2A05　技術開発支援手法ロードマッピングプロセスに関する研究
—燃料電池技術開発支援 *in JAIST*

○閻　潔，三宅幹夫，小林俊哉，中森義輝（北陸先端科学技術大学院大）

ABSTRACT

With the development of Management of Technology (MOT) in industry, many methods of MOT have been proposed for technology development. In this research we want to propose some methods which have been used successfully in industry to deal with some problems for technology development in a university setting. First, after introduces differences between technology development in industry and university, we get a conclusion that the process of technology development in industry and university is very similar. Therefore, in this research we will propose a process method, roadmapping for supporting technology development in university setting with cooperation among government, industry and university. Then, a roadmapping system is proposed, based on a case study concerning integrated forecasting of a transportation fuel cell roadmap.

Keywords: Supporting for technology development, Transportation Fuel Cell Forecast, Roadmapping Method

1. INTRODUCTION

Technology roadmapping is a disciplined process for identifying the activities and schedules necessary to manage technical (and other) risks and uncertainties associated with solving complex problems. *Robert Galvin, CEO of Motorola, 1998*

Technology roadmapping is used as a planning process that gives decision-makers a means to identify, evaluate and select among strategic alternatives for achieving technological objectives in industry[1]. In this case, technology roadmapping is a technology developing process for supporting researchers doing scientific research in a university setting. A roadmap is an extended look at the future of a chosen field of inquiry composed from the collective knowledge and imagination of the brightest drivers of change in that field . *Bennett R. Idaho National Engineering and Environmental Laboratory (INEEL)*

The roadmap document resulting from the technology roadmapping process is the first step toward technological innovation [1]. In industry, a technology roadmap document presents　consensus on a number of topics: a vision of the industry at a set time in the future; what new types of products (or services) will be required; the enabling technologies to create those products; the feasibility of creating the needed technologies; the technological alternatives for achieving the needed technologies; and how to address these technology needs through R&D [2]. The roadmap document addresses the role of an industry's suppliers in creating the desired future, human resources needs, governmental and non-governmental barriers, and other topics [1]. In this context, companies must use effective tools to plan their future. Technology roadmapping is a way to identify future product or service needs, map them onto technology alternatives, and develop plans to ensure the required technologies will be available when needed [1]. The principal functions of technology roadmaps have been for representation, communication, planning, coordination, and technology forecasting and selection [3]. For researchers in university timely, advantageous, and original research is what they want to do. How technology will be developed, what are the advantageous of technology and products, what are the societal influences on technology development [4]. As a result what we find in this research is the process of technology development in industry and university is very similar, based on the process of technology development in industry, we propose a process model for supporting technology development in university.

2. TECHNOLOGY DEVELOP IN UNIVERSITY

How researchers can utilize the vast amount of available data and information to make decisions regarding their future research to do technology development is an extremely important problem in university setting .

2.1 Why support for researchers

For almost technology development topics, a cooperative effort among industry, research institutes and government. In this cooperation, the most important part is between industry and research institutes [5]. In this paper, we present a concept for cooperative research for technology development among industry, institutes and government [6]:

- Industry: industries that introduce products
- Institutes: universities that make technology or method of technology development as research topics.
- Government: government organizations that make the policy for technology and marketing development .

As Fig. 1 shows, there is an obstacle to realize cooperation between industry and institutes. In industry, there is support from the technology development and marketing sections to obtain patents [7]. In universities there are no such organizations to support researchers in their scientific research. On the other hand, as shown in Fig. 2, government uses reports from industry to get data to make policies technology development, while industry gets data from universities to create marketing strategies and develop

technology [8], but where will the researchers in university who want to do technology development, get their data? Therefore, in this make policies technology development, while industry gets data from universities to create marketing strategies and develop technology [8], but where will the researchers in university who want to do technology development, get their data? Therefore, in this paper, we want to propose a model supporting researchers for technology development in university.
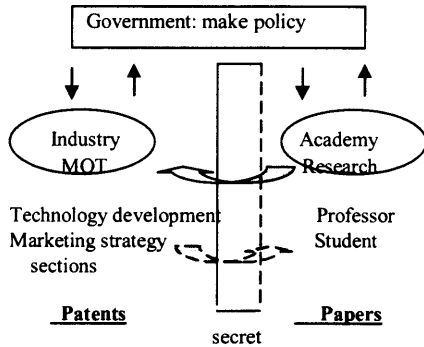

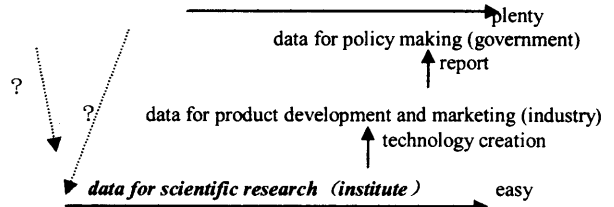Fig. 1 Cooperation between industry and academy

Fig. 2 Data resource

	Indusry	Universiry
Purpose	benefit ⎨ new product / new technique	knowledge ⎨ new theory / new technique
Process	Needs ⇧ Development customer ⇩ Evaluation	Needs-seeds ⇩ researchers Research plan Experiment/data Result
Object	Definite/objective technique	Ambiguous/subjective knowledge
Result	Benefit wealth/fame	Original ideal/theory Wisdom/capability

Fig. 3 Comparison of technology development between industry and university

2.2 How to support researchers for technology development?

As Fig. 3 shows, the process of technology development in industry and university is very similar, so if we can find a process method of technology development in industry, maybe it can also deal with some technology development problems in university. With the development of MOT in industry, many technology roadmapping methods have been proposed as a process way to do forecasting and planning for supporting technology development. Therefore, in this research, we will use roadmapping process to propose a roadmapping process model for supporting technology development in university. In industry, they use technology roadmapping as a way for technology development with four approaches:
·   To present a concept of the needs of technology and market

·   To forecast the trend of technology
·   To provide the data not only for technology, but also include the society influences
·   To support decision makers to do technology development
and three steps:
·   step1 Centralizing: decide technology development topics
·   step2 Dispersing: share and discussion
·   step3 Centralizing: feedback and conclusion

For researchers in university they have no chance to discussion on technology development topics with other researchers face to face who are in the same research field and get necessary data and information from industry and government. Therefore we will propose a roadmapping process model for supporting researchers in university to do technology development with cooperation among industry and government:

- Data collection: Collect data from four sides, technology, marketing, economic influence such as costs and benefits, and environmental influences, by using the internet and papers, and structure a database.
- First-cut Roadmap: Analyze the data collected, produce a first-cut roadmap for technology forecasting.
- Idea exchange: Show the first-cut roadmap to researchers who are in the same research field, collect their opinions about the roadmap and ideas for forecast items, and find out further information what they need, then re-roadmap.
- Cooperation: Collect information from industry and government about the the products, marketing and societal influences of technology witch researchers want to develop, get the scenarios for how to develop and evaluate technology who researchers want to develop.
- Topics or methods of technology development: Integrate the roadmap and scenarios get idea for technology development.

3 . CASE STUDY

In this paper, we examine a case study for supporting fuel cell researchers in JAIST with a forecasting roadmap by roadmapping process. The fuel cell can trace its roots back to the 1800s. A Welsh born, Oxford educated barrister named Sir William Robert Grove, who practiced patent law and also studied chemistry or "natural science" as it was then known, realized that if electrolysis, using electricity, could split water into hydrogen and oxygen then the opposite would also be true. Combining hydrogen and oxygen, with the correct method, would produce electricity. To test his reasoning, Grove built a device that would combine hydrogen and oxygen to produce electricity, the world's first gas battery, later renamed the fuel cell [10]. Because of its characteristics such as long durability, high efficiency and no pollution, the fuel cell has been used in several fields (this paper deals only with the transportation fuel cell). How do fuel cell researchers make their decisions about topics of technology development ? What kinds of information do
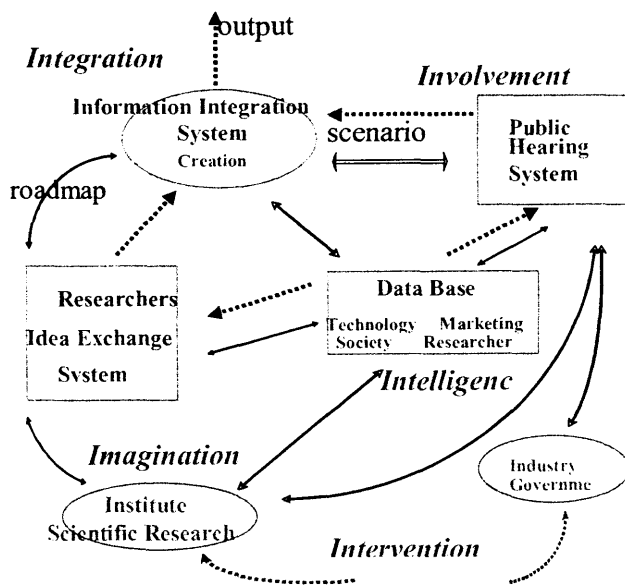

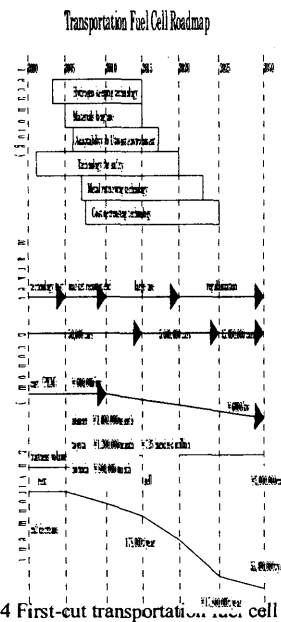Fig. 5 Roadmapping system framework

Fig. 4 First-cut transportation fuel cell roadmap

they need and what information do they want? In order to address a problem how to do the support for researchers to developtechnology in university by roadmapping process, we carried out the case study. Fig.1 shows the first-cut roadmap of technology forecasting for transportation fuel cell. We collect data from internet and paper of researchers in university, technology developer in industry, and policy maker in government with four items technology, marketing, economy and environment, after analysis get the first-cut roadmap. From this map, fuel cell researchers can get data and information about technology in current, present, and future, data and information about evaluation of technology development is also provided. We show the first-cut roadmap to researchers who are in the same research field, interview them getting suggestions for how to improve roadmap and what kinds of data and information else they want. As a result of interview, almost researchers want to know

more information about advanced technology research topics and who are doing such research not only in university, but also incluiding technology developers in government and industry.

4. Roadmapping system

For researchers in university, they have no chance to discuss techonolgy development topics with other researchers in other university, industry and government face to face to get data and information what they want, therefore we will propose a roadmapping system to give them a chance discussion with all researchers in university, industry and government at the internet. Fig. 5 shows a roadmapping system framework based on the case study of the thetransportation fuel cell roadmapping process and i-system (as a technology development thinking way) [11].

- Intervention:
  The purpose of the technology development topics under a cooperative effort of industry, institutes and government.
- Intelligence:
  Collect data in different fields such as technology, marketing, economic influence (costs and benefits), and environmental influences (air, water, noise pollutions), and structure a database. After data analysis, produce first-cut roadmap.
- Imagination:
  Show the roadmap to researchers to collect their ideas and suggestions about the roadmap and identify their need for further information, re-roadmap.
- Involvement:
  For industry and government, collect their relative product information, research topic and policy in accordance with what researcherswant to know, and put all this information into the database, get some scenarios about how to realize technology development or evaluate topics of technology development.
- Integration:
  Integrate all the data collected from industry, institutes, and government supporting researchers get new ideas for technology development.

Before integration, after getting new roadmap and scenarioes , move to the researchers idea exchange system, show the new roadmap to researchers and collect their new ideas. Move to the public hearing system, collect new product information, research topics and policies until they have no new idears about roadmap and secnarioes. Finally, move to the information integration system to integrate the data collected. Through this recurring cycle (Intelligence-Imagination-Involvement-Integration), researchers can comprehend recent and future forecasting information, not only in terms of technology, but also including the researchers ideas along with policy and marketing information. Researchers can get some ideas for technology development.

5. Conlusion

Roadmapping as a method of MOT is used widly in industry, how we can do some surpporting to researchers in university for technology development is the problem addressed on this study. We find roadmapping process may be can deal with some problems for technology development because the process of technology development in industry and university is very similar. For researchers having no chance to discussion problems of technology development with other researchers face to face, we propose a system to support them discussion at internet. Yet, as a result of fuel cell researchers interview, what is researchers who want to do technology development want to know is advanced technology and product information, prompt related policy information and who are doing such research, producing such product. Therefore We will provide roadmapping process model, make a real roadmapping system for researchers supporting technology development in universiy. We hope that this system will prove to be a dynamic and powerful tool for technology development at university research institutes and will be helpful in expediting cooperation among industry, institutes, and government.

REFERENCES

[1] Understanding technology roadmapping www.strategis.ic.gc.ca/epic/internet/intrm-crt.nsf/en/rm00057e.html
[2] Robert Phaal, ` Technology roadmapping- A planning framework for evolution and revolution` Technological forecasting & social change 71 pp67-80, 2003.5
[3] Martin Rinne, `Technology roadmaps: Infrastructure for innovation` Technological forecasting & social change 71 pp5-26, 2003.10
[4] Toshiya Kobayasi, `Future forecasting` 1996

[5] Watanabe Masahiro, `Self-Humidifying Polymer Electrolyte Membranes for Fuel Cells` M. Watanabe H. Uchida et. al. J. Electrochem. Soc. Vol.143(12) 3847-3852 (1996).
[6] `Fuel cell practicability strategy` Ministry of Economy Trade and Industry, Japan, 2001.1
[7] Yano, `Advanced fuel cell market investigation`, Yano Research Institute, 2002.8
[8] Kenichi Hattori, `Managment of Technology` Roland Berger strategy consultants vol.13, 2003.6
[10] Fuel cell history www.fuelcellstroe.com/information/fuel_cell_history.html
[11]. Yoshiteru NAKAMORI, `System Methodology and Hematical Models for Knowledge Management` Journal of System Science and Systems Engineering Vol.12, No.1,pp49-72, 2003.3