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Space technology transfer: Spin-off cases from Japan

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ABSTRACT

Government organizations have to justify high expenditure during periods of financial crisis such as the one we are experiencing today. Space agencies have attempted to increase the returns on their investments in space missions by encouraging the commercial use of advanced technologies. This paper describes two technology transfer (TT) cases promoted by JAXA, in order to identify the organizational models and determinants of TT. The development of a TT process from space to Earth not only benefits the aerospace industry but also the network of national companies. The aim of the paper is to investigate who the actors are and the nature of their role, as well as the determinants of the TT process in the Japanese space sector. The case studies confirm the typical path of transfer as 'Earth–space–Earth'.

1. Introduction

Analysis of the processes of technology transfer in the space industry is prompted for various reasons. First, the space industry needs to justify its high consumption of public resources; second, it provides a significant source of technological spillovers, which make an important contribution to the economic development of a nation. The integration of advanced technologies with high-grade materials and components leads the space sector to utilize a wide range of support industries; thereby spreading its technology to other industries and benefiting the economy as a whole. It also invests heavily in R&D [1]. The size and risks of such investments, and the strategic relevance of space technologies in the economic and military fields, have encouraged nations to support the demands of industry, both by carrying out research and development within public organizations and by funding and directing private research.

The Japanese situation is emblematic because Japan has always used technology transfer as a reinforcement strategy for its industrial system and its own technological capital [2,3]. After the Second World War, one of the public areas of research selected for the expansion of the industrial system was the space sector. Among the first targets set by the country's space agency, JAXA, when it was formed in 2003, was to adopt a more application-oriented and industrially competitive policy. In the same period it created a collaboration department, whose aims were to increase the competitiveness of the Japanese space industry in the international market, to promote expansion and diversification in the market for space products and to facilitate technology transfer to non-space industries[1] with intellectual property that was the result of JAXA's R&D activities.

As noted, there is a strong focus on TT in the space sector because of its important role in developing industrial and civil society and its ability to obtain high returns from the huge investments required for space activities. Nevertheless, the process and organization of TT is hard to achieve and is not yet well understood.

A number of researchers has investigated the progress of technology transfer in the space sector within certain large nations, Europe in general, Italy, the USA, Canada and Russia [4–8], illustrating that TT has a different significance and takes many forms within different nations, depending on the objectives of their individual policy. Few studies have focused on TT in the Japanese space sector. This paper aims to fill the gap by analyzing two TT cases promoted by JAXA, involving transfer from large enterprises to small and medium-size enterprises (SMEs) in order to identify the organizational models and determinants of this type of technology transfer.

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[1] We used the terms non-space industry and terrestrial industry to indicate industries outside the aerospace sector.

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The final aim of the paper is to supply useful indications to business management and public decision makers for formulating appropriate policies and procedures for effectively dealing with the problem of technology transfer to other industrial sectors. Indeed, maximizing investments has become a fundamental objective of all the operators in the space sector. Earlier work in this journal has presented four case studies concerned with identifying the determinants of TT with reference to satellite technologies [9].

2. The Japanese aerospace industry: the main actors and roles

Although the Japanese aerospace industry experienced significant delay compared to other countries, as a result of the ban imposed at the end of World War II on developing its own air defense, it has since steadily grown [10]. When compared with the automobile, electrical consumer goods, computer and other industries in Japan, the aerospace industry is relatively small because it purchases a large amount of its aircraft fleet from abroad. Nevertheless, the Japanese aerospace industry is being continually upgraded to stand alongside those in the USA and EU.

Civil and military R&D in the aerospace sector is implemented by (and coordinated between) different agencies and ministries: JAXA, the Defense Agency, the Ministry of Economy, Trade and Industry (METI) and the Ministry of Education, Culture Sports, Science and technology (MEXT), which set the pace for the private sector represented by the Society of Japanese Aerospace Companies (SJAC). The Japanese government plays two key roles in the aerospace industry: it is the primary purchaser of aircraft and the source of financial subsidies. However, it is the large multinational corporations that supported the production of space equipment and JAXA's activities in the field of technology transfer (TT). The main private companies involved in the aerospace industry are strategic businesses, such as machinery, shipbuilding, electrical machinery and automobiles. This management structure is, in fact, advantageous in offsetting modest sales and sometimes restricted public funding. The principal companies are: Ishikawajima-Harima Heavy Industries (IHI), Mitsubishi Heavy Industries (MHI), Fuji Heavy Industries (FHI) and Kawasaki Heavy Industries (KHI). Many of these firms belong to large trading companies where space activity is minor, however the latter have a solid financial base for making the necessary investment or for refunding a program when needed. They also have in-house R&D which often co-develops programs with JAXA; 100% privately sponsored programs are, in fact, almost non-existent.

JAXA has been the operational arm of the Japanese space program and it is responsible for the development of satellites (including space experiments and space station operations), launching and tracking vehicles, and for the facilities and equipment required for satellite development. JAXA's civil programs can be grouped into three categories in terms of space research and development: Earth observation, space exploration and transportation, and human activities in space. Each year the Japanese Diet revises and approves the space budget submitted by MEXT. Funds are then given to JAXA, whose task is to allocate them to various programs. In 2010, the Japanese space budget reached ¥180 billion (€1.63 billion) with a total personnel of 1571.

JAXA's main strategic activity is to increase the country's industrial system by developing access, exploration and navigation programs, while a complementary activity is the development of civil applications, especially telecommunications, through technology transfer programs. JAXA has a well-organized structure for research and for the design of missions and space instruments. In addition, joint initiatives have been launched with universities, public and private research centers and the chain of suppliers. These ventures are a result of the close relationships JAXA has developed with METI. JAXA is also trying to energize the Japanese economy by creating and making use of its own Intellectual Property (IP) (Fig. 1). Using JAXA's IP for developing new products in the private sector could entail technical risks and financing problems. The role of the "Technology Transfer Program" is to mitigate such risks and development problems for private companies by promoting practical applications of JAXA's IP. Through this program, JAXA helps private companies with the research and development of commercial products. A final measure to enhance the commercial use of JAXA's IP is the new "JAXA venture support program", created to help JAXA employees develop projects using JAXA IP by providing them with assistance for licensing IP and establishing businesses [13].

JAXA [14] has also classified the various types of spin-offs according to whether they are its own patents (granted under license) or if they are technologies that belong to other companies:

- spin-offs transferred from JAXA's technology and based on license agreements;
- spin-offs transferred from JAXA's technology but not based on license agreements (paper publication, etc.);
- spin-offs transferred from technology shared between JAXA and commercial firms and then implemented by other firms;
- spin-offs transferred from space technology owned by Japanese firms.

3. Theoretical framework: technology transfer and spin-offs

By the term "technology transfer" we mean the process that allows the passage of a technology from one organization (donor) to another entrepreneurial organization (receiver) [15]. Space technology essentially refers to components for the construction and operation of launch vehicles and ground stations, but above all to the development of satellites for military and civilian missions.

The transfer of technology in the space sector occurs in two principal ways:

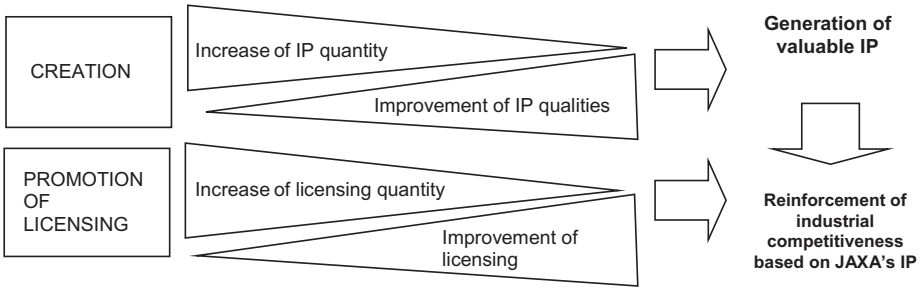

Fig. 1. Objectives of JAXA IP application (Source: JAXA [13]).