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Description	一般講演要旨

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産学連携におけるネットワークに関する研究･考察

○大澤　理（シュルンベルジェ）

企業がテクノロジーにおいて最先端の位置を維持していくために、大学や研究機関と共同で研究・開発を行うことが不可欠となってきている。これは最近の技術の進歩のスピードが速くなっていること、技術自体が複雑化、また多様化していることなどが主な理由である。オープンイノベーションの概念と同様に産学連携にの重要さについても多くの研究がなされているが、本発表においては国のファンディングを活用した国内のプロジェクトにおけるネットワークに注目し、調査した結果について考察し、調査の途中経過として報告する。産学連携のレベルによってプロジェクトを次のように分類する。すなわち大学のみの基礎研究（レベル０）、１大学と１企業とによるフィージビリティースタディー（レベル１）、別の企業を含めた製品の検証（レベル２）、そしてさらに製品のユーザー企業も共同で進める商品化（レベル３）のネットワークレベルである。これらの分類やネットワークの進化について実例を挙げて議論する。

During the recent decades, the collaboration with universities or academia is becoming more important than before for firms to retain their leading position in technology, because of the recent complexity and diversity in technologies with much faster changes than in the past. Together with the concept of open innovation, the significance of U-I (University-Industry) collaboration has been studies by many researchers. In this paper I focus on the networking structure of U-I collaboration through the investigation of past government funded projects in Japan. The first stage of the studies revealed that there are different levels of U-I collaboration such as a) level 0: basic research only by university itself, b) level 1: feasibility study by a single firm with university, c) level 2: validation of product involving another manufacturer, and d) level 3: product realization, together with manufacturer(s) and/or user firm(s).This classification and the network evolution of U-I collaboration will be presented with some examples, followed by further discussion.

Introduction

As summarized by Fabrizio (2005), firms in many industries have recognized the value of looking outside of their borders for ideas, knowledge, and sources of innovation. As Cohen et al. summarized (2002), industry researchers report that linkages with university researchers provide benefits in terms of keeping abreast of university research, gaining access to the university researchers' expertise, and receiving general assistance with problem-solving

(Rappert et. al. 1999). The successes and failures from basic research at universities provide information useful for guiding applied research in the direction of most promising opportunities, avoiding unfruitful areas, thereby increasing the productivity of applied research (David et al. 1992). Access to a stronger knowledge base facilitates more efficient and effective search for new innovation by firm researchers (Nelson 1982; Cockburn and Henderson 2000).

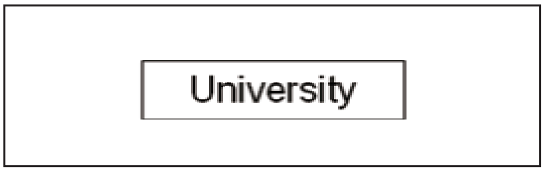
Tidd and Trewhella (1997) discussed about the forms of collaboration, such as 1) subcontract/supplier relations, 2) licensing, 3) consortia, 4) strategic alliance, 5) joint venture, and 6) network, summarizing the advantages and disadvantages of each type of collaboration. Simard and West (2006) describes, however, that there are numerous unresolved questions regarding the role of these network portfolios in promoting open Innovation, including balancing the trade-offs on each dimensions, the influencing of external factors in determining the available tie options, and the optimal tie mix to maximize knowledge flows that support innovation.

In terms of the effect of U-I collaboration to success, Maine et al. (2006) studied the case of advanced materials ventures, and offered managerial and policy recommendations to support value creation by advanced materials ventures. Baba et al. (2008) studies the scientists in advanced material field, and discussed how collaboration with universities affects firms' innovative performance.

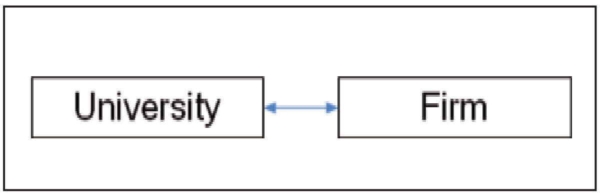
Faulker and Senker (2005) studied knowledge frontiers, public sectors research (PSR) and industrial innovation, and commented that extensive links between powder suppliers, processor, and end users, even consulting companies providing both technical and marketing information. In the past, Shockley said: "Transistor was born from interaction between fundamental research and application research. Research to investigate what is happening inside semi-conductor was eventually more beneficial than making the component itself", described by Mizushima (1985).

Classification of levels of U-I collaboration

Based on the forms of collaboration discussed by Tidd (1997), I tried to apply a similar approach in categorizing the forms of U-I collaboration, and came up with the following levels:



1) Level 0: typically basic researches are conducted by the researchers at the university, with least interaction or collaboration with any external parties. There are some cases that researchers among several universities collaborate on a common theme, but this kind of form can also be mapped in this category.



2) Level 1: U-I collaboration starts typically from a firm who shows interest in a research seed or technology from a university. It starts by the firm evaluating how

relevant the research seed from the university is to judge if it is worthwhile proceeding for further feasibility study of the applicability of the technology in their product

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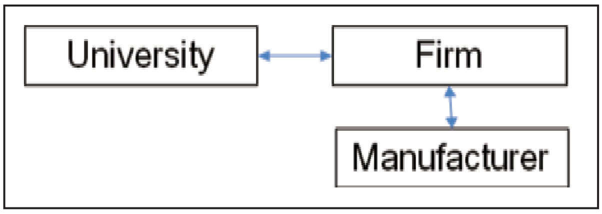
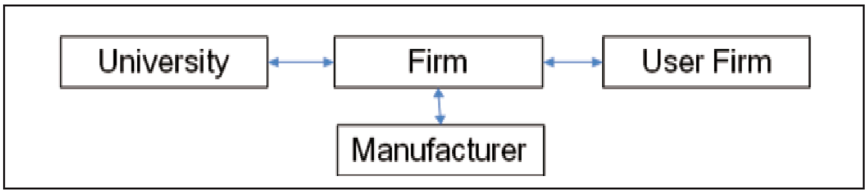


3) Level 2: When the firm confirms the technology from the university is feasible, the firm tries to make a prototype or samples of the product to confirm its funcitions in validating the concept. Some firm makes the prototype by themselves, but many subcontract the manufacturing of the prototype to their supplier or a manufacturing firm.

   The manufacturer here in many cases is merely a subcontractor to make a prototype. But there are some cases that the manufacturer also has a technical capability to participate in the R&D efforts of the firm with the university to improve the product, resulting in an effective outcome of the product development.

4) Level 3: Once the firm validates the feasibility and manufacturability of the product, the next and final step toward commercialization is to work with the user firm, i.e., the final user of the product or the firm facing to the end users. Working closely with the user firm will speed up the process toward the commercialization in minimizing the risk of not meeting the market needs.



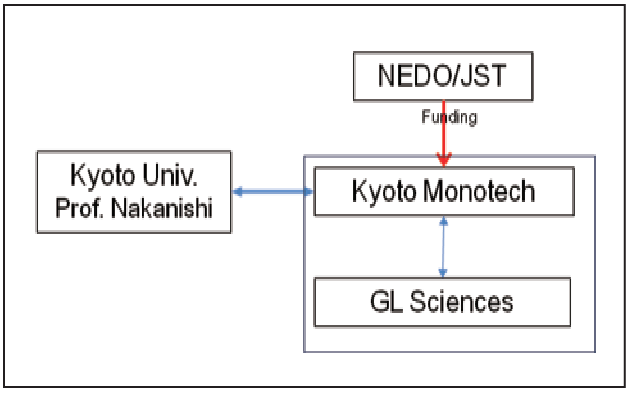
Case investigation and analysis

I started the investigation from the list of U-I collaborative projects funded by JST (Japan Science and Technology Agency) and NEDO (New Energy and Industrial Technology Development Organization) -423 JST projects and 328 NEDO projects (total 761 projects). The information on the public web pages of JST and NEDO, we can easily identify at least how many firms are involved in each project. Even for those where only one firm is listed, I tried to investigate more information related to each project, such as press release, public announcement, paper, and patents.

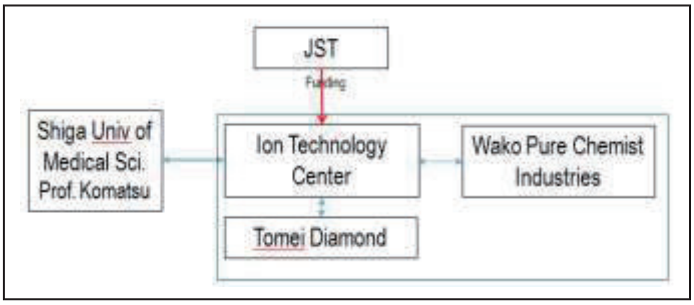
Through this first look of those projects, 50 projects turned out to involve two or more firms within the collaboration. For the projects with multiple firms involved, I tried to categorize the role of each firm within this project, and tried to identify the Level of collaboration to identify the research network. Chronological evolution of this networking was also investigated.

Case studies

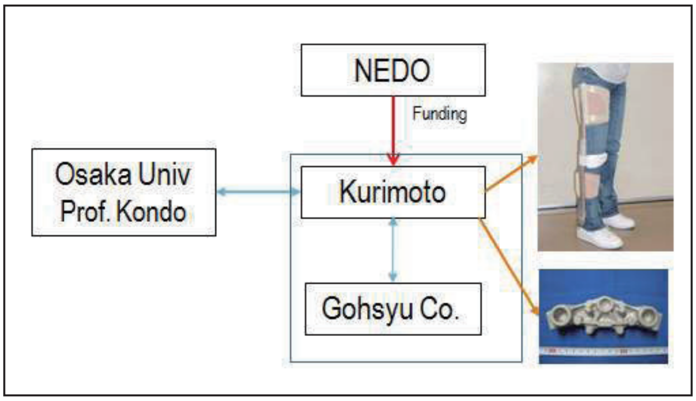
Several Level 2 cases have been identified through the initial investigation. The following example is one of the cases where two companies are involved; one (Kyoto Monotech) tried to work closely with the university to develop the research seed into a product, while another (GL Sciences) commercialized this technology as a device to sell to the market.



An example below shows another example involving multiple firms in different sense. Ion Technology Center took initiative in developing diamond nano-diamond probe together with Tomei Diamond, then Wako Pure Chemist Industry commercialized it technology as the imaging kit

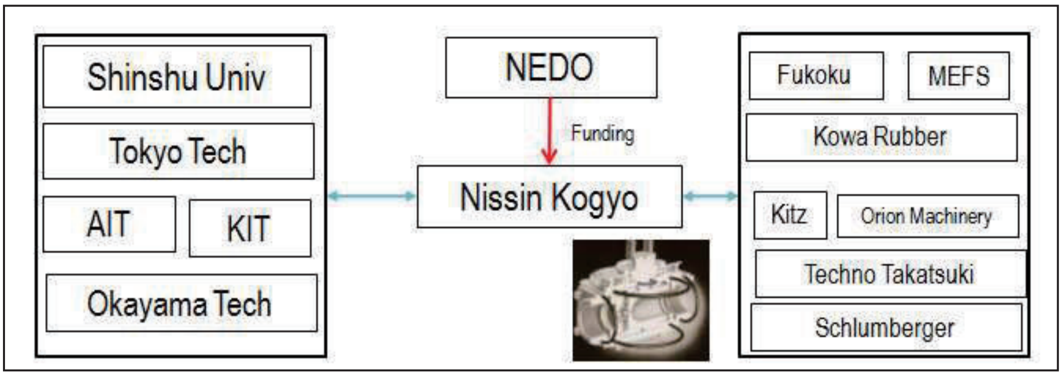


Prof. Kondo of Osaka University worked on magnesium alloy together with Kurimoto using NEDO funding. Through this collaboration, they also worked with a machining firm, Gosyu, invented a production method of the metal materials, and developed final products for various markets. Joint patent with three parties show clearly on their close collaboration in this R&D effort.



Since 2003, Nissin Kogyo started to work with Shinshu University on metal composite with carbon nanotube (CNT) to produce a new light but strong material. Through this collaboration, Nissin came up with a unique technology of mixing carbon nanotube uniformly with metal and filed several patents on the methodology.

Based on this base technology seed, Shinshu University and Nissin Kogyo decided to pursue the potential of CNT rubber composite technology, and formed a new combination of universities and firms to accelerate their project of CNT composite material development toward the commercialization of final products. Based on the technology seeds from Shinshu University, other universities collaborated in understanding the science. Several manufacturing firms (e.g., Fukoku and Kowa Rubber contributed as molders in producing the rubber products). In this collaboration, several application firms participated in producing the final products using the rubber products (e.g., seal products such as O-rings) to take advantage of its superior performance. As a remarkable point, those application firms directly participated in the research with the university to understand the science to develop the seal products using the material optimized for their final application products (e.g., Kitz for water valve seal, and Schlumberger for high temperature seal for oilfield application). This collaboration showed a good example of direct R&D networking with university, technology firm manufacturing firm and application firm to realize the faster commercialization of the product from technology seed from the university.



Prof. Noguchi of Shinshu University stated through the interview that the involvement of user s companies and close collaboration with them resulted in effective and efficient development of the products toward quicker commercialization.

Conclusion and consideration for further studies

Through this investigation of classification of collaboration network, we could identify several cases of U-I collaboration that match Level 2 or 3. It also showed several examples of collaboration where the product commercialization was achieved through the U-I collaboration including the manufacturing firm, or even with user firms concurrently within the project of research. The research also showed several examples of U-I collaboration where the network evolved from Level 1 to Level 2, then Level 2 to 3 toward the progress of the R&D effort. This initial study suggests that the type of network evolves through the level of R&D collaboration, implying that the concurrent involvement of university researches even at the later stage of development will be effective toward the faster commercialization of the final products. We would continue this case investigation even further through the patent search and published information in syncing to the timing of commercialization of the product utilizing the result from the U-I collaboration, and would aim to come up with a recommendation on how to form the U-I collaboration network throughout the product development.

Acknowledgement

In starting this research and investigation, I could obtain a lot of basic knowledge in Management of Technology from Prof. Miyazaki of the Tokyo Institute of Technology. I would also thank Prof. Noguchi of Shinshu University who shared his experience regarding their collaborative research. I would express a sincere gratitude not limited to those professors, but also to many researchers from their labs, throughout my research work.

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