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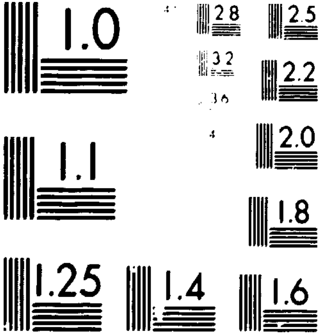

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TECHNOLOGY PLANNING IN INDUSTRIAL PLANNING PROCESS — A CRITICAL ISSUE IN TRANSFER OF TECHNOLOGY

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Technology Planning in Industrial Planning Process:

A Critical Issue in Transfer of Technology

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Introduction

Most of the developing countries have been making impressively rapid capital formation during the last two decades. Average rates of growth of Gross Domestic Investment in the 1970's were 6.4 percent per annum in the low income countries, and 7.0 percent per annum in the middle income countries. The shares of GDI in GDP also increased from 18 percent to 26 percent in the low income countries and from 21 percent to 26 percent in the middle income countries during the period of 1960 to 1979.(1) This fact seems to indicate that the developing countries have been increasing rapidly the capital stock and raising the capital intensity per worker since obviously the growth rates of GDI exceed those of labor force in all the developing countries. As long as we are concerned to the growth rates of GDP in the world in the 1970's we find out that these are higher in the developing countries than in the developed countries; average growth rates of GDP in the low income countries was 4.7 percent per annum compared to that of 3.2 percent per annum in the industrially advanced countries.(2) In spite of these relatively encouraging performance of economic growth in the developing countries, there have been increasing concern to the ways how they developed technological basis of their own for further facilitating the growth performance.

It is well known that the industrialization of developing economies has been pursued by transfer of technology and institutions from the industrially advanced countries. The dependency on foreign technology is nothing new in the processes of industrialization among late-starters. As Nathen Rosenberg pointed out, "the U.S. in the nineteenth century was a major beneficiary of the technological progress which had already taken place in Great Britain. In large measure, her economic development in this period involved the transfer and exploitation of British techniques."(3) Similarly in the case of Japan's industrialization in the period of the 1850's to the present, we can undoubtedly claim that "the factor most directly responsible for the change was probably Japan's wholesale adoption of innovations based on Western technology, especially in manufacturing and transport."(4) The transfer of technology from the West to Japan, however, involved more complicated problems than that of the U.S. from Great Britain since Japan as a non-Western country had to confront with cultural and social adaptation in effectively utilizing imported technologies from the West. A locomotive came to Japan together with the system of railways, and industrial machinery with that of the factory production. More than these dimensions were added to inevitable adoptation of free market-oriented mechanism of production and distribution. The degree of Japan's technological backwardness in the mid-19th century was so obvious in many respects that she misunderstood modernization as Westernization and industrialization as imports of the Western technology as such. Japan imported hurriedly and indiscriminately Western technology and institutions regardless at all their appropriateness to the prevailing conditions at that time of Japan. It was therefore natural that Japan made many false starts in importing whatever appeared to be useful for attainment of her national goals, namely, modernization and industrialization. Its consequence was costful but useful lessons for Japan regarding how a false start could be easily made and also how the false start could be corrected.(5)

In the transfer of technology from Great Britain to the U.S., Rosenberg stressed the significance of borrower's wisdom concerning to selection and modification of technologies to be imported. It is in the first place selection of what to be imported, i.e., to borrow some techniques rapidly, others more slowly, and perhaps yet others not at all. In the second place, he emphasized the decisive importance on modification of importing technology to adapt it in the prevailing conditions of importing countries. "New techniques frequently require considerable modification before they can function successfully in a new environment. This process of modification often involves a high order of skill and ability, which is typically underestimated or ignored. Yet the capacity to achieve these modifications and adaptations is critical to successful transfer of a technology."[6] Combining together the historical experience of the U.S. and Japan in their attempts at making the transfer of technology succeeded, we can draw out the notion of indigenization of imported technology in the recipient country. We conceive the whole process of the transfer of technology as an expanding cycle of three continued steps of adoption, adaptation and indigenization of technologies and institutions to be imported.

This paper aims at seeking for strategies to enhance the social capability of a nation for strengthening technological basis of the country. In doing so, we shall deal with practical implication of the social capability by introducing some genuine cases. Secondly, quantitative assessment of the social capability will be presented in order that strategies for increasing technological fundations in developing economies may be identified. Thirdly, a short case study on technology planning will be introduced from the development of the metal processing industry in Central Java in Indonesia. Finally, a conclusive remark will be given.

1. Social Capability and Technology Planning

In theoretical terms, the concept of social capability is closely related to the "residuals" in growth accounting, which is expressed as follows: GY = a GK + b GL + GR. Here K and L represent conventional inputs of capital and labor respectively, and G means growth rates. The growth rates of GNP or GY cannot be fully explained by the conventional inputs only, and there are always some extents of residuals (R). Given a target of GY, it will be achieved by a combined totality of K, L and R. GK-GL is an indicator of changes in capital intensity per worker. It is a generally observed trend that GK-GL increases in the process of industrialization, but the behavior of GR have not yet fully analyzed in the growth accounting. However, we can safely argue that larger the GR is, the smaller GK-GL can still bring about higher GY, and GR tends to be higher at advanced phases in industrialization. Let us examine these changes in K, L and R in the development experience in Japan's industrialization.

Japan's industrialization began in 1868. The period 1868-85, however, was the one in which a transition from fragmented feudal states were consolidated into a modern nation-state with the imports of the Western institutions including the establishment of the modern market economy. During this period of the pahse I, considerable false starts were inevitably made since Japan thought modernization as

Westernization and she pursued industrialization by indiscrimate and inappropriate importation of Western technology.[7] The phase II (1885-1904) was marked by the initiation of import-substitution industrialization together with an attainment of the self-sufficiency in food supply. The major driving force was the traditional sector which produced the most important export goods such as raw silk and tea. In the phase III (1904-1919) the industrialization advanced rapidly in the production of consumers' goods, which gradually became to replace raw silk and tea to cotton textile products manufactured by large-scale factories. We consider this phase as the primary export substitution from the traditional to modern sector products. Towards the end of this phase, the growth rates in the agricultural sector appeared to slow down considerably, resulting in an increasing extent of food imports from overseas. The most important characteristics of the phase IVa was the beginning of the import substitution of producers' durables based upon the growth of the exports of the modern sector production of consumers' goods. In the phase IVb, the progress of the import substitution of the producers' durables reached to a stage of the secondary export substitution in which the exports of producer's durables gradually began to replace the exports of consumers' goods produced in the modern sector.[8]

Table 1 Major Phases in Japan's Industrialization: 1885-1965 (%)

Year	1885-1904	1904-1919	1919-1938	1953-1965
Phase	II	III	IVa	IVb
GNP (GY)	2.6	3.3	4.9	9.6
Labor Force (GL)	0.6	0.6	1.3	2.0
Productivity (GY-GL)	2.0	2.7	3.6	7.6
Capital Formation (I/Y)	9.7	14.8	18.4	27.0
Capital Stock (GK)	1.9	3.2	3.5	7.8
Capital Intencity (GK-GL)	1.3	2.6	2.2	5.1
Residuals (GR)	1.6	1.6	2.6	5.6
GR/GY	59	50	52	58

Source: International Development Center of Japan, Survey on a Long-Term Economic Cooperation Baseed on Development Phases of Developing Countries (Keizai Hatten Kyokumen-betsu Choki Kyoryoku Hoshin Chosa), IDCJ, Tokyo, 1982, p. 24-26.

Table 1 reveals that GY, growth rates of GNP, clearly and acceleratedly rose from the phase II to the phase IVb, accompanied by simultaneous increases in labor productivity (GY-GL), capital intensicty per worker (GK-GL), and also by a rising growth rate of residuals (GR). It is quite impressive to observe the fact that GR used to contributed to GY by 50 percent or more throughout the four distinctive development phases in Japan's industrialization. What sorts of implication can we draw out of these findings with regard to the industrialization of developing countries of today? As mentioned at the beginning of this paper, the ratio of I/Y in the developing countries in the 1970's was notably high; about 26 percent on average. This ratio is somewhat equivalent to that of Japan in the phase IVb. Considering the phases of industrialization in the developing countries, we may argue that Japan was successful to make progress in industrialization by relatively smaller I/Y in comparison to the developing countries of today.

Let us, therefore, examine further the growth patterns between Japan and the selected Asian developing countries.(9) Thirteen countries in Asia from which we could obtain necessary data are classified to four groups by employing the shares of the manufacturing sector in GDP. The bench-marks for grouping are the ranges of less than 10 percent for phase I countries, 10-17 percent for phase II countries, 17-23 percent for phase III and 23 percent or more for phase IV countries. The phase I group includes Bangladesh and Burma, the phase II group with India, Sri Lanka, Pakistan and Indonesia, the phase III group with Thailand, Philippines and Malaysia, and finally the phase IV with Korea, Taiwan, Hong Kong and Singapore. Although the bench-marks used here are admitted by so crude and rough that it is certainly not possible to analyze beyond trends of growth variables. However, the grouping based on the phasening proposed here seems to be consistent to our general understanding of the relative levels of economic development in these countries.

Table 2 Patterns of Industrialization in Asian Countries (%)

% Mfctr in GDP		<10	10<17	17<23	23<
Phase		**I**	**II**	**III**	**IV**
No. of Countries		2	4	3	4
GY	1960-70	3.1	4.6	6.6	9.1
	1970-78	3.5	4.8	7.2	8.6
	(Japan)		2.6	3.3	4.9
GL	1960-70	1.8	1.8	2.3	2.8
	1970-78	2.0	2.1	2.8	2.6
			0.6	0.6	1.3
I/Y	1960	10	13	15	15
	1970	13	17	22	28
	1978	16	21	27	30
	(Japan)		10	15	18
GK	1960-70	5.2	6.6	8.1	12.1
	1970-78	4.9	6.6	8.1	11.1
	(Japan)		1.9	3.2	3.5
GY-GL	1960-70	1.3	2.8	3.3	6.3
	1970-78	1.5	2.0	4.4	6.0
	(Japan)		2.0	2.7	3.6
GK-GL	1960-70	3.4	4.8	5.8	9.5
	1970-78	2.9	4.5	5.3	8.5
	(Japan)		1.3	2.6	2.2
GR	1960-70	0.3	0.9	2.0	2.6
	1970-78	0.3	0.9	2.1	2.4
	(Japan)		1.6	1.6	2.6
GR/GY	1960-70	10	19	30	29
	1970-78	9	18	33	28
	(Japan)		59	50	52

Source: See Table 1, p. 31-32.
Countries in each group:
Phase I: Bangladesh and Burma;
Phase II: India, Sri Lanka, Pakistan and Indonesia;
Phase III: Thailand, Philippines and Malaysia;
Phase IV: Korea, Taiwan, Hong Kong and Singapore

Table 2 reveals that annual average growth rates of GDP (GY) rise when the phase shifts forward. In the period of 1970-78, for example, they changed from 3.5 percent in the phase I, to 4.8 percent in the phase II, to 7.2 percent in the phase III and to 8.6 percent in the phase IV. GY in the four phases of Asian countries appears to be impressively higher than GY in the relevant phases in Japan's industrialization. The same point can be ovserved in the changes in I/Y. In 1978, the values of I/Y in the Asian developing countries in each group were nearly twice as large as those in the equivalent development phases in Japan. Also, I/Y in each phases has shown a consistently rising trend during the last two decades. In the phase II group, it rose from 15 percent in 1960 to 27 percent in 1978, and in the phase IV group from 15 percent to 30 percent in the same period. Naturally, therefore, we can expect a very rapid growth of capital formation. GK in the Asian countries seems to be nearly three times higher than those in the equivalent development phases in Japan. This fact then lead us to conclude, as shown in the levels and changes in GK-GL, that capital intensity per worker in the Asian countries grew up by a tremendous pace in comparison to that in Japan. Because of this, the observed differences of the growth of labor productivity between Japan and the Asian countries appear to have widened in comparable development phases; in the phase II GY-GL was almost the same between them, but it widened in the phase III, and further undoubtedly widened in the phase IV. Finally, there is a clearly rising trend in GR in the Asian countries in each development phases, as was so in Japan. GR increased from 0.3 in the phase I group to 0.9 in the phase II group, also to 2.0 in the phase III group, and finally to 2.5 percent per annum in the phase IV group, showing an interest coincidence of Japan's GR at 2.6 percent per annum in the phase IVa in her development. GR/GY, namely contributions of GR to GY, in Japan was from the beginning strikingly high at 50 percent or more. This may reflect the differnece in the initial conditions between Japan and the Asian countries. Because of the relatively high GR, Japan could make shift from earlier phases to later ones even though GK-GL was smaller than in the Asian countries. Those observation and anlaysis may allow us to conclude that the Asian developing countries in the earlier phases such as the phase I or II ~~may~~ might be able to accelerate the GY by emphasizing the great importance of strengthening GR.

It is said that dominant channels of technological transfer in developing countries of today , foreign direct investment and the supply of foreign plant, equipment and machinery and its associated inputs.[10] If this takes place, and it is indeed taking place in most of the developing countries, higher values of GK-GL may occur even when GR is very low. Sixteen African countries in the phase I achieved GK-GL at 4.8 percent per annum in the period of 1970-78, while GR in this period was negative at minus 0.6 percent per annum. This may represent an excreme case, but in general GR in the phase I countries as a group tends to be at an order of 0 growth.(11) Yet, GK-GL in those countries are quite positive at an order of 3-5 percent per annum. What does this imply in terms of transfer of technology? It may not be an exaggeration to refer this situation as a total technological dependency on foreign countries. If an adaptative process of imported technology can make successful progress, producing appropriate technology to the prevailing resource endowments and organizations in the importing countries, even relatively low levels of GK-GL may raise GR so that GY-GL will be increased and higher GY can be attained.

So far, we have been concerned to demonstrate the importance of GR in industrialization. Now it is necessary to consider some qualitative aspects of the residuals. We believe that the residuals in the growth accounting method involve three elements which are mutually interdependent: knowledge of technology, institutions in which the technology can be effectively employed, and human resources which will combine technology and institutions together.(12) A quite simple but very illustrative example of the regiduals in reality can be drawn from the beginning stage of modern textile industry in Japan. Japan had to import all the textile machinery and equipment for factory production from the West, together with European instructors who trained Japanese workers how to use imported machinery. The foreign instructors blamed the Japanese trainees because the latter got easily exhausted themselves training. A careful observation of the training program revealed the fact that the machines imported were too large for the Japanese workers since those were designed to suit to tall European workers while the heights of the Japanese on average were much shorter than those of Europeans. A modification which was simple but very effective was to place a wooden steps in front of each machines so that the heights, thus physical positions, of the Japanese workers could be adjusted to the size of imported machines. Little additional capital investments were needed (small GK) and there was no change in GL, but an increase in labor productivity (GY-GL) was gained from this modification. Almost no change in GK-GL took place in this case. The ability of discovering the simple modification seems to be a core of adaptation of imported technology from the West.

In the transitional phase of Japan's industrialization the government built model plants based on the large machinery imported from European countries, and encouraged the people to join in the government pursuit in promoting rapid industrialization. The Report of the National Convention of Sugar and Cotton Textile Manufacturers in 1880 appealed to the government, stating that:

> We find it very necessary to improve the methods of production by adopting innovations.... However, we have not yet reached a stage in which we can employ the extremely costly cotton spinning machinery currently used in England and America.(13)

The government had to recognize how the false starts had been made by adopting inappropriate technology to the prevailing conditions of the country at that time. The Kogyo Iken which is considered as the Japan's first Ten-Year Development plan was published in 1884. In this document, the government proclaimed its policy on technological development in the following manner.

> Having carefully studied the present economic conditions of the nation, we have reached an important conclusion... It is not the time to promote any large-scale enterprises. ... At the present, therefore, it is crucial to advise the people not to undertake any promotion of enterprises which are inappropriate to the amount of capital they have, but rather they should be advised to pay more careful attention to improvements in their methods of production... We must also direct the people to postpone their establishments of factories with large machines imported. Instead, they should currently make improvements in the machinery they have been actually using, and thus bring about gradual progress in these undertakings. In short, it is important to make progress with whatever they have now, and draw forth the willingness for careful learning of each entrepreneurs.(14)

It was not merely a matter of coincidence that the first spurt in industrial growth in Japan took place along with the publication of the Ten-Year Plan of 1884. The nature of technology planning based on the improvement engineering seems to be quite clear in the document. This was followed by the people. When Japan began to manufacture textile machinery in the late nineteenth century, she had to import iron and steel as input materials. The import components in the manufacture of those machinery were so large that the production costs were inevitably very high. The reduction of production costs, thus the prices of manufactured machinery, had to be urgently achieved for the growth of factory production of textile goods. Then, it was discovered that "it was possible to substitute wood for iron in beams of the machines, so long as the joints were made of iron. A significant cost reduction was achieved."(15) When the cotton textile industry in Japan began to engage in the primary export substitution (a shift from the exports of traditional rural products to that of urban modern factory products), Japan had to import raw cotton from overseas. It was this dependency on imported cotton that had been making it difficult to gain overseas markets by challenging against the British textile products. In this situation, the Jpaanese cotton textile industry pioneered in scientific cotton blending, "i.e., turning out a deisred quality of cloth based on using the cheapest possible varieties of raw cotton. (One has the feeling that the British, at least at that time, considered the method <u>infra</u> <u>dig</u>'.)"(16)

The adoption of technology plan based upon the improvement engineering can also be demonstrated by a failure of the US TV manufacturers in penetrating in to Japanese markets. When ZENITH TV sets appeared in Japan for the first time, the manufacturer was confident in expanding its sales in the Japanese market. There was a very rapidly rising interest among Japanese consumers in purchasing a TV set. The size of the ZENITH might be quite suitable for the size of average American houses, but it was too big to an ordinally house in Japan, which was regarded as a "rabit hatch" by a report of EC. The manufacturing technology of a TV set was imported, and the earnest efforts were made to reduce the size so that even a Japanese family living in the rabit hatch could comfortably place it in their small room. It was the attitude of an innovative imitation of foreign technology which brought about the real success in the electric appliance manufacturing industry in Japan. All these practical examples can be summarized as follows:

> No major innovations were involved in any of these improvements, but their economic impact has in all instances been considerable. Improvement engineering (and innovative imitation) reduces the real cost of imported technology by making it more productive. At the margin it will permit the adoption of some techniques that otherwise would not have been profitable. If, by means of these efforts a technique is made more economical, it could also result in a greater domestic and foreign markets, leading to otherwise unexploitable economies of scale. The very act of improvement engineering can also raise the quality of certain categories of workers. It is largely an activity of "carefully taking apart and putting together a little better"; it is concrete and directly related to production, especially when compared to basic research. In contrast to the pursuit of core innovations, this type of activity is less risky and much cheaper: in effect, one is working in already proved direction (the words within parenthis were added).(17)

An economic feature of the improvement engineering and innovative imitation is found in the fact that these require less capital outlays but more entrepreneurial insights. As we found already, the developing countries of today have been engaging in rapid capital formation. Together with equally rapid increase in labor force, the growth rates of conventional inputs, namely K and L, have been quite high. On the other hand, the respurce balance (I/Y - S/Y) has been aggravating in most of the developing countries, and their dependency on external resource flows has been rising, although "self-reliant" development has become a fashionable slogan among them. In this section, we discussed a great importance of residuals in economic growth, and a practical interpretation of the residuals was presented along with the introduction of the improevement engineering and innovative imitation. Capital formation based on transfer of technology would be more productively utilized with associated increase in social capability, and a rise in the social capability would enable more productive use of capital stock. The interaction of capital formation and social capability is indeed a metter of great importance in facilitating economic development. A technology planning in industrial planning therefore has to be deliberately linked to the wider concept of social capability.(18)

II. Patterns of industrial Integration and Technology Planning

It is commonly found in many developing countries that large modern corporations which are often related to foreign direct investment and indigenous small-scale enterprises base on traditional technology and institutions are existing in a dualistic structure. The former tends to be self-contained; they use capital-intensive technology, obtain supply of raw materials, parts and conponent from overseas, equip with own maintenance facilities, and provide workers particular and advanced skills which are often irrevant to the productive acitivyy outside the modern large industry. The latter is often too much backward in productive technology, too small in scale of production to exploit merits of scale economy, and orgnaizationally mostly unincorporated. In other words, the industrial sector in the developing countries is dualisticly disintegrated. This dualism has been so deeply rooted for years in the developing countries that one may hold a view that it is unsurmountable. It is not easy at all to reform the disintegrated dualism, and to eventually build up an integrated industrial structure. With regard to the cycle of transfer of technology, however, it appears to be a matter of crucial importance to make earnest effort for searching any possible measures which would facilitate the whole process of adoption, adoptation and indeginization of imported technology and institutions. In this regard, patterns of industrial integration have to be carefully examined.

Needless to say, enterprises in the manufacturing sector are not homogeneous even when they may belong to a specific branch of manufacturing industry. Table 3 summarizes characteristics of enterprises in the electlic appliance manufacturing industry in Japan. There are five categories of manufacturing units. The smallest unit is "side-job" in which productive activity is carried on a part-time base by unpaid family workers or house wives. They use only simple hand tools for partial and simple processing of materials.

Table 3. CLASSIFICATION OF ENTERPRISES IN MANUFACTURING INDUSTRY

	Side - job	Household industry	Small-scale industry	Medium-scale industry	Large-scale industry
Number of workers per enterprise	1 - 2	1 - 3	4 - 49	50 - 499	1,000 & more
Products	parts	parts	parts & component	finished parts & component	finished goods
Activity of processing	partial & simple	partial & simple	partial & multiple	multiple & assembly	integrated assembly
Technology	tools	tools & simple-purpose machine	tools & multi-purpose machine	multi-purpose machine & semi-automation	automation
Quality of labor	fringe labor force	skilled & apprentices	skilled, unskilled, apprentices	skilled & semi-skilled unskilled	skilled, semi-skilled, unskilled
Types of workers	unpaid family	proprietors, unpaid family apprentices	proprietors wage worker	wage workers	wage workers
Management	------	proprietors	proprietors	proprietors, salaried managers	salaried managers
Capital supply	------	proprietors' assets	proprietors' capital	proprietors' family partnership, share capital	share capital
Links to market	[illegible], subcontract (tertiary)	[illegible], subcontract (tertiary)	[illegible], subcontract (secondary)	primary subcontract and direct marketing	direct marketing
Price setting	subcontract price	subcontract price	subcontract price	market price	monopoly price
Types of incomes	commissioned margin	proprietors' income	wage, profits & proprietor's income	wage and corporate profits	wage and corporate profits
Levels of income	unskilled workers' wages	skilled workers" wages	below average profits	average profits	above average profits
Organization	individual	unincorporated, artisan's workshop	unincorporated and incorporated, and	incorporated	incorporated

Notes: This classification is a modified version of Ujuhara-Takanashi model.
Shojiro Ujihara and Masashi Takanashi, "Reisai Kiryo no Sonritsu Joken", in Shigehiko Tokai, Nihon no Sho, Reisai Kigyo, Nihon Keisai Hyoron Sha, 1077, pp.46

The largest unit is an corporated company which assembles parts and component to a finished goods by using fully automated production lines. Between these two extremes there are different organizations and levels of technologies. A household industry is usually equipped with tools and a simple-purpose machine, producing relatively simple parts. A small-scale industry is using tools, a number of simple-purpose and multi-purpose machines. In some enterprises we see now even numerically controlled machines. In the medium-scale industry, we find out many multi-purpose machines, numerically controlled ones and even semi-assembling facilities. Depending upon the technological mixes measured by a combination of different tools, equipment and machinery, the skills mixes of workers engaged are also varied. In a household industry, a skilled worker in use of a specific machine would be sufficient, while in a large-scale industry not only unskilled workers but also up to a skilled computer maintenance worker would be needed.

Let us now consider two patterns of industrial integration. First, we can think of horizontal integration of independent enterprises which are operating on the basis of the same levels of technology and institutions into a manufacture of certain commodities. Second, also it is possible to think of vertical integration of independent enterprises which are operating on the basis of <u>different levels</u> of technology and institutions. It should be noted that we are not concerned to types of technology and institutions in our discussion of industrial integration. Even we may say that because many different types of technology and institutions are actually co-existing in the manufacturing sector, we propose to ~~mutually~~ utilize those variations.

Consider, for example, manufacturing of a vacuum bottle. It involves basically different three types of technology, namely, glass processing, sheet metal processing and plastic processing for manufacturing a galss bottle, a sheet metal bottle and a plastic cap. Because of the differences of raw materials involved in production of each parts of the vacuum bottle, three sets of quite a different kind of tools, equipment and machines should be needed. Needless to say, the machines and equipment to be used for manufacturing a glass bottle cannot be used for processing of metal sheet to a metal sheet bottle. Plastic processing facilities are useless for making of glass and sheet metal bottles. Required skills for operating each of those production facilities are also not the same at all; a skilled sheet metal worker knows nothing about glass bottle manufacturing.

How to promote then the vacuum bottle manufacturing? One way is an establishment of a self-contained factory in which all the necessary production facilities are installed.

This involves necessarily more complicated management, larger sum of capital outlay, both for investments and operations, and a number of workers whose skill mixes are appropriate in relation to the technology mixes. Another way is to break down the production process into three groups (a glass bottle manufacturer, a sheet metal processing and a plastic processing), and establish one enterprise for each of these operations. An essential feature of this method is that it aims at establishing three enterprises which share mutually the same level of technology and institutions; technologically, simple-purpose machines and a set of tools and equipment are needed and institutionally, the level of a small-scale industry would be sufficient. The initial investment costs should be much less at each enterprise level than those required for an establishment of a self-contained factory.

It is even possible and probably desirable to induce existing small-scale enterprises in glass production, sheet metal processing and plastic processing to join the vacuum bottle manufacturing in order for them to diversify their products. In this approach, however, a degree of precision in manufacturing process has to be increased. The caliber of inner glass bottle of a vacuum bottle must match exactly to that of the outside sheet metal bottle, and the same thing is required for the production of plastic cap. The improvements in productive accuracy are an indispensable part of technological progress in any manufacturing industry.

The ability to supply parts of desired quality ~~of parts~~ is a pre-requisit for successful horizontal integration of manufacturing industries.

Table 4 Utilization of Subcontractors in Japanese Manufacturing Industries, by Size of Principal Enterprise, 1973

Size of Principal Enterprise, by Number of Employees	Percentage of Enterprises Using Subcontractors	Average Number of Subcontractors Per Enterprise
1 - 3	11.5	3
4 - 9	33.9	4
10 - 19	48.4	7
20 - 29	58.9	9
30 - 49	64.0	11
50 - 99	69.3	18
100 - 195	75.8	23
200 - 299	77.6	28
300 - 499	80.3	36
500 - 999	82.3	84
1,000 or more	83.3	160

Source: Japan, Ministry of Small and Medium Business, The Fourth Foundamental Survey on Industrial Structure (1973).

One may argue that the horizontal integration is based on subcontracting among small-scale establishments, and that it could be uncommon for the small-scale establishments to put out a part of processing activity to other small-scale establishments. Japan's experience, however, discloses

Table 8

Horizontal Subcontracting

Specialisation of factories	Subcontract utilisatio ratio (2)	Number of subcontractors per factory	Subcontracted processing (1)							Tota
			Machanical, exc.press	Press processing	Welding	Coating with paints	Plating	Casting & forging	Others	
Manufacture of machinery	86.0	19	46.0	4.6	3.0	4.4	3.0	16.0	23.0	100
Manufacture of machine parts	80.0	14	43.0	4.0	6.0	4.0	12.0	5.0	26.0	100
Various processing by machines	71.0	6	70.0	4.0	5.0	0.0	5.0	7.0	9.0	100
Processing by lathe	48.0	3	73.0	1.5	10.0	1.5	0.0	8.0	6.0	100
Metal products	72.0	11	32.0	21.0	1.0	0.0	4.0	23.0	10.0	100
Manufacture of screw	64.0	11	63.5	1.2	1.7	4.0	9.4	2.8	17.4	100
Press processing	89.0	5	8.8	25.9	10.7	8.2	19.2	8.8	22.4	100
Sheet metal, welding	50.0	6	10.5	28.0	19.0	4.5	7.0	1.0	30.0	100
Plating	48.0	8	1.3	0.0	2.2	2.2	38.1	0.0	56.2	100
Coating	57.0	4	5.1	1.7	0.0	33.7	11.5	0.0	47.7	100
Heat treatment	37.5	2	28.6	0.0	0.0	0.0	0.0	0.0	71.6	100

Source: Katsutaka Itakura, et al., Daitoshi Reisai Kojo no Kozo (The Structure of Small Factories in a Large Urban Centers), Shinhyoron-sha, 1973, pp. 134

Notes: (1) Figures indicate percentage of factories with gievn specialisation in the total factories used for subcontracting.
(2) Figures indicate percentage of factories used subcontractors among the total factories surveyed.

the fact that even small-scale establishments use subcontractors to a considerable extent. As shown in Table 4, 11 percent of total number of very small manufacturing enterprises which employ only 1 to 3 workers put out orders of partial processing to other firms; each of those enterprises which use subcontractors has on average 3 subcontractors on a regular basis. Sixty-four percent of enterprises employing 30-49 workers rely on subcontractors and they have on average 11 regular subcontractors. Table 5 illustrate how 11 small-scale metal processing enterprises in Tokyo use subcontractors in various procesisng. One can well imagine that even the production of relatively simple parts require different types of processing; forging, cutting, bending, pressing, drilling, welding, coating, painting and heat treatments and so on. The small-scale enterprises cannot equip with all the necessary machinery and equipment for carrying out most of these operations, but the horizontal integration makes it possible for them to manufacture certain types of products by mutually relying upon other firms' production facilities.

The vertical integration is defined as an integration of enterprises which are operating on <u>different technological and organizational levels</u> toward manufacturing final products by large-scale enterprises. Table 6 is prepared to illustrate the essential nature of the vertical integration in the case of Hitachi Ltd., one of the leading large corporations in

Japan. As was shown in Table 4, an average large corporation has usually 160 subcontractors. It seems that this figure of subcontractors covers up to the tertiary subcontractors. If the lowest level of subcontracting is included, the figure may well reach to hundreds. Hitachi puts out first its subcontracting orders to its primary subcontractors which are usually counted as the affiliated firms to the Hitachi Group. The primary subcontractors give further subcontracted works to the secondary subcontractors which are usually small-scale enterprises. A part of processing works is then transfered to the tertiary subcontractors. An interesting point which should be stressed here is the fact that the manufacturers at this level may not know who are end users of their products and it is not uncommon that they may be unaware of how their products are actually used.

Table 6 Vertical Integration of Enterprises by Subcontracting: A Case of Hitachi Ltd.

Strata	Products	Technology	Location	Labor Sources
Hitachi Ltd.	Finished goods	Automation	Urban	Newly graduated
Primary subcontractor (medium-scale)	Finished goods & nit component	Automation & semi-automation	Urban	Newly graduated & mobile job-seekers
Secondary subcontractor (small-scale)	Unit component & parts	semi-automation, multi-purpose machinery	Rural	Rural under-employed
Tertiary subcontractor	Parts	Simple machi machinery & hand tools	Rural	Rural under-employed
Side-line part-time works	Parts	Tools	Urban & rural	Urban & rural underemployed

Source: Chuo Daigaku Keizai Kenkyujo, ed., Chusho Kigyo no Kaiso Kozo (Structural Strata of Small-Scale Industries), Chuo Daigaku Press, 1976, pp. 16.

One of the most important factors by which the vertical integration can function properly is the quality of products that will be delivered from lower levels of subcontractors to those of higher levels. Let us take an example from a secondary subcontractor. Whether or not it can survive in the vertical integration depends completely its ability to deliver products of desired quality to a primary subcontractor. This ability is partly maintained and even it can be enhanced by own efforts of the secondary subcontractor itself. But at the same time, it is fully dependent upon the quality of works done by tertiary subcontractors. Here we see a sort of <u>mutual dependency</u> between different levels of enterprises within the network of vertical subcontracting system. In fact, the mutual dependency on the quality of work and products penetrates from the bottom to the top layer of the vertically integrated system; a worker in a small-scale factory may claim proudly that Hitachi can compete to other large firms because of his craftmanship in making small parts.

It should therefore be a matter of natural consequence in the vertically integrated system that small and medium enterprises obtain technological information from parent companies and customers who put out subcontracting works. The second important source of information is producers of machines and the third is the firms in the same line of trade. In most cases, the information of technological progress is passed on to each other through the daily transactions of materials and products. And also, many producers' association in the same trade help exchanges of information among their members. It is interesting to note that in the small- and medium-scale industries, about three-fourths of the flow of technological information takes place in mutual contacts of private producers and the share of public and private research and development institutions dealing with soft-wares is very small as the source of information. The reasons for these situations can be explained by the fact that the small- and medium-scale industries do not usually have continuous relations with these institutions, and that they are more interested in practical use of adaptated technology.(19)

Diagram 1. Flow of technological information

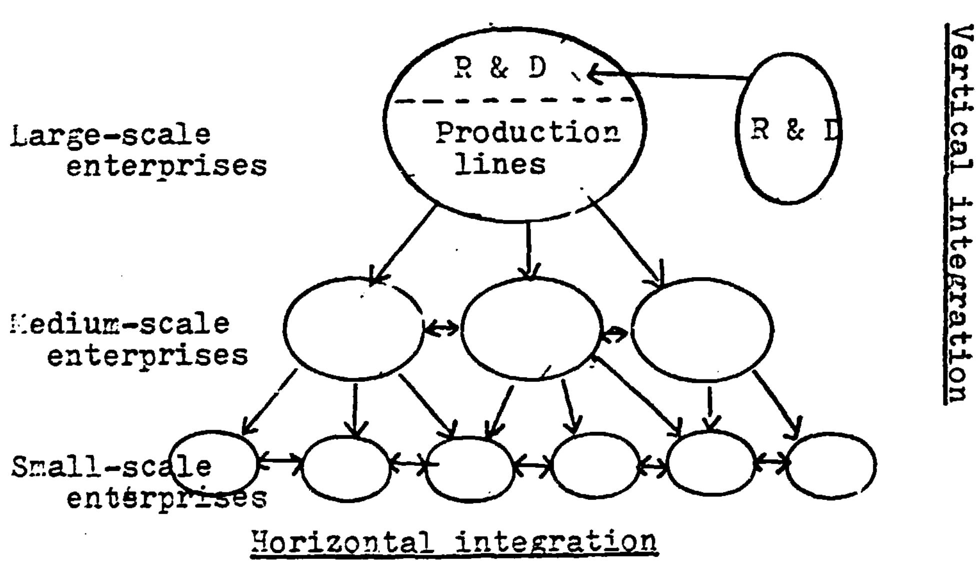

Diagram 1 illustrate how technological information is dessiminated in the system of vertical and horizontal integration in the industrial sector. It should be stressed that the daily transactions among producers constitute the largest channel in the technological dessimination. This channle, however, seems to be underestimated or even ignored in the developing countries. We do not deny the importance of industrial extension services provided by the government agencies. However, in most of industrial development planning in the developing countries, significance of the private sector's role in the diffusion of technological know-how is not well taken into account. In the second place, the diagram indicates that adoption and adaptation of technological and organizational progress have to be pursued by a shift of the technological and organizational level on continuous basis. A small-scale enterprise cannot adopt the level of technology utilized in a large-scale enterprise, but it may adopt and adaptate the level of technology employed in a medium-scale enterprise. Any discontinuous shifts such as from a sngle-purpose machine to a numerically controlled one will not be possible. At the same time, as long as an enterprise on a given level of technology and organization is unable to command its productive facilities to their full extent, improvement engineering would be more practical than an attempt at shifting to a higher level of technology. In this section, we are concerned to a technology plan on a sector base. Let us then move to an enterprise base. For this purpose, we shall deal with a forging industry in Java as an example in the next section.

iii. Metal Processing Industry in Java: A Case Study (20)

There are many clusters of small-scale metal processing workshops in Java and they have historically been playing an important role in supplying low-priced farm tools and implements to farmers. "Golok Ciwidey (Ciwidey hatchets)" manufactured in Ciwidey Village, south of Bandung, is still famous throughout West Java. Traditional blacksmiths are found in a large number concentrated in ceratin areas. For example, 68 in Sragen, 36 in Kebumen, 60 in Purworkerto, 44 in Purworejo, 76 in Megalang, 110 in Tegal and 186 in Klaten in Central Java. Most of these blacksmiths employ a limited range of hand tools and produce mainly farm tools, crude kitchen-wares and the like. Tegal and Klaten are alson known as centers of small-scale iron foundries. In Batur Village in Klaten, for example, nearly 100 families are engaged in iron foundries. The village has a total capacity of 12,000 tons per month in iron casting and is producing a variety of products including the treadles of sewing machines. At Dagangan in East Java are 119 forging workshops manufcaturing a number of hoes and ploughs which are widely circulated to East and Cantral Java. 90 percent of these metal processing workshops employ less then 5 workers and are equiped with hand tools and mannualy operated machines. If these workshops get access to modern technologies, adaptating them in accordance to their capacity, they can certainly contribute to the growth of manufacturing industry in Indonesia to a great extent.

One may wonder why in certain areas so many blacksmiths and iron foundries exist in a form of clusters. From our limited number of interviews with the proprietors of these workshops, it became clear that the Railway Workshops in Jakarta and repair workshops of sugar plantations were historically the most important source for creating industrial skills of metal processing, and the skills acquired once by craftsmen were passed on their sons. In this sense, an informal on-the-job training at a family work-shop cannot be overlooked. On the other hand, the growth of these small workshops has been greatly facilitated by middlemen who used to deliver not only raw materials but also market information to the manufacturers by their regular and frequeent visits to these workshop clusters in remote areas. Most of these metal workshops could not remain in their business if they were not linked to markets by the middlemen.

The level of technology at the family enterprises is extremely labor-intensive. A couple of young men work on a hand-driven lathe: a man as a turner and the other man as generator of power by driving a pedal attached to the lathe. A power generating mechanism of a bicycle, namely a large gear with a handle (instead of a pedal) is connected to a ller gear by a chain, and a man turn the handle to generate power for a lathe. At a workshop in Tgeal, 8 units of hand-driven lathes and 3 units of hand-driven drills are used by 22 men under the supervision of the proprietor, and the workshop is producing 850 units of small parts of motor-cicyles in each month, and 800 sets of particular types of bolt and nuts in every 3 months. Orders are given by a middleman who distributes the products not only in Java Island alone but also even to Sumatra. One may well imagine that this workshop is one of the best equiped one among the small-scale proprietors in Java. The majority of the metal processing workshops does not own even a hand-driven lathe.

There are a number of medium-scale metal processing factories in towns. A factory has 7 hand-driven lathes, 1 motorized lathe and 1 motorized drill. The proprietor knows clearly that his work can be better if he can increase the number of electrified machines at his factory; the labor productivity will be increased and a larger amount of orders can be accepted by replacing hand-driven machines to motorized ones. But his hope is discouraged by two factors. One is frequent variations in voltage of electric current and repeated interruptions of power supply. The other is the skill of his workers in the sense that they might not be easily trained to use a high speed motor-driven machines. There are some well organized factories which are fully equiped with electrified machines in addition to an iron foundry. One factory we visited in Tegal has an iron foundry having a capacity of 3 tons per day, a dozen of electrified lathes and a variety of power-driven machines. An electric generator (30kw capacity) has been used to provide elecricity in order to continue operations when the power supply is interrupted. All the workers have been trained by on-the-job basis within the factory.

From the above discription of the metal proceesing industry in Java, we find that there are small-, medium- and large-scale enterprises which are operating on the different levels of technology respectively in each group. Needless to say, improvements in technology and institutions would enhance the potential of their capacity to actual production. Let us therefore consider in practical terms how the rural-based small-scale metal processing enterprises can be further developed by introducing ~~it~~ advanced technology and institutions. For this purpose, we will choose the Dagangan forging industry in East Java as an example.

Kecematan Dagangan in Kabupaten Madiun in East Java is a typical rural area in Java, but it is interesting that there are a total of 119 forging workshops in four villages in Dagangan, employing 700 workers as a whole. The operation of these workshops is mostly seasonal and during the farming season, 90 percent of the workshops are closed so that the workers may be fully engaged in farming. However, due to the population growth ~~partly~~ and owing to the needs for supplementary incomes ~~partly~~, the workshops began increasingly to operate its productive activity on a full-time-base. A typical workshop is organized by a master craftsman who owns a set of hand tools required for forging processes. He employs in general 5 men for forming process and another man for blowing with a bellow. The main processing is cutting raw materials such as rails, steel plate scrapes and other hard scrap metal by gravers, forging cut materilas by charcoal furnace with a hand-driven bellow, and harden it by hammers.

With these limited ranges of hand tools and equipment, the whole forging industry in Dagangan produces considerably a large number of limited items. According to a survey carried out by the IDCJ team in 1979 it was found that annual outputs were 16,000 units of axes, 74,000 units of picks, 91,000 units of sickles 47,000 units of scoops/shovels, 67,000 units of plane hoes, and 82,000 units of two-prong hoes. These products were being distributed by many middlemen, among whom four traders had already established considerable networks of sales throughout East and Central Java provinces. They also supplied raw materials and introduced some technological progress by putting out orders of new products to the Dagangan forging industry.

In 1952, the workshop proprietors once organized themselves to a producers' cooperative, but the efforts of horizontal integration of workshops ended in failure within a few years due to over-competition among themselves. When the cooperative was formed, the government provided it with a common facility which was equiped with grinders and files for finishing processes, but it could not function as a factor of promoting horizontal integration of manufacturers. In 1960, a new cooperative was again formed but it also ended in disintegration in 1965 due to the mismanagement and intra-hostility among the members. In the mid-1970's, the proprietors began to try again to form a new producers' cooperative and the government encouraged the new movement for solidarity. It seems, however, that the cooperative has been facing at the similar problems as mentioned earlier.

There are a number of problems which have to be carefully studied. In the first place, the proprietors seem rather weak in management. Although they are often very skilled in handling ~~the~~ a limited range of tools and equipment properly, and in some cases they even display a considerable degree of adaptativeness and "improvement engeneering" in modifying the production methods, the management of workshops is not often separated from the household economy. This makes them it difficult to save capital on the one-hand, and on the other, tends to weaken their bargaining power in dealing with the middlemen. When we think of the importance of social capability in development of manufacturing industry, we come to conclude that the institutional progress combined with the generation of entrepreneurship among the Dagangan forging industry is much to be desired. Secondly, the sense of precision of work must be cultivated among the workers. The training of workers has been done on the-job-basis. The level of prevailing skills of those workers may be sufficient as long as they remain in manufacturing such farm tools as hoes and ploughs. In most of the workshops we visited in Java, the workers did not know measurement tools such as a vernier caplier and micrometer; at most they could use a pass. However, any attempts at diversifying the product mixes of the Dagangan forging industry would require undoubtedly an improvement in the accuracy of works. Here again, we see a fact that the social capability is closely related to the quality of labor force; we may say that it is in fact embodied within the human resources. Unreliable supply of electric power poses serious prblems for mechanization of workshops, which are too small to install own generator of electricity. In the short-run, workshops without power-driven machines may survive and may even propser. It is indispensable however, for up-grading technological levels in the small workshops to provide them with reliable electric power supply. The quality of power supply may be used as a measure of social capability to make technological progress.

With those general remarks, now let us propose a technology plan for the Dagangan forging industry, as shwon in Table 7. The technology plan involevs not only technological progress but also organizational changes, and a shift from one level to another on a continuous up-grading is proposed. Also, the technological and organizational improvements are combined with the diversification of product mixes in the industry. At the present level of technology, cutting process of rails is carried out by a graver. By introducing a use of cut-grinder or a cutting torch, this process will be greatly shortened and the accuracy in length of cut metal can be improved, thus enabling to save raw materials. A change from charcoal furnace with hand-driven bellows to pedal-driven bellows with blast pipes will allow an increase in tempa-rature in heating processes, thus making it possible to diversify a range of product mixes. Finishing process done by a graver can be easily changed to a use of grinders. These improvements are not necessarily too expensive or too sophisticated to the workshops in Dagangan. Another point to be stressed here is that the proposed plan does not aim at the adoption of improvements evenly among the existing workshops. Contrarily, it proposes partial adoptions by each of workshops since it is much more practical

Table 7. Possible Technological Improvements in the Dagangan Forging Industry

Technology level	Hand tools	+ Mannual machines	+ power-driven machines
Organizational level	Household	Small-scale	Medium-scale
Processes	Present technology	Intermediate improvement	Future development
Material	Railway rails and steel plate scraps	Better selection of materials by grinder test	Use of special steel such as SK 2-3 and SKD
Cutting	By hand with graver	Use of cut-grinder and/or cutting torch	Mechanical cutting
Heating	Charcoal furnace with hand-driven bellow	Improvement of furnace by adopting blast pipe	Gas or electric furnace
Forming	By a team of 4-5 men with hammers	Selection of hammers and use of wolding techniques	Introduction of belt hammer or air hammer
Hardening	Water cooling	Use of quenching oil	Adaquate selection of quenching agent
Tempering	Not practiced	Use of tempering medium	
Finishing	By graver	By grinder	By machines
Inspection	Not practiced	Standardization and quality control	Use of hardness tester
Product diversification	Hoes, two-prong hoes, ploughs, sickles, axes, shovels, scoops and picks	Folk hoes, rakes, knives, chisels, gimlets, gravers, blades, cradles, scythes, hammers, bars, pincers	hand-push cutters, saws scissors, cutting pliers pliers, files

Source: IDCJ, Development of Medium- and Small-scale Industry in Indonesia, 1979, p.41 and 46 in terms of capital expendidures involved. For example, a workshop may begin with the adoption of cutting torch for cutting process while the other may start with the use of finishing grinders. The former then may provide the latter with cut metal while the latter with the service of finishing of the products of the former. In other words, the partial adoption of improvement in technology among the workshops seems to function for introducing horizontal integration of productive activity among them. Only when the shift from the level of hand tool technology and the household industry to that of mannual machine technology and the small-scale industry can be successfully completed, we can anticipate further technological and organizational development in the Dagangan forging industry.

A final comment on the implementation of the proposed technology plan touches upon rather a politically delicate issue in Indonesia. The metal processing industry in Java has been historically developed by a combination of the Puribumi artisans with non-Puribumi middlemen. A father-to-son dissemination of skills resulted in the emergence of many clusters of small workshops in many areas in Java. Its growth, however, might have met many serious problems,particularly in marketing, unless there were middlemen who linked their products to wide domestic markets in the country. Although the government industrial extension services by BIPIK has been strengthened and to some extent it proved its usefullness in the promotion of small-scale industry in Indonesia, its ability to cope with the problems of marketing is regrettedly limited. Admitted that the daily trasnactions between the producers and middlemen did play decisively important roles in the development of the metal processing industry in Java, a very cautious approach would be needed in mobilizing the middlemen as an agent who would facilitate the technological as well as organizational progress in the Dagangan forging industry.

IV. Conclusion

In this paper, we discussed technology planning in industrial planning process from three dimensions. First, we dealt with the essential nature of a technology planning in an analytical framework of growth accounting, and reduced our discussion mostly on the concept of social capability of a nation to engage in technological and orgainzational progress. In a quantitative term, residuals were used as a measure of a degree of the social capability. It was shown that the higher the growth rates of residuals are, the more accelerated growth of GNP will be attained. And the substance of the residuals were explained in a practical manner. In transfer of technology from advanced countries, improvement engineering and innovative imitation, as we saw, constitute major parts of the whole process of transfer of technology. Second, we argued that technological and organizational progress would be greatly enhanced by creating integrated industrial structure, either in horizontally or in vertically, or even in a combination of these. An adaptation of Adopted technology may take place in an enterprise, but more important point is the diffusion of adaptated technology among many enterprises. Finally, a micro-study of the Dagangan forging industry was presented to illustrate a pragmatic technology plan.

Any technology planning, we found, must be closely related to organizational progress in which an advanced technology can be adopted and adaptated. Interactions between technology and institutions are crucial in facilitating the whole process of transfer of technology - adoption, adaptation and indigenization - in any phase of industrialization. In this regard, a formulation of an technology plan should not be confined into narrowly defined technological choices. What is urgently needed in technology plannings in the developing countries could be a choice of technology within the given nature of the interaction mechanism of technology and institutions. It is probably too bald to argue that the conventional methods of project appraisal in which choice of technoloy is an indispensable part for computing internal rates of return has not yet developed to take into account the interaction mechanism of technology and institutions. Because of this, we would propose that any technology planning should start from a careful consideration of social capabilty, and should include in the planning both a choice of techlogy and associated choice of institutions.

Note:

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20. This section is a condensed version of a paper "Transfer of Technology and Human Resource Development'" included in Agenda for Industrial Relations in Asian Development, op.cit. The information used in my original paper is based on IDCJ's Indonesia no Chusho Kigyo Kaihatsu (Promotion of Medium- and Small-scale Industry in Indonesia), 1979, and Java Regional Survey, 1977, in which I was a member of the mission.