below is a personal view of the co-ordinator. I may be wrong. As I am ready to correct my errors, readers are cordially requested to give their comments on my view.

Both large factories (including spinning mills) and small ones (reeling mills) are found to be characterized by thorough division of labour according to the sequence of processing, if one pays attention to the organization of labour therein. This characteristic helped accelerate the 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 labour to the motions of machinery.

In this respect, modern spinning mills in India, where skilled labour was at first utilized according to 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 rational division of the manufacturing process according to the function of machinery resulted in an increase in the number of skilled workers mastering the procedures and skills of the related stages of work, and, further, in an improvement, though gradual, in their remuneration. In India, on the other hand, the division of the production process had to be based on the social segmentation of the caste structure rather than 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 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 property, and this tendency prevented ready arrange-

ments for personnel substitution. Here we can point out a relationship between technology and labour and one between labour 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.

Small-scale Industries and Technology Transfer

2.20. Small-scale industrial sectors are too diverse to permit ready outlining. What is certain is that they depended mainly on the labour of the urban poor (especially the cheap labour of the old, juveniles, and females working at home), were undertaken by cottage enterprises, and exported the bulk of their output. Typical product items of these industries were matches, soap, glassware, and other handicraft goods.

Characteristically, in spite of their urban background, these industries could have been readily shifted to rural areas where necessary conditions were met.

As examples of these industries, the shell button, optical lens, bicycle, and clock/watch manufacturing sectors have been examined. Readers may wonder at our choices – which range from a handicraft sector suitable for home work or farmers' side jobs to an assembling industry based on a certain level of social division of labour and even a highly sophisticated precision machinery industry – and their wonder would be quite justifiable, but we would like to assert that they are relevant to the level of development of industrial technology in Japan.

The material for shell buttons, for instance, was abundantly available in Japan but had not been utilized. It came to be used by a foreign entrepreneur, who established a factory in Kobe to produce and extensively sell, both in and out of Japan, shell buttons under a European brand name. A former employee of the factory mastered the production process, divided it into many steps, each of which could be accomplished with simple tools rather than machinery or equipment, and introduced the manualized process to his native village, which interestingly was in one of the areas deprived of its important source of side income by the import of Indian raw cotton. Further, the fact that this technology transfer was achieved by a manufacturer-wholesaler who himself had a stake in the production process provides an important hint for the inquiry into the agents and channels of technology transfer. The same can be said of the production of optical lenses (and subsequently of binocular frames).

A major problem in the local production of bicycles was posed by ball-bearings. A breakthrough in this aspect was achieved by the engineer-manager of a small factory which is still soundly operating today. In other words, large-scale industrialization would be impossible without the presence of a large group of smaller enterprises

having high technological standards. This aspect of technological development in Japan is often overlooked by foreign (and sometimes by Japanese) observers. And the skills of workers employed by these smaller enterprises are far more extensive and intensive than those of employees of big, modern factories, each assigned only a small fragment of an integrated production process.

The case of the clock/watch industry is profoundly pertinent to the culture of modern industrial society in many respects. For instance, Japanese railways and broadcasting stations are reputed world-wide for their punctuality. The strict disciplining of the Japanese in regard to time is believed to have been accomplished in school, military service, and railways, and anyhow it certainly was inseparable from the diffusion of clocks and watches. However, it is said that what contributed even more to making timepieces familiar to a majority of the Japanese population was silkworm raising. This important side work in farm households required scrupulous care of the feeble creature. Here is the reason why wall clocks and thermometers established their presence even in the remotest villages.

Wrist watches, especially imported quality products, used to be a small item of property, or even a status symbol, before the war. Today they are nothing more than a kind of accessory. The biggest demand for watches now comes from the younger generation. Supported by the remarkable extent of diffusion of watches, the age of quartz timepieces began in Japan. The scientific discovery of the principle that quartz could provide a far higher level of accuracy than a spring had been known about across the world. Then why was the industrial production of quartz watches successfully achieved in Japan but not in Switzerland, Japan's teacher of watch making? Here is our answer. The Swiss watch industry was mainly dependent on the sophisticated skills, which had attained an artistic height, of assembling and adjusting carefully selected components procured from a wide range of parts manufacturers. It was impossible, however, for watch assemblers to mobilize so many master artisans for the production of a newly developed version. In contrast, Japanese watch manufacturers, employing not only precision machinery engineers but also scientists specializing in physics, electricity, and other fields, achieved the innovation by coupling the fruits of their research with the traditional integrated system of production. It is the established practice of Japanese manufacturers to have highly educated engineers experience what is going on in the shop, or to keep planning and designing engineers and shop technicians undifferentiated from each other. This practice facilitates numerous improvements in the individual fragments of the production process, and prevents engineers from becoming conscious of a class gap separating them from workers. Japanese trade unions are organized on a company-by-company basis, and future members of top management also belong to the union in their early years with the company.

No immediate conclusion can be reached as to whether the practice represents crystallization of the experience of Japan as a technology-importing nation, or is rooted in the social structure and culture of the nation, or is the combination of both.

3. Interim Theorization

With gratitude for the many comments so far offered on our work, we would like to attempt some theorization – or, rather, a rearrangement of our findings in preparation for future theorization, something much less ambitious than theorization as such.

The Role of the State

3.1. 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 on 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 their way. 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 development projects, or infrastructure undertakings.

The hiring of many foreign engineers and experts was a major expenditure: many of them were paid even higher salaries than cabinet ministers, but much was learned from them. We do not mean that all their advice and proposals proved effective – we have already referred to a number of failures which resulted from excessive trust in their scientific or technical knowledge. As we quoted in our annual report of last year, Kageyoshi Noro, who was a capable engineer and scientist, said that, 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 is there a possibility of success." Noro was the man who identified the cause of the trouble in the foreign-designed Yawata Iron Works as being use of the wrong kind of fuel, 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, pragmatic bureaucrats were recruited from the former samurai class.

Here again we have to touch on the negative role of the government. It was typical 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 favour of industrialization, but here in fact was a pitfall. The rationale that they served the national interest justified all business activities, and was apt to give rise to the notion that the sacrificing of individual citizens' interests could not be helped. This was the private-industry counterpart of the authoritarianism of the pragmatic bureaucrats. They had in mind the state, but not the people. What is now considered a classic example of the consequence of their mentality is the pollution caused by the Ashio copper mine, an early predecessor, as it were, of the case of the Minamata disease. Shozo Tanaka (1841-1913), a politician who untiringly denounced the unreasonable acts 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 their right to live in safety.

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 to degeneration from inside, and frequently businesses increase their pollution damages by trying to cope with them in secret.

According to one scholar, as far as industrial facilities are concerned, the problems of environmental pollution can be completely solved technologically, 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 will be utilized.

Institutionalization of Science

3.2 One important reply to the question of 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 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 the very beginning. Hiroshige pointed out that such international activities had begun during the final quarter of the nineteenth 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 as dissociated from each other as they are now, although there still are some interactions between them) and that of today, the advantage for late starters is not as great as it used to be. Further, as far as technology is concerned, such an advantage is not necessarily great anyway. In fact, the 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 at 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, in this regard, is self-reliance. Let us give one example. The littoral integrated steel mills, which embody Japan's foremost steel-making technology, could not necessarily be transferred elsewhere with any benefit 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 weak points. Therefore, there is no guarantee that transferring them to any other country would result in profitable production at a given steel price level in the international market. As earlier pointed out, this kind of huge, modern equipment can be economically operated only with the assistance of 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 requirements for both quality and quantity. The technology "institutionalized" in this particular factory is supported by these peripheral units, without whose support no prompt remedies would be possible if an accident or trouble were to occur. The greater a plant in dimensions, the more complex its operational control. Its operation can be neither readily suspended nor restarted. Trouble in only one segment of a huge plant may entail suspension of the whole production process or even destruction of

the plant. In past instances, accidents have often been 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 risk, 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, inevitably experiencing what repeatedly occurred in Japan in her early decades of industrialization.

After all these requirements are met, there will still remain the problem of labour, whose training is so difficult that, in the case of Japan, more than half a century was taken to secure an adequate qualified supply. Although late starters are supposed to have an advantage in this respect too, labour development should be sought in the direction of solving the employment problem. Today's large-scale technology and factory systems have no background in nationality or culture, unlike those of the last century. The factory system is organized in huge groups or complexes of plants. As previously pointed out, its weak point 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 twenty-first century. (See a series of treatises by Professor Tetsuro Nakaoka.)

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 ninteenth-century pattern of division of labour 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 dormant creativity. A problem is that the populace does not and cannot speak in the language of science. Developing their creativity, therefore, is undoubtedly the task of native scientists. Various attempts will have to be made at international co-operation for this purpose. We are already planning to undertake in 1981 triangular or quadrangular joint surveys (comparative studies to discover and solve problems) on a number of countries to which the same technologies have been transferred from Japan. They are planned as our modest first step in this direction.

3.3. 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 a disparity in standards.

Japan has also had bitter experience in this respect: namely, 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.

A case in China has come to our attention. 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 factory workers' ingenuity and endeavour, which certainly have to be appreciated. However, its failure to conform to specifications meant 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 labour and collaboration on a national scale. This takes us back to the question, touched on earlier, of quality control through rational division of the production process and process control. In a huge country like China, perhaps, people may not have to insist so much on standardization: something 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 million. England in 1851 had one of 20.8 million. They were probably in an age when measurements 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, instead seeming 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 to develop their own system, 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 judgement on this question. Hasty and easy pursuit of domestic standardization might only invite technological subordination, and we do not 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 to making this possible seems to be an industrial census. What embarrasses us in developing countries is that their élite, 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.

3.4. A major premise for our project was that technology transfer was not just effective but indispensable in meeting developmental needs. To speak of the Japanese experience in particular, there certainly is a tendency to easily 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 outright. However, although dexterity or diligence in fact constitutes a precondition to the shift from agricultural to industrial society – and we ourselves have stressed this – it has to be noted that "diligence" can mean different things to different societies. There must be widely different views as to whether there is no other alternative to this painful shift in values. As Max Weber said, man of our days dies tired with, not of, life. Living in an industrialized society, or with the high standard of living it affords, does not automatically afford us the meaning of life. The reason we raise this point here is that we would like to ask if technology can assume responsibility for resolving all its consequences. In this respect, neither technologists nor scientists in Japan are as optimistic as their nineteenth-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. The underlying philosophy was 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 mis-evaluating the significance of modern Western science and technology in the total history of humankind. 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 that 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 proceeeds in a balanced manner. As we pointed out with reference to urban society and technology, exactly because Tokyo was so blessed with underground water, there was no urgent need for development of waterworks, and now not only industrial drainage but also sewage from households is contaminating drinking water

from wells which once was abundant and clean. The unbalanced progress of science and technology goes on without reference to the concern over the number of people who could be relieved of hunger with the sum of money spent sending men to the moon.

This reminds us of the irony that the Zero fighters of the Japanese Navy, which horrified the pilots of the US 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 many scientists could give reassuring answers today to the question of whether 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 — and, as I see it, this is what the Japanese experience teaches us.