기술혁신학회지 제1권제3호
1998년 12월 pp. 338-350

Targeting the Future: Asian Aerospace, Its Current Status and Challenges

- 미래로의 지향: 아시아의 항공산업, 그 현황과 도전 -

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〈Abstract〉

Asian countries, ranging from China and Japan to Korea and Taiwan, differ in their industrial development stages to support the aerospace industry, and market access conditions. Despite these differences, all these countries target the aerospace industry as one of their future industries. The phenomenon challenges the conventional view that entry into the aerospace sector follows a gradual path from simple hanger repairs to license production, and to international collaboration. This paper reviews current status of the Asian aerospace with a dichotomy of the conventional promotion and Fast-Track promotion strategies. Analysis revealed that multiple entry points, in terms of technological level, exist in the aerospace industry, while the conventional thinking still holds validity. Then the paper presents potential obstacles and challenges these Asian countries would face in the promotion of the industry.

Key Words: Asian aerospace, entry barrier, system integration, market demand, conventional view, fast-track promotion, portfolio of industries, license production

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I. Introduction

Aerospace sector seems to be a dream industry for Asian countries ranging from Japan and China to Korea, Taiwan and Indonesia. These countries differ in their industrial development stages, portfolio of industries to support the aerospace industry, and market access conditions.

Despite these differences, all these countries target the aerospace industry as a key industry for the future. This paper reviews the several Asian countries' status and past & present programs in the aerospace industry with a reference to each country's industrial portfolio[1] where national divergence exists. Analyses of the countries reveal that each country has pursued unique development strategies. The conventional view holds that entry into the aerospace sector follows a gradual path from simple hanger repairs to license production and from license production to international collaboration see Figure.[1] The eventual goal is to acquire an independent design capability. Regarding theorization of the development model, it is possible to present that multiple entry points, in terms of technological level, exist in the promotion of the aerospace industry, while the conventional thinking still holds validity. In conclusion, this paper presents potential obstacles and challenges these Asian countries would face in the promotion of aerospace industry.

Ⅱ. Conventional Thinking of Promoting Aerospace Industry

1. Characteristics of the Industry

The aerospace industry requires huge degrees of system integration that are virtually unmatched by any other manufacturing product existing in the world. The nature of the aerospace industry seems to impose a barrier to entry(Bain, J., 1956, Weizsacker, 1980, Yip, G., 1982). Through the history of different nations, system integration requirements have set a barrier to learning and growth. Early 19th century German industrialization shows the technological development in machinery sector was slower than its steel industry in catching up with the Britain, the most advanced model country of the period(Gerschenkron,A., 1962). Similarly, in a more recent Korean Industrialization, heavy industry sectors, with an exception of the shipbuilding industry, spent more time than electronics industry in learning how to be competitive in the world market(Kim, J., 1997). Perhaps the exception in the Korean case, the shipbuilding industry requires less degrees of system integration than machinery sectors.

Another characteristic that defines the aerospace industry is that the principle of economies of scale is applied in the industry. The principle applies to other industrial sectors such as steel, automobile, and various manufacturing

1) Portfolio of industries means a variety of supporting industries a country has and how developed each supporting sector is. For example, machinery and electronics industries can be regarded as supporting industries for aerospace sector, and their variety and degrees of development can be the components of the portfolio.

and service sectors that are operated in the Fordist production philosophy(Piore and Sable 1984). Despite the common influence, the degree to which aerospace sector is affected by the economies of scale is much greater, since the consumers of the aerospace industry are much restricted. This works as a natural barrier to start and invest in the aerospace sector from a developing country's point of view, and the point becomes stronger when the country is a small country in both economic and geographical senses. The meaning of limited customers and limited orders is that production costs are higher in the industry, and low competitiveness of the industry. This aspect is clearly seen in most Asian countries, and license production is not an exception to this. Japan has been willing to pay almost several times of the import price in license producing aircrafts.[2] This would be also applied to license production cases in Taiwan and Korea as well, though the actual price differentials would be different, depending on how much parts and components are locally produced.

These characteristics of the aerospace industry lead us to think that in the industrialization process the aerospace industry is the final stage where the earlier stages of industrialization and the accumulated scientific and technological know-hows are all integrated. This line of thinking naturally guides us to think that there is a path through which aerospace industry is developed. The gradual stage is understood starting from simple hanger repairs to simple assembly & license production, and eventually to design stages.

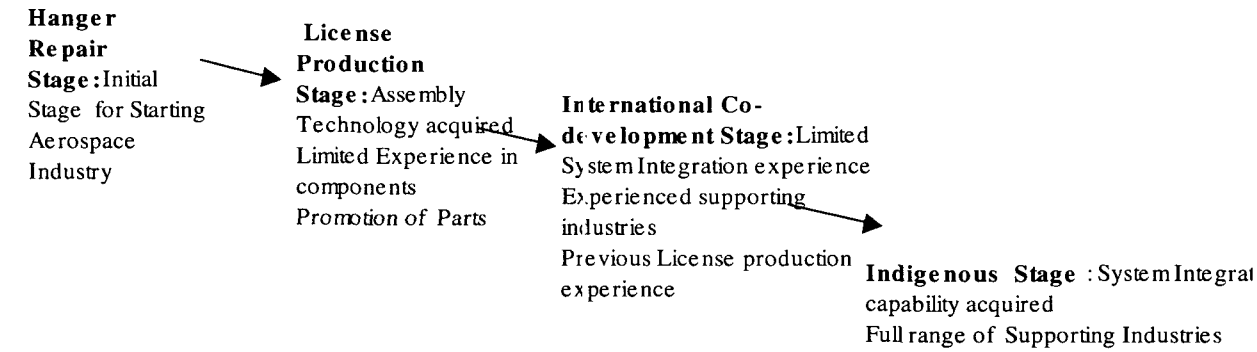

Figure 1 : Conventional Stages of Aerospace Industry Development

2. Stages of Aerospace Industry Development

This section provides a review of the conventional thinking on how aerospace industry is promoted.

Hanger Repairs

Nearly everybody agrees that the start of the aerospace sector begins with hanger repairs. In this operation, the degrees to which a country

2) *Defense News*, June 15th-21st, 1998, p.6.
Various sources suggest that production costs for FSX are nearly several times higher than the costs for direct purchase of F-16 from the U.S.

can perform repairs and maintenance would differ by several factors. Also the quality of maintenance would differ across countries. Despite the differences, many countries currently have this capability, including Singapore.

Assembly and License Production

After the hanger repair stage, license production offers a leapfrog opportunity in promoting the industry. In the license production, depending on license production deals and the technological level of the country that plans to license produce, there exists a spectrum of countries in terms of their involvement in the business. In the most simplified form, license production can be simply assembling components provided by the original manufacturer(Killing, J.P. 1980, Contractor, F. 1983). The next stage would be to participate in the production of fuselage. After participating in the fuselage, the path is opened to ever-increasing local components in the manufacturing, including engines and electronics.

An interesting observation is that while many countries are interested in license production, their industrial structure and level differ greatly. This causes a barrier in deepening the development of the industry. For example, Japan and Turkey have different industrial portfolio in license producing F-2(F-16 derived FSX) and F-16 respectively. From this point, an implication is that simple license production would not bring technological learning to the licenser country. Korean helicopter industry is also an example. With about 20 years of licensing helicopters, technological learning was minimal.[3] Thus, how advanced a country's industrial portfolio is prepared pretty much pre-defines the learning and developmental capability the aerospace industry in that country.

International Co-Development

The next stage to license production is to launch international co-development(Nelson, R.) projects or to join a multi-nation consortium. This reduces the burden of market potentials by ensuring larger markets, and technologically it also has a function of insurance. In this stage, participant countries differ in their capabilities. There is a gap between a leader country and follower countries. Even there is divergence among developing countries. The hot project of developing regional jetliners in Asian countries is a good example. Japan has a potential connection with Bombardier,[4] while China has signed a memoranda with Airbus. Korea is actively seeking outside partners.[5]

Indigenous Development

Perhaps what every country participating in the aerospace industry would agree is to acquire some degrees of its own capability in manufacturing aircrafts. China, Japan, and Indonesia, although different, have their own capabilities to design and manufacture aircrafts.

Ⅲ. Asian Aerospace: Different Approaches to the Target

Asian countries are approaching the aerospace sector with different industrial background. As seen in Figure 2, it is possible to present two distinctive patterns of aerospace industry

3) *Flight International*, "Upward Mobile," October 23-29th, 1996, p.34.
4) *Flight International*, "In Search of the New Jet Age," March, 5-11th, 1997.
5) *Flight International*, "Making Markets," March, 5-11th, 1997

promotion among Asian Nations. One pattern can be named as the conventional way of promoting the Aerospace industry. In this model of development, there are two important pillars : licensing and emphasis on localizing components. Thus, nations fall into this category has emphasized the promotion of related supporting industries, such as machinery and auto industries. Usually, these supporting industries promotion preceded the promotion of aerospace industry.

On the other extreme, there exists a fast track system integration oriented promotion of aerospace industry. Examples of this group include Taiwan and Indonesia. In the fast track model, rather than having a full range of supporting industries that can assist the development of the aerospace industry with localized parts, acquiring system level integration skill is emphasized. Thus, it is based on a totally different philosophy for promoting the industry. Between Taiwan and Indonesia. the latter country shows a more extreme tendency to follow the model.

1. Conventional Model of Aerospace Industry Promotion

Countries in this category have promoted a wide range of supporting industries in material, machinery, and other engineering sectors. With the industrial background, each country has utilized license production method as a way to acquire assembly and system integration technology. While countries in this group share the common direction in the promotion, they differ widely in their experience and capability.

1) Japan

License Production and Technology Acquisition

The Japanese way of promoting the aerospace industry is the typical reference case in which the government boosted the demand and led technological leadership. As would be similar in most countries, demand for airplanes were limited to armed forces. In this situation, the Japanese government wisely linked the license production experience to its indigenous airplane development programs. Examples run from 1950's Fuji T-1 to FSX in a broader sense.[6] The first project for the industry to re-enter the aerospace business after the World War II was to the license production of F-86 Sabare fighters. The experiences from the F-86 project was transferred to the development of Fuji T-1 trainer project. License production was continued for the production of 149 McDonnell Douglas F-4 Phantom and more than 167 F-15 Eagle fighters, while indigenous development efforts were mat erialized in projects such as the Mitsubishi F-1 and T-2 jet fighter/ trainers, which were produced 77 and 96 units respectively.[7] Nihon YS-11 and Kawasaki C-1 transport airplanes were the efforts for the indigenous development.

Advancing one step further, the Japanese aerospace industry has persistently developed its indigenous capability to develop its own models, components and system integration. In this case, as in the license production model, the Japanese industry had a clear goal to follow. The industry had a model of airplane they wanted to imitate. Mitsubishi F-1 is clearly influenced by the specifications of the British-French Jaguar Attack

6) *Aviation Week & Space Technology*, "Joint FS-X Team at Work," July 29th

7) *Aviation Week & Space Technology*, " Mitsubishi Expands Commercial Sectors," July 29th, 1991.

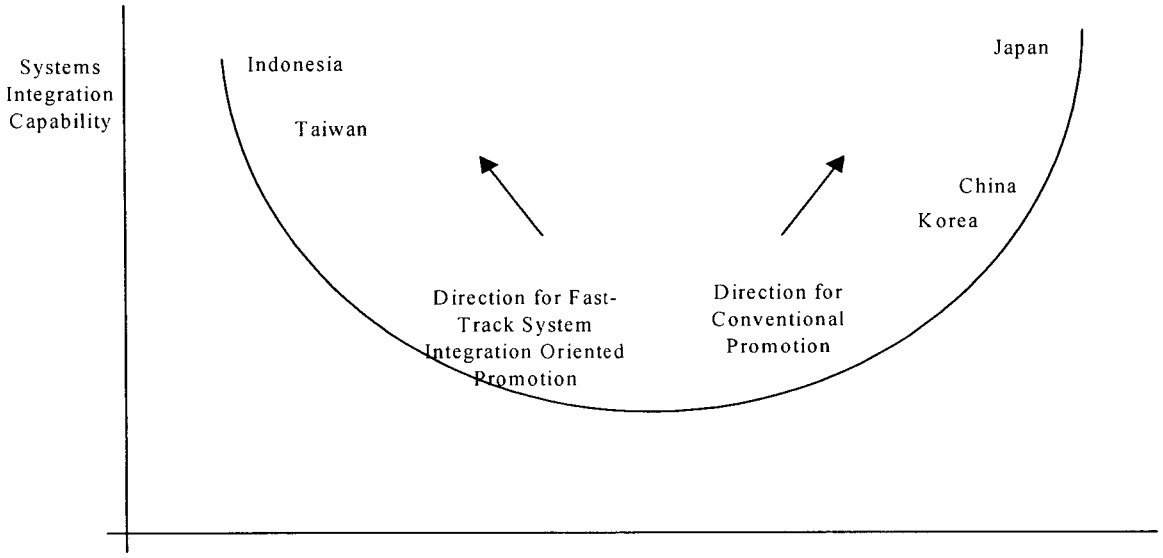

Figure 2: Profiles of Asian Aerospace Industry:National Divergence of Promotional Strategy

planes. In fact, Japan took the path to its own development, partly due to high licensing fees of producing the Jaguar.[8] License production was focused on more advanced aircraft of theperiod, while indigenous development efforts were concentrated in the trainers and light attack crafts. After entering into the license production of F-4 and F-15, the Japanese industry went into a more independent development. Kawasaki T-4 intermediate trainer aircraft shows an indigenous integration efforts from designs to engine production.[9] In the class of aircraft larger than fighters, the Japanese industry has accumulated an unique path. From the famous YS-11 and Shin Meiwa SS-2 amphibian craft to Kawasaki C-1, the industry has made significant efforts to accumulate experience.

Development of Supporting Industries

Among Asian countries, Japan has the most advanced machinery industry supported by strong electronics industry. In technological sense, the Japanese aerospace industry is unsurpassed by any other Asian countries. Not only Japan has accumulated license production experiences, but also the Japanese industry has increased to design and produce core parts. In the T-4 development, the IHI produced its indigenous engines for the trainer. In electronics and avionics, the Japanese industry has accumulated technological capabilities. From the 1970's F-1 project on, radars have been domestically produced. License production of radars continued in the F-15 production, and eventually in FSX, phased array technology is being adopted.[10] Going further,

8) *World Air Power Journal*, "Mitsubishi F-1," Vol 23, Winter, 1995, PP.51-52.
9) *Aviation Week & Space Technology*, "Kawasaki turns to advanced materials," July 29th, 1991.
10) *International Defense Review*, "US and Japan in Technology Transfer Ju-jitsu," June,1993, pp.461-462.

in new material areas, the Japanese industry has more advanced status.[11] Its composite material based airframe manufacturing is well known.

The forte of the Japanese aerospace industry, in fact, does not stop at the capabilities of the aerospace firms themselves. In many of the machine-related manufacturing fields, the Japanese products are known for reliability. From machine tools to automobiles, and to material, the Japanese aerospace sector has the strongest capabilities among the Asian nations.

2) China

License Production and Technology Acquisition

China's aerospace products range from vintage Antonov An-2 under the designation Shijiazhuang Y-5 and its modern equivalent Harbin Y-11 and Y-12 to license production McDonnell-Douglas MD-80 passenger aircraft.[12] On military aviation side, the Chinese production expands from indigenous copy of soviet origin fighters and license production of Antonov-12 under the designation Harbin Y-8. Adding to these, China is actively involved in international development of regional jet program with Airbus, and in Sino-Pakistani collaboration on the trainer project named K-8. Furthermore, Chinese license production of Sukhoi-27 fighters is underway.

After successfully involving itself in the licensing projects, the Chinese aerospace industry was actively seeking its partner for its regional jet project, which is now named as AE-100.[13] While the plane planned is smaller than the 737s and MD-80s, the Aviation Industries of China (AVIC) is also considering the license production of ATR-42/ 72 turbo-prop aircrafts.[14] With these projects, Chinese aerospace industry has acquired invaluable experience in assembly and system integration skills. One evidence is that after license production, similar domestic variants with modification came out in the international airshows.

Development of Supporting Industries

Chinese Aerospace Industry have virtually all aspects of capability in the Industry. Its only problem is technological sophistication necessary for passenger planes and avionics suites. In fact, China has been producing military and some of civil planes for itself and some foreign markets for several decades. Chinese machinery industry is well developed to produce military hardware both for China and overseas. In comparison, Chinese auto industry, though booming, is smaller than its population size and than the development in aerospace industry. Thus, Chinese automobile projects are usually in collaboration with foreign firms in the auto industry. Motivation for a foreign collaboration for regional jet project clearly supports the point.

Second, the Chinese industry lacks sophistication in electronics and avionics, which will eventually linked to system integration issue for aircraft design. This point will also lead the Chinese industry toward international collaboration.

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11) *Aviation Week & Space Technology*, "FS-X process Transferred," March 11.
12) *The New York Times*, "Western Lift for China's Air Plans," Feb 25th, 1995.
13) Flight International, " Difficult Journey," September 4-10th, 1996.
Aviation Week & Space Technology, "Europeans, Chinese Terminate AE31X," July, 13th, 1998.
14) *Flight International*, "Chinese negotiate for ATR 42 /72 production," March 5th-11th, 1997.

3) Korea

License Production and Technology Acquisition

The Korean aerospace industry has a unique position. Its stage of development can be located in a point where localization was more emphasized than system integration through its two decades' experience in the aerospace sector. With recent intensive investment, however, the industry would have a boom both in volume and technological levels. Korean Aerospace industry has gone through a typical development track of aerospace industry development discussed in the earlier part. Starting from hanger repairs, the next stage was license production. From the 1970s, McDonnell Douglas MD-500 helicopters were licensed. In the early 1980s, Northrop F-5 E/F fighter/ trainers were produced. Chronologically, it was at least few years behind Taiwan in producing the same type of aircraft. With this regard, it is reasonable to locate Korea next to Taiwan in establishing its aerospace industry.

The Korean government continued its effort to build aerospace industry in the 1990's with its Korean Fighter Project(KFP) in which Lockheed Martin F-16 fighters were produced. In addition to license production, in the cases of direct purchase, offset deals were made. One representative case is the Westland Lynx deal. In the deal, a Korean firm, Kia, was arranged to produce landing gear sets for the Westland. In the license production case of the 1990's, several core parts were locally produced. This is very similar to the case of Japan in licensing F-4 and F-15 fighters. Engines for the KFP were licensed by the Samsung Aerospace, while other participating firms were involved in parts and fuselage.

Following the license production stage, the Korean government is initiating its trainer programs: KTX-1[15] and KTX-2.[16] KTX-1 is a Pillatus PC-9 class turbo prop trainer intended for the service with the Korean Air force, while KTX-2 is British Aerospace Hawk class trainer. As can be understood, Korea's policy direction is very similar to both Taiwanese and Japanese models. All the three countries faithfully followed the typical development track, while these countries differed in the degrees of localization efforts. In localization efforts, Koran policy is in the similar direction as the Japanese, although the magnitude may be different. In linking license production experience to follow-up programs, the Korean policy shares similarity with both Taiwanese and Japanese: Even Chinese cases can be regarded as the similar pattern in the sense that licensed airplane types have some impact on the types of airplane to be followed.

Development of Supporting Industries

Korea's industry profile is in the middle point between Japan and Taiwan in terms of involvement of supporting industries. Korea has a wide range of heavy industries due from the Korean government's ambitious Heavy and Chemical Industrialization Drive (HCI) of the 1970's (Kim, J. 1997). This point makes the difference between Korea and Taiwan. Although Taiwan was faster in license production stage, Korea accumulated a faithful know-hows in machine-related sectors. While Taiwan does not have a viable auto industry, Korea became the 4th largest automobile producing country as of 1996. Industrial machinery sector in Korea has made

15) *Flight International*, "Upward Mobility," October 23-29th, 1996.
Flight International, "Good Flying," October 21st-27th, 1998.

16) *Aviation Week & Space Technology*, "Will Export Save KTX-2," Feb. 19th, 1996.
Asian Defense Journal, "The Republic of Korea's Forces at 50," October, 1998.

great progress during the 1980's while overcoming initial difficulties after the massive investment. Thus, it is quite clear that aerospace industry in Korea would benefit from the industrial base.

Despite the development, the Korean industry shares the same problem with Japan and Taiwan: demand. Military demand has a clear limitation in maintaining the industrial base.[17] Nor is Korea is endowed with abundant financial resources as is Japan. Also, compared to the Japanese case, Korea has fewer number of indigenous projects. With these circumstances, Korean effort in regional jet project is a brave attempt, considering conservative moves of the Japanese aerospace industry until recently.

2. The Fast Track-System Integration Oriented Promotion of Aerospace Industry

This model is named as the fast track promotion in the sense that it is against the traditional understanding of fostering the aerospace sector. With the model, an important implication is that there are possibilities for different entry points in starting aerospace industry. Traditionally, the aerospace industry has been regarded as the last step of industrialization where previous experiences in other machine-related industries all melt into a high system integration required industry. One limitation of the model that is so visible is that there should be outside suppliers of technology and components. There should also be suppliers of system integration skills to the late starters. In comparison with the other model, the fast track model does not differ itself in utilizing licensing opportunities. A difference lies in the fact that localization efforts are less intensive in this approach.

1) Indonesia

License Production and Technology Acquisition

Indonesia can be located in one extreme in the map of Asian countries that promote aerospace industry. Quite different from other countries in Asia, such as Taiwan, Korea, Japan, and China, Indonesia does not have a developed supporting industries for aerospace industry. Automobile industry in Indonesia is starting on a major scale from 1980s and 1990s after it established itself in aerospace industry. In this sense, conventional order of industrialization is not applied.

Going back to 1970s, under Dr. Habibie's leadership, Indonesia started its aerospace industry(Wijangco, M., 1989) with technical ties with CASA of Spain. Indonesia's IPTN licensed several aircraft and helicopter types, of which CN-235 turbo prop plane is regarded as its representative model. In the promotion of industry, Indonesian policy can be characterized in the following. First, from the beginning, co-development was planned with foreign assistance, which was CASA of Spain.[18] Second, localization of parts, which has been a representative industrial policy measure in Japan and Korea, was not pursued on a major scale. Third, instead, acquiring key technologies to integrate an aircraft was emphasized.

As a result, the IPTN developed its own N 250 turbo-prop plane and is aiming at regional jet plane titled as N2130.[19] With little to do with aerospace sector, Indonesian development is remarkable in any

17) *Flight International*, "South Korean trio start single-entity talks," October 21st-27th, 1998.
18) *The Korea Herald*, " IPTN Develops High Tech Aerospace Industry," August 18th, 1997.
19) *Flight International*, "IPTN focuses on higher capacity for N2130 regional family," March 5-11th, 1997.

perspective, and offers a reflection on the traditional thinking on the path of industrialization.

Development of Supporting Industries

Compared to other Asian nations that promote aerospace industry, Indonesia probably has the least supporting industrial background. Its auto in dustry is starting its own citizens car project in the 1990s, and machinery sectors are still under developed vis-a-vis other Asian countries that promote aerospace industry. Its electronics industry is also in the stage of producing Japanese firms' outsourced low-priced low-tech consumer electronics. With the industrial background, the Indonesian case shows a strong case that aerospace industry promotion can be achieved, to some extent, without a full range of industries.

2) Taiwan

License Production and Technology Acquisition

Taiwan's promotion of aerospace industry has centered around the military projects. State-owned Aero Industry Development Center(AIDC) initiated the development of AT-3 Tzu-Chung Light Attack planes and Ching-Kuo Indigenous Fighter (IDF) project with extensive assistance from foreign countries.

Taiwanese policy toward the industry was a typical track in which license production was the pre-stage before its own development. To fill its defense needs, Taiwan has licensed Northrop F-5 fighter planes through the 1970s. Following this, the AIDC started the collaboration with the Northrop for the development of the AT-3; in the case of the Ching-kuo IDF, significant assistance was given to the AIDC in many areas of development. General Dynamics gave assistance on airframe design, while Garrett provided civil jet engines derived turbofan engine for the IDF, which was later coded as the F125.[20] Menasco helped with landing gear, Westinghouse provided its APG-67 radar, which was originally proposed for the Northrop F-20 fighter. In addition, Bendix/King provided avionics, while Lear Astronics brought the fly-by-wire control system with side-stick controller(Gunston. B. 1990).

In addition to the fighter projects, it is also known that Taiwan once prepared to launch its turbo-prop plane project back in the 1970s. This project was aborted. Taiwan may be regretting the lost opportunity as of 1990's.[21] Taiwanese industry still has some possibility to participate in the Chinese regional jet project, if a Pan-Chinese collaboration ever materializes.

Development of Supporting Industries

Taiwan's aerospace industry is not fully equipped with other supporting industries as in the Japanese case. Taiwan's aerospace projects were aiming at imminent necessities for national defense, and relied on foreign sources. This suggests that the industry is vulnerable against the domestic business cycles of airplane orders. In some sense, the sale of U.S. and French planes to Taiwan would undermine its industrial base, since the production volume of the IDF would be reduced reflexively. Not having any other significant civil aerospace projects is a disadvantage for the Taiwanese industry. On the other hand, not having supporting industries means that the shrinking aerospace sector, at least for the time being, would have relatively small impact on the overall economy of Taiwan.

20) *World Air Power Journal*, "AIDC Ching-Kuo," Vol 26, Fall, 1996.
21) *Flight International*, "Changing the Guard," March 5-11th, 1997.

Ⅳ. Challenges and Prospects of the Asian Aerospace Industry

With the contrast among countries, what seems to be common problem facing the Asian Aerospace industry is the limitation of demand and marketability of their products partly due from technological reliability to persuade potential customers.Except for China, especially its civil aerospace market, all Asian countries, including Japan, have only limited domestic demand. This means the production costs can be significantly higher than direct purchasing price from foreign sources. The high costs even undermine export potentials, unless the export volume is significantly large. In the Chinese case, the great market potential is not yet materialized. Furthermore, market definition is not clear whether it needs a single airframe or a multiple airplanes to cover its domestic routes; it is even not clear which option is economical, considering the Chinese economic situations.

Another bottleneck in promoting the Aerospace industry in Asia is technological aspect. To sell civil airplanes, air safety is the prime issue together with operational economy. If there is a limitation in the Indonesian regional project, it is this aspect. Even though, Indonesia mastered technological aspects, it may take some time to persuade potential customers, airlines, to buy the planes. This applies to the reason that the Chinese industry wants a joint-venture with Europe in developing its own regional jets.

Add to these, even technological issues are resolved, there is another dimension of market competition. Knowing the oligopolistic nature of aerospace industry, whether a new entrant can survive is not clear in the future. This may have been the reason that Japan has been so conservative in entering into the civil airliner production until today, despite the fact that the country has full potential of industrial background. The new segment of regional jet market is not free from competition. Bombardier and AIR may be dividing the market in the future.[22] and this means a fierce competition for Indonesia and the Chinese joint venture AE-100.

Prospects

While these challenges exist in the development of Aerospace industry in Asia. There are, on the other hand, great potentials to be exploited. First, like in other manufacturing fields, manufacturing aircrafts is more widely spread than before, this trend will continue to lower the status of the aerospace industry toward the direction of a common machinery product such as trains or automobiles. Assuming the diffusion of technology continues, Asian countries will have greater access to the industry, as long as the countries have willingness to invest.

Second, together with technological diffusion, labor costs may still be an advantage as long as the quality of labor can be matched with the existing airframe producing nations. Third, as shown in the case of Indonesia, starting an aerospace industry does not require that a country have a full set of supporting industries. In some sense, for latecomers, it may be better to acquire integration know-hows rather than have everything on its soil. This suggests that

22) *Flight International*, "In Search of the New Jet Ages," March 5-11th, 1997.

depending on how Asian countries design their future plans for aerospace industry promotion, the goal can be achieved in a nearer future than conventional wisdom and experiences would tell us.

V. A Concluding Remark

This paper reviewed the industry profile of Asian aerospace, and point out challenges and prospects of the industry. Whether the aerospace industry, at least some segments, will prosper like auto industry or remain as a partially established industry will depend both on Asian countries themselves and international structural environments. With these contexts, this paper provides policy suggestions for the Asian countries that chose either conventional promotion or the Fast-Track System Integration oriented strategy.

First, limited demand condition has been one of the most serious challenge to the Asian aerospace industry. To cope with this, it is essential for Asian governments to provide their vision for their own aerospace industry. In designing the policy vision and implementing it, however, national characteristics should be considered. While Japanese government's promotion can be a good example of presenting the vision, as found in FSX case, generalizing from the Japanese idea is not an easy task. Soaring unit fly-away costs for the FSX implies that only large economies such as Japan can pursue the project. Thus, it is reasonable to infer that while policy vision is useful, the scope of a project or a policy should be limited to a point where each country can bear total costs and benefits. In this sense, Korean KTX-2 is a moderate choice, considering Korea's relative economic size vis-a-vis that of Japan.

Countries that chose the Fast-Track System Integration oriented approach has relative advantage in dealing with the demand problem, since it would be easier to maintain the facility together with a fact that national projects are usually linked to this approach. Ultimately, however, countries on the Fast-Track System Integration strategy are expected to converge toward the conventional strategy as their learning of integration is matured. From this point on, the advantage on demand enjoyed by the Fast Track approach would be reduced. Furthermore, it is very likely that the paths and problems of the conventional promotion may be repeated.

Second, in conventional promotion strategy, it would be important to upgrade technological level of sub-system providers. It would be important for these firms rely not only on government projects, but also participate in international markets. By doing so, technological learning and demand problem can be reduced. Especially in East Asian contexts, electronics industry suggests great potential for success. Considering dual-use nature and current competitive advantage of electronics sector, Asian countries can upgrade its aerospace related sub-system industry such as avionics and related electronics. This advantage can be a value-adding aspect for the Asian aerospace industry.

With bright aspects coexisting with high entry barriers from technology and market, it would be an interesting observation of the future to see how the Asian aerospace industry will become of.

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