Ⅲ. A socio-cultural study of the discourses of *mono-zukuri* in the manufacturing of launch vehicles in Japan

Hirofumi IWATANI

National Museum of Ethnology, Visiting Researcher,

Cultural Anthropology

Abstract

The space industry encompasses a variety of economic activities, including the manufacturing of satellites, rockets, and other products. These complex products are manufactured under socially multilayered supply chains involving numerous companies in Japan. In recent years, the manufacturing process has often been discussed in terms of *mono-zukuri*, a term associated with traditional handicrafts. This paper will examine the contexts in which the word is used and contexts that have socio-cultural implications.

Keywords: Space industry, supply chain, *Mono-zukuri*

1. Introduction

The space industry encompasses a range of economic activities including the manufacturing of products that will eventually go into space in the Earth's orbit. Thus, it is an industry that utilizes outer space for commercial reasons.

In Japan, the Basic Plan on National Space Policy was established to plan Japanese development and utilization of outer space. Enacted in 2008, its purpose, according to Article 24 of the Basic Space Law, is to promote integrated and systematic measures for

the development and utilization of outer space.

The suppliers of products to the space industry are often large companies, with many small and medium-sized companies also manufacturing machinery and parts. These complex products are manufactured by socially multilayered supply chains between many companies.

Some machinery and parts are manufactured in small factories, called *machi-kouba* in Japanese, that do subcontract work. The manufacturing process is not a mechanical activity which could be described in a manual, but rather a complex, elaborate, and socially and economically mediated activity. The workers often referred to as *syokunin*, meaning "craftsmen," must be able to exercise appropriate behaviors in their work, such as adjustment to change, communication, and management of knowledge.

In recent years, their work has come to be frequently discussed in the context of *mono-zukuri*, which literally means to manufacture and produce things. The recent uses of this word are not necessarily traditional. This paper will examine the social contexts in which the word is used as well as its connotations.

2. Division of labor in the manufacturing of launch vehicles

The Japanese rocket H2A is an active expendable launch system operated by Mitsubishi Heavy Industries (MHI) for the Japan Aerospace Exploration Agency (JAXA).

The production of H2A involves several large Japanese enterprises.[2] NEC produces the inertial guidance computer; Kawasaki Heavy Industries, Ltd., the fairing and payload attachment fitting; Japan Aviation Electronics Industry Ltd., the inertia sensor unit; Mitsubishi Precision Co., Ltd., the electronic component package and rate gyro package; Mitsubishi Space Software Co., Ltd., the guidance program; IHI Corporation, the LE-5B turbopump and LE-7A turbopump; IHI Aerospace Co., Ltd., the solid rocket booster, pyrotechnic composition, and reaction control system; and Mitsubishi Heavy Industries, Ltd., the coordination and total fabrication of the rocket engine and LE-7A and LE-5B engine.

The rocket parts are custom-made from a range of materials that must be processed with high machining and positioning accuracy. Considering that only around two H2A rockets a year are launched and the amount of production is significant, manufacturing is assumed to be costly, with low production.

These large enterprises are associated with numerous small and medium-sized

[2] "Space industry in Japan" December 18, 2014
(http://aerospacebiz.jaxa.jp/jp/spaceindustry/company/h-iia.html)

enterprises (SMEs) through procurement and supply chains of hierarchically structured subcontractor networks. There, we can see a microcosm of industrial structure through the domestic division of labor.

Most Japanese people are not employed by larger enterprises but by small and medium-sized enterprises, SMEs.[3] Many economists point it out that Japanese procurement-and-supply-chain have a vertical structure. The well-known role of Japanese SMEs' agglomerations is the formation of hierarchical and subordinate subcontractor networks. The pyramid-like hierarchical structure of inter-firm networks is formed.

At a glance, rocket production also uses this procurement-and-supply-chain system. As an example, we will examine MHI's Nagoya Aerospace Systems Works, where the manufacture of aerospace instruments and appliances, the repair and manufacture of fighters and helicopters, and the assembly of planes and rockets are carried out. This facility and MHI Nagoya Guidance & Propulsion Systems Works are important bases for MHI's aerospace businesses. According to public materials from MHI's Nagoya Aerospace Systems Works, we can confirm procurement and supply relationships with SMEs, which are concentrated in the city district of Nagoya and the peripheral area.

In recent years, Japan has increasingly recognized the importance of SMEs, inter-firm networks, and industrial agglomerations, because of the impact of globalization on Japanese leading industries. It has come to be regarded that some traditional and high technology can be accumulated in the fields of Japanese *mono-zukuri*, concretely, *machi-kouba* of many SMEs. This consciousness of technology has driven Japan to differentiate itself from rising economies, particular its neighboring countries.

3. The field of *mono-zukuri* in *machi-kouba*

Takahiro Fujimoto has defined *mono-zukuri* as the duplication of design data into an object.[4] He has also called it the "art, science and craft of making things." I assume the notion of *mono-zukuri* as duplication of a design depends on a point of view of data processing in computer. If approached as a kind of planning model, it locates the organization and significance of human action in underlying plans.[5]

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[3] Roberson, James M. 1998. Manufacturing Men: Working Class Masculinities in Japan. Hitotsubashi journal of social studies, 30(1), pp.45-59.

[4] Fujimoto, Takahiro. 2004. Nihon no mono-zukuri no tetsugaku [Monozukuri Philosophy of Japan]. Nihon Keizaishimbunsya, Tokyo. (in Japanese)

[5] Suchman, L. 1987. Plans and situated actions: The Problem of Human-Machine Communication. Cambridge University Press, New York.

At least, in the context of *mono-zukuri* in *machi-kouba*, we need to pose the converse question of how an object will affect a worker rather than how a worker as subject to an object. In other words, it is a question of de-subjectification. The human participant is an active and perfomative being as well as a passive being.

We can understand this from the writings of Tomohiro Koseki.[6] He is a well-known labor writer who has worked as a skilled machinist in Tokyo for over forty years. He has published many books describing the life and work of factory workers in small factories very vividly and in depth. These publications are an excellent collection of labor history documents in post-war Japan.

According to Koseki, factory workers use a special language for metal processing. For example, *Kezuru*, "shave, plane, sharpen;" *Hatsuru*, "shave little by little;" *Hiku*, "saw, grind, mill;" *Kiru*, "cut;" *Hezuru*, "scrape the outer surface;" *Kisagu*, "shave off;" *Momu*, "make a hole;" *Eguru*, "hollow;" *Sarau*, "clear;" *Nameru*, "to smooth;" and *Mushiru,* "movement as if to pull the feathers off a chicken."

Moreover, workers tend to regard metal as a living thing. This is reflected in expressions such as "the metal cries" and "the metal is glad."

Expressions change, depending on products made, tools used, and work procedures. The materials affect workers, and individual workers making full use of their skills make adjustments between materials and means of production, and colleagues. In that sense, the process of *mono-zukuri* is not a simple duplication.

An interesting metalwork method, metal spinning, or *hera-shibori*, is used for some Japanese rocket parts manufactured in some small town factories, and demonstrates the centrality of *mono-zukuri*. Materials subject to metal spinning are iron, copper, aluminum, and other metal sheets. An iron *hera*, or spatula with circular head and a handle about 1.0–1.5 meters long, is applied to the piece in progress to mold it into shape.

Hera-shibori is used to manufacture both buckets for daily life and space rocket parts. It is a metal sheet-processing technique requiring precision manual work. Rocket nose cones and parabolic antennas, which are made with precision machinery, are often made by metal spinning. It is said that finished products boast higher degrees of precision than those made by state-of-the-art processing machines in terms of their fine details of processing.

A Japanese H2A rocket is like a solid cluster of precision parts, filled with

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[6] Koseki, Tomohiro. 2000. Iki na senbanko [Trendy turner]. Iwanami modern library. (in Japanese), Koseki, Tomohiro. 2002. Mono-zukuri no jidai: machi-kouba no chosen [Era of manufacturing: challenge of the town factory]. NHK library, Tokyo. (in Japanese)

state-of-the-art technology. Its nose cone is manufactured by metal spinning. Since these parts require a high degree of precision but are not made in large numbers, metal spinning, applied by a *syokunin* or craftsman, one item at a time, is best suited for their production.

Tomohiro Koseki noted that workers engaged in *mono-zukuri* are often considered as *syokunin*. The *syokunin* is a skilled manual worker who makes items, tools, or even machines such as the handmade devices.

Formerly, their work was considered simple manual labor not requiring a high degree of skill or expertise, nor specific years of experience. Their works were often ruthlessly labeled "3K," for the first letter of the three words *kitsui* ("harsh") *kitanai* ("dirty"), and *kiken* ("dangerous") in Japanese.

However, factory workers tend to identify themselves as *syokunin*, and are also identified as such from the outside. Therefore the former positioning has shifted. The Japanese traditional word *syokunin*, used in the context of *mono-zukuri*, now has socially positive connotations.

4. Discourses of *mono-zukuri*

Again, I will discuss the term *mono-zukuri*. The word *mono-zukuri* simply means to produce something. It is always written in hiragana or katakana, which are Japanese characters. According to Kojien, one of the authoritative dictionaries of Japan, the meanings of this word are the following: 1. To cultivate, farm, or a farmer; 2. Events to celebrate the little New Year. Originally, the word was related to agriculture.

The word *mono-zukuri* has special connotations. The meaning of *mono* in Japanese ranges from visible and touchable materials to general events – in other words, anything that can be perceived and recognized as an object. Its meaning also extends to invisible and spiritual beings, as the words *mono-no-ke* or *tsuki-mono* indicate.

The word of mono would be compared to the word of *mana*, which is found in Austronesian languages and indicates magical power. While relying on Levi-Staruss's view, Komatsu points out that the word of *mono* and the word of *mana* are mutually interchangeable concepts.

In any case, the concept encompassed by *mono* is comprehensive and ambiguous.[7] In that sense, the word differs from the word "thing" in English, which also has a variety of

[7] Komatsu, Kazuhiko. 1994. Hyorei shinko ron: yokai kenkyu no kokoromi [An essay on the worship for spirit possession: Challenge for the study of yokai]. Kodansya gakujutsu bunko, Tokyo. (in Japanese)

meanings: an inanimate object, an action, event, thought, or utterance, but basically means something to be visible.

Of course, we are careful not to simply see the word of *mono-zukuri* in modern Japanese society from a religious perspective. But, as Koseki has written, it is clear that people engaged in *mono-zukuri* do not consider *mono* simply as material thing.

It is necessary for us to see that its former usage is clearly different from the current one. Its usage has extended to encompass production and manufacturing in general in a modern factory. Although the word which seems to be somewhat antiquated has been frequently used in newspapers, magazines, and reports, it spread to more general use in the second half of the 1990s.

A search on the full-text database system for the Minutes of the Diet[8] showed the word had clearly emerged in the policy discussion in the plenary session of the House of Representatives on the March 12, 1992. At this time, it was placed on the agenda to amend the part of Dentoteki kogehin sangyo no shinko ni kansuru horitsu, the Act on the Promotion of Traditional Craft Industries. This law had been enacted as a law for the promotion of Japanese traditional crafts industry on May 25, 1974. Sanji Muto, a member of the House of Representatives, spoke as follows.

From this point of view, the merits were proposed in order to achieve the following. To convey the “mono-zukuri no kokoro”, spirit of manufacturing, for posterity. Its spirit is traditional to Japanese culture. As a unique culture that has been nurtured in the history and culture of the region, the traditional craft industry should be reactivated and strengthened. The industry is the face of the region.

It can be seen that *mono-zukuri* refers to Japanese traditional crafts from the translated quotation above.

However, the situation changed. In 1998, the Japanese Prime Minister’s Office set up a *mono-zukuri kondankai*, a consultative council on *mono-zukuri*, and enacted *Mono-zukuri kiban gijutsu shinko kihon ho,* the Basic Act on the Promotion of Core Manufacturing Technology, on March 19, 1999. The preface of the basic act is as follows.[9]

By way of supporting the development of the manufacturing industry, which is Japan's

[8] The full-text database system for the Minutes of the Diet (http://kokkai.ndl.go.jp/)
[9] Japanese Law Translation, December 18, 2014.(http://www.japaneselawtranslation.go.jp/?re=01)

fundamental industry, Mono-zukuri kiban gijutsu, core-manufacturing technology, has contributed to the development of all areas of the national economy such as to the expansion of production, promotion of trade, creation of new industries, and increase in employment; and has contributed to improving the lives of the citizenry. In addition, workers engaged in operations related to core manufacturing technology have played an important role in maintaining and improving the level of technology in their capacity as supporters of such technology.

We believe that the economic and social role of such core manufacturing technology and workers who engage in it will continue to be an important element in the foundation of the existence of the State in the future.

Recently, however, due to changes in the employment structure, changes in competitive conditions resulting from factors such as the progress of industrialization overseas and other diverse and structural changes in the economy, the share of the manufacturing industry in Japan's gross domestic product has fallen, and concerns about a decline in the industry have grown, and the smooth succession of core manufacturing technology is becoming difficult.

In order to address such a situation and maintain the sound development of Japan" national economy through the development of the manufacturing industry, which is a fundamental to the State, the active promotion of core manufacturing technology is indispensable, while the social respect for skills related to core manufacturing technology must be enhanced.

We hereby establish this Act to drive forward measures for the promotion of core manufacturing technology in a comprehensive and organized manner.

It is said that the purpose of the act was to reverse the trend of de-industrialization and the hollowing out experienced by Japan after the Japanese financial bubble in the 1990s by reaffirming Japan's strengths in manufacturing.

Here, I would like to highlight the usage in recent days of the word *mono-zukuri*; nevertheless there are already two other words for manufacturing and production: *seisan,* 生産, and *seizo*, 製造, written in Chinese characters, and s*eisan* and *seizo* are used for all types of modern manufacturing and production. Now the word *mono-zukuri* has been used to describe technology and processes integrating development, production, and procurement.

Then, the word is always connected with intangible qualities such as Japanese traditional craftsmanship and connotes the manual dexterity of Japanese craftsmen. The modern manufacturing is apologized by this word. Perhaps its word written in

Japanese original characters will give many of Japanese people a familiar and old-fashioned feeling. They are convinced of the Japanese industrial strength that made Japan an economic powerhouse in the 1970s and 1980s.

5. Conclusion

The manufacture of a rocket is based on a social division of labor. While it may change, it remains deeply connected to conventional Japanese social and economic structure.
On the other hand, rocket production with state-of-the art technology is often discussed with stereotyped sayings and expressions from both traditional technology and advanced technology. To emphasize *mono-zukuri* in Japan suggests the strength of the Japanese manufacturing industry, especially SMEs, which have been overlooked as unimportant.
Certainly, it is a fact that some SMEs have a high level of technology and international competitiveness, and have supported Japanese society and its economy. And, the skilled workers called *syokunin* in some of the SMEs do fine work.
Under the situation, it tends to be believed that only the *syokunin* is capable of producing a highly accurate product.
The head of Kitajimashibori Works, a company familiar with *hera-shibori,* echoed this sentiment in a report.[10]

A special feature of the processing of hera-shibori *is that only one metal modal is necessary Thus, it is not more expensive than the press work, and the products are manufactured using a quick and easy method. This is a good point. However, this processing reduces mass productivity because of manual procedures. Since the work is done by hand, it has the advantage of being suitable for small-lot production. So, we are selective in which method we use: Press work is used to manufacture simple items, the* hera-shibori *is used for complex items and small quantities, for example, the parabolic antenna and nose cone of a fuel tank of a rocket and an aircraft. An accuracy in dimensions of more than five-hundred is often required. Press work is not easy because of their size. The answer to the question of whether highly precise and fast processing is possible is not Yes or No. Numerical control machining is possible to shorten machining time. But, it takes a long time to make a program. Further, only* syokunin *with skills in*

[10] Iida Fumiaki et al. 2008. Keep Craftsmanship! Japanese Small Factories' Potentials: Aerospace, Journal of the Japan Society for Precision Engineering, 74(6), pp. 571-575. (in Japanese) This citation is what is summarized by the author.

hera-shibori *can do so.*

The head believes only the *syokunin* are capable of producing a highly accurate product. But, we can read the other important aspect. It is a fact that the company selectively employs a specific technology. Rather than of whether technically possible, its employment will be considered to be largely dependent on economic factors of cost. This suggests the following: if the manufacturing of launch vehicles is under a different situation from the current, for example, the product is under mass production, the absolute necessity of the technology with a focus on such handwork may not be ensured. In conclusion, it can be said that the discourses of *mono-zukuri* assume to keep the current economical and social situation in Japan, and will justify the presence of somebody who expresses in their language, or that there is a sense of nationalism hidden in the discourses.