

Dung-Sheng Chen, *Making It Integrated: Organizational Networks in Taiwan's Integrated-circuit Industry*

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Dung-Sheng Chen's book is an important addition to the growing literature on the question of why late developing countries are catching up with advanced countries in the field of technology, especially through the mechanism of technology diffusion and innovation. Using the development in Taiwan's integrated-circuit industry and TFT-LCD industry as examples, Chen examines the forces that shaped Taiwan's high-tech industry. He argues that the synergy of foreign technology and technology diffusion and innovation played a critical role, as did changes in organizational network. He approaches this question twofold: first, from a network governance structure, that of the trust relationships between organizations, and second, from the technology learning and development model, that of the trinity development model of technology introduction, technology diffusion and innovation.

Chapter 2 describes the types and characteristic features of the organizational network in Taiwan's integrated-circuit industry. Chen frames this discussion by way of a theoretical analysis of the historical, social, political, and economic institutions that helped to create Taiwan's unique model of high-tech industrial organizational network. Chen argues that the organizational network in Taiwan's integrated-circuit industry has two prominent characteristics. The first is the hybrid product network that combines vertical specialization in the manufacturing process and horizontal specialization in the inter-organizational technology transfer and venture capital. The second is the relational characteristic with strong ties and weak ties combined in inter-organizational network. Primary personal relationships continue to play a focal role in the organizational network of Taiwan's small and medium-sized enterprise (SME). However, the results of Chen's analysis show that the organizational network of technology and capital-intensive industry uses both local network such as industrial cluster and global inter-organizational network as the situation demands. In this respect, the influence of past dependence is minimal when compared with that

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of SME. Integrated circuit was a new technology for Taiwan's high-tech manufacturers. Less accumulation of technology and financial resources made it necessary to expand the collaboration network globally while also introducing advanced technology and sufficient funds for capital investment.

The next two chapters investigate the governance structure of inter-organizational network in Taiwan's integrated circuit industry from the perspective of power and trust relationships. Chen criticizes previous studies on network governance structure for overestimating the role of personal relationships and personal interaction in the formation process of trust mechanism. He argues that inter-organizational network in Taiwan's integrated circuit industry could not have been maintained exclusively on informal trust relationships. As Chapter 3 demonstrates, although trust relationships are playing a significant role in the horizontal specialization among fabless companies, power interaction mechanism is the main network operational principle in the vertical specialization between Taiwan's fabless and American CPU manufacturer. In this respect, the maintenance of organizational network is dependent on both the formal trust relationships as well as personal trust mechanism. Relational trust is a closed mechanism that is distributed only in a small inner circle. However, formal trust, such as ISO standards or international certification of quality, flows freely over various networks across the border, and breaks down closed character of organizational network.

According to Chen's analysis, integrated circuit related firms is able to independently construct cooperate inter-organizational network because of formal and informal trust mechanisms on the one hand, and on the other hand, third parties, such as public research organization and venture capital, both of which help to accelerate the construction of network relationships. At the early stage of integrated circuit industry, public research organizations are the main booster of organizational network formation. As the industry matures, private venture capital will come to supplant government organizations. Furthermore, it will also be central in corporation organization since it seeks to boost the formation and expansion of inter-organizational network. In chapter 5, Chen furthers this argument by suggesting that the formal fund raising channel of venture capital provided initial funding to high-tech companies. In traditional SME, personal and social relationships are the main channels for raising funds and starting up a business, however, in high-tech industry, government organization and venture capital play the pivotal role to back up establishing a new company. Chen points out that formal corporation organization (venture capital) was an important actor in the construction of relational capital. Unlike the individual actor, venture capital facilitates inter-organizational interaction through formal financing channel and articulates the resource of network relationships in order to reinforce relational advantage in its centrality and structural hole. Chen's analysis shows that as venture capital market develops, articulation of network resources is not only intensified by personal relationships, but that it is also effectively-reinforced by formal or institutional gatekeeper mechanism.

In terms of the trajectory about the development of high-tech industry in developing country, chapter 6 and chapter 7 describe survival strategy of integrated circuit industry and technology learning model. According to Chen, spin-off companies from Electronics Research and Service Organization (ERSO), newly-established companies founded by engineers who left a job and other start-up firms,

did not always start from scratch. Rather, all of them articulated sufficient resources (human resources, product technology, operational funds and customers) by themselves, and gained financial assistance from either the government or major large companies in Taiwan prior to launch. Overall, Taiwan's integrated circuit industry utilized government and big business support flexibly, and survived against international competition. Using Evans's terminology (1995), we can say that Taiwan's integrated circuit industry got on track through the balance of embedded autonomy. Flexible supporting network between the midwife state and local industry made Taiwan's integrated circuit industry easier to engage in universal developmental goals. In chapter 7, Chen provided an explanation about Taiwan's "collective technology development mechanism" from historical economy, National Innovation System (NIS), and economic geography perspective. The argument of "collective technology development mechanism" emphasizes that in addition to the introduction of foreign technology, developing technology by local high-tech firms also plays a crucial role in the process of technology learning and innovation system among developing countries. The ability to develop technology is not only brought about by a small number of holders of key technology, but it is also developed through network relationships between the variety of institutional arrangement and society. From an historical point of view, every stage of technology learning in Taiwan's high-tech industry was closely-related to the spillover effect of institutional system and foreign human resource back flow mechanism. For example, the successful implementation of an engineering-related higher education system by the 1980s provided excellent human resources for integrated circuit industry. In addition, the massive injection of those returning from Silicon Valley also accelerated the learning and diffusion of technological knowledge.

In the final chapter, Chen relies on time-series database about the technology introduction, collaboration and innovation to examine the development mechanism of TFT-LCD industry modeling itself after integrated circuit industry. His study shows that foreign technology introduction, technology diffusion and innovation occurred at the same time in the development model of TFT-LCD industry. More specifically, as soon as local firms introduced a key technology from a foreign country, this technological knowledge would quickly diffuse among Taiwan's TFT-LCD industry and related technological innovation was immediately launched by local firms. This "trinity (technology introduction, diffusion and innovation) development model" is supported by great capital resources, accumulation of technology and human resources from integrated circuit and IT industry.

In summary, Chen makes a significant contribution to our understanding of both the hybrid network governance structure selected by organizational actors and the well-balanced technology innovation network relationships between state and society in Taiwan's high-tech industry. In terms of trust efficient frontier, trust mechanism failure does not always switch into other governing structure, such as a hierarchy or a market. Taiwan's high-tech firms integrate trust relationship in other functions (power structure, competitive relationship) to overcome the problem of trust failure, and continue to maintain inter-organizational network relationships. However, Chen's analysis overemphasizes the different mechanism between traditional SME and high-tech industry in the formation and maintenance of trust relationships. It offers a false dualism, that the network logic of SME is informal

trust and high-tech industry has formal trust network mechanism. According to my own research about the collaboration relationships between Taiwan's integrated circuit firms and Japan's counterparts, Taiwan's companies established long term technical tie-up and business relationships through informal trust logic (Tabata, 2008). As Chen also pointed out appropriately, Taiwan's high-tech industry uses formal trust and informal trust logic as the situation demands.

This issue notwithstanding, *Making It Integrated* is an important book. It successfully demonstrates that the inter-organizational network in Taiwan's high-tech industry is not closed relationships organized by inner circles, that it is unlike traditional SME. The advantage of Taiwan's inter-organizational network is that formal trust mechanism allows for limitless network expansion. In terms of technology learning, technological knowledge tends to be standardized in Taiwan's high-tech industry through formal trust inter-organizational relationships. Personalized and tacit knowledge is more likely to transform into collective knowledge, and therefore change to the "public property" of Taiwan's whole industry community. In short, Chen's book makes a major contribution to STS studies. The work will also be of interest to economic sociologist and organizational sociologists. Moreover, the work will also engage scholars interested in the interaction mechanism of formal institutional arrangement, trust relationships of inter-organization network and social structure in high-tech industry.

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