*Electronic Paper for Nelson and Winter Conference 2001*

# KNOWLEDGE COMMUNITY: A SYNTHETIC PERSPECTIVE ON INNOVATION

**Tzung-wen CHEN**

Ph.D student
Graduate Institute of Technology and Innovation Management (TIM)
National Chengchi University, Taipei, TAIWAN
&
Exchange student
Institut d'Etudes Politiques de Paris, FRANCE

Address:
91, Boulevard Maréchal Joffre
92340 Bourg-la-Reine, FRANCE

Tel: + 33 (0) 1 46 61 14 39

E-mail:
g7359501@grad.cc.nccu.edu.tw
tzungw.chen@etudiant.sciences-po.fr

Keywords: knowledge community, innovation, foundry

First Draft: May 2001

# KNOWLEDGE COMMUNITY: A SYNTHETIC PERSPECTIVE ON INNOVATION

**Tzung-wen CHEN**
*TIM, National Chengchi University, Taipei, TAIWAN*
*Institut d'Etudes Politiques de Paris, FRANCE*

## Abstract

In the global knowledge economy there are several emerging problematical issues such as the nature of production, property rights, innovation cycle, governance structure and uneven development. This paper therefore provides an alternative concept, i.e., a knowledge community, to examine these issues. The knowledge community, which is a concept derived from interdisciplinary theoretical synthesis, consists of a plurality of actors who recognize the common value of a specific knowledge tradition, identify themselves as members of the community and thereby voluntarily contribute to the production, diffusion and use of that knowledge. The knowledge community is driven by an ideology. Moreover, a knowledge community has four basic elements, including homogeneity, diversity, autonomy and collective advantage. Even though the knowledge community has a lot of positive functions in innovation, there are also negative functions. The story of Taiwan Semiconductor Manufacturing Company (TSMC), the world's largest semiconductor foundry, is described and analyzed in the paper as an illustrative example. The case of TSMC shows that a latecomer can also appropriate from positive self-identity in the knowledge community. With the concept of knowledge community, the innovator in the knowledge economy plays new game with old players, turns disadvantages into advantages, and uses contradiction to create values.

## Introduction

Within the perspective of a global knowledge-based economy, the governance structure of innovation and related knowledge activities becomes one of the most important issues in business management as well as in public policy. This is because the case, particularly the creation of knowledge tends to be a collective activity, which happens not only inside the firm but also in the external environment. (Foray, 2000) In other words, collective work in which frequent interaction between various innovative actors occurs is critical in innovation process.

In the last decade, various new concepts have emerged to explain the complicated interactive configurations in the innovation process. For example, an innovation cluster has been used to describe a number of innovative actors who are geographically concentrated but functionally diversified. (Castells, 1996) The concept of cluster did explain why it is important to network together the innovators but it is limited to its regional characteristics and fails to explain the "global" aspect of knowledge activities, especially for emerging economies.

These and other problems have been studied in recent years. Most of these studies were contribution of evolutionary economists. They first noticed and understood the importance of knowledge as well as institutions in the new economic world. But their economic perspective, especially from Western economic traditions, leaves room for researchers from other disciplines and cultural traditions to undertake further analysis.

On the other hand, the gap between forerunners and latecomers of the knowledge economy has been grown continuously. (OECD, 2000) For example, the rapid progress of Internet related economic activity in the US has made it more difficult for other countries to catch up. Does it mean that the latecomers have no chance in the knowledge economy? If they were excluded from the knowledge economy, how could a "global" knowledge economy be possible? Accordingly, it has become a much more complicated problem for the latecomers if they would like to positively face the effects of globalization rather than just suffer from them.

This paper therefore provides an alternative concept to examine the innovation issues in the global knowledge economy. The problems that conventional theoretical models cannot solve in the knowledge economy as well as those encountered by the

latecomers will be briefly discussed in the paper. These problems may not be completely and perfectly overcome through the new concept, that is, the framework of a knowledge community in this short paper. But the perspective, which will be developed from an interdisciplinary synthesis and empirical observations, will be heuristic to outsiders or those just entering in the gateway of the knowledge economy.

## Problematical Issues

While it was economists who first defined and brought it to the public, the coming of knowledge economy is not merely an economic research question, but has strong impact on the social and political dimensions of the real world. Characterized by ambiguity, complexity and uncertainty, the knowledge economy is beyond traditional economic or social perspectives. Accordingly, a series of problematical issues could be summarized as follows.

**Nature of production activity**

Unlike other input factors of conventional economic production, knowledge is difficult to measure and evaluate. While a distinction between codified and tacit knowledge and emphasis on the former are important to knowledge management, (Cowan & Foray, 1998) fundamental recognition about the nature of knowledge and its related environment or institution seems to be more critical. In other words, the knowledge economy differs from the conventional economy, not only in the input factors and their outcomes, but also in economic rationale and even the socially dependent ideology.

Moreover, the scope of knowledge in the knowledge economy has been broadened from independent specific domain to inter-sector and cross-functional integration of multidisciplinary knowledge. Knowledge required in economic activities includes not only scientific knowledge and technological skills but also managerial mind and corporate culture. (Leonard-Barton, 1995) All these changes in knowledge context make the innovation process more complicated, thus increasing ambiguity and uncertainty in achieving innovation results

**Property right and contract relations**

The transformation of knowledge into economic goods challenges the traditional property right institutions. For example, the knowledge goods have at least three properties: uncontrollable, non-rival, and cumulative. (Foray, 2000) These properties

make knowledge goods beyond the boundary of traditional property rights. Since a clear definition of individual property rights is critical to transaction and all kinds of exchange activities, contract relations which are the foundations of traditional economic behavior must be reconfigured due to the ambiguity in ownership of knowledge goods.

**Innovation cycle**

The rapid progress of information and communication technology (ICT) facilitates knowledge flows and increases interactions between social actors. The importance of customers or users in the innovation process, as emphasized by von Hippel (1988), is further enhanced by ICT. Moreover, since there is frequent interaction and strong feedback in the knowledge innovation process, the roles of a provider and user are confused. Without communication barriers, social relations in the knowledge economy are beyond the control of systematic and institutional design.

On the other hand, conventional innovation often needs a period of diffusion to the public. This diffusion period is necessary because the initial innovation should be gradually developed and modified and at the same time, the social institutions have to be reformed to accept the innovation. Due to competing investments in innovation, the rapid progress in knowledge has however shortened the period. Such an effect in innovation diffusion has therefore strong impact to both the innovators and the social institution. For example, due to rapid progress in biotech knowledge and its application, new genetic modified products are developed faster than public perception.

**Governance structure**

Since the *nature of firm* by Coase and his followers, transaction cost economics (TCE) seemed robust in explaining the governance structure of conventional economic organizations. (Coase, 1937; Williamson, 1979) The TCE perspective considers organizations as processors of information. (Cohendet, 1998) As mentioned above, however, as the complexity in the knowledge economy increases and contractual relations become more ambiguous, taxonomies of governance structures derived from TCE might be problematical.

**Uneven development and culture conflict**

As mentioned in the introduction to this paper, the gap is growing between forerunners and latecomers in the knowledge economy. Also the gap exists in uneven regional developments in ICT and availability of the Internet, which is called as the

*digital divide.* (OECD, 2001)

Moreover, since knowledge is highly culture related, collisions of different knowledge flows induce fusion as well as conflict between various cultures. These processes happen to each group of actors who are responsible for the knowledge flows. The selection mechanism of appropriate knowledge is important, while as the conflict increases in a multicultural society, the criteria are more contingent than they used to be.

## Theoretical Backgrounds

To cope with characteristics of the knowledge economy, an aggregated unit for theoretical understanding and empirical observation of innovation activity is required. It means that innovation in a knowledge economy is neither an individual nor an isolated activity. Before explaining the rationale of the collective innovation activity, a proper analytical unit should be determined. Besides the cluster mentioned above, there are concepts such as "network", "alliance", "tribe", "cult", and "community" proposed to describe collective phenomenon of human being. These factors are briefly summarized in Table 1.

Among the six types, the community might be the most appropriate symbol for further theoretical and empirical development in the study because of its compatibility with knowledge activities. The paper therefore provides a community-based framework to handle the aforementioned emerging knowledge management issues. The framework is built upon the concept of a *knowledge community*.

However, the notion of "community" has a vast variety of definitions because it has been widely utilized in social science traditions and has various disciplinary origins that their epistemological and methodological presumptions are quite different. Even in recent research, authors from different disciplines have put a variety of new concepts into community-based research and its managerial implications. For example, referring to Table 2, since 1994 at least four kinds of community-based innovation collectives have been proposed, including a technology community, innovation community, micro-communities and the community of innovation.

Therefore, in order to clarify the different configurations in community-based analysis of innovation and thus provide an appropriate definition, a multidisciplinary

theoretical review and synthesis are required. The paper will review critical discourses about community from three main disciplines: sociology, political philosophy and evolutionary economics.

**Sociological tradition of community**

According to classical sociology, a community is defined as all forms of relationship, which are characterized by a high degree of personal intimacy, emotional depth, moral commitment, social cohesion, and continuity in time. (Nisbet, 1966)

Among sociologists, Tönnies (1988) first proposed a dichotomy between community and society. According to Tönnies' definition, those who belong to a same community have a consensus and devote themselves to amoral life, and which is possible only when a common language exists between them. Moreover, since community members are so intimate and mutually dependent, they share and enjoy common goods. The moral coherence in community life also makes it possible that art and region are easily sustained and diffused in the community.

On the contrary, society as a collective entity of human life is however a combination of functionally separated individuals. The primary *raison d'être* of a society is that people have to exchange goods for personal interest through money, and this exchange process should be protected by public authority. Social life is therefore regulated by man-made law. In other words, the relation in the society is interest-oriented.

The concept of community in sociology turns to describe the collective phenomena of scientific knowledge when sociology of science arose in the mid-1960s. One of the examples is that the term *scientific community* appeared to stand for a precapitalist system of exchange in scientific research. (Hagstrom, 1965)

The scientific community is a quasi-stable collection of scientists who believe or accept a dominant paradigm until the next scientific revolution. (Kuhn, 1970) The existence of paradigm in a community highlights the importance of consensus between knowledge workers. The kuhnian community also implies that the development of knowledge should have a common base or reference point. The paradigm is however composed of heterogeneous elements such as concepts and examples. It reflects also a form of life and a social structure. (Vinck, 1995)

The concept of community was further applied to investigate the collective

activity of cultural workers. (Crane, 1972) Even though this research did not point out what is the source of innovation, the concept of community in sociology implies that production, diffusion and application of knowledge are better to be bottom-up processes rather than top-down processes that are systematically designed. Since the system approach is criticized as over-socialization in personal behavior, (Granovetter, 1985) the community approach goes somewhat against the systematic approach. In other words, institutional design for innovation is good only when a right ambience is created to stimulate actors therein to be committed to innovation.

**Community in political philosophy**

The political definition of a community originated from the work of Aristotle. He considered that human beings have the nature of grouping and living together to form communities, which are the primarily political configuration in the human history. (Aristotle, 1996) While it was not until the theory of justice by Rawls appeared in the early 1970s, that the debates between Rawls' *liberalism* and its opposite side, the *Communitarianism*, become the toughest issue in the political philosophy. According to the Communitarianism point of view, no actor can escape from the influence of his/her related communities.

We can first analyze the innovation process by looking at individuals. The birth of a new idea should have been influenced by one's personal experience. For a scientific innovation, the new idea could be a fruit from prior logical and professional training. That is, socialization in an innovator's personal history plays an important role. The process of socialization, which could be given by formal social institutions (education, professional training) and informal social institutions (self-study, work experience) should have happened under an influential group. In other words, there must be a *memorial community* by which the innovator was shaped.

Second, as an economic activity, innovation with the birth of a new idea is not enough. Innovation is not just the production of new knowledge but that the knowledge must be diffused and appreciated. It means that a successful innovation should be recognized by a group of people. The group as a result of innovation diffusion includes an innovator and those who interact directly or indirectly with the innovator by way of adapting the new knowledge into their present lives. The interactive group is an *ecological community* because members of the group might have other choices but they accept the same one.

Finally, where there is innovation, some knowledge is replaced, updated, or

rejected. In other words, there is a knowledge tradition which the innovator found unsatisfactory. Since satisfaction and dissatisfaction both come from the innovator's self-identification about the knowledge tradition, he/she should identify him-/herself to a specific group of knowledge workers. That is, the innovator is a member of a *psychological community* that is characterized by self-identification of knowledge traditions.

The three types of community including the ecological, memorial, and psychological communities, which are similar to those proposed by communitarian political philosophy, (Bell, 1993) imply again the importance of collective efforts in innovation.

**Evolutionary economics and modern biology**

Evolutionary economists described the process of innovation as a gradual accumulation of changes in *routine*. (Nelson & Winter, 1982, pp. 129) The effect of routines in knowledge activity is assimilated to that of genes to an organism. (Cohendet, 1998) Using the biological phenomenon as a metaphor for innovation does make sense because the role of a community in the innovation process could be made more understandable.

Recent research in biology has shown that a biological community with a diversity of genes has higher immunity to environmental degradation. (Tilman et al, 1997). The diversity in genes reduces competition of resources and enforces the effect of natural selection. Such an explanation can also be applied to a routine-base innovation model, as proposed by evolutionary economists. For example, a community of innovators with a diversity of routines is believed to be more prosperous and innovative.

Besides, the concept of *selection*, analogies to biological evolutionary theory, are more macro- and contextual considerations, and they are endogenous, results of boundedly rational actors. (Hodgson, 2000) Accordingly, even though rarely mentioned by evolutionary economists, the knowledge community has strong affinity to several main concepts in the discipline.

On the other hand, a knowledge system or innovation system perspective that emphasizes the institutional effects on innovation became plausible in the last decade. (Lundvall, 1995; Smith, 1995) However, the institutional or systematic aspect is somewhat different from the community perspective. The institutional or systematic

perspective emphasizes on external control of knowledge activity, whereas a community view stresses internal efforts. These perspectives are not contradictory but complementary.

## Analytical Framework

### Theoretical Synthesis and Related Issues

A knowledge community consists of a plurality of actors who recognize the common value of a specific knowledge, identify themselves as members of the community and thereby voluntarily contribute to the production, diffusion and use of that knowledge. The knowledge community perspective emphasizes that knowledge activities are results of common interest and identity of actors rather than their explicit functional division of labor. This definition of a knowledge community is therefore different from those of conventional collective entities of knowledge actors such as functional departments, teams and networks.

### Ideology in a knowledge community

The establishment of an emerging industry or a new knowledge domain should, at the same time, form an ideology that implicitly drives innovators to a convergent vision of technology's future. Here the ideology is somewhat different from what has been well discussed in the sociology of knowledge, such as that proposed by Mannheim. (Mannheim, 1936) In a knowledge community the ideology has the following effects:

1. direct the development of technology or knowledge by redirection of human and knowledge resources, allocation of economic resource and rearrangement of social institutions;

2. provide behavior guidelines for the actors, thus forming a rationale base (such as research paradigm) or reference points (such as criteria of a scientific method);

3. act as an internal source of energy for voluntary and autonomous innovation activities, further developing into entrepreneurship.

### Elements of a knowledge community

According to the aforementioned definition, at least four elements are required for a knowledge community, including homogeneity, diversity, autonomy, and

collective advantage. These elements are explained as follows.

***Homogeneity***

The members' consensus is the primary criteria to identify a knowledge community. There should be dominant knowledge traditions in a knowledge community. The members communicate with a common language. They struggle for their common interests. Those who speak other languages or have interest in other things are often excluded as outsiders. For example, a genetic biotechnological knowledge community inherits the knowledge tradition from Mondel. For their common interests, genetic scientists collaborate to sequence genomes. Other biological discipline such as cell biologists were sometimes considered as outsiders of the knowledge community.

***Diversity***

In order to survive, a knowledge community must be an organic constitution. Community members identify themselves but are not identical. In a conventional model of knowledge process, from the production to application of the knowledge is a linear process. But due to the strong interaction between diversified members in a knowledge community, an interactive model is possible. Taking the genetic biotechnological knowledge community for example, there were geneticists, physicists, computer engineers, and other specialists devoted to genomic research. They are obviously members of the knowledge community but their functions are quite different.

***Autonomy***

The community perspective differs from other contextual perspectives such as institutionalism and systematic perspectives in that a community is formed voluntarily. In other words, the knowledge community is a bottom-up organic collection of innovators, which is different from or complementary to the conventional systematic approach to promote externally knowledge innovation.

***Collective advantage***

The fundamental concept of knowledge community is that the generation and development of knowledge relies on a collective entity rather than individual rationality. The uncertainty in the process of innovation is gradually diminished through the process of common recognition, instead of individual rationality. For example: the collective advantage contributes to the success of QWERTY typewriter. (David, 1985)

**Functions of a Knowledge Community**

A knowledge community is not a theoretical or abstract concept. It has specific functions in innovation. According to the conditions of a knowledge community, several hypothetical functions of knowledge community can be developed. They include positive functions that are supposed to enhance knowledge activities but also negative parts that suppress innovation.

***Positive functions***:

1. Facilitation of knowledge flow and diffusion. Members of a knowledge community should have a common language as their interactive means. Ideas about the specific knowledge domain can be easily translated into the common language and spread through the knowledge community. Diffusion of knowledge could be formal and informal. Formal ways of knowledge flow include social institutions (such as professional education), technology transfer, and research collaboration. Informal ways include technology imitation and knowledge spillover.

2. Reduction of complexity in innovation. One feature of a knowledge community is to cope with the complexity in the nature of knowledge process. The knowledge community is, however, not a static or orderly collection of actors. Similar to the self-organizational process, the formation of a knowledge community enters between order and chaos. The process of innovation is promoted and limited by the formation of a knowledge community. The paradox of innovation is a result of the collective but voluntary characteristics of the knowledge community. Moreover, the consensus in a knowledge community directs knowledge activities to certain orientations. These consciously focused knowledge activities also gather human and economic resources to have synergy.

3. Collaboration with common interests. In order to benefit from their common interests, members of a knowledge community have to share information and develop more intimate relations in innovative activities. There might be secondary information exchange institutions such as public information centers, newsletters, journals, and other digital publications. They might meet each other to enhance mutual relations. Conferences and forum are therefore held. Moreover, they make efforts together to speed up knowledge creation, thereby forming associations, alliances and consortia.

4. Accumulation of codified knowledge stocks. The common memory of a knowledge

community reflects in its knowledge tradition that is generally codified. Innovation is an activity of a broadening knowledge frontier beyond the codified tradition. For example, prior art should be cited in a patent application to define the boundary of a traditional knowledge boundary. Academic research should also review and list reference articles to identify the knowledge context. In the knowledge economy, codified knowledge will be presented in digital format. The accumulation of a digital knowledge stock provides a stronger common memory to all knowledge community members.

***Negative functions***:

1. Limitation by language boundaries. Each language has its limitation in expression. The common language in a knowledge community also has its boundaries. When an external innovative idea cannot be properly expressed by the common language, or cannot be appreciated by those who communicate with the common language, it will not be adapted. The language boundaries are therefore constraints to innovative activities.

2. Political interference. The community is the primary political configuration of human beings. It means that knowledge activity in a community is not merely rational creation, diffusion or application of knowledge. The political force generally plays an important role in shaping the development of knowledge.

3. Rigidity. The knowledge tradition in a knowledge community guides orientation of innovation, and at the same time, opposites to radical inventions. Rigidity is a killer to creation. By rigidity in conventional thinking style, brave new concepts were often suppressed. Sometimes excellent ideas were excluded from the knowledge community.

4. Idolatry worship. Governance structure in a knowledge community generates *masters* and *stars* easily. There will be popular discourses that attract attentions. The standard theory or model set by the popular discourse further gives a bias to innovation.

## Illustrative Example

The case of Taiwan Semiconductor Manufacturing Company (TSMC), which identifies itself as a foundry or company for IC wafer manufacturing service, is

studied to illustrate the characteristics of a knowledge community and to verify certain main issues raised in the paper.

Before entering into the example, the reasons why the knowledge community framework is applicable in the semiconductor industry will be given. First, there have been ideologies directing the knowledge or technology development in this knowledge domain for some time. For example, Moore's law has driven the scientists and engineers continuously to scale down the dimensions and increase the density of semiconductor components in a single chip in the past forty years. Another example is that a strong consensus between governmental bureaucrats and industrial entrepreneurs in knowledge construction did finally make Taiwan become one of major players of the world semiconductor industry. (Wu & Chen, 2001)

Second, though the governments were once very important in creating industrial environments, especially in the East, (Mathews & Cho, 2000) recent successful innovations and knowledge activities are voluntarily bottom-up processes done in the private sector. That is, the major development in the technology and management style is not systematically designed through policy.

Third, the semiconductor industry has become a global and knowledge intensive industry. For example, in the semiconductor industry, the domain language familiar to both business engineers and academic scientists facilitates knowledge flow from university to industry, and also from Silicon Valley to Hsinchu Science-base Park of Taiwan. (Saxenian, 1999)

Accordingly, even though the object of analysis is a firm in the following example, it must be noted that the firm should be examined in both global and historical contexts. In other words, the example illustrates the firm's efforts, by way of a knowledge community, to succeed in the world semiconductor industry.

**Foundry and world semiconductor industry**

Founded in 1987, TSMC is the second spin-off from the Industrial Technology Research Institute (ITRI) of Taiwan. In view of the high entry barriers and strong competition in the world semiconductor industry, the laboratory-based spin-off was strategically self-identified as a dedicated semiconductor foundry. As an original equipment manufacturer (OEM), the foundry is a novel concept in the late 1980s because almost all semiconductor companies have their own production lines at that time for the quality's sake. However, thanks to the high quality human resource and

high yield performance, one of world's largest semiconductor companies decided to invest in TSMC, thus making the concept of a foundry possible.

Referring to Figure 1, a conventional foundry provides production lines for brand name companies. That is, the foundry does not have its own products. For example, by not competing against the big companies by designing and manufacturing own brand of IC products, the TSMC is dedicated to new manufacturing technology by investing in advanced facilities and human resource development. Since the rise of foundry and rapid progress in semiconductor technology, several world famous semiconductor companies became "Fab-less" firms. To meet their demands for higher speeds and product quality, the brand companies just order from the foundry to manufacture the products.

The initial strategy of TSMC was very successful because the most difficult issue in entering the semiconductor industry was avoided. It was the intellectual property right that advanced companies utilized against potential competitors. TSMC as a manufacturing agent, or a foundry, was licensed to apply for advanced process technology from principal companies. In other words, since most advanced players in the semiconductor industry identified TSMC as a partner rather than a competitor, they would work together in their common interests rather than fight with each other.

By wise strategic positioning in the industry, TSMC entered successfully in the world semiconductor knowledge community in the 1990s. In order to collaborate with advanced actors of the world, TSMC participated in global consortia such as SEMATECH. (Ham, et al., 1998) TSMC has become the world's largest and most successful dedicated independent semiconductor foundry. Today TSMC has two 6-inch wafer Fabs in full operation, nine 8-inch wafer Fabs in full operation, and one 8-inch wafer Fab facility through TSMC's affiliate,Vanguard International Semiconductor Corporation. In the future, there will be two 12-inch wafer fabs in Hsin-Chu Science-based Park and Tainan Science-based Industrial Park, and a joint venture with Philips Semiconductor and with Singapore's EDB Investments will also bring increased capacity in the coming years.

**From foundry to e-foundry**

The early adaptation of ICT is one of the important factors in TSMC's success. TSMC has, since its establishment, set up a document center by which corporate knowledge could be categorized and stored. TSMC's intranet system is maintained up to date by a team of more than a hundred members. The effects of proper knowledge

management are obvious: the rapid growth in the new Fab number, as mentioned above, is a direct result of "smart copy." It means that knowledge required in the Fab could be easily transferred to the new one through a central team, thus copying the Fab from one context to another.

In 1992 TSMC established its Total Order Management (TOM) system, which was meant to structure future e-business. Three subsystems were further developed from the TOM, including TSMC-Direct, TSMC-On Line and TSMC-YES. Obviously, communication with clients is easier through these systems. But the most critical issue is that TSMC became a transparent company because the clients can access their own orders and modify them whenever they like.

The successful establishment of TOM and implication ICT made TSMC an *e-Foundry*, a new term invented by TSMC. It means that customers of TSMC can online access to the engineering information and electronic supply chain information such as purchase orders, work-in-process reports, shipping notices, and other important logistical information.

Another feature is that TSMC offers foundry specific intellectual property. The third party IP offerings include system-level cores such as Embedded Processors, Digital Signal Processing, Communications and Networking, Special Memories, Bus Interfaces, Mixed Signal, RF, Multimedia and Programmable logic. All cores in the TSMC catalogue are created, directly sold and directly supported by the individual IP vendor. Each TSMC process-proven IP core complies with TSMC design rules and models.

Since the transformation from conventional foundry to e-foundry, the knowledge boundaries of TSMC have further expanded. Referring to Figure 1, important factors such as ICT, IP and knowledge management actions taken by TSMC make the knowledge community broader and virtualized.

The model of TSMC was imitated by other firms in Taiwan and other countries, while the sale in the world foundry has been concentrated to Taiwan, referring to Table 3, and especially to TSMC. As compared with other big foundries (United Microelectronics Ltd. of Taiwan and Chartered Semiconductor of Singapore), the rapid growth of TSMC's sale in the past four years further proves its advantage, referring to Figure 2.

Another fact of TSMC's competence is that, though attacked by Taiwan's most serious earthquake in the very morning of September 21, 1999, TSMC recovered and started normal operation within eighty-four hours.

**Insights from the story of TSMC**

The story of TSMC is heuristic. Born in the group of latecomers, TSMC never isolated itself from the world but self-identified as an important actor in the industry community. By this identification, it transformed itself with the progress of new technology and was finally recognized as an advanced player in the global semiconductor industry. Examined by the four elements of a knowledge community, the TSMC model can be summarized as follows.

*Homogeneity*: TSMC was licensed with advanced process technology and also doing research in accordance with the knowledge development in the world semiconductor industry. TSMC provides IP cores for common language with clients. By fulfilling the demand of brand companies and design houses, TSMC has common interests with them. That is, TSMC is self-identified and also recognized by the global knowledge community of the semiconductor industry.

*Diversity*: The role of TSMC as a foundry is significant. Its dedication in process technology makes the difference. Moreover, the e-foundry strategy further differs itself from other imitators of the world.

*Autonomy*: TSMC knew its position in the world semiconductor industry. By introducing new technology, IP, and other tools, TSMC made itself transparent to clients. These efforts are voluntary with strong self-consciousness.

*Collective advantage*: Without its own product, a foundry cannot live alone. TSMC depends on clients' orders. On the other hand, due to fast and flexible process technology, TSMC did contribute to high profits of world leading semiconductor firms. These profits are result from their collective advantage.

The development of TSMC can further be examined in two phases. The first phase is from its establishment in 1987 to mid-1990s. During this period, as a new member of the knowledge community, TSMC put the concept of foundry on trial. The second phase is the e-foundry era in which the concept of conventional foundry was gradually transformed by adding new *routines* to the business, thereby changing configurations of the knowledge community. In other words, mutations occur in the

knowledge community due to the efforts of TSMC, and the outcome is positive.

The fact that TSMC develops by way of knowledge community has however some other meanings. First, foundry is still a manufacturing-base firm. It means that the physical investment is still the dominant factor in value creation of final products. While the high cost of advanced manufacturing instruments can not be reduced, the concept and practice of an e-foundry has however minimized the managerial cost and further created corporate values by expanding the firm's boundaries. This is the only way for a foundry to survive.

Second, becoming a member of knowledge community, the inferior position as a manufacturer was replaced by the superior role of a manufacturing service. In other words, as the knowledge intensity increases, the foundry was transferred from the manufacturing sector to service sector. No doubt, a service-based firm is more profitable than a manufacturing-based one.

It should be noted that to enter into or establish the knowledge community is not the final object of a firm. However, it is a critical method, a fast way for the firm, and especially for a latecomer to survive or even to develop. Leveraged by the knowledge community, the firm can grow with the environment.

## Implications and Conclusions

Obtained from the theoretical synthesis and verified through the illustrative example, the four elements of a knowledge community could be criteria for an innovator to create more opportunities in the knowledge economy. The knowledge community is an *imagined community* that requires strong identity of community members. (Anderson, 1991) It means that even a latecomer can appropriate from positive self-identity in the knowledge community.

Those problematical issues in the global knowledge economy, if considered with the concept of knowledge community, will be quite different. The knowledge economy is not a completely new era. With the concept of knowledge community, the innovator plays new game with old players, turns disadvantages into advantages, and uses contradiction to create values. For example, the case of TSMC shows that an initially disadvantageous or culturally contradictory production style was transformed into profitable business by correctly self-positioning and adaptation of new

technology.

If any member can not justify itself and create its value in the knowledge community, the ideology that it is driven by would be a *false ideology*, because *in all things the knowledge community works for the good of those who love it*. This is what the institutional or systematic designation should make efforts: providing an ambience in which actors can find out their proper positions and identify themselves to a knowledge community for innovation and further development. And this is why a knowledge community-based perspective is complementary to the system-based perspective.

## References


Anderson, B. (1991), *Imagined Communities: Reflections on the Origin and Spread of Nationalism*, London: Verso.

Aristotle. (1996), *Politics*, Cambridge: Cambridge University Press.

Bell, Daniel, Dr. (1993), *Communitarianism and its Critics*, Oxford: Clarendon Press.

Castells, M. (1996), *The Rise of the Network Society*, Oxford: Blackwell.

Coase, R. H. (1937), "The Nature of the Firm", *Economica*, 4, pp. 386-405.

Cohendet, P. (1998), "Information, Connaissances et Théorie Évolutionniste de la Firme", in Petit, Pascal ed., *L'économie de l'information: les enseignements des théories économiques*, Paris: Découverte.

Cowan, Robin and Dominique Foray. (1998), "Économie de la Codification et de la Diffusion des Connaissances", in Petit, Pascal ed., *L'économie de l'information: les enseignements des théories économiques*, Paris: Découverte.

Crane, Diana. (1972), *Invisible Colleges: Diffusion of Knowledge in Scientific Communities*, Chicago: University of Chicago Press.

David, Paul A. (1985), "Clio and the Economics of QWERTY", *American Economic Review*, Vol. 75, no. 2, pp. 332-337.

Foray, Dominique. (2000), *L'Économie de la Connaissance*, Paris: Éditions la Découverte.

Granovetter, M. (1985), "Economic Action and Social Structure: the Problem of Embeddedness", *American Journal of Sociology*, Vol. 91, no. 3, pp. 481-510.

Hagstrom, Warren O. (1965), *The Scientific Community*, New York: Basic Books.

Ham, R. M., Greg Linden and Melissa M. Appleyard. (1998), "The Evoluting Role of Semiconductor Consortia in the United States and Japan," *California Management Review*, Vol. 41, No. 1, pp. 137-150.

Hodgson, Geoffrey M. (1999), *Evolution and Institutions: On Evolutionary Economics and the Evolution of Economics*, Aldershot: Edward Elgar.

Kuhn, Thomas S. (1970), *The structure of Scientific Revolutions*, 2nd edn., Chicago: University of Chicago Press.

Leonard-Barton, Dorothy. (1995), *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation*, Boston, Mass.: Harvard Business School Press.

Lundvall, Bengt-Åke. (1995), *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, London: Pinter.

Lynn, L. H., John D. Aram and N. Mohan Reddy. (1997), "Technology Communities and Innovation Communities," *Journal of Engineering and Technology Management*, Vol. 14, pp. 129-145.

Mannheim, K. (1936), *Ideology and Utopia*, New York: Harcourt, Brace & World,

Inc.

Mathews, J. A. and Cho, D. S. (2000), *Tiger Technology*, Cambridge: Cambridge University Press

Nelson, R. R. and Sidney G. Winter. (1982), *An Evolutionary Theory of Economic Change*, Cambridge Mass: Harvard University Press.

Nisbet, R. A. (1966), *The Sociological Tradition*, Basic Books.

OECD. (2000), *A New Economy? The Changing Role of Innovation and Information Technology in Growth*, Paris: OECD.

OECD. (2001), *Understanding the Digital Divide*, Paris: OECD.

Pavitt, Keith. (1998), "The Social Shaping of the National Science Base", *Research Policy*, 27, pp. 793-805.

Polanyi, Michael. (1967), *The Tacit Dimension*, London: Routledge and Kegan Paul.

Rawls, J. (1973), *A Theory of Justice*, Oxford: Oxford University Press.

Sawhney, M. and Emanuela Prandelli. (2000), "Communities of Creation: Managing Distributed Innovation in Turbulent Market," *California Management Review*, Vol. 42, No. 4, pp. 24-54.

Saxenian, A. (1999), *Silicon Valley's New Immigrant Entrepreneurs*, Public Policy Institute of California.

Smith, K. (1995), "Interactions in Knowledge Systems: Foundations, Empirical Mapping, and Policy Implications", *Science Technology Industry Review*, 16, pp. 69-102.

Tilman, David, Johannes Knops, David Wedin, Peter Reich, Mark Ritchie, Evan Siemann. (1997), "The Influence of Functional Diversity and Composition on Ecosystem Processes", *Science*, Vol. 277, pp. 1300-1302.

Tönnies, Ferdinand. (1988), *Community & Society*, Transaction Books.

Van de Ven, A. H. (1993), "A Community Perspective on the Emergence of Innovations," *Journal of Engineering and Technology Management*, Vol. 10, pp. 23-51.

Vinck, D. (1995), *Sociologie des Sciences*, Paris: Armand Colin.

von Hippel, Eric. (1988), *The Sources of Innovation*, Oxford: Oxford University Press.

von Krogh, G., I. Noraka and K. Ichijo. (1997), "Develop Knowledge Activists!", *European Management Journal*, Vol. 15, No. 5, pp. 475-483.

Williamson, O. (1979), "Transaction-cost Economics: The Governance of Contractual Relations", *Journal of Law and Economics*, Vol. 22, pp. 223-251.

Wu, S. W. and Tzung-wen Chen. (2001), "Knowledge Construction of an Emerging Industry: Genesis of Semiconductor Industry in Taiwan," *Taiwanese Industry Research Mook*, 4, forthcoming (In Chinese)

**Table 1: Various collective configurations**

| | Property or subjects | Determinant factors |
|---|---|---|
| **Cluster** | Innovation, industry | Ecological relation |
| **Network** | Socio-economic network, Technology network | Interaction (exchange, collaboration…) |
| **Alliance** | Strategy, R&D alliance | Specific exchange relation |
| **Tribe** | Information, style, art | Kinship or ethical relation |
| **Cult** | Information | Religious relations |
| **Community** | Innovation, technology, creation, … | Identity, common language, norms, etc. |

**Table 2: Configurations of various managerial implications of community**

| | Members | Function | Approach | Main Issues |
|---|---|---|---|---|
| **Technology Community** (Van de Ven, 1994) | Firms (in an instrumental subsystem) | Improving creative destruction (radical innovation) | Sociology (social system) | Macro-environment of organization: Adoption of technology, public/private interaction, … |
| **Innovation Community** (Lynn, Aram & Reddy, 1997) | Organizations | Enabling process of innovation commercialization | Organizational sociology | Role of superstructure (coordinating organizations) |
| **Micro-community** (von Krogh, Noraka & Ichijo, 1997) | Professionals, individuals | Facilitating the diffusion of tacit knowledge | Socio-psychology | Intrafirm (intra-organization) knowledge activities |
| **Community of Creation** (Sawhney & Prandelli, 2000) | Firms (suppliers, demanders), consumers | Governance of distributed knowledge | Transaction-cost economics, IPR management, complex theory | Appropriate governance mechanisms |

**Table 3: Global and Taiwan Foundry Sales**

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|
| **Sale of Global foundry** (Million US$) | 4419 | 5136 | 5179 | 5381 | 6387 | 8622 |
| Growth Rate (%) | - | 16.2 | 0.8 | 3.9 | 18.7 | 35.0 |
| **Sale of Taiwanese foundry** (Million US$) | 1476 | 2034 | 2905 | 2975 | 4196 | 7419 |
| Growth Rate (%) | - | 37.80 | 42.80 | 2.40 | 41.00 | 76.80 |
| Taiwan/Global | 33.4 | 39.6 | 56.1 | 55.3 | 65.7 | 86.0 |

Source: Dataquest.

**Figure 1: From Conventional Foundry to e-Foundry**

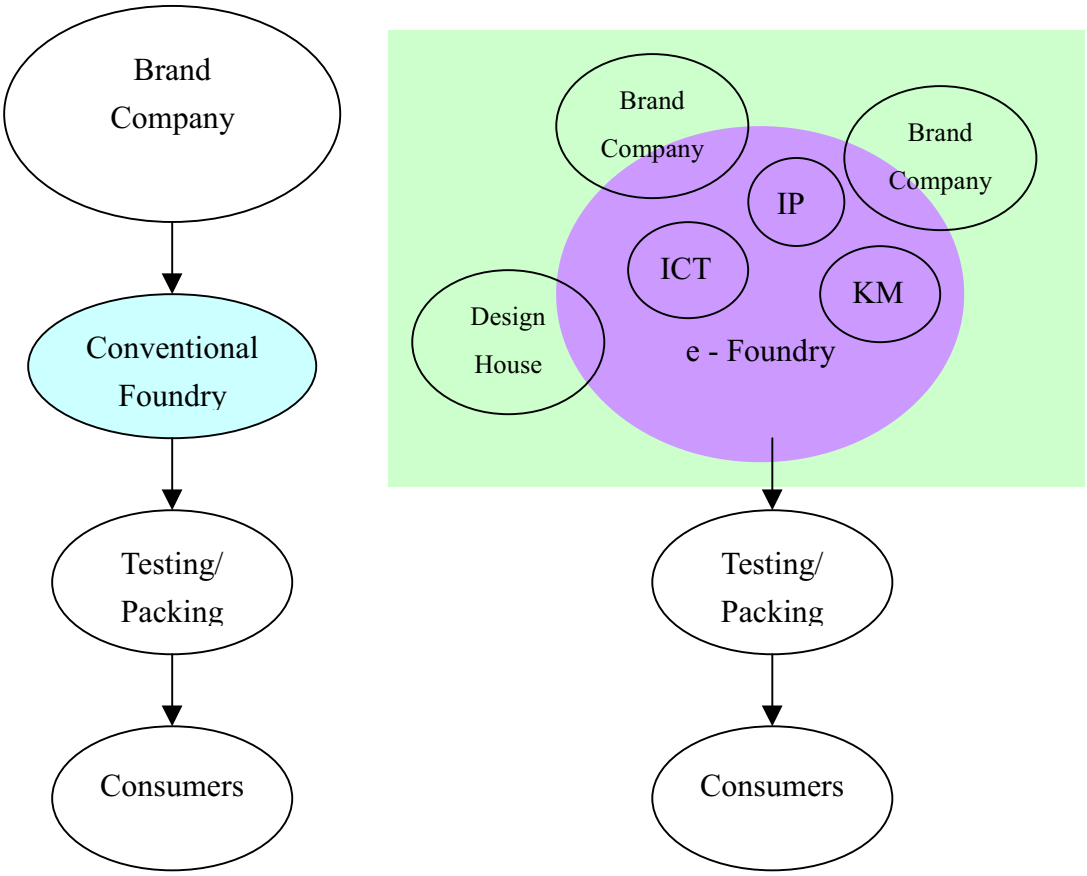
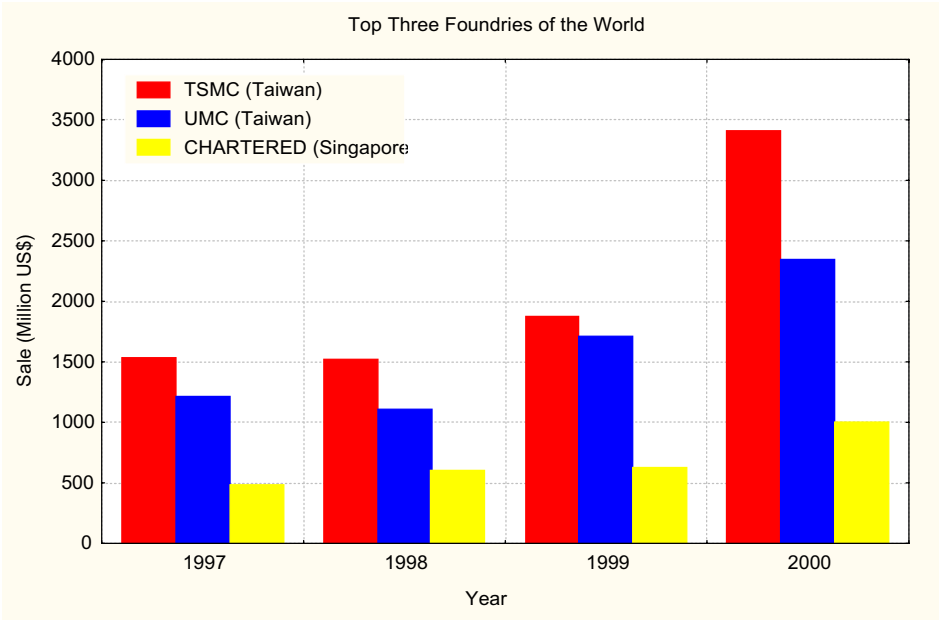



**Figure 2: Growth of Top Three Foundries of the World**




Source: Dataquest