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PRODUCTION OF WEAPONS IN POSTWAR JAPAN AND ITS CHARACTERISTICS

—PRODUCTION OF ROCKETS AND MISSILES IN PARTICULAR—

By Masao KIHARA*

Foreword

Space development and atomic energy are considered as major tasks of scientific and technological research and development. Ever since the Fiscal 1955 (FY Showa 30) budget made appropriation for development of rocket for the first time in Japan, space development has always been one of the most important technological policies of the Japanese Government.

The FY1955 budget in the amount of 17,425,000 yen was a part of the appropriations for the Ministry of Education, but since then, the total budget for space development rapidly increased. For example, the government established the Space Activities Council in May, 1960 as a means of coordination and structuring for technological development, and published the basic policies for space development, In addition to the budgetary appropriations for the Ministry of Education already mentioned, those for the Science and Technology Agency were also made. Growth of these appropriations has been exceptionally large during the period which followed these decisions, subject, of course, to minor fluctuations from year to year. (Ref. Table 1)

* Professor.

Table 1. National Budgets for Space Development

Agency \ Fiscal Year	1955	1956	1957	1958	1959	1960
Science and Technology Agency (STA)	0	0	0	0	0	37,876
Ministry of Education (MOE)	17,425	61,525	120,000	175,000	84,775	167,461
Ministry of International Trade and Industry (MITI)	0	0	0	0	4,800	5,000
Ministry of Transportation (MOT)	0	0	0	0	0	0
Ministry of Posts Telecommunications (MOPT)	0	0	0	0	0	25,000
Ministry of Construction (MOC)	0	0	0	0	0	0
Total	17,425	61,525	120,000	175,000	89,575	235,337
Rate of Annual Growth		353.1	95.0	45.8	−48.8	162.7
	100	353	689	1,004	514	1,351
Defense Agency (JDA)				428,244	1,322,217	1,069,465
Rate of Annual Growth					208.8	−19.1

Agency \ Fiscal Year	1961	1962	1963	1964	1965
STA	72,191	101,924 TL 215,211	370,450 TL 334,762	95,000 TL 625,710	115,000 TL 762,350
MOE	259,197	326,619	528,110	1,224,191	2,000,407
MITI	10,500	16,000	9,500	75,373	81,400
MOT	0	0	0	18,160	20,988
MOPT	155,389	160,197	160,837 TL 189,529	288,662	97,251
MOC	0	0	0	601	2,666
Total	497,277	101,924 TL 718,027	531,287 TL 1,061,901	95,000 TL 2,332,697	115,000 TL 2,865,062
Rate of Annual Growth	111.3	44.4	47.9	110.3	32.8
	2,854	4,121	6,094	12,813	17,016
JDA	1,258,174	757,144	961,748	5,441,557	3,709,404
Rate of Annual Growth	23.6	−39.8	27.0	465.8	−31.8

Agency \ Fiscal Year	1966	1967	1968	1969	1970
STA	213,510 TL 793,806	148,600 TL 1,702,180	1,874,050 TL 3,269,442	5,046,064 TL 5,710,991	6,776,400 TL 11,358,333
MOE	2,700,417	529,900 TL 3,421,427	530,000 TL 3,044,437	597,000 TL 3,027,447	410,200 TL 2,863,457
MITI	143,502	195,500	153,000	167,300	111,000
MOT	101,144	91,631	145,816	124,331	152,631
MOPT	206,392	451,000 TL	498,136 TL	418,000 TL	183,000 TL
MOC	10,568	8,608	4,763	28,535	12,635

Total	213,510 TL 3,955,829	1,129,500 TL 5,887,192	2,902,186 TL 7,236,922	6,061,064 TL 9,181,329	7,369,600 TL 14,797,447
Rate of Annual Growth	33.4	48.8	22.9	26.9	61.2
	22,702	33,786	41,532	52,691	84,921
JDA	5,191,466	5,435,044	9,596,070	1,204,866 TL 15,544,137	
Rate of Annual Growth	40.0	4.7	76.6	62.0	
Fiscal Year / Agency	1971	1972	1973	1974	Total
STA[illegible]	8,181,690 TL 11,663,268	14,211,240 TL 19,811,082	25,603,380 TL 30,358,779	48,781,210 TL 48,612,678	135,323,159
MOE	917,760 TL 2,885,224	778,541 TL 3,268,317	800,921 TL 3,808,596	2,410,166 TL 5,083,565	35,067,597
MITI	124,000	98,000	88,000	75,000	1,357,875
MOT	315,507	274,200 TL 459,647	1,669,769 TL 1,052,904	3,540,914 TL 2,454,130	4,936,889
MOPT	269,200 TL 353,369	189,190 TL 313,016	119,660 TL 1,240,464	4,581,778 TL 1,236,206	5,774,901
MOC	12,368	13,508	13,035	3,448	110,735
Total	9,368,650 TL 15,353,736	15,453,161 TL 23,963,570	28,193,730 TL 36,561,278	59,314,068 TL 57,465,027	182,576,156
Rate of Annual Growth	3.8	56.1	52.6	57.2	
	88,113	137,524	209,821	329,785	

Note 1) The figures represent original amount of appropriations.
2) TL.....Treasury Liability Expenditures.
3) Budget of the Defense Agency shows those items relating to missiles only.
Source: "Space Development Handbook", 1973 and 1974
Report of Japan Rocket Industry Association, No. 127 and 137

If we take a look at the period from 1958 which was the first year of the First Defense Buildup Plan and 1966, the last year of the Second DBP, the budgetary appropriations for space development, excluding those for the Japanese Defense Agency, showed an increase of 24 times. On the contrary, the budgetary appropriations for rocket and missiles to the Defense Agency grew no more than 12 times, or one half of the others. (The rate of annual growth of JDA budget traditionally shows large fluctuations due to political reasons and partly because of dependence on overseas technology, although it has been increasing from year to year.) However, in terms of the absolute amount, JDA obtained total appropriations of ¥20,139,419,000, while other governmental agencies received about one half of the amount only, namely, ¥11,930,705,000 as budgetary appropriations and ¥56,731,000 as treasury liabilities. This bears witness to the fact that in Japan, acquisition of space development technology was realized through research and development of rocket and missile which led to establishment of their production capability.

Thus, the national system of space development was organized around the Science

and Technology Agency on the basis of the emerging research, development and production capability of rocket and missile, while on the other hand various efforts, primarily on the part of the KEIDANREN (Federation of Economic Organizations FEO)[1] to encourage growth of the related industries, continued to provide basis for the space industry.

The Japanese monopolistic capital in the postwar period consistently tried to promote advance and diversification of the national economy by means of industry. In this kind of environment, the space industry is beginning to occupy an important position in the national economy as the one representing higher added value, capital and technology-intensive type of industry, and as a typical 'knowledge-intensive' industry in which research and development are by themselves the purpose of entrepreneurial and industrial activities. In other words, the space industry has come to be recognized as one of the forerunners of growth of the Japanese economy.

We can broadly define the space industry as the one consisting of the following elements: (1) development of rocket and missiles, (2) development of satellites, and (3) development of technology to utilize the satellites of which (1) has been given the top priority as the key technology to the space development.

Incidentally, as the history of space development in U.S. clearly shows, rockets and missiles were originally developed as a means of carrying nuclear warheads. Satellites also were developed initially as a means of warfare.

It has always been stressed that the space development in Japan is uniquely for the purpose of scientific researches and that it is fundamentally peaceful in its nature. Those reaserch, development and experiment starting from the so-called 'pencil rocket' at the University of Tokyo are often cited as an example to show that Japanese space development programs are completely free from military contexts[2]. However, even if we grant that the Japanese programs, be it those carried out by the University of Tokyo or those undertaken by the Science and Technology Agency, are not intended for military purpose

1) Establishment of the Special Commission for Peaceful Utilization of Space in June, 1961 marks the beginning of activity of the Federation of Economic Organization concerning space development. As the U.S.-Japan Joint Communique of November, 1967 laid emphasis on the need to promote cooperation of the two nations in the domain of space development, the special committee was replaced, in June, 1968, by the Space Development Promotion Council (comprising about 60 companies in the related industry) in order to realize full-fledged promotion on the basis of the U.S.-Japan cooperation. More specifically, the Council had those ends in view: preparation and development of long-range visions, making proposals to the Government, promotion of international cooperation and others.

2) The research and development concerning rockets at the University of Tokyo was started from December, 1953 when AVSA (Advanced Vehicle Study Association), a group created within the Institute of Industrial Science of the Tokyo University, undertook the study of rocket production. In April, 1955, the first experiment of 'pencil rocket' made by Prince Automobile Company (Now Nissan Motors Company) was carried out. The first model, 23 cm in length, was followed on by those models like Baby, Kappa, Lambda and Mu, through the cooperation of the Council of Production Technology of Observation Rocket, an association comprising 30 firms active in the related areas, headed by Y. Seki, Council Chairman and President of Mitsubishi Electric Company. The Council was absorbed in April, 1968 by the Space Development Promotion Council of KEIDANREN.

and their uses are limited to those scientific and peaceful purposes only, so far we have not been able to see any firm guarantee that they are not going to be used for the purpose of warfare.

The reasons are as follows: Firstly, there is the problem of character inherent in the technology, and that of the structure of its development and utilization. In other words, the technology could advance only when it is activated by the technology of modern warfare, and the space development is undertaken in the economic structure in which producers of weapon whose profit is realized through utilization of technology for military purpose are in existence. Research and development of rocket and missile were initiated essentially as a part of the modern means of warfare-especially as a means of transportation of nuclear warheads and as a means of launching military satellites because weapons are commercial products and business can expect considerable profit by producing them.

The scientific use of space through development of rocket, missile and satellite is a means of modernising military power very effectively, and for this reason, development and utilization of space should not be separated from military purpose[3].

Secondly, even if some of the technology and the products are to be utilized only for scientific and peaceful purposes, they are developed and produced by the same enterprises utilizing those for military purpose. In fact, because the rockets and missiles are manufactured by same firms regardless of whether they are used for scientific purpose or as weapons. There always exists the danger that all of the scientific and peaceful research and development are uitlized for military purpose. To think that there is a clear-out demarcation line between the two and to ignore the danger of diversion for military purpose is a sheer abstraction and unrealistic. The economic base is such that the diverson to military purpose would become real as soon as there is any reflux in the political power which is against the utilization.

For instance, Mr. Ino, ex-Director of Japanese Defense Agency, stated that 'Professor Itokawa (the scientist who developed the Itokawa Rocket at the University of Tokyo) has been very cooperative to JDA's rocket research'. From this, it is quite clear that Itokawa's data obtained through development of Kappa VI rocket were utilized by JDA for research and development of missiles[4]. This became possible because Nissan Motors, Co., Teikoku Kako Co. and other firms who participated in manufacture of various rockets for the University of Tokyo were, at the same time, producers of Air-to-Air Rockets and Surface-to-Surface Rockets for the Japanese Defense Agency. Although the Mu 4Sl rocket

3) An article in the 'Weapons and Technology' in June, 1968 published by the Japan Ordnance Associations expresses very clearly how business considers the matter. "Because of the characteristics of (communication satellites) having universality and aimultaneity over a wide area, they are very effective as means of communication for defense purpose, and we look forward very much to their utilization....These JSDF vessels and aircrafts operating around our country will be able to perform theri duty in much more reliable manner by the use of navigation satellites. From such a viewpoint, it is apparent that as technology advances, it is necessary to promote scientific utilization of space in order to modernize our national defense more effectively. We should not allow exclusion of defense considerations from development and utilization of space" (page 1).

4) Refer to the 'Mainichi' daily news, Sept. 22, 1959.

(carrying the scientific satellite MS-FI weighting 62 kg), launched by the Institute of Space and Aeronautical Science of the Tokyo University in September, 1970 failed to put the satellite into the orbit due to misfiring of the 4th stage rocket, the fact that the total vehicle weighting almost one ton was launched covering a distance of 3,500 km should be interpreted to mean that the propulson was equvalent to that of the Polaris missiles, well on the level of the Intermediate Range Ballistic Missile (IRBM).

Thirdly, we must question the legal and statutory restrictions. When the Diet passed the Law concerning Space Activities Commission on April 26, 1968, all of the ruling and opposition parties in the House of Representatives and House of Councilors jointly resolved that 'the basic law for the space' should be enacted as quickly as possible on the same ideals governing Article 2 of the Atomic Power Act (i.e., the principles of democracy, autonomy and openess to the public)[5]. Nevertheless, the government has not submitted the bill to this date due to 'technical difficulty', and for this reason, there is no legislation in existence to prevent diversion of space development into military purpose. The 'technical difficulty' arises, for instance, because the Japanese government, under the protocols concerning U.S.-Japan Agreement concerning domestic production of Nike-Hercules and Hawk missiles, is obligated to maintain complete secrecy for those areas designated as classified by the U.S. Department of Defense, and under these circumstances, enactment of the Space Law based on the principles of Democracy, Autonomy and Openess would constitute a material obstacle to production of the rockets and missiles. Thus, we can say that space development projects are carried out in Japan without any legal restriction as to their diversion to military purpose, while at the time research, development and production of rocket and missile weapons are actually taking place.

Inasmuch as the strategic effectiveness of nuclear warheads can be displayed only when they are made weapon system by combination with their means of transportation, i.e. rockets and missiles, the fact that research and development of rocket and missile in Japan are carried out without any legal restriction and with larger far dependence on U. S. technology—which can be said total dependence—and in secrecy as compared with the case of atomic energy development, enhances the imminent danger of diversion of the space development projects into military purposes.

That Japan's space development efforts totally depend on the technology available in U.S. is apparent if one takes a look at the Space Development Plan. National Space Development Agency of Japan and Space Activities Commission jointly adopted, in October, 1970, a new plan which has the effect of completely modifying the original Space Development Plan made twelve months earlier (i.e., the plan to launch an ionosphere sounding satellite (85 kg) in 1972 utilizing the rocket, and to use N rocket to launch in 1974 an experimental communications (ECS) satellite for communication

5) Article 2 of the Atomic Energy Act provides that "Research, development and utilization of atomic energy shall be limited to those peaceful purposes only and they shall be carried out autonomously under democratic management. The results of such efforts shall be made public and shall positively be contributed for the sake of international cooperation", thus laying out the so-called principles of autonomy, democracy and openess.

purpose, respectively). According to the new plan, development of the Q rocket is to be abandoned in order to give priority to the medium-size liquid propellant rocket as quickly as possible, as well as to convert the N rocket into a three-stage vehicle of which the first stage will be a liquid-propelled rocket, while the second and third stages are the third and fourth stage of the Q rocket. The reasons officially given to explain the stop of Q rocket which utilizes solid propellant in favor of the N rocket powered by liquid propellant are that the solid propellant rocket could not meet the need to launch advanced satellites growing in size and weight, and also that the solid propellant rockets are difficult to control depending on weather, wind direction and other parameters.

However, a much more important reason for the change was that the new plan considered 'maximum utilization of U.S. technology would be most desirable for development of the N rocket and considerations should be given to license and knock-down production'. In other words, production under manufacturing license based on U.S. technology was the basic premises of development of the N rocket, with a result that Japan's dependence on the U.S. technology base considerably increased in comparison with the preceding development of the Q rocket. In fact, it means space development in Japan was made fully dependent on the technology of the United States.

Lastly, it is necessary to consider those problems arising from Japan's relationships with the United States. The joint communique of 15 November, 1967 by Premier Sato and President Johnson stated that the two countries should closely cooperate in the domain of space development, along with nuclear energy and ocean development[6].

As is clear from the statement, on the occasion of the meeting between the heads of the states, Japan agreed, on the basis of 'responsible partnership', to expand the scope of her national defense and to strengthen her national defense capability through U.S.-Japanese cooperation in order to fulfill her obligations under the defense agreement between the two countries, vital to the security in Far East. Inasmuch as "maintenance of the U. S.-Japan Mutual Security Pact is the basic policy of the two countries" (viz. the joint statement), the commitment to 'strengthen Japan's defense capability' simply means strengthening of military cooperation to be achieved through modernization of the Japanese Defense Agency. In the era of nuclear warfare, 'modernization' could only mean

6) The U.S.-Japan communique in question states, in essence, that having reviewed past cooperation in the field of space development and possibility of cooperation in future, the two governments would continue to assess further potential of cooperation of which the most important aspect would be development and launching of the satellites for scientific research and peaceful utilization of outer space. Also, in the joint statement by Premier Sato and President Nixon of November 21, 1969, it was stated-after the reference to the success of Apollo 12' landing on the moon, that "The Prime Minister and the President agreed that the future of space would bring about vast opportunities to expand cooperation between every country concerning peaceful work in the domain of science...In this connection, the Prime Minister stated that he was pleased to see the conclusion of a U.S.-Japan agreement concerning space in the summer of that year...The Prime Minister and the President agreed that implementation of this special project would be very important to both countries."

provision of nuclear arms[7].

It is clear, under these circumstances, that the United States demanded Japan to recognize openly[8] the freedom of bringing nuclear arms to Okinawa, and that on the other side, Japan tried to utilize such a demand as a pretext to possess its own nuclear arms. The fact that the U.S.-Japanese cooperation in the domain of space development was taken up as a major item in the joint statement, which on the other hand stated that Japan would not only firmly maintain the U.S.-Japan security agreement but that she would be prepared to filfill her responsibility of mutual defense, makes us wonder whether such joint space development program is really unrelated to any military context. As a matter of fact, this is implicitly expressed in so-called 'Johnson memorandum' relating to the U.S.-Japan joint cooperation in space development. In this memorandum stating basic policies of the United States (conditions) to the space cooperation[9], which was published by the Science and Technology Agency on December 13, 1968, it is stated that 'the United States are prepared to cooperate, in the domain of rockets, for all engineering research

7) Prior to the U.S.-Japan top meeting, key members of the Japanese Government were involved in a discussion concerning 'defensive nuclear armaments'. At that time, Cabinet Minister Kimura, Ambassador (to U.S.) Shimoda, JDA Director Masuhara and others openly maintained the need for nuclear armament in conjunction with the return of Okinawa islands to Japan. Thus, it would be easy to conclude 'strengthening of defense capability' means nothing but acquisition of nuclear weapons. Cabinet Minister Kimura stated in a press interview on September 18, 1967 that '(with regard to the return of Okinawa), also in consideration of the security of western Pacific area, the negotiation will become a kind of double-edged sword, and therefore, there is some possibility for Japan to reconsider her traditional position of 'banning introduction of U.S. nuclear arms' in the course of the negotiation concerning this aspect.' (viz. Nippon Keizai Shimbun, Sept. 18, 1967) In a press meeting held on October 3, 1967, Ambassador Shimoda said "what the United States want is that the role of U.S. military bases in Okinawa be recognized and they are allowed to use the bases freely. For this reason, I must say that the contention that U.S. should withdraw nuclear arms and return Okinawa is unreallistic", and "unless Japan guarantees U.S. that the military bases in Okinawa could be used in the same way as they have been used even after the return of Okinawa, the United States will not agree to return Okinawa ...as it is, Japan must decide clearly what attitude it should take on this problem". The comment led to wide criticism and discussions among the public at that time (viz. Japanese daily newspapers on 4 and 5 October, 1967). On the other hand, JDA Director Masuhara said, at the Lower House Cabinet Committee meeting held on October 6, 1967, that while Japanese nuclear policy is based on the three non-nuclear principles of 'no production, no conservation, and no entry', to apply these three principles to Okinawa would be detrimental to the effect of the military bases upon the security of Far East, and consequently, considerations should be given as to allowing certain exceptions to these principles (viz. daily papers of October 7, 1967).

8) At present, it is no longer possible to deny the fact that nuclear arms have been brought into Japan (viz. testimony of Larock and others). In fact, we may be able to say that the U.S. nuclear weapons were first brought into Japan—in Okinawa in July 1955, and in the mainland in August of the same year, following the decision by the U.S. Armed Forces to make their military bases in Okinawa permanent ones.

9) Johnson memorandum was delivered to Prime Minister Sato directly by U.S. Ambassador Johnson on January 17, 1968. There was an agreement not to disclose the content of the memorandum, although Ambassador Johnson unilaterally published a part of the memorandum on December 12, 1978 at the International Subcommittee of Space Activities Promotion Council of KEIDANREN, and STAB consequently had to publish in the whole text of this document.

nescessary to place actual use satellites on orbits; however, the United States consider that in order to implement such cooperation, agreement between the two governments are necessary concerning the following two points: 1) that any technology or equipment provided by means of the inter-governmental agreement or agreement between two parties in private sector must be used for peaceful purpose only, and 2) that no technology or equipment obtained as the result of cooperation of the United States should not be exported either to People's China or to the Soviet Union, and with regard to other countries, they should be exported only through U.S.-Japan agreement in accordance with their common export policy'. It further made reference to secrecy guarantee and other conditions the most important of which was that utilization of U.S. technology is limited to domestic purpose only, by saying that 'U.S. expects that the supply of technology will be made to those practical organizations inside the country not in contradiction with the Intersat Agreement or when such technology is going to be utilized for purely experimental communication satellites'.

However, it was made known that the memorandum published by the Science and Technology Agency on December 13 had not been the full text; in fact, the document, as published by STA, omitted reference to the use of space technology for military purposes. The full text disclosed on December 17 says that the United States '*desires' conclusion of formal agreement including the following two points*'. In other words, U.S. clearly demanded the security of technology in consideration of the Soviet Union and People's China as a formal obligation on the part of the Japanese government.

Moreover, the phrase 'technology or equipment'..., in the original memorandum, reads '*unless otherwise agreed to*', such technology or equipment should only be used for peaceful purposes[10]. As various news agencies pointed out at that time, this should be interpreted that if there is any agreement, Japan may divert the U.S. technology and equipment for space development into military purposes.

Also, the portion restricting export or transfer of the technology or equipment to People's China or Soviet Union, in the full text, was categorical in that it says technology..., should not... *by any means and under any circumstances*[11].

Thus, the fact that the Johnson memorandum, summarizing the basic objectives of the United States in the U.S.-Japan space cooperation, 1) was not disclosed by the Japanese Government for almost a year, 2) was published by STA for the first time only after U.S. disclosed the text, and 3) the text published by STA intentionally omitted (or misinterpreted) the key words clearly shows the absence of guarantee not to give any military context to the U.S.-Japan cooperation in space development in spite of the existance of the Mutual Security Agreement.

In an economic system in which capital is assured of profit from producing weapons as merchandise, and in which the principles of democarcy, autonomy and openess are

10) Viz. the Asahi, December 18 and others.

11) Viz. the U.S. memorandum published by the Government on 23 December. According to the 'Asahi', (December 18), the U.S. memorandum said (in lieu of 'desires conclusion of...') 'U.S. hopes to obtain agreement...'

ignored, Japan's space development is promoted on the basis of very close cooperation (compared with the atomic energy, technological dependence in space development is much greater, to the extent of being qualified as total dependence) with the United States, the country to which Japan depends also militarily, politically and economically. For these reasons, Japanese space development efforts involve a particular danger of being diverted to military use, especially since they were concentrated, from the beginning, to research and development of missiles and rockets.

Apart from the danger of diversion to military purpose, we do not seem to have any knowledge or expertise concerning the problem of safety and other factors inherent in launching of large rockets and missiles[12], and no safeguard or consideration exists to prevent environmental pollution and other hazards due to fuels and propellants.

In this thesis, the author plans to discuss in more details research and development of rockets and missiles which have been the bases of Japanese space development program as well as the characteristics of Japan's space development efforts in general.

I

Generally speaking, rockets and missile weapons consist of the following elements: 1) mainframe or fuselage, 2) rocket engine, 3) propellant, 4) launcher, 5) devices to detect presence of target, 6) guidance and control systems, 7) automatic homing device, and possibly others. Of these, 5), 6) and 7) are computer controlled and operated by radio communication systems. All of these elements must have very high degree of reliability and durability which can only be achieved by rigorous process of selection and intensive cared in handling raw materials, design and production engineering. These alone make the final products display their full capabilities or performance, with standing such adverse factors as high speed, low temperature, vacuum and absence of gravity, encounter with cosmic dusts, etc. The reliability aspect is particularly important since rockets and missiles are made of a very large number parts which are closely interrelated. For instance, the MU-4Sl rocket of the University of Tokyo, which is no more than an experimental rocket for scientific use, contains altogether 118,000 parts: 43,000 for the rocket itself, 42,000 for the equipment carried in the rocket, and 33,000 for the satellite.

For these reasons, rocket and missile represent the final product of tremendous scientific and technological disciplines covering such extensive fields like material engineering, electronics, mechanical engineering, metalurgical science, fluid power engineering and system engineering backed up by the industry-aerospace, electronic and mechanical.

When we take a look at the total production costs of a missile, it can be seen that approx. 30% of the costs are taken by the ground-based facilities of which the largest part are control and guidance systems. The costs proper to the flying vehicle itself represents about 60%. Furthermore, approx. 50% of the vehicle costs are shared by electronic and guidance control systems. Table 2 shows an example of this cost structure for a medium-sized guided missile, in which 53.7% of the costs are those relating to electrical parts and

12) Ref. Report of Japan Rocket Industry Association, No. 193, p. 39.

and components. Consequently, it can be said that the most important part of a missile is the computer and other electronic systems, and that the relative importance of electronics continues to increase as more control and guidance capability are being realized. We should remember in this connection that electronics was an industry primarily developed in answer to the military needs. For example, invention and development of intergrated circuit took place mainly because they were essential for use in missiles and other advanced weapon systems. We should, of course, recognize the fact that such development greatly benefited civilian industry and hence life of ordinary citizens, however, Japanese space development originated from research and development of rocket and missile, and the domestic production of Nike and Hawk missiles, which was made possible by introduction of American technology, prepared the bases of Japanese aerospace industry.

From its very beginning, aerospace industry was characterized by the military and strategic considerations of the customers. Even if a part of a product, i.e. a rocket or a missile, is not produced for the warfare purpose, its basic characteristic is such that it could readily be converted into military use when necessary. For instance, basic construction of a rocket used to launch a communication satellite does no show much difference from the one used to carry a nuclear warhead. As for commercial satellites, they can be converted to military use at any time.

Most of the modern weapons, and particularly rockets and missiles, become obsolete very quickly, and for this reason, research and development must be continued with the maximum efforts at all times. Moreover, these weapons can exist simply because all of the bases of advanced modern industry are readily available and the fruits of such tech-

Table 2. Cost Structures of Small-Size Guided Missile

Cost Item	Missile Body	Ground Facilities	Total	Grand Total
Electrical Parts				
Electronic	17.5	22.6	40.1	53.7
Measurement	13.6	—	13.6	
Chemical				
Explosives	2.3	—	2.3	6.7
Propellant	4.4	—	4.4	
Mechanical parts				
Optical	—	0.4	0.4	
Aeronautical	11.1	—	11.1	31.6
Instrumentation	—	6.6	6.6	
Measurement	13.5	—	13.5	
Overhead Costs	8.0	—	8.0	8.0
Total	70.4	29.6	100.0	100.0

Source: Japan Rocket Industry Association, Report No. 131 (August, 1968, page 17)

nology and output can be combined at will. Therefore, rockets and missiles are particularly prone to create strong affiliation and relationship between related technology and industry, going beyond the conventional framework of capitalistic organizational structures. So-called system engineering tends to ignore traditional barriers. Production system of missiles and rockets, therefore, exerts a strong influence over related industry for their reorganization and restructruization, to such an extent that a national economy will sooner or later face a radical qualitative change.

Advent of combination of nuclear warhead and missile which, if used at all, could destroy any target on the earth within minutes—and we cannot ignore the danger that they are erroneously used, for instance due to any data-handling hitch—necessitated the means to detect a nuclear attack and to take effective counter measures within seconds in order to avoid major catastrophy. It is no longer possible to follow the traditional process of mobilization of armed forces and counter warfare after an attack. The fronts are to be kept permanently in the conditions of stand-by so that immediate countermeasures can be taken against an attack[13]. For this purpose, technology and production capability to turn out weapons must exist, and moreover, such capability should be maintained at the latest and highest level by means of continuous research and development expenditures. Above all, presence of such capability must be real rather than potential, because once hostility sets in, it is too late to try development and grading up of the back-up capability. Those modern weapon systems like missiles and BDGAE cannot exist on the basis of dormant or potential capability which may be able to produce them eventually only after the need arises. In order to maintain modern weapon systems in good order, there should be no boundary, no barrier between the armed forces and civilian producers. The latter's manufacturing operations must become an integral part of logistic support system which will be able to function at all times. Thus, the modern weapon systems tend to alter the traditional relationships between the military forces and industrial bases who produce armaments, and consequently, they alter the economic structure itself.

Thus, because of the historical process of space development and in consideration of the nature of technology and industrial substructure needed to support the process, the distinction between military and non-military hardwares is something fictive and in ap-

13) According to the summary statement of the 3rd DBP, "the defense capability as an effective deterrent" should be aimed at "those which can meet in most effective manner any regional or local invasion or agression by means of conventional weapons", and "the back-up structures such as supply of munitions necessary to counteract any hostility promptly and to maintain manoeuvrability must be developed and upgraded". It also states that the basic policy in this respect should be "to provide effective defense capability to serve as deterrent against agression consistent with the U.S.-Japan Security System" and, in this context, the policy to "enhance the back-up structure"... could only be interpreted as the one to build up permanently the conditions of "clear for action", depending on the missile systems and early warning network. Also, inasmuch as the major military powers are fiercely competing with each other to develop best nuclear armament as effective "deterrent", building up of effective defense capability on the basis of the U.S.-Japan Security System" will eventually lead Japan not only to introduction of nuclear arms but also to production thereof, particularly in view of the policy to strengthen missile weapons as indicated earlier.

pearance only. There is very little to distinguish the two. The output of space industry such as rockets and missiles are characterized by the fact that they are almost impossible to show any real difference as to whether they are the means of transport of nuclear warheads or something essentially peaceful, or at least those who cannot become a 'direct' means of warfare[14].

In the following part, we shall see how research and development of rockets and missiles have been carried out until now.

II

Japanese war industry was reopened as the result of the U.S. Army special procurement during the Korean war. In the beginning, those procurement orders, for the most part, were limited to repair and replacement of parts, but in May, 1952, the U.S. started to place orders for completed weapons, and production of munitions grew up very quickly thereafter. For example, in 1952, total output of the munition industry was 145 million yen, most of which were projectiles and mortars. In 1953, however, the output increased to 4,980 millions which was equivalent to the total output of watchmaking industry. Orders included numerous arms such as rocket launchers, the first to be made in the postwar Japan.

Resumption of Japanese munition industry was one of the ways by which U.S. technology was actively introduced by the monopolistic capital to fill up the gap and to modernize and expand basic industry such as electricity, steel and chemical production. In one part, it served to prepare Japanese industry for international cooperation and for entry into overseas market, as well as to utilize its capability for the purpose of enforcing the rule of Pax Americana. The process, at the same time, was that of preparation and establishment of bases for expansive reproduction of monopolistic capital.

It was characteristic of the Japanese postwar munition industry, reopened to meet 'U.S. Army special procurement', that it did not represent an autonomous effort to support Japan's need for self defense and independence, but a kind of subcontracting structure to cooperate with U.S. in their strategic operations in the Far East. To the monopolistic capital, the special procurement was an ideal opportunity to regain and strengthen their prewar position and power. To them, anything was good as long as it served their purpose, and they showed no hesitation to go along with production of arms whether or not it was banned under the Constitution. The procurement was an excellent pretext.

Shortly thereafter, the weapon industry was made eligible for special protection and

14) Following the successful moon trip by Apollo 11, U.S. largely eased previous restrictions concerning transfer of space technology, and Japan was able to obtain technical assistance for the development of N rocket. The Thor-Delta rocket, capable of launching a fixed position satellite (weight: 340 kg) or a moon rocket (weight: 240 kg) was originally a version of IRBM (intermediate range ballistic missile) deployed at U.S. military bases in the United Kingdom, and NASA converted it later for its own use. Likewise, the Allas rocket, which was used to launch the manned spacecraft 'Mercury', was originally an ICBM (intercontinental ballistic missile) converted, in 1965, again by NASA. The Titan 3C, used for launching the manned spacecraft 'Dyna-Soar', also was converted from ICBM.

development incentives in order to ensure adequate supply of munitions to the 'Police Reserve Force', a de facto armed forces recreated by the directive of U.S. Occupation Forces. American technology was introduced and played a very important role in upgrading the level of the postwar weapon industry.

In September 1952, a special committee was formed in the Police Reserve Force in order to develop a plan for building up Japan's defense capability over a long time period[15]. In conjunction with the plan, munition industry was designated as 'key sector' on September 11, 1952 and a decision to transfer exmilitary arsenals to private industry was taken. Finally, on October 3, the armament industry was formally given eligibility for full protection, a significant change from their previous stature of controlled activity. Thus, the policy to develop war industry was given official sanction.

At present, the Japanese industry in general is one of the top in the world in scale, in technological level and in its complexity. It has powerful steel mills, shipyards, petrochemical, electronic and other types of plants. Compared with the impressive size of the total activity, share of the munition industry may seem to be insignificant yet. However, we must remember that those who are in that industry are conducting, without exception, extensive research and development of advanced military equipment and production thereof. Although most of so-called 'advanced sectors' such as aircraft production, aerospace, atomic power and ocean development are based upon imported technology for the moment, they are gradually going beyond the initial stage of learning and are going to occupy important position in Japanese industry.

In fact, those who occupy major position in the 'defense-related industry' are such industrial giants like Mitsubishi Heavy Industry (MHI), Kawasaki Heavy Industry (KH I), Fuji Heavy Industry, Mitsubishi Electric, Hitachi, Toshiba, Nippon Electric (NEC) and a few others, who are also prominent in the 'advanced sectors' too.

The postwar technology in military equipment field has predominantly been those originated in the United States. However, along with the advent of modern production and management technique, Japanese industry has already achieved the stage of being capable of turning out almost all of ordinary weapons, and in certain cases such as guns and naval vessels, the products are able to compete successfully in the international market.

The Japanese was industry may be said to have come out of infancy during the 3rd DBP (1967–1971). During the 3rd and 4th DBP (1972–1976), demand from the defense authority grew consistently on plan, and thus, military requirement became an important source of revenue for the industry. In anticipation of future potential of defense expenditures—particularly those pertaining to modernization of equipment in line with the defense plans—massive investments were made by manufacturers, especially by those who were in the aircraft business[16]. This shows the fact that the defense buildup plans had already become a major factor of market expansion, to such an extent that manufacture, research and development of weapons, and especially those relating to aircraft, space development and electronics, became an integral part of Japanese industry.

15) The First Draft of DBP was submitted for review in May, 1953.

Furthermore, it illustrates the fact that current structures and technological level of Japanese industry would enable it to become a major source of production of military equipment if supply of raw materials and capital are adequate.

III

Formation of a Technical Research and Development Institute of the National Security Agency (the predesessor of JDA) in 1952 marks the official start of research and development of weapons in postwar Japan. The Institute's initial tasks consisted mainly of efforts to digest new technology embodied in the military equipment supplied by the United States in order to prepare for their domestic production. Later on, it went to purchase sample weapons from abroad, along with acquisition of foreign technology and research and development on their own[17]. From the very beginning, priority was given to missiles which was considered as the key to upgrade and reinforce national defense capability.

The need for Japan to own guided missiles was already advocated in 1953 on the ground that 'they represent a remarkable improvement of firing accuracy, thanks to guided control features, and also because they are unmanned, their application is very versatile and there is a good possibility to improve their performance effectively. They are much less dependent on topographical conditions and for this reason, they are the best means of warfare in air and sea. It is most likely that guided missiles will become the most important means of defense, indispensable in case of a country like Japan consisting of islands. It is very clear in our mind that defense of Japan cannot be achieved without guided missiles"[18].

In other words, Japan's self defense must be accomplished both in air and on the sea, and if she can maintain mastery of sea and air sufficient to sustain ocean transport, there will be no fear of direct invasion, and the nation as a whole will be assured of its subsistence. "Consequently, it is by no means an exaggeration to say that quantity and quality

16) Kawasaki Heavy Industry, for instance, adopted a policy to strengthen production of defense missiles and for this purpose, the company projected separation of Spacecraft Department of Aircraft Division as an independent profit center to be located in Gifu (the Mainichi, July 22, 1969). Furthermore, KHI planned to invest by 1973 one billion yen for development of missiles, mainly in conjunction with new facilities and equipments at Gifu plant (the Nikkan Kogyo Shimbun, August 17, 1969). This positive attitude of KHI to spend a large amount of money for development of missiles was motivated by its desire to 'secure orders from JDA and to strengthen KHI's position in this domain in anticipation of future space development program' (statement by K. Naito, KHI director, quoted in the Mainichi of July 22, 1969).

17) The history of Technical Research and Development Institute can be distinguished into four periods: 1) the first phase, in which priority was given to those studies concerning domestic production of U.S. weapons, (1952–1957), 2) the second phase in which emphasis was laid on development of weapons adapted to local conditions in Japan (1958–1962), 3) the third phase which was that of development of new equipment such as antisubmarine patrol flying boat which used the latest technology available (1963–1967) and 4) the fourth phase in which development of advanced weapons—such as XC-1 transport and XT-2 trainer aircraft began to emerge (1968 to the present).

18) Defense Report D-56, Guided Weapons, page 2.

of guided weapons we shall have will determine whether or not we shall be able to defense our country successfully. In other words, the value of guided missiles in our national defense is absolute rather then relative"[19]. Based on such an appreciation, "although guided missiles are expensive, they are by no means uneconomical if we think of their strategic value and efficiency. On the contrary, it would be desirable for us to hold sufficient number of guided missiles even though it necessitates cutback in the secondary weapons and manpowers"[20].

Thus, on the recognition that missile weapons have an epoch-making impact on the strategic and tactical operations, JDA has made it one of its fundamental long-range policy to equip its forces with missiles, "whether or not they are to be used in future as nuclear weapons"[21]. At that time, it was not yet possible for Japanese industry to manufacture guided missiles in Japan. However, inasmuch as JDA considered that "national defense without dependence on foreign powers cannot be accomplished without guided weapons", it is necessary for the authority to make maximum efforts in connection with manpower, budgetary appropriation, administrative actions and utilization of technological resources, both governmental and private"[22] and to introduce advanced technology from abroad whenever desirable.

In accordance with this policy, JDA inaugurated 'Missile Study Committee' in October, 1954 to discuss long-range plans for development of rocket and missile weapons, Technical Research Institute was ordered to conduct basic research and development and in August, 1955, a special task force was created for this purpose.

Also in 1955, JDA decided to purchase a surface-to-surface training missile from Oerlikon of Switzerland (actual procurement order was issued in 1958), and started research concerning anti-tank missile (ATM), Sparrow-class air-to-air missile (AAM), short-range surface-to-air missile (SAM), Mk-30 rocket and others[23].

Research and development of rocket and missile got momentum from 1956 when JDA requested the U.S. government to lease seven types of missile systems for study. On June 4, 1957, the Defense Council decided, by means of a document titled 'Defense Capability Objectives' that "research and development of advanced weapons should be encouraged consistent with scientific and technological progress in general". JDA disclosed at the same time its own "plans for research and development of advanced weapons".

As the Technical R and D Institute of JDA (TRDI) was established in 1958, research and development of rocket and missile became an object of even more concentrated attention. Assistant Undersecretary of U.S. Department of Defense at that time, Schaff, visited Japan in autumn of that year to study Japan's defense setup and defense-related

19) Ibid., page 21

20) Ibid., page 2–3

21) Comment of JDA Director Ino at the press conference of May 16, 1959 (the Asahi, May 27, 1959).

22) Defense Report, D-56, Guided Weapons, page 25.

23) The Oerlikon missile was a short-range (20 km) and lightweight (250 kg) missile and was exported to several countries. The JDA decision to purchase the Oerlikon missile was made with a view to produce it under license.

industry. He met with the key people at JDA as well as with KEIDANREN Vice Chairman Uemura and others. During his trip to Japan, Schaff obtained a new appreciation as to the country's technical competence and its strong industrial bases which would make Japan a very important factor in the Far East. He believed that Japan should start production of missiles (his idea was to allow manufacture of Hawk (surface-to-air) missile[24] in order to strengthen Japan's defense capability. JDA, in view of the U.S. attitude, decided to include in the second DBP (1962–1964) a program to acquire the missile weapon by all possible means[25]. In the meantime, the Oerlikon missiles were purchased for training purpose, and research and development of rocket and missile finally materialized[26].

In 1956, research and development of an anti-tank missile was started by a group of companies comprising KHI (missile body), NEC (guidance system), Daicel (propellant), Fujikura Electric Cable (wiring) and others. The ATM was partially complete in 1957, and after the field experiments conducted in 1963, the missile was formally adopted by the Ground Defense Force of JDA. The anti-tank missile[27] was the first missile developed and made in Japan, and ever since, JDA has been procuring the weapon at the rate of 500 units par year, or 800 million yen[28].

Concurrently, another air-to-air missile (AAM-I)[29] was developed by Mitsubishi Heavy Industry and other firms. The missile completed field tests in 1963 and currently in production for use aboard F—104J of the Air Self Defense Force.

Another development project covering a large rocket (SSR) was started in August, 1957 by a group of companies headed by Nissan Motors. The group included Rikoh,

24) This can be confirmed by the fact that the Assistant Undersecretary stated at the U.S. House Appropriation Committee held on May 22, 1959 that Japan was considering to participate to production of the Hawk missiles (the Asahi and Mainichi of May 24, 1959). Shortly thereafter, JDA Director Ino, during a press conference held on May 26, 1959, said "JDA should like to have the Hawk missiles and also to have them manufactured in Japan if U.S. and U.K. are willing to assist" (the Asahi, May 27, 1959). For these reasons, it seems certain that close consultations were held between Schaff and JDA officials during his visit as to the possibility of equipping JDA forces with the Hawk and other missiles.

25) The Nippon Keizai Shimbun, May, 27 1959.

26) Mitsubishi Electric Company was planning to conclude a manufacturing license agreement with Oerlikon and to export the missiles made under the license to Southeast Asia.

27) The ATM (Mk-64) is a wired short range missile for destroying moving objects. 1000mm in length, 120 mm in diameter and weighting 15.7kg, it has the speed of 85m/sec with the effective range of 1,500m. It consists of guidance controller, optical unit, telemetering system, divider and other components.

28) The Nikkan Kogyo Shimbun and the Nippon Keizai Shimbun of July 22, 1969.

29) The AAM-I was developed as the replacement for the Sidewinder missile previously equiped on board the F-104J, originally developed by NOTS of the U.S. Navy and procured through FMS by JDA at the cost of approx. one million yen per unit. About 1,000 of those were imported, according to the Nikkan Kogyo Shimbun of October 21, 1969, to be used by the Air Self Defence Force. The first order for AAM-I was issued to MHI in 1968 at the cost of 70 million yen for 20 missiles, which means the unit cost of AAM-I was 3.5 million yen, or 3.5 times of acquisition cost of the Sidewinder. In 1969, 330 units were ordered at the price of 1,382.7 million yen. The unit price of 4.19 million yen is an increase of more than 20% compared with the previous year's price (the Nikkan Koku Tsushin, February 2, 1968 and October 3, 1969).

Nipon Seikosho, Nippon Yushi (responsible for solid propellant) and others. Originally, the group aimed at a rocket of 200m/m in diameter and 4.5m in length, but in 1960, it was decided to increase the diameter to 300m/m in order to obtain more power. After six prototypes production, the SSR was tested successfully in 1963 and provisionally adopted by JDA in 1968 as Mk-68 Mod. 30 rocket[30].

Thus, although a large amount of money was spent since 1953 to promote research and development of rocket and missile, actual results during the period of more than 20 years cannot be said to have been very productive. Of the several projects undertaken by TRDI-JDA and civilian industry, those which have already been referred to, namely, the Mk-64 ATM of Ground Self Defense Force (R/D start in 1956 and provisional adoption in 1963, prime contractor: KHI), Mk-68 Mod. 30 rocket (R/D started in 1957, provisional adoption in 1968, prime contractor: Nissan Motors), also for the GSDF, and the AAM for Air Self Defense Force (IR-AAM-I) to be installed on S-86F and F-104J (R/D started in 1956, field tests completed in 1968, prime contractor: NHI), are the only products which successfully completed tests and adopted by JDA. There are some more unsuccessful attempts, such as the AAM using rader homing system which was eventually abandoned.

There were, obviously, a great deal of technical difficulties to explain the failure to develop viable products in spite of the generous budgetary appropriations (ref. Table 1); however, it clearly shows that development of weapons is by nature prone to cause a huge waste of resources.

In the following part, we shall see how Japanese industry participated to production of the rockets and missiles.

IV

Towards 1957–1958, when "even the term 'guided missile' was a sort of taboo"[31], industrialists were aware of "the necessity that guided weapons will become indispensable in near future"[32]. "In order to develop plans without losing the opportunity"[33], and to collect information and to study the future, Federation of Economic Organizations established on September 30, 1953 the Guided Missile Subcommittee as a common forum of Weapons, Aeronautical and Electrical Subcommittees attached to the Defense Production Committee of FEO. The new subcommittee comprised fourteen member companies who were: Toshiba, Nippon Electric, Hokushin Electric, Hitachi, Kawasaki Heavy Industry, Tokyo Keiki, Tokyo Koku Keiki, Fuji Seimitsu, Mitsubishi Shipyard, Shin Mitsubishi Heavy Industry, Nippei Sangyo, Japan Radio, Japan Jet Engine and Kobe Kogyo.

30) The Mk-68 Mod. 30 rocket has the range of 25 km which is sufficient to attack a complete army division on the front. Intended mainly for local firing with good manoeuvrability, the vehicle-carried missile is the largest surface-to-surface missile owned by the Ground Self Defense Force.

31) "Ten Years of Defense Production Committee", page 136.

32) Ibid.

33) Ibid.

On November 5 of the same year, the Subcommittee was reorganized into "Guided Missile Round Table Conference" since a 'normal subcommittee cannot meet those needs peculiar to missiles because of their extensive relationships with many sectors of basic and specialized industry'[34]. However, shortly thereafter in early December, the round table conference was again reorganized[35] as "guided missiles represent integration of various technology and development must be backed up by closer cooperation among the enterprises concerned.....therefore, in order to establish such cooperation, and to ensure that work is systematically and effectively coordinated for the requirement of national defense, the organ must have a unitary character to integrate all of the companies involved". Rules concerning secrecy of classified information were adopted at the same time, and the organization started full-fledged activities to prepare the groundwork for production of guided missiles.

Thus, by the end of 1954, Japanese industry was more or less ready to start related activities. In March, 1954, a technical subcommittee was established in GM-RTC (S. Shimizu, President of Hokushin Denki became the Committee Chairman) as the civilian counterpart of the Spacecraft Committee of which had been founded in October, 1953 within the Security Agency. Three companies—Mitsubishi Electric, Fuji Heavy Industries and Japan Avionics—joined GM-RTC, making the total membership 17.

The organization became very active as the Security Agency was promoted to the stature of Japanese Defense Agency (July, 1954) and in view of the imminent establishment of Air Self Defense Force within JDA. The Technical Committee was divided into four subcommittees[36] which started activities to prepare operational plans for development of

34) Ibid.

35) The structure, operating policies and guidelines of the reorganized RTC were as follows:

(Structure) 1. The GM-RTC shall be the sole and unitary organ in the civilian sector concerning guided missiles. 2. Membership shall be maintained at the minimum and limited to those 14 companies for a time being, and if a need arises in future to increase the membership, the RTC will discuss it from time to time. 3. Chairman and vice Chairman are to remain unchanged. 4. The GM-RTC shall have the Sectretariat Committee responsible for development of plans for activities of the organization. 5. The Secretariat Committee shall consist of the following members: R. Mabuchi, Member of Defense Production Committee, M. Kumagai, Managing Director of Japan Ordnance Association, S. Arimori, Managing Director of The Society of Japanese Aircraft Constructors, and T. Senga, Assistant to Chariman, GM-RTC (FEO Director of Economic Cooperation). 6. Defense Production Committee shall support activities of GM-RTC as its secretariat office.

(Operational Policies) 1. Plans relating to administration, research and development structures concerning guided missiles. 2. Acquisition and distribution of information and data concerning guided missiles. 3. Study of actual status of research and manufacturing organization. 4. Preparation of the lists of experts, both past and present. 5. Preliminary study concerning development of guided missiles.

(Guidelines) GM-RTC will pursue its activities independently as the sole civilian organization consisting of these enterprises concerned, but Defense Production Committee will assume final responsibility for the GM-RTC activities with a view to strengthen its position (Viz. Ten Years of Defense Production Committee, pp. 138-139)

36) The subcommittees, established on June 19, 1954, were: Subcommittee 1, responsible for plans, policies coordination and research; Subcommittee 2, responsible for propulsion; Subcommittee 3, responsible for aerodynamics and guidance, and Subcommittee 4, responsible for electronics.

guided missiles in close cooperation with JDA.

Shortly after the start of JDA, the GM-RTC submitted, on September 28, the "Policy Proposal for Research of Guided Missiles"[37] which contains detailed long range plans for research, prototype development and production of guided missiles, proving the fact that FEO attached a very great importance to this subject.

Main points of the proposal were as follows:

1. Research and development of guided missiles must be carried out speedily and effectively, although dependence on foreign technology should be avoided as far as possible because of the following reasons:
   (1) Neither U.S. nor U.K., who have the necessary technology, are unlikely to disclose it in view of the security problems.
   (2) Oerlikon of Switzerland appears ready to export missiles, but performance of Oerlikon products is not very satisfactory and their value is that of reference purpose only.
   (3) Import of complete missile may appear to be economical, but it discourages basic research, resulting in lack of initiatives and permanent delay of progress.
   (4) Payment of large amount of money for importation equals to payment of research and development costs to the foreign firms. The money should be spent in domestic efforts.
2. In order to realize maximum saving of resources, the following policies are recommended:
   (1) Test missiles must be selected rationally and systematically in considering those conditions peculiar to Japan.
   (2) Research organization should be concentrated in order to avoid unnecessary duplication.
   (3) In principle, competition should not be introduced.
   (4) Appropriate actions must be taken to ensure adequate flow and exchange of results of research. Opportunities must be given equally, but research priority must be respected.
   (5) Research priorities should be established in order to avoid all-round expenditures of resources.
3. The entire research program should be divided into basic research, prototype development and production of guided missiles. The basic research should be carried out by participation of all members without regard to their capital and other types of affiliation which, however, should be considered to a certain extent in the stage of prototype production, and duly respected in the sate of production.
4. The program must be implemented with due cares so as it may not supress or discourage research activities carried out by individual companies on their own initiatives.

The proposal clearly shows that the industrialists were anxious to expedite research

37) Ten Years of Defense Production Committee, pp. 141–142.

and development of guided missiles in order to catch up with U.S., U.K., France, Switzerland and other advanced nations, and to accomplish this by defining research objectives, by excluding principle of competition, by cooperation of eligible members, and by structurizing and organizing production of missiles according to capital affiliation with a view to gain monopolistic control in the long run.

In April, 1955, the Tokyo University conducted the first test of 'Pencil Rocket' for which development had started in 1953, and in September 1957, the Kappa 4-C rocket—the first full-sized rocket made in Japan—was launched successfully. In the meantime, JDA established the Technical R and D Institute, and this led JDA to strengthen budgetary backup to the efforts to develop rocket and missile. Towards this period, the plan to build a missile firing range in Niijima Insland was disclosed. The first DBP—the plan for military expansion and procurement of weapons—was implemented from 1957, and all these factors motivated the industrialists to move frantically not to miss the chance, i.e., "to start research and development of missiles and rockets at all costs"[38].

Mitsubishi Heavy Industry, Fuji Precision and other companies promptly organized a joint research structure and invited manufacturers of propellant and electronics to join. They started research and development of air-to-air, surface-to-air and surface-to-surface missiles. At the same time, this served to organize affiliation of manufacturers and division of work among themselves. Such a remarkable initiative on the part of profit-making enterprises was due to their willingness to get leadership not only in conjunction with the DCBP, but also in the domain of rocket and missile production which was certain to become the crucial part of future defense industry, and hence, in aerospace industry in general.

With such a background, and also because of the start of the International Geophysical Survey Year (1957), the Japan Rocket Association[39] was established in September, 1956 "to unite all who take interest in rocket, and to promote technology and cooperation among the members."

GM-RTC in the meantime made fair progress in research and prototype development, and its activities came to encompass much larger domains of industry. The membership increased to 20 as three new members joined it (Nippon Yushi and Nippon Kogaku in January, 1955, and Matsushita Electric in August, 1956). However, the organization was no longer large nor strong enough to lead development of guided missiles, and for this reason, GM-RTC was reorganized as of June 26, 1957 into the "Guided Missile Council" and 21 more new members were admitted. As before, the Council was to act as the sole organization to represent the interest of private sector and to maintaining liaison with JDA and other governmental agencies, and by promoting cooperation among the related organizations[40]. This marked the culminating point of development of rocket and missile research, development efforts in the private sector.

38) The Nippon Keizai Shimbun, Nov. 20, 1957.

39) Ten Years of Defense Production Committee, page 144.

40) In May 1961, corporation which increased into the GM Council became 52 members.

Now, we shall turn our attention to one more aspect, i.e., preparation and establishment of production base for domestic production of Nike and Hawk missiles.

V

On May 26, 1959, JDA Director Ino disclosed that consistent with the basic policy of th Agency to acquire guided missiles, Hawk missiles would be introduced during the second DBP (1962–1966). U.S. had already decided to supply JDA with Hawk through the MAP channel in order to set up two Hawk battalions. The JDA director also had a plan to manufacture the Hawk under license during the 3rd and 4th DBP (1967–1971 and 1972–1976, respectively) and decided to create 'Military Technology Council' as one of the highest ranking decision-making organ of JDA. He stated that "in order to promote military technology, it would be necessary to re-establish educational courses on weapon and aircraft engineering in those academic institutions like the University of Tokyo"[41], emphasizing the need for cooperation between JDA, industry and institution of learning. His statement bears witness to the fact that JDA was more than anxious to develop and acquire missile weapons as a vital means to strengthen the Japanese armed forces in compliance with the pressure of U.S. on Japan to take larger share of defense expenditures. This policy also reflects strong desire on the part of industrialists to acquire technological base for future space development through domestic production of missile weapons.

In fact, Mitsui Group, led by Toshiba, as well as Mitsubishi Group had completed already their own research and development structures for rockets and missiles, and started preliminary plans of domestic production of Hawk missile in consideration of the policies as mentioned already[42].

The statement by the Assistant Undersecretary Schaff of U.S. Department of Defense on April 24, 1959 at the House Diplomatic Committee that "U.S. will allow Japan to manufacture Hawk" prompted Mitsui and Mitsubishi Groups to compete vigorously for

41) The Asahi, May 30, 1959.

42) Mitsui Group consisted of 6 companies including Toshiba (Toshiba, Fuji Heavy Industry, Nippon Seikosho, Dai Nippon Celluloid, Tokyo Keiki and Mitsui and Co.). It started in 1958 a joint study for manufacture of Hawk. On September 25, 1959, these firms established MSA (Missile and Space Technique Research Group) in which each member was to have the following responsibilities: Toshiba—electronics, Fuji, Nippon Seikosho—aircraft and materials, Dai Nippon Celluloid—propellant, Tokyo Keiki—instruments and automation, Mitsui and Co.—acquisition of data and coordination. The Group submitted to JDA "the domestic production plan for Hawk missile" in July, 1966.

The Mitsubishi Group was made up of MHI, Mitsubishi Shipyard, Mitsubishi Electric and Asahi Chemical. In December, 1965, the group sent the Hawk Survey Mission to Raytheon and concluded a 'preliminary technical assistance agreement' and the report of the survey mission was submitted to JDA in January, 1966. In compliance with the agreement, Mitsubishi paid $300,000 to Raytheon and $50,000 to Northrop (manufacturer of the launcher). These agreements were closely reviewed at the Budget Committee of the House of Representatives on October 25, 1967, as questionable deals under the foreign exchange control law.

Apart from these two groups, Fuji Precision Group (Fuji Precision, Toshiba, Tokyo Koku Keiki and Nippon Yushi) as well as Kawasaki Group (Kawasaki, Fuji Precision, Nippon Electric) were organized for the similar purpose.

domestic production orders for Hawk as well as Nike missiles. Both tied up with the U.S. manufacture—Raytheon for Hawk, Western Electric and Douglas for Nike.

In the meantime, the Japanese Government and that of the United States came to an agreement concerning the domestic production of Nike Hawk on October 13, 1967. The "U.S.-Japan Memorandum on Acquisition of Nike and Hawk Missiles" was exchanged between Foreign Minister Miki and U.S. Ambassador Osborne in accordance with the Mutual Security Agreement (DDEP). The protocol listing details of mutual understanding was executed by D.O.D. Official Fiddy and Chief of Equipment K. Akazaki of JDA[43].

The Nike-Hercules obtained a budgetary appropriation in the total amount of 40 billion yen, of which 38.5 billion was to be spent as a part of the 3rd DBP[44] (the budget for domestic production was 20 billion—13 billion for the missile, 4 billion for the guidance system and 2 billion for propellants). Mitsubishi Heavy Industry was nominated as the prime contractor for the domestic production. The electronic guidance system was subcontracted to Nippon Electric (licensee of Western Electric), propellant to Asahi Chemical (licensee of Hercules for booster), Nippon Yushi (licensee of Chiocol for sustainer) and Nissan Motors (rocket motor licensee of Aerojet), respectively.

As for the Hawk, the budget for domestic production was 51.5 billion yen[45] of which 43 billion was to be spent under the 3rd DBP. 665 missile units were to be manufactured at the cost of 20 million yen per unit. Mitsubishi Electric and Toshiba keenly competed for the prime contract award, and finally, it was decided that Mitsubishi Electric was to be given the order for system management (final assembly and test). Approx. 70% of

43) The memorandum contains basic agreement concerning procurement or production of Nike and Hawk by the Japanese Government and sale or grant of manufacturing license by the U.S. government to meet the Japanese requirement. The protocol, on the other hand, contains the following: 1. U.S. Department of Defense will provide JDA with drawings, specifications and other technical information necessary to produce and maintain the missiles.
2. Japan will bear a part of the development cost incurred in the past. Payment will be made as a part of the hardware price (initially, U.S. asked for 3.6 billion yen, and comprimise was reached at 2.7 billion, to be paid in installment spread over the hardware costs).
3. Japanese government will protect secrecy of classified information on certain parts specified by the U.S. Department of Defense.
In accordance with the protocol, JDA undertook to make hardwared necessary to maintain three battalions and one training corps in the Ground Self Defense Force (Hawk) as well as two battalions and one training corps in the Air Self Defense Force (Nike). Viz. the Akahata, October 17, 1967 and Nippon Keizai Shimbun, October 13, 1967.

44) The budget of 38.5 billion yen covers 311 units of Nike-Hercules (unit price: 60 million yen). Domestic production of the missile was limited to the main body only. Actually, 36.7 billion yen was spent until the end of fiscal year 1971, of which 14.8 billion was for procurement of hardwared needed to convert Nike-Ajax (for two battalions) into Nike-Hercules through the FMS channel.

45) The 3rd DBP expected to acquire Hawk missiles enough to equip two battalions (or 14 companies, each having 6 launchers and command systems) or total of 665 missile units by 1972. During fiscal 1967, 10.1 billion was spent to equip 3 companies as well as the training corps, including the knock-down portion of production. In fiscal 1968, 51.5 billion yen was appropriated for the missiles, including those needed to equip 11 companies, representing 41.4 billion yen.

the contract—excluding those parts common to Nike—representing 30 billion yen or 70% of 43 billion yen[46]—was subcontracted to Mitsubishi Group led by Mitsubishi Electric Company (Mitsubishi Electric—main unit of missile and a part of electronics, Nippon Electric—electronics, Japan Radio—a part of electronics, Mitsubishi Heavy Industry—launcher and mechanical components, Daicel—propellant, Nissan Motors—rocket motor) while the rest—30% or 13 billion yen—was subcontracted to Mitsui Group led by Toshiba (mainly radars) and including Tokyo Keiki, Nippon Seikosho and a few other companies. This decision (to allocate Hawk production not to a prime contractor but to Mitsubishi Electric and Toshiba on the basis of joint production by equal partners) was made at the cabinet meeting held on November 10, 1967.

Thus, the domestic production of Nike and Hawk was assigned to Mitsubishi Group and Mitsui Group. It means that manufacture of modern weapon systems came to be controlled by the two giants of monopolistic capital.

The Japanese government (Foreign Investment Committee) approved on March 21, 1968 the application filed by MHI and McDonnel Douglas to conclude the license agreement for production of Nike-Hercules Missile (an umbrella type license) and that of Mitsubishi Electric and Raytheon for license agreement on Hawk system. The government also approved the license agreement between Daicel and Aerojet on Hawk warhead, the one between Japan Aviotronics and Huges Aircraft on TSQ-51 missile battalion command system, as well as the license agreement between Toshiba and Litton on BTE-CTSA 77 (interface terminal for missile company) and some others, although details of these agreements have never been disclosed.

In the meantime, MHI concentrated Nike production at its Nagoya plant (basic research group and aircraft plant in nature), while Toshiba expanded its Kawasaki plant for Hawk production. Mistubishi Electric located the technical center at its Kamakura plant, and production was undertaken both at the plant and at Amagasaki (communication equipment plant). Mitsubishi Precision, a subsidiary of Mitsubishi Electric, built a new plant at Kamakura for production of missile body and command system at the cost of 200 million yen. Mitsubishi Electric also built the assembly and test facilities in Chiba City (surface area: 40,000 square meter—actual flight test was conducted at McGregor Army Test Field in New Mexico, U.S.A.).

Thus, domestic production of the missile weapons involved a very large amount of capital investment.

This does not mean, of course, production based on technology developed in Japan. It means no more than importation of all key portion of the technology from U.S.A., and

46) Several missile experts of the U.S. Department of Defense visited Japan from 24 to 28 July, 1967, to discuss with the top level JDA officials the location of Nike-Hercules and Hawk bases and details of domestic production of the missiles. During the discussions secretly held at the U.S. Military Assistance Advisory Group office in Tokyo, it was agreed to adopt the U.S. military system for the domestic production, which was 70% of the total volume. Consequently, excluding those common parts of Hawk system, Mitsubishi Group was to receive orders amounting to 22.05 billion yen, while 9.45 billion was to go to Toshiba Group.

moreover, the basic technology is completely classified under the mutual secrecy agreement.

As it is, the 'domestic production' of Nike and Hawk clearly shows that production of modern weapon systems is completely dependent, at least technologically, on big business in America. Moreover, Hawk missile, for instance, no longer represents the latest state of technology. It was completed well back to 1955, and a lot of fire control system—from detection of the target to firing—is dependent on manual operation and for this reason, the reaction time takes several minutes. It does not have sufficient ECCM capability to overcome electronic interference. As such, it is very questionable if Hawk can be called a modern weapon system today. In other words, public expenditures in excess of 50 billion yen to manufacture Hawk missile is unlikely to be a meaningful investment from a practical point of view[47].

Then, why did Mitsui and Mitsubishi became so anxious toget the orders? Competition was justified, from their standpoint, because it allowed them to acquire technology in electronics, communication, propellant, heat-resistant materials and other domain at the public expense and thus to reinforce their own competitive power. To these companies, it did not matter whether Hawk was obsolete or not, because the domestic production was just one of the means of getting technology they need in order to allow them to compete better and to get more profit. Production of obsolete missile was important, in spite of its questionable value, because it was to be profitable. Consequently, it is apparent that production of weapon is controlled by capital.

On the other hand, Japan is an excellent market for U.S. manufacturers of weapon system because it allows them to sell obsolete technology for which they have fully amortized the development cost at a good price, thereby to acquire extra profit. For instance, Japan had to pay 2.7 billion yen for research and development expenses which the U.S. companies had already spent and amortized.

It has been said that military technology has a vast spin-off effect on civilian economy in general, and this should be true to a certain extent. However, we must remember that domestic production of Nike and Hawk depended on U.S. technology, and it did not contribute to development of Japan's technological base on their own. Consequently, its spin-off effect must be a secondary one, limited in scope. On the contrary, it tends to encourage the technological dependence even more.

Also, since the domestic production is not complete—key parts and components were all imported—acquisition of technology is incomplete too. Production was carried out based on the licenser's specification and thus, the missiles produced tend to show defects. For instance, in the case of Nike-J missile manufactured by Mitsubishi Heavy Industry, some of them misfired or developed other types of failure during the tests[48]. These

47) the Yomiuri, February 13, 1974.

48) Nike-J missiles manufactured by Mitsubishi Heavy Industry during 1970 were tested at the U.S. Army Test Field at McGregor, New Mexico from November 1972 to February, 1974. The test showed that out of 12 missiles tested, two misfired at the second stage—a failure rate well above 10% (Viz. the Yomiuri, February 24, 1974). The rate of misfire is very high and it is not difficult to imagine that a large number of Nike-J currently held are not fit for actual use.

failures are not surprising, but they do indicate the limit of imported technology, apart from being large waste of public resources (one Nike missile costs 60 million yen).

The above description summarizes process of the domestic production of Nike and Hawk missiles in Japan. As Table 1 shows, it would not be a mistake to say that Japanese space development has always been led by research and development of missile weapons for the Japanese Defense Agency which laid the ground work both technologically and in terms of manufacturing. This also shows that the space development in Japan has not been promoted for peaceful purposes alone.

For the moment, research, development and production of missiles for JDA are limited to those having short range and relatively low crusing altitude. Intercontinental ballistic missile (ICBM) with nuclear warheads or intermediary range ballistic missile (IRBM) are not—at least publicly—made the object of research and development efforts. However, development of space rocket is being undertaken by the Science and Technology Agency and Ministry of Education (Institute of Space and Aeronautical Science of Tokyo University) for launching of satellites. Furthermore, Japan already has necessary technological and material bases to make nuclear warheads. She also has the infrastructure sufficient to develop space rockets and missiles, even though technologically it is dependent on the United States.

Modern weapons such as missiles or rockets cannot exist without very high degree of reliability to support their optimum performance. Production of such weapons require comprehensive and close cooperation among companies representing different fields of specialized expertise. It must depend on integration of best of technology and best of production base. Consequently it emphasizes the social character of production and close cooperation (complex) between industry, armed forces and academic institutions. Inasmuch as rocket and missiles constitute the core of modern armament, we cannot neglect the strategic character inherent in space industry nor its influence over the Japanese national economy.