Future Role and Mission of Japan's Heavy Industry Firms

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(Tsuge)

Taking the opportunity of 40th Anniversary of publishing "Mitsubishi Heavy Industries Technical Review," it is our pleasure to arrange the talks for Future Role & Mission of Japan's Heavy Industry Firms, as well as "Tomorrow and Dreams" of Mitsubishi Heavy Industries, Ltd. (MHI) , among Mr. Takashi Nishioka, the President of MHI and Professor Emeritus Takemochi Ishii, University of Tokyo and myself. Now, the time is 21st century and during the period when the society is drastically changing, I would like you to talk over the way how to create innovative technologies and product-making to aim for establishment of state based science and technologies. Also, to discuss the future role and mission of Japan's heavy industry firms and MHI's tomorrow and dreams. To start with, I would suggest to talk over the changes of surrounding conditions and relatively declined competitiveness of Japanese manufacturing industries in the past ten years.

Environment of the Japanese Manufacturing Industry

(Ishii)

Looking back at the 20th century, Japan as a defeated nation was able to recover after World War II and realize the world's strongest manufacturing industry by the 1980s. In the 1990s, however, I think we can say that Japan reached the limits of the 20th century-style mass-production system. So, I think it is true that the time has now come for Japan to break away from the industrial society of the 20th century.

(Nishioka)

In complete ruin after World War II, the Japanese manufacturing industry started its recovery from production based on licenses, and supplied its products to the world by refining them in a unique Japanese way.

In the late 1980s, it was said that Japan had caught up with the world. The fact of the matter is that the Japanese manufacturing industry had not yet been able to catch up with the world in creation of new products, although it was excellent in production techniques and technical improvements. Nevertheless, both Japan and other countries were under the false impression that the Japanese manufacturing industry really could catch up with the world. Thus, the Japanese manufacturing industry was subjected to great external pressure and was thrown into a world of severe competition. The manufacturing industry then encountered severe price competition, including the relationship between the dollar and the yen, and was compelled to move in the direction of cost reduction. For this reason, our engineering could not afford to look to new technologies and new products. In my opinion, it was this that led to the present lower competitiveness of the Japanese industry.

(Ishii)

With regard to price competition, Japan has been taking the lead in this since World War II, but other Asian nations have also begun to participate in this competition. The biggest reason why Asian nations have rapidly improved their competitiveness is that they were able to learn from Japan's example how to succeed in exporting products to the world market, and began to follow this example under more favorable conditions such as cheap labor cost. At first, the Japanese underestimated this Asian power. In my opinion, however, we should consider the circumstances a little more seriously. This is because Asian nations have begun to implement the IT revolution, the new technical innovation of the 21st century, simultaneously with the promotion of industrialization. In the Asian nations, the IT revolution is now underway in parallel with industrialization by way of the

so-called "Jump-over Phenomenon" that includes widespread use of the internet even in a very poor living environment and use of mobile telephones from the start despite the fact that fixed-wire telephone sets were never popular in these nations.

The Asian nations are proceeding with industrialization concurrently with the IT revolution for the first time in human history. I think we should understand that a kind of experiment is now being conducted in those nations, and accept the idea that we must also make effective use of the experimental data for the industrial revolution of the 21st century.

(Nishioka)

The steel-making companies of China and Korea, for example, have installed ultramodern machines and equipment capable of making quality and cost-competitive products. This is an actual fact. We should remember that we live in an age when Japan cannot be a match for its competitors with production technologies alone.

(Ishii)

Speaking from my own experience of acting as a consultant for a steel-making company, I know that the Japanese steel industry was dispatching engineers to China and other Asian nations for technical guidance on operation of steel mills. However, since the equipment installed at worksites was of the latest type not yet seen in Japan, it seems that under these circumstances the engineers could only teach their long-accumulated experience in operation.

It goes without saying that hardware is better in quality when it has been made recently. The same may also be said of semi-conductors. Since the hardware is better in quality when it is of recent manufacture, this may finally result in the difference in competitive abilities of products when product-manufacture is subjected to market evaluation. We must understand that it is absolutely impossible to maintain our predominant position permanently on account of the difference in accumulated operating experience and know-how.

(Nishioka)

Occasionally, people from Japanese steel-making companies have told us that Chinese and Korean steelmakers increased their competitiveness so impressively because MHI had delivered high-performance iron and steel machinery to them. In answer to such comments, I usually say "You should therefore make a steady investment in equipment together with research and development. Otherwise, the Japanese steel industry will lose much more in competition with foreign countries." If heavy industry firms including MHI increase their exports, this may lead to strengthened international competitiveness of industries in importing nations because of less domestic equipment investment.

I fear that the recent tendency of Japanese industry to neglect equipment investment will lead to the hollowing-out of the industry, and finally losing its ability to make the world's best products.

(Ishii)

To cite the example of the telephone, Nippon Telegraph and Telephone Public Corporation, the precursor

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Took office in 1973 as a professor at the Department of Mechanical Engineering, University of Tokyo.
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of NTT, has grown into a world-class communication enterprise through the propagation of fixed-wire telephone sets. With the popularization of mobile telephones, however, the company's business as a whole began to turn into the red. NTT must stop losing money by removing these fixed telephones as early as possible, but it may take a considerable amount of time to decide how to promote such a structural change. In terms of action for future development, the developing countries of Asia have the advantage of being able to concentrate their efforts only on the fastest growing fields from the start, because they have no old equipment.

Conversely, I think that Japan is strong in points of accumulated experience. For example, Japan built the world's No. 1 railroad (the "Shinkansen") by innovating railroad technology considered to be technology at the mature phase, and operated it successfully without accident. We have accumulated this technical experience. Asian nations are now increasing their price competitiveness in jump-over style with no Shinkansen. However, they will find themselves needing to consolidate their hardware systems and infrastructures before long. At that time, based on the history of our building the Shinkansen, we wonder how Asian nations, in which the internet is available without a Shinkansen, will be able to build and use a Shinkansen from now on. Thinking ahead of that to develop the next-generation Shinkansen in the 21st century, Japan will have a very good opportunity to make the next jump. As I mentioned a little earlier, Japan has a burden of old equipment and structures. However, this also means that Japan has the advantage over other nations of being able to take a big chance if she can successfully rebuild such equipment and structures.

(Nishioka)

As regards the outflow of technologies to China and Korea, it is impossible to stop the current flow and exchange of technologies. While they are developing on the basis of rapidly improving production technologies, Japan has accumulated many more technologies. So we should always take one step forward. From this viewpoint, we are now at a time when much more importance should be attached to technical research starting from the basics. In my opinion, we are now at a turning point for shifting from the conventional way of living based on production technologies to a way of living based on creative technologies.

(Ishii)

Technologies that once flourished in Rome spread to neighbouring countries such as Gaul, Germania and Britannia, with the result that Western Europe as a whole was activated, and it was there that the world-leading industrial revolution and Renaissance occurred. In exactly the same way, the outflow of technologies from Japan has now led to the occurrence of various changes and evolutionary phenomena in the whole of Asia. This, I believe, is a historical current that cannot be changed substantially.

On the other hand, I think it advisable to consider the "Techno-evolution" in the context of Japan's promotion of new development under these circumstances. In the course of evolution, all creatures retain their old genes in their DNA. The reason why a mammal has a gene for making a body structure capable of secreting milk from a mammary gland is that it makes proper use of DNA from its ancestor, a batrachian, to control osmotic pressure when the batrachian goes from water to land. Since Japan has many "techno-genomes" that were created in the course of her "progress" in industrialization during the last 100 years and is about to take the next step in her technical evolution, I think it would be inadvisable to discard the techno-genomes of the Japanese type. In my opinion, Japan would be well-advised to keep such genomes in her possession because this may be useful at the time of the occurrence of the phenomenon of the mammal making best use of the batrachian's DNA, as I just mentioned.

It will thus be very important for Japan to find ways of making the most of Japanese-type techno-genomes in the course of her evolution in the 21st century, while referring fully to the evolution of other Asian nations. Recently, there has been a tendency to argue that the old Japanese genomes should be discarded, but I think this view is erroneous.

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Completed the postgraduate doctor course at University of Tokyo in 1973.
Appointed General Manager, Takasago Research & Development Center of Technical Headquarters in 1997.
Took office in 2000 as a director, General Manager, Technical Headquarters.
Took office in 2002 as a managing director, General Manager, Technical Headquarters.

(Nishioka)

In my opinion, your thoughts may also be applied to the managerial aspect. The western style of management with first priority given to profits has been supported during the last five to six years. In the Japanese style of management, importance has been attached to "personnel" from the belief that the next technologies will be based on long-accumulated technologies. However, it is now considered that we should foster only successful products and technologies and throw away the useless ones. However, since the next technologies will be based on long-accumulated technologies, it is important in my opinion to consider ways of preserving these technologies. The second merit of the Japanese style of management is that business is conducted by looking ahead five to ten years into the future. In the western style of management, business is conducted inevitably from the viewpoint of whether good results may be obtained or not in the short term of one or two years. It is the key and strong point of the Japanese manufacturing industry to develop the next new technologies on the basis of its long-accumulated technologies and know-how. If we forget this, Japan will fall into a very critical condition, I think.

Particularly in the USA, it seems that the western-style management philosophy has made it very difficult to manage the business of the manufacturing industry. The manufacture of gas turbines and aircraft, for example, costs a great deal, and therefore the funds for such business are not readily approved by the board of directors. I have also heard that since such business is too risky to guarantee successful results, the executives are compelled to shift the corporate business to the fields of service and finance in order to satisfy the shareholders. Thinking of these points, the fundamentals on which the Japanese manufacturing industry can continue to hold the No. 1 position in the world still remain in the industry/university/official circles.

(Ishii)

Since Japan has genomes which have enhanced the level of its manufacturing industry, including the long-term management philosophy that you have mentioned, the way for Japan to survive is to evolve such genomes wisely, I think.

(Nishioka)

At the time when we were under pressure from conventional cost competition, it was rather difficult for us to take a broad and long-term view of things. Upon reconsideration of our past activities, we are now thinking about where we can find new products, how we can expand our business starting from our existing products and where we should be in five or ten years.

It is fairly difficult to make a fresh development, and success cannot be achieved in separation. As for the separate technologies, since there are also many specialists who have accumulated experience for tens of years, it is difficult for us to catch up with them alone and independently. Therefore, we intend to proceed with technical development together with other companies even if we have to combine our technologies with the technologies of others. I feel that such combinations will become important in the future.

(Ishii)

Regarding the combination of technologies, the Mechanical Engineering Course at University of Tokyo once believed that communication and network systems should be taught in separate courses. However, on the assumption that machines are only useful when connected to each other by communication and network systems, I think machines should be made with built-in information/communication and control functions, in the same way as they have bolts and nuts.

(Nishioka)

In my opinion, one of the major tasks of the future will be to build software making the most of the essence of electronics, innovative information and communication technologies in machines. In view of the fact that there is a limit on the profit to be gained by a machine alone, and that software makes a machine work well, it will be very important to expand the possibility of machines to the maximum extent, I think. In this sense, since the young people of today have software-oriented minds, it is, in my opinion, important to merge such minds with the long-accumulated experience of their seniors.

(Ishii)

As the 20th century approaches its end, great changes are apparent in modes of scientific thinking as a whole. In the 19th century, when human thinking was based mainly on the general idea of energy, all things ranging from food to steam engines were linked together by "calories." In this respect, all species of living creatures and all types of machines are now going to be linked together by ways of acquiring information. The structure of the genome was discovered in 1953, and the human genome was totally analysed in 2000. During this period of 50 years, great changes in thought have taken place. This means that things must be thought of not separately, but in combination. Namely, thinking was reversed so that things could only exist depending on their relativity. In the field of quantum mechanics, for example, the testing condition in which only one electron existed was thought to be ideal. However, since an electric field is generated even in a vacuum if there exists an electron, interaction becomes an issue. Therefore, the

idea of the "field," i.e., a quantum field, has become important. This idea is called by various names such as complex systems, fractal, the idea of "renormalization" and non-linearity. In the internet, its link is most representative of non-linearity. Since people now make a living by making daily use of the internet, this way of thinking has naturally become all-pervasive. In the manufacturing industry also, I believe that new ideas will be embodied by such people on the basis of the experience and technologies accumulated in the 20th century.

(Nishioka)

In consideration of relativity, we must think about what customers wish from us and what they are now expecting, because our company is centered around its customers. As Dr. Ishii said, the next product can be created only by fully gathering various items of information concerning complex systems through human relations. Take gas turbines, for example: we have started to use the IT to gather information concerning the kinds of issues that face gas turbines in use around the world. By determining what customers think of such products, we are then able to apply such information to the next product. We are now spreading this method to various kinds of products. We intend to enhance the level of our technological ability while endeavoring to ascertain what customers wish us to do next. We are now making gradual but steady efforts to gain high evaluation from our customers by always combining these two factors to create the next products.

The 21st Century is the Time for Technical Creation and Product-making

(Tsuge)

Next on our topics, I hope you will discuss the challenging target of the Japanese manufacturing industry "The 21st Century is the Time for Technical Creation and Product-making," including the question of how to promote the secondary IT revolution and nano-technology revolution now under way and how to merge these with the techno-genomes in the possession of heavy industry firms.

(Ishii)

In the 20th century, it was difficult for technical engineering departments at universities to deal with phenomena in the order of nanometers. In the 21st century, however, rapid progress has been made in nano-technology, to the extent that no technical engineering department can be imagined without nano-technological research. This means that it has become possible to exert very precise control through the merger of digital technology and mechatronics. As for the handling of scanning tunneling microscope (STM), for example, beds need to be moved in a very

delicate manner, but this precondition was satisfied by mechatronics. Another difficulty concerns the visualization technique that makes it possible to see the specimen. This problem was also solved by IT, and we can now see everything including the details of molecular structures such as DNA. STM-related technologies are the fruit of IT and mechatronics. Through STM, we feel that we can see a new world. Thanks to its application to genomes, the structure of genomes could be analysed, thus enabling a road map (plan) for genomes to be drawn from now on. This means that we are able to discover new facts through the merger of mechatronics and IT. I have said that we were able to make a leap forward in the 21st century owing to the fact that we are jumping from microns to nanometers like the divisions on a measuring tape, i.e., we are really entering the world of quantum mechanics.

(Nishioka)

As for the merger of technologies, we are making a similar challenge. In the field of energy, technical research and development have conventionally been conducted only on combustion techniques. Today, however, we have begun to carry out R&D on alternative techniques such as fuel cells and solar power generation, for which we apply the principles of electrochemistry and physics based on the direct conversion of chemical energy and optical energy to electricity. Application of this new energy conversion can be expanded not only to land, but also to outer space and deep sea. Furthermore, robots for plant inspection and repair, developed by making best use of mechatronics, are also evolving into life-assisting robots and high-precision cancer treatment equipment meeting the needs of the welfare/aging society through mergers with

internet technology and mobile technology. I think these will be included among the value-creative type technologies of the 21st century.

(Tsuge)

To develop the Japanese manufacturing industry into a value-creative type industry through the merger of techno-genomes as an objective of technologies cultivated by Japan as an innovative and product-making nation, I think it is still important to nurture fresh talent. I would like to hear your comments on this point.

(Ishii)

According to conventional common sense in the technical engineering departments of universities, molecular biology and DNA were considered to be strange subjects. As from the start of the 1990s, however, first-line researchers had to know all about molecular biology as a subject for general education. This means that it is not acceptable to use the same curriculum in the 21st century, the century of biotechnology, as that used in the 20th century, the century of physics. Now, it is no longer considered sufficient to take only one course as in the past, but it is thought preferable to take two or even three courses and to hold two or three Ph.D.s. In fact, a person who was engaged in research on artificial intelligence and artificial languages recently obtained two degrees in this field. Nevertheless, he became a graduate student once again while teaching as an assistant professor, and also entered the medical department and obtained the title of Ph.D. in Medicine. As a triple-major man, he is now a leader in bioinformatics research. Students are greatly impressed by him. I think many more people like him will appear in the near future. In my opinion, it will be very important for the purpose of nurturing talent even in the technical world to hold a multi-major.

(Nishioka)

Since we are now in a situation where technical progress is being made with increasing speed, there should be a marked difference between the speed of technical progress in the days when we went to university and the present. As to whether this can be covered by university education alone, however, I think we cannot expect too much because time is limited. When university graduates enter our company, they will be engaged in business operations with greater importance given to applied research rather than to basic research, and even more to commercialization. So, I hope solid education on basic research will be provided, especially at the university level. Moreover, Japan should also create a system for closer connection between industry/university/official circles like that in western countries in order to complete the cycle of basic research, applied research and practical development, including the nurturing of talent and personnel exchanges. If not, it will be difficult to develop science and technologies in Japan. A system design for colleges and universities specializing in engineering based on this viewpoint is desirable.

As for the merger of technologies, our company is conducting exchanges of information to a considerable extent across the Research & Development Centers. A strong sectionalism apparently still remains in individual fields such as shipbuilding and aircraft manufacturing. I hope we will be able to foster multi-major degree type talents in future.

Role and Mission of Heavy Industry Firms in the 21st Century

(Tsuge)

Next, based on the gist of what you have said so far, I would like to hear your comments on the role and mission of heavy industry firms in the 21st century - first from Mr. Nishioka, President.

(Nishioka)

Now, we must determine what degree of technical ability we can continue to maintain in the world in consideration of our position not only in Japan, but also in the world. In my opinion, it is necessary to enhance our level of technical ability and ascertain the marketability of our products from the global viewpoint. On the other hand, since Japan can only survive as a state on the basis of technologies, if our manufacturing basis becomes inefficient, the technical level of Japan as a whole may decline. Therefore, we must accept responsibility for maintaining the technical level of Japan. However, we can never succeed if we go out into the world for the purpose of taking advantage of such opportunity. I think our way of surviving in the 21st century is to do business based on a relationship of coexistence and coprosperity, namely a "WIN-WIN" relationship with other nations must always be taken into consideration.



(Ishii)

New products have been developed in quick succession in the fields of software and systems. In IT-related business, Korea has begun to show rapid growth in the last three years. The so-called Virtual Shopping Street business operates by gathering sites selling goods on the internet. If introduced from Korea, the shop costs are as low as 1/10 of the domestic price. The market is capable of rapid growth because many people think it proper to participate in the business the first thing even at such low cost. It is absurd to think of the domestic market only, in disregard of such Korean behavior. What you have said is quite right in the sense that Japan's heavy industry firms must always keep a sharp eye not only on the domestic market, but also on foreign markets in order to be able to cope immediately with any situation. On the other hand, one might ask, why not go to Korea to conduct all business there, if Korea is able to manufacture products so cheaply and quickly? But it is impossible to do this. In fact, Korea is promoting the sale of her products to Japan, regarding Japan as a market. Japan is a prospective market for the Asian nations. Therefore, I think Japan must create a new type of structure based on the principle of live- and let-live, in which Japan herself makes full use of her domestic market, and of information including that from overseas.

(Nishioka)

From the global point of view, I think that Japan's heavy industry firms must find its first business chance in the field of energy. Since the world population will continue to increase in the future while underdeveloped countries will also wish to enhance the standard of living of their people, the energy field has the potential to develop in various ways while aiming at harmony with the environment. The second business chance lies in the transportation/distribution field. No matter how popular the internet has become, movement of people will never cease. Therefore, I think there will be a steady demand for efficient means of transportation. As for the third business chance, we intend to specialize in fields supporting the life and enterprises because products capable of contributing to the progress of society are absolutely necessary. It is, in my opinion, the role and mission of heavy industry firms to make constant efforts in these three fields aiming to enhance the level of hardware and systems as well as services required by people in the world and society.

(Ishii)

Of these three fields, it is the "Mobile" in which I personally take the greatest interest. The most important result of the connection between the internet and mobile telephones is that people can use the internet while moving. I briefly mentioned "linking" a little earlier. Transportation and traffic are the most representative examples of such linking and will be, in my opinion, decisive factors in the 21st century. With conventional transport facilities, it was not surprising that information was not available to people while moving. Today, however, people can move while making use of information because information is always available through wireless communication. Therefore, it is important for us to conceive from the viewpoint of the mobile telephone in industrial circles including the heavy industry. In this connection, transportation, logistics, hardware and systems contributing to the progress of society which you have mentioned include new modes of traffic and transportation of types that were not available in the 20th century. This new epoch-making development includes areas in which Japan is able to exhibit her ability to the full extent, such as miniaturization and lightweight information/communication equipment that can be realized only through progress in nano-technology.

(Tsuge)

We are approaching the time for conclusion of your talks. In conclusion, I would like to hear MHI's vision for the 21st century from the President and expectations of the future of heavy industry firms from Dr. Ishii.

(Nishioka)

As I mentioned a little while ago, importance must be attached to our customers. I think this should be promoted from the aspects of technology and the market in consideration of exchanges and sophistication of all technologies based on a global and long-term vision by always looking ten years into the future. The most important thing, however, is that I wish to make MHI a company in which young engineers can dream of the challenge of creating the hardware/systems and services required by the world's people and nations, including Japan, because today's engineers seem to be losing their dreams.

(Ishii)

Regarding the key word "dreams," I wish to make a brief comment. They say that a dream is divorced from reality. However, it is deemed fruitless and sometimes dangerous that a dream remains simply in the world of simulation. In my opinion, no dream can be persuasive unless it is realistic. In the 1990s when the so-called IT Bubble prevailed, excessive expectations that far exceeded reality were entertained because the link with reality was very weak, thus leading to the increase in number of dark fibers and the tragedy of World Com. As for realistic dreams in the future, however, there must be the last judge of natural science, not speak of manufacturing industry, because the real and physical law was strictly established there. So therefore, the things captured there are just the true dreams. In order to realize their dreams, engineers must master the process of creating new products by gathering information, thinking of the future and making repeated tests through trial and error. Of course, this may involve the risk of failure. However, because failure is the mother of success, it is, in my opinion, important for engineers to use the system capable of coping with every situation, including failure, the so-called Complex Systems. Recently, a start has been made with research on a quantum computer with a new information unit called the qubit based on the status of quantum mechanics of not 0-1. In a sense, I think this is a kind of dream. And it may perhaps be a realistic dream. As a new infant in the 21st century, a quantum computer of the order of 7-qubit has begun to operate. I hope engineers will use this computer as a dream tool to make up a new system of the 21st century.

(Tsuge)

Through your discussion of the role and mission of heavy industry firms, it was possible to clarify the challenging target of MHI - namely that it should be capable of contributing to Japan, Asia and the world in the 21st century through its technologies. Thank you very much.