

Irrigation methods and installations are different in each area, and Tomosugi describes the historical development of irrigation as represented by the order of the above four regions. He finds that social symbolism is expressed differently in each. Tomosugi shows that in the Ishikari region, being the last stage of development, money has become a more powerful symbol than water and notes that the most concrete expression of the penetration of the money economy into rural life, the agricultural co-operative, serves the function of creating stronger unity among local farmers.

Hirashima analyses the impact of irrigation projects on increasing agricultural production and equity in developing economies. Major development of irrigation works, he notes, is now being carried out by the public sector under the control of the central government in developing countries, where modern irrigation systems are replacing the traditional water-management practices of rural society. As a result, the role of the community in water control has been diminishing and the efficiency in water use has decreased accordingly.

Investment in irrigation projects almost never yields a return on the principal, making reinvestment difficult. Moreover, funds tend to be invested in fertile regions in order to raise productivity. This produces a widening gap in productivity and incomes between individuals and between regions.

Hirashima also points out that the development of underground water resources for irrigation purposes is going to play an important role in boosting agricultural production in the developing countries. But irrigation rights to this water are not clearly defined, and private capital is free to develop and use it as it sees fit.

One of the features that characterizes the development of irrigation in Japan is the fact that investment in irrigation projects has been made in a decentralized manner. Hirashima concludes that this factor has enabled village communities and local bodies to manage local water resources despite a strong centralized bureaucracy and also enabled them to prevent regional as well as inter-personal disparity from widening in the course of irrigation development.

### 3A. IRON AND STEEL

1. The origin and development of iron and steel technology -- Ken'ichi Iida
2. Japanese-run iron ore mines in prewar South-East Asia -- Bunji Nagura

3. Postwar development of iron and steel technology -- Ken'ichi Iida
4. Technology transfer from Japan to Brazil: the case of USIMINAS --  
Centro Brasileiro de Análise e Planejamento (CEBRAP)

Iida's first paper outlines the long history of development of the iron and steel industry in Japan up to the Second World War. First, it compares the general history of Japanese iron and steel technology with that of Western countries, concluding that the two coincided basically in terms of the sequence of development. Then it identifies the distinctive feature of the Japanese case by noting that even before Meiji Japanese technology produced steel of a quality unrivalled elsewhere in the world (for instance, that of Japanese sword blades). It also points out that such technology was that of small-scale handicraft industry and that it was not capable of meeting the huge demand brought about by the industrial revolution.

Both the Kamaishi Iron Works, construction of which was completed in 1880, and the Yawata Steel Works, completed in 1901, were built by the government under the direction of Western engineers, and both failed miserably at the beginning because of blind acceptance of planning and design done by foreigners who were unfamiliar with the quality and available quantities of Japanese iron ore and coke and other pertinent conditions. After the foreign engineers packed up and went home, however, a Japanese metallurgist, Kageyoshi Noro tried to identify the trouble spots and revised them on a trial-and-error basis using considerable ingenuity until finally both iron and steel production at the works were put on a sound and viable footing.

Thanks to state assistance and improvement of market conditions, rapid progress was made in Japanese metallurgical and metal materials science, and by 1917 Japan developed a strong magnet steel known as "KS magnet steel" which was of the highest quality in the world at that time and went on to develop a whole series of new types of magnet steel. Between the world wars Japanese iron and steel production technology made further advances in this and other research and development, resulting in the construction of gigantic blast furnaces and installation of other new production facilities. Such progress paved the way for the rapid strides forward that were made after the war.

Nagura's paper, which is a historical study of procurement of raw materials for iron and steel production, a research subject that has been well-nigh neglected up to now, is complementary to Iida's.

Although Japan was behind Western countries in steel-manufacturing technology, it was ahead of countries such as China and Malaysia from which it imported iron ore. A case study (covering the period 1920-1935) of the discovery and development of iron ore deposits in Malaysia by the Ishihara Industrial Co., Ltd., forms the core of Nagura's paper. That undertaking was very successful, partly because of government promotion

but more importantly because of employment of outstanding mining and transportation technology and particularly successful in contriving efficient, low-cost means of getting the ore to a suitable seaport. In this connection, attention is drawn to the way in which technology that took very good advantage of local topography was developed.

Iida's second paper and the CEBRAP (Centro Brasileiro de Análise e Planejamento) paper represent a part of the findings of what we call a "triangle project."

Iida outlines transfer and improvement of technology that made possible the rapid development of the Japanese iron and steel industry in the postwar period. While it is true that the Japanese iron and steel industry introduced the newest and most advanced principles of iron and steel production from abroad in an ongoing fashion after the war, one must also bear in mind that (1) Japan had already attained a high level of technology in this field before the war, and the industry was able to produce a well-thought-out and very appropriate blueprint for reconstruction immediately after the war, (2) the industry was capable of good judgement in selecting what technology to import, and (3) it never failed to make some kind of improvement of its own in connection with such technology transfer, such improvements subsequently leading to development of the world-famous OG system (basic oxygen furnace waste gas cooling and clearing system) and other new techniques.

Japan has the largest steelworks in the world, but that does not mean that steelworks must be large in all countries. For instance, small Malaysian steel mills based on technology imported from Japan are operating successfully thanks to the consideration that was given to local conditions.

The CEBRAP paper, a case study of Brazil's USIMINAS (Usinas Siderúrgicas de Minas Gerais S.A.) steelworks, which were established in 1956 with participation of Japanese capital on the basis of import of Japanese technology analyses the actual conditions of technology transfer and transformation from a broad perspective. This particular case is considered to have been a success, the reasons for such success being (1) the existence in advance of adequate external conditions in terms of resources and markets as required by large-scale integrated iron and steel works, (2) the fact that Brazil already had a long history of modern iron and steel production technology, albeit on a small scale, as well as a considerable pool of related skills, and, of course, (3) active government support.

Not only was the technology transfer a success, but the management of this undertaking has also fared well even since the administrative reins were handed over entirely to the Brazilians in 1966. The reasons that are cited for such success are (1) the fact that the technology transfer was accomplished on the basis of thorough man-to-man training, (2) the

transfer as well of some Japanese management techniques, although, of course, in a form suitable to local conditions, and (3) the inclusion of research and development methods and techniques in the technology transfer.

This particular case is considered to be worthy of serving as a point of reference for technology transfer in general.

### 3B. TRANSPORTATION

1. The traditional transportation system
2. Transportation in the period of transition (1868-1891)
3. The golden age of the railway (1892-1909)
4. Self-reliance in transportation technology (1910-1921)
5. The integration of the transportation systems (1922-1937)
6. Transportation during the war years (1938-1945)
7. Transportation in the postwar recovery period (1946-1954)
8. Recent development in transportation

(Note: Each paper is written jointly by several members of the group with responsibility for content being divided as follows: roads, Hirofumi Yamamoto; transportation policy and railroads, Katsumasa Harada and Eiichi Aoki; river and coastal shipping, Hiromi Masuda.)

The first paper explains that inland transportation in Japan before the Meiji period was mainly by road. At the post towns located along the major routes the shogunate and feudal lords assigned officials who were responsible for overseeing arrangements for the provision of horses and labour, accommodations, and other facilities for members of the samurai class at much cheaper official rates than the going prices. This was a feudal system of transportation in which horses and labour were requisitioned from local peasants on a temporary basis whenever the demand made it necessary to do so. Rivers were used as significant transportation routes for the conveyance of cargo including land tax rice, and there were river-port agents who organized river transportation, arranging for boats, crews, and stevedores. As for sea transportation, because of the shogunate's policy of national isolation, there was only coastal traffic by traditional Japanese-type sail boats, such as single-masted flat-bottomed boats.

The second paper deals with transportation in the period of transition. During the period of internal fighting, peasants became very disgruntled because both the old and the new government used the system of supplemental local requisitioning to the limit. In the fact of such opposition, the new government was forced to restrict the use of that