

University-Industry Linkage -The Case of Taiwan

Vincent F.-S. Wu

Associate Professor

Graduate Institute of Technology and Innovation Management

National Cheng Chi University

Taiwan, ROC.

E-mail:fswu@nccu.edu.tw

1. Introduction

Taiwan has been working hard to change the situation from labor-intensive to knowledge-intensive economy. Nevertheless, one can still recognize that its current capabilities for innovation is not solid enough, i.e., its “national innovation system (NIS)” is yet well-constructed. For example, Taiwan is placed on top 3 in the world in computer-related product areas in terms of outputs, but the corporations’ profits and value added are not sufficient compared with those in developed economies. In addition, very few new products are originally developed from the firms based in Taiwan.

New technology is critical to the industrial corporations' competitiveness. Companies can develop their technical capabilities and products either based on internal research and development (R&D) or outsourcing. Although it remains necessary to build own internal R&D capacity, the external sources of technologies have become more and more important (Fusfeld & Haklisch, 1987; Sen & Rubenstein, 1989; Berman, 1990; Wu, 1994; etc.). To develop technologies externally can be conducted in several ways, including inter-firm cooperation, industry-research institution cooperation, and university-industry cooperation. Among them, the university-industry cooperation has been considered a top issue by many scholars regarding the national competitiveness (Rahn et al., 1988; Avveduo & Silvani, 1988; Belanger, 1988; Wainwright, 1988; Sumney, 1989; Chen, 1990; Novozhilov, 1991; Chen, 1994; Wu, 1994). The issue is particularly important in Taiwan from the following two aspects:

- (1) Taiwan is currently still in the "investment-driven" stage so that she must pay much attention to upgrading her innovative capabilities in order to move to innovation-driven stage. In fact, because of lack of the aforementioned capabilities, the performance of most corporations in Taiwan are not good compared to those of foreign ones.
- (2) In general, high-level of researchers and engineers are not sufficiently available in the industries in Taiwan. For example, there were about 15,947 engineers with doctoral degree in Taiwan in 1998. Among them, 1,732 people were working in industry, 3,869 in research institutions, and 10,346 in universities. According to the numbers above, one can find that there are more than 60% of researchers and engineers with doctoral degrees are working in universities. Therefore, industrial companies can benefit a lot if they are able to leverage the technical resources of universities.

This summarized report is to explore the university-industry linkage Taiwan from both micro and macro perspectives based on extensive literature review, in-depth case studies.

2. Background and Brief Literature Review

University-industry research cooperation is a new issue in Taiwan, but its related practices have been faced in developed countries for a long time.

Several main reasons, which are claimed to motivate the industry to increase university-industry cooperation, have been provided by Atlan (1990) and Peters and Fusfeld (1982). They are: (1) access to manpower, including well-trained graduates and knowledgeable faculty; (2) access to basic and applied research results from which new products and processes will evolve; (3) solutions to specific problems or professional expertise, not usually found in an individual firm; (4) access to university facilities, not available in the company; (5) assistance in continuing education and training; (6) obtaining prestige or enhancing the company's image; and (7) being good local citizens or fostering good community relations.

On the other hand, the reasons for universities to seek cooperation with industry appear to be relatively simple. Peters and Fusfeld (1982) have identified several reasons for this interaction: (1) Industry provides a new source of money for university; (2) Industrial money involves less "red tape" than government money; (3) Industrially sponsored research provides student with exposure to real world research problems; (4) Industrially sponsored research provides university researchers a chance to work on an intellectually challenging research programs; (5) Some government funds are available for applied research, based upon a joint effort between university and industry.

As far as the types of university-industry (U-I) interactions are concerned, there has not been a universally accepted classification. Nevertheless, we still can simply categorize

university-industry interactions into (1) general support; (2) contract research; (3) research centers and institutes; (4) research consortia; (5) industrial associate/affiliate programs; (6) new business incubators and research parks.

3. University-Industry Linkage in Taiwan

University-industry interaction in Taiwan began to be approved by the Ministry of Education in the early 1980s. Before that time, universities were not allowed to actively cooperate with industrial firms. The degree of interactions can be further understood by a recent survey which is a part of the “Taiwan’s National Innovation System” study. As mentioned earlier, the company can develop its technological capabilities either based on internal R&D or external sources of technologies. For the latter ones, they may include sources from universities, research institutes, foreign companies, suppliers and customers. Table 1 lists the survey results about the sources of technological innovation of Taiwanese corporations based on a Likert’s 1-7 scale. We can see universities are not major sources of innovation in Taiwan. In addition, 68% of the respondents indicate the foreign companies are either very high or extremely high important to them as the sources of innovation. However, only 2.4% of respondents mention to university at the same level of importance.

In the early stage, Nevertheless, there remained two formal organizations: Taiwan University’s Tjing-Ling Industrial Research Institute (TLIRI) and Tze-Chiang Foundation of Science and Technology (TCFST), which have been involved in university-industry cooperation since early 1970s. The latter one, TCFST, will be described in the following section. On the other side, the National Science Council (NSC) of Taiwan thought the lack of good U-I interactions could be one of the reasons why Taiwan is always not able to catch up in the emerging technology areas. Therefore, it initiated a “University-Industry Research Cooperation” Program in 1991, and started to implement in February of 1992. Until March of 1999, there have been more than 140 companies and 14 universities involved 95 U-I Cooperative Research Projects. For the Program as a whole, the NSC has supported the Program with 60 million US\$. Until January of 1998, there were 91 patents and 27 technologies from the Program being transferred or licensed. A deep case study from the Program will be elaborated below. In addition, the university incubator program is also a hot topic in Taiwan recently. It is the Department of Small & Medium-sized Enterprises (DSME) of the Ministry of Economic Affairs that has been supporting and been helping set up more than 50 incubators in the past 5 years. Most of them are located in university campus for a few centers.

Table 1 Sources of Technological Innovation

| | Internal R&D | Foreign Companies | Customers | Other Industries | Suppliers | Research Institutes | Universities |
|----------------|--------------|-------------------|-----------|------------------|-----------|---------------------|--------------|
| Rank (Average) | 5.7 | 4.8 | 4.1 | 3.6 | 3.6 | 3.4 | 2.7 |

*7:extremely –high important 1:extremely-lw important
Source: Wu (2000)

4. Programs and Policies Enhancing the University-Industry Linkage

The following section will describe the three major a forementioned programs (see Table 2).

Table 2 Major Programs Used to Enhance University-Industry Linkage in Taiwan

| Angle of Intervention | TCFST | UIRC | Incubator Program |
|--|----------|----------|-------------------|
| Awareness of the Network Possibility | | X | X |
| Search for Partners | X | | |
| Building Trust and A shared Knowledge Base | | | |
| Organizing the Network | X | X | |
| Ensuring Providing Complementary Resource | X | X | X |
| Active cooperation | | X | |

4.1 Tze-Chiang Foundation of Science and Technology (TCFST)

Tze-Chiang Foundation of Science and Technology (TCFST), a non-profit organization, was founded in 1973 by alumni of National Tsing-Hua University (NTHU). The primary goal of TCFST is to build up connections among academic, research, industrial and governmental institutions in order to promote economic growth, upgrade the industry, popularize human and social science as well as speed up modernization of industrial and business management. TCFST is thus devoted to cooperative research and professional training programs by utilizing academic expertise and facilities as well as obtaining the support of the government.

TCFST was set up as a semiconductor-based laboratory. With the success in semiconductor technology, TCFST was expanded into a science and technology research and training center in 1988. It owned five laboratories, namely Semiconductor Lab., Optoelectronics Lab. Information Technology Lab., Special Chemicals Lab. And Industrial Material Lab. In light of the severeness of environmental problems, the Environmental Protection Laboratory was built up in 1990. At jointly with NTHU. There are two major tasks of the laboratories. First, it arranges professional training programs for hi-tech. Engineers in the industry. Second, it explores into opportunities in technical research and development.

To help increase the technology level of the industry, TCFST has developed the capability to develop and manufacture hi-tech products such as solar cell, power MOS, Lcd display and composite materials. In addition, systems such as automatic mail box and automatic tailoring machines were built up. Since 1989, over fifty research projects for upgrading traditional industries and over ten survey projects have been accomplished. Many patents have been acquired. TCFST sees the needs of the industry, integrates academic resources and seeks government support to help upgrade the industry. To establish research and development capabilities of advanced technologies, TCFST is currently involved in the ROC satellite-related projects and magnetic-levitation transportation project.

In the area of professional training, TCFST has earned the reputation by providing high-quality training programs. In 1986, TCFST was appointed by the Administration of Hsinchu Science-Based Industrial Park to set up a training center of semiconductor technologies. Since then nearly forty thousand engineers have been trained through our prior and post employment training programs. Special systematic training programs were arranged upon request by large corporations such as UMC, TI-ACER and TSMC.

Since 1989, TCFST has been offering other professional training courses besides semiconductors, including optoelectronics, communication, automations, information systems, composite materials and environmental projection issues. For years, these courses, mostly appointed by governmental institutions such as Industrial Development Bureau and Employment & Vocational Training Administration, have been recognized as excellent training courses by the industry.

4.2 A case study of University-Industry Research Cooperative (UIRC) Project

The section describes one UIRC project sponsored by National Science Council based on initiation, implementation and results transfer stages respectively.

Background

Following the fast development of emerging opto-electronic industry, “how to develop and build the competence of the critical components of the industry” has become a very important issue to both the government agencies and industrial companies. Therefore, the UIRC Advanced Erasable CD project has attracted so much attention. The original project was conducted from 1993 to 1995. The cooperative partners include professor David Shieh from the Institute of Electro-optical Engineering of Chiao-Tung University and industrial researchers from Princo and CMC Magnetic corporation. After the completion of the three-year project, a continuing project was initiated in 1997 with the expected finishing date in 1999. CMC Magnetic Corporation was established in 1997 and produced the audio tape products. The company completed initial public offering (IPO) in 1991 and became one of the major producers of videotapes. An automatic production line for computer diskette was added later. This made CMC become the largest manufacturer of 3.5“ diskette products in the world. It successfully produced and marketed CD-R in December of 1996 and transformed itself from a magnetic memory media to a CD-oriented media company. The other industrial company, Princo, was established in Hsinchu Science Park in 1983. Its major products are related to film technology whose areas include CD-R, MD diskette, CD-RW, LD, and tools for surface processing.

Planning and Initiation Stage

The project leader is professor Shieh who came back Taiwan in 1992. Before that, he worked at IBM in the U.S. He presented a paper in a conference where he met with the participants from the Princo and CMC Magnetic corporation. Meanwhile, the National Science Council of Taiwan was promoting research cooperation between university and industry and thus initiated the Advanced Erasable CD(AECD) project. The budget for the three-year project is 34 million NT\$. Princo and CMC Magnetic need to invest respectively 1 million NT\$ of matching fund which accounts for about 18% of the total. Although the professor Shieh is quite famous and has a lot of experiences, both corporations still hesitated to join the project initially and regarded 1 million NT\$ as a big load. Nevertheless, they were persuaded and eventually accepted to join the project through the professor Shieh’s continuous effort. For the continuing project, the initiation and contract process seems to be smoother than earlier one because of the leader’s experience and satisfactory results from the former project.

Implementation and Cooperation Stage

According to NSC’s stipulation, the UIRC project require 3-5 persons of participating company to go to university campus to join research. However, it did not elaborate detailed cooperative activities. The company side thinks it will encounter a big problem if it follows the rule. This is true even for a large company like Acer Peripheral Corporation. Both sides set a regular meeting on Wednesday. Basically, the companies try their best to send engineers to attend the meetings held in campus. However, whether the university research group members can frequently visit company depends on the corporation’s attitude to U-I interactions. Some firms, such as Princo and CMC Magnetic, look the issue from the perspectives of trade secret and hence they do not welcome university researchers to visit. However, the company like Acer Peripheral takes an open way so that it welcome graduate students to visit and consequently it has quite good communication with university researchers and professors. Just one year after the project started, Acer has planned to setup a new business division for developing the related product. On the other hand, CMC Magnetic changed the participating researcher several times because of the business requirement and dispatch another engineers to join the project. However, the new comer always can’t perform well in knowledge acquisition and communication because he is not familiar with the project.

Results Transfer Stage

Following the completion of the AECD project, 3 patent applications have been filed. In

fact, one of them has been approved. In the mean time, more than 20 papers resulted from the project have been published. Also, 6 graduate students, participating the project, graduated and entered the industry, thus helped transfer the related technology and knowledge to industrial firms. Princo has had a good interaction with the university during the cooperative period and thus it can easily recognize which research results are worthy to further explore. On the other hand, CMC Magnetic encountered a hard time in absorbing and transferring technology because of its frequent change in participating researchers. In addition, some companies, without participating the project before, tried to license the results because the results' licensing is not exclusive. However, they were frustrated because of the system for licensing application, such as royalty fee, is not satisfactory.

4.3 Incubator Programs

In January of 1995, Taiwan's Small & Medium Enterprise Agency (SMEA) of Ministry of Economic Affairs was assigned to launch SME Incubation Policy as one of the moves under the macro policy of "Asia Pacific Operation Center". Half year later, SMEA assigned Institute of Management of Technology of National Chiao Tung University to complete the "Planning Report for Small & Medium Enterprise Incubator Center". After one year's effort on it, the first incubator enter was set up by Industrial Technology Research Institute with the assistance from SMEA in 1996. Since then, SMEA has assisted the establishment of about 50 incubators all over Taiwan. Most of them are located within the university campus. There are other centers run by China Petroleum Corp. and private organizations.

The concept of setting up incubation centers can be traced back to 1959, when the U.S. government wanted to develop small & medium enterprises, create new jobs, pull economy out of depressed by subsidizing academics and individuals to integrate existing resources to supply what SME needed at the beginning. As we know start-ups are always difficult to get through in the early stage because of lack of business operational experiences and knowledge. Though the involvement and residential program in incubators, entrepreneurs can gain advice and required skills, including technology, finance, marketing, business law, taxation, and initial public offering, etc. Once the start-ups become strong, they can choose to leave. In the past few years, SMEA spent about 5 million US\$ each year to support the operation of the incubators.

SMEA will continue to facilitate the operation of the existing incubators to assure the success of those business that sign up in one of the centers. SMEA will also continue to encourage both private and public sectors to establish the presence of incubators in each and every one of the counties and cities in Taiwan.

5. Research Findings and Discussions

According to the extensive literature review, survey and case studies, several preliminary research findings can be drawn. In addition, some implications can be further derived and could be useful for governmental policy-makers.

(1) Need to Support the Establishment of Intermediary Organization

The university and industry exist for different purposes. The university exists to foster an environment conducive to advancement of knowledge, the free inquiry, and exchange of ideas. On the other hand, a company or business activity exists to offer a service or product to society and on this basis, to make a profit which sustains the employment of its personnel, and provides return to those investors, primarily stockholders. Hence, it is critical to have intermediaries to coordinate the universities and industrial companies. The typical examples of "Linkage Organization" include Wisconsin Alumni Research Foundation (WARF), ARCH of Chicago University, and AUTM in the United States, and Steinbeis' Foundation in Germany. In Taiwan, except Tze-Chiang Foundation of Science and Technology, there is

almost no formal linkage organization to help U-I research cooperation and transfer.

(2) Need to Establish University Research Center Oriented for Industrial Technology

In this respect, the most famous case is recognized in the United States where National Science Foundation (NSF) sponsored Engineering Research Center (ERC) and Industry-University Cooperative Research Center (IUCRC). Until 1996, NSF has been supporting over 25 ERCs and 70 IUCRCs. NSF supports the research center for the early stage, normally 5 years, after the center is established. Meanwhile, NSF requires the center to find partners from the industry to cooperate with. It expects the center will be able to support itself once the fund from NSF is terminated. Although there are some research centers in universities in Taiwan, most of them are not oriented for industrial technologies.

(3) Need to Delegate Intellectual Property Rights

Currently, the law in Taiwan still rule that the ownership and rights of the government-sponsored cooperative research results belong to government. To industrial companies, if they can't own the intellectual property rights, then they may lose some competitive advantage. In addition, if looking those more than 600 patents owned by National Science Council, one can find the percentage of the patents having been commercialized is less than 10%. On the other hand, many developed countries have already passed the Act to delegate the ownership and rights of the government-sponsored cooperative research results to either university or even industrial companies so that they are more able to commercialize those patents.

(4) Need for Universities to Setup Patenting & Licensing office

Industrial people always complain about the difficulty in negotiating the contract and intellectual property rights with university. On the other hand, the researchers and faculty members of universities normally lack sufficient time, resources, and capabilities to conduct patent application or research results transfer. Therefore, if universities are able to setup a formal office for patenting and licensing, then the office could take care of the patent application, process of research result transfer and determines the commercial potential of university invention disclosure, and negotiates the process of licensing. Thus the university researchers will not be burdened by the administrative affairs.

(5) Need to Assess the Performance of University Incubators

Until present, SMEA support most of the organizations which are interested in setting up incubators. However, as more and more universities will apply for the funds, the budget definitely will become tight. In addition, some incubators actually are not able to attract the entrepreneurs and start-ups, i.e., they don't perform well. Therefore, they should not be supported in the future. In the long run, the government should enact criteria for performance evaluations so that the funds can be better utilized.

6. Conclusion

In the early 1980s, the government of Taiwan was able to enact industrial technology policies, to setup research institutes, and to attract Chinese engineers and scholars overseas to come back. Therefore, the high-technology industries were able to arise and some industries are even placed on top in the world. Nevertheless, we can still find the industrial firms' innovative capabilities and profitability are still low compared to those in developed countries. Hence, the next step for Taiwan to move forward is to strengthen the linkage between the industry and university in order to enhance the level of technological sophistication. However, the issue and related practices are new to universities, government agencies, and industries in Taiwan. Therefore, all of them need to learn regarding university-industry interactions.

Reference

- Aaron, Elizabeth (1988 December) "Tapping Into University Technology," High Technology Business, pp.26-32
- Allen, Martha L., M. Dayne Aldredge, and Bettye B. Burkhalter (1989) "The Evolution of University and Industry Research Relationships," Engineering Education, Part : April, pp.418—Part α: May/June, pp.476-481
- APCO Associates (1986) Research Cooperation Between University and Industry, Washington, D.C.
- Atlan, Taylan (1987) "Bring Together Industry and University Engineering Schools," in Getting More Out of R&D and Technology, The Conference Board, Research Report #904
- Barber, Albert A. (1985) "University-Industry Research Cooperation," Journal of Society of Research Administrators, pp.19-29
- Baldwin, Donald R. and James W. Green (1984 Spring) "University-Industry Relations: A Review of Literature," Journal of Society of Research Administrators, pp.5-17
- Bartlett, Joseph W. (1988 November) "Joint Ventures With Industry," High Technology Business, pp.30-32
- Berman, Evan M. (1990 Summer) "R&D Consortia: Impact on Competitiveness," Journal of Technology Transfer
- Brown, Theodore L. (1985 Fall) "University-Industry Relations: Is There a Conflict? ," Journal of Society of Research Administrators, pp.7-17
- Chan, Sinchen, (1990), "The factor influencing university and industry cooperative performance research", Unpublished thesis, Graduate School of Business Administration, National Chungchi University, Taiwan
- Chermside, Herbert B. (1985 Winter) "Some Ethical Conflicts Affecting University Patent Administration (PART I)," Journal of Society of Research Administrators, pp.23-24
- Chuo, Jisu, (1992), "The research of high technology industry, government, and university technology transfer", Unpublished thesis, Graduate School of Business, National Taiwan University.
- Ditzel, Roger G. (1988 Summer) "Patent Rights at the University/Industry Interface," Journal of Society of Research Administrators, pp.221-228
- Geiger, R. (1986) To Advance Knowledge: Growth of American Research Universities 1900-1940, Oxford University Press, Press, England
- Geisler, Elizer, Antonio Furino, and Thomas J. Kiresuk (1991 May) "Toward a Conceptual Model of Cooperative Research: Patterns of Development and Success in University-Industry Alliances," IEEE Transactions on Engineering Management, vol. EM-38, no.2, pp.136-145
- Huang, Jien & Liu, Paul (1996) IPR law and Its managemnet, Whiti Publisher Chinese Taipei
- Krebs, Robert E. (1984 Sprint) "A Dilemma – Scholarship vs. Entrepreneurship," Journal of Society of Research Administrators, pp.19-28
- Lauo, Jinlong, (1983) "The research of industry and university cooperative models" incited from Liaw, Jidir (1989) Industry, government, and university cooperative research, Unpublished thesis, Graduate School of Business Administration, National Chungshan University, Taiwan
- Liaw, Jih-Der (1988) "An Empirical Study of the Cooperative Research Among Industry, University, and Government," Unpublished Master Thesis, National Chungshan University, Taiwan
- Liu, Jinlung (1983) A Study of Models for Cooperation Between Industrial Firms and Academic Institutions, Chinese Taipei
- Macomber, John D. (1991 February) Industrial Perspectives on Innovation and Interactions with Universities, Government-University-Industry Research Roundtable, National

Academy Press, Washington, D.C.

Peters, Lois S. and Herbert I. Fusfeld (1982) University-Industry Research Relationships, National Science Foundation

Stewart, G. Hutchinson and David Gibson (1990) "University and Industry Linkages: The Austin, Texas, Study," in Frederick Williams and David V. Gibson (ed.) Technology Transfer: A Communication Perspective, pp.109-131, Sage Publications, Inc., California

Wu, Ching-Song, (1992), "R&D consortia and Industry Development", the First Symposium on Industry Management conference, Funjung University, Taiwan

Wu, Feng-Shang (1994), "Technological Cooperation: Model and Trend", the Third Symposium on Industrial Management, Funjung University, Taiwan