Chapter 1
Technology Transfer from Keio University: Development of Professionals Fostering Innovation over the Past Decade

Kenichi Hatori and Koichi Hishida

Abstract It has not been long since Keio University started university–industry collaborations and technology transfer as one of its mandates. The Japanese government had great expectation for universities to overcome the recession of the 1990s and quickly developed several measures to harness universities' potentials. Keio established the Intellectual Property Center in 1998 as an internal office, almost simultaneously with other well-known Japanese universities. Thereafter, during the next decade, Keio gradually secured institutionally-owned patent applications and set about exploiting them and university–industry collaborations. The foundation for university–industry collaborations and technology transfer has accordingly been established and some successful examples can be found, but these collaborations have not reached the level of self-sustainability as with many other universities. However, not all university–industry collaborations are the same and should thus vary depending on the scale, nature, culture, and history of each university. This chapter looks back at some of the successes and activities of Keio and considers what universities can do to foster innovation for the benefit of society.

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1 Introduction

In 1858, Yukichi Fukuzawa founded a private school called Rangakujuku, which was the predecessor of Keio University (Fig. 1.1). In 1861–1862, he visited Europe to serve as an interpreter. He was overwhelmed by the advanced European culture in contrast to Edo-era Japan. The industrial revolution in the United Kingdom in the late 1700s leapt to Belgium and France in the early 1800s, and then to Germany in the late 1800s. After studying the background of this industrial revolution, Fukuzawa discovered the patent system there. Consequently he became the first man to introduce the European patent system to Japan through publishing "Seiyo jijyo" in 1867 [1]. Because the book was so popular and thus was copied for sale without author's permission, it was said that he needed to introduce the Copyright Act to protect his work from infringement. The Japanese Patent Office started its duties approximately 20 years after he introduced the patent system to Japan.

This chapter outlines the current system of university–industry collaborations and intellectual property management at Keio University. Keio has headquarters at its Mita campus and several dispersed campuses such as the Medical School and its graduate school at Shinanomachi, the Faculty of Science and Technology and its graduate school at Yagami, and the Faculty of Environmental and Information Studies and its graduate school at Shonan Fujisawa. Each campus has research administration offices which mainly handle the management of externally acquired research funds and the office management of collaborative research agreements with external institutes. The Headquarters for Research Collaboration and Administration carries out the planning and serves as the contact office of university–industry collaboration, intellectual property management, and technology transfer [2] (Fig. 1.2).

1.1 Historical Background of Intellectual Property Management at Keio

The economy in Japan was very strong in the 1970s and 1980s. Indeed, the economy of the late 1980s was said to be a "bubble." In the 1990s, however, the Japanese economy fell into recession. Japan rapidly lost international competitiveness from the late 1990s and the government started to reform universities to secure sources of innovation to overcome this recession [3]. This was similar to the situation in the United States in the early 1990s. When Japan and Germany were prosperous in the 1970s, the United States was suffering from a recession and decided to start to strengthen intellectual property strategies, including the promotion of technology transfer from universities to industry. The symbolic legal revision of this was the Bayh–Dole Act [4], which the United States introduced for the first time in 1980. Triggered by this law, patent applications derived from university research results were to be owned by the university (Fig. 1.3).

The Japanese government took these policies into account and quickly introduced several new laws such as the TLO Act [5] and the Japanese version of the

Fig. 1.1 Keio University, current building (*left*); Yukichi Fukuzawa, the founder of the Rangakujuku (*right*)

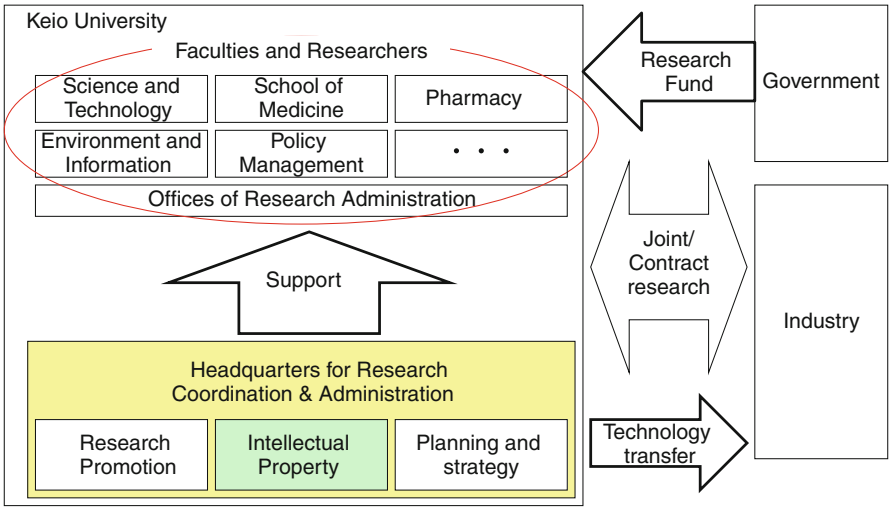


Fig. 1.2 Keio's System for Industry-University Collaboration & Technology Transfer

Bayh–Dole Act [6] to change universities to meet new demands. The Basic Act on Education was also revised [7] to include "contribution to society" as the third mission of universities in addition to "education and research." In the midst of these movements, Keio established in 1998 the Intellectual Property Center to embark on management of institutionally owned patent applications and technology transfer from the university. Mr. Keisuke Shimizu, former professor of the Faculty of Business and Commerce and the first director of the Center started this organization from scratch at the university. In the first 5 years, university patent applications increased steadily. Recently, Keio has nearly 130–150 domestic patent applications and nearly 30 Patent Cooperation Treaty applications per year (Fig. 1.4).

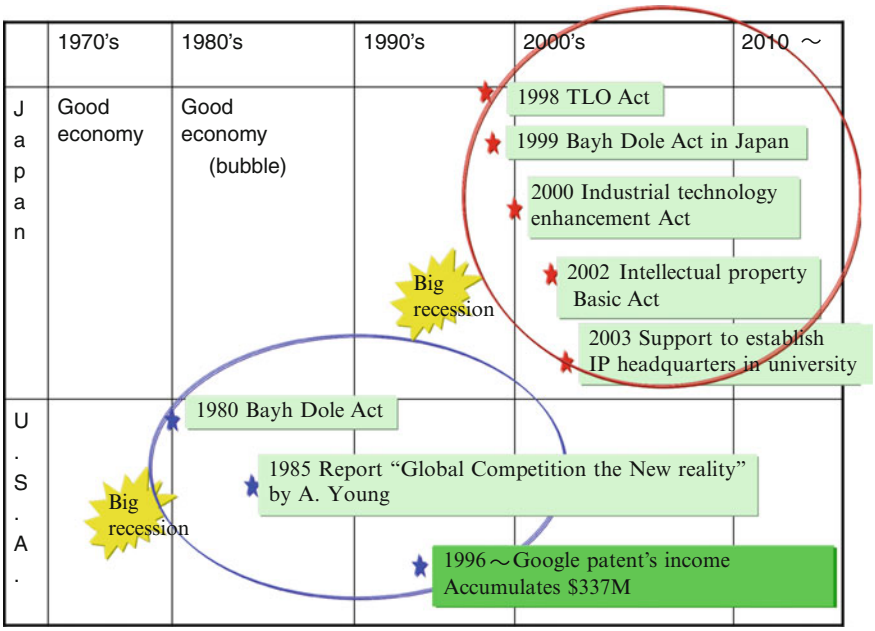


Fig. 1.3 Toward IP strategic nation—Expectation to the University

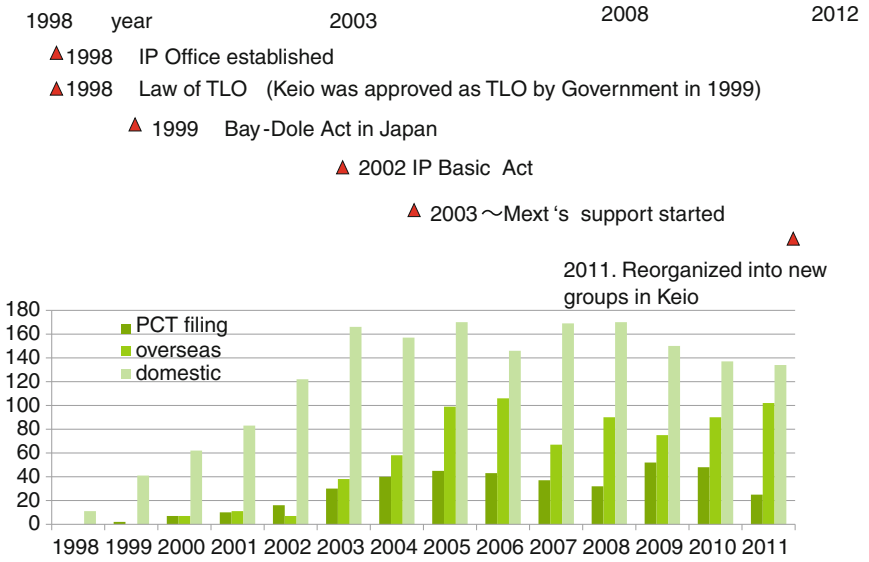


Fig. 1.4 History of intellectual property office (center/headquarters) in Keio

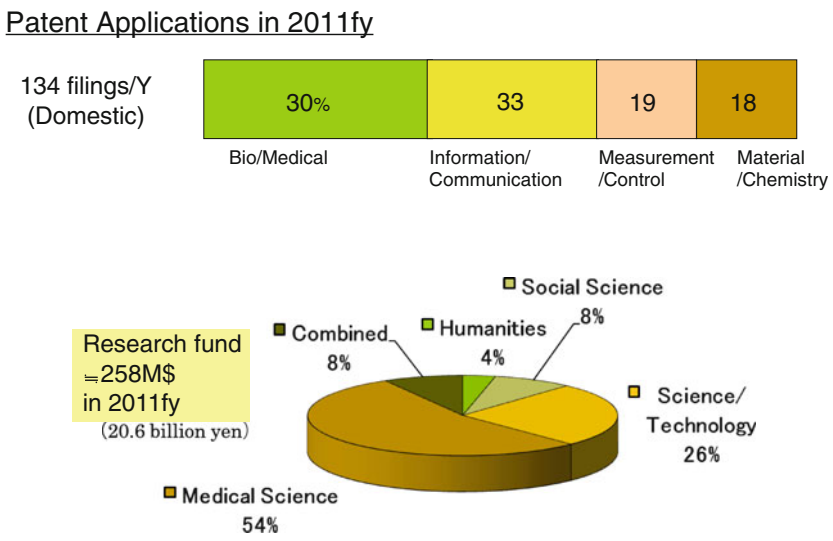


Fig. 1.5 Research Fund & Technical Fields of Keio's IP

Table 1.1 Research fund from external entities, number of IP and license revenue

	2010 fy	2011 fy
Research fund from external entities	20.09 billion ¥ (≒251 million $)	19.78 billion ¥ (≒247 million $)
Contract research	5.88 billion ¥ (≒73 million $)	4.63 billion ¥ (≒58 million $)
Joint research	1.9 billion ¥ (≒24 million $)	1.6 billion ¥ (≒20 million $)
Patent applications (domestic filing)	137	134
Patent applications (PCT filing[a])	48	25
License revenue	50 million ¥ (≒0.63 million $)	42 million ¥ (≒0.53 million $)

[a]Filing by Patent Cooperation Treaty

Patent applications were mostly in the information and communication field (33%), biology (30%), measurement and control (19%), and material science (18%) in the 2011 fiscal year. A large amount of competitive research funds awarded to Keio researchers enables creation of inventions from their promising research results. Research funds from external entities totaled nearly $247 million, contract research funds nearly $58 million, and joint research funds nearly $20 million in the 2011 fiscal year. Additionally, there were about 130 domestic patent applications, and licensing income was about $0.5 million (Fig. 1.5, Table 1.1).

2 Activities of the Intellectual Property Center

The Intellectual Property Center at Keio is an internal office with experts who do the prosecution work as well as technology transfer. Additionally, they sometimes check and study some terms of collaborative research agreements from the point of view of securing intellectual property assets and supporting startups from the university based on Keio's intellectual property. When a researcher creates an invention, an expert visits the inventor to understand the invention and make some prior art searches. On the basis of this expert's findings, Keio holds a judgment meeting to decide whether to file a patent application (Fig. 1.6).

The judgment meeting is held every week and includes the director and experts in the intellectual property division. Around 60–70% of inventions are filed, with the remainder basically being returned to the inventor. When the decision to file an application is made, the filing procedure is entrusted to an external patent attorney. After filing, an expert takes steps to transfer the technology to industry. The incentive to the inventor is very high because 42.5% of licensing income is allocated to inventors, with the remainder going to the university. Additionally, the executive director of Keio gives a Keio intellectual property award at the end of the fiscal year to the researcher making the most important achievement in the year concerning intellectual property and technology transfer activity (Fig. 1.7).

2.1 Examples of Contribution to Society Through Technology Transfer

Keio has been involved in a number of inventions that have benefitted society. For example, Professor Masanobu Maeda and colleagues, previously of the System Design Department, invented a method for the measurement of minute droplets. Previously, it was difficult to measure the size and distribution of minute droplets such as fog in engine vaporizers and air bubbles in wine because the circular outlines of these droplets overlap. This invention used an optical system to detect the overlapping circles by separating them through conversion into horizontal lines by compressing the image into the y-plane.

Another example involves a system of generating fonts from handwriting, invented by Professor Masato Nakajima, previously of the Electronics Department, and colleagues. Characters are conventionally displayed in a standard computer font, but this system allows users to turn their handwriting into a font in a very simple way. By merely inputting about ten handwritten characters into a tablet, the system analyzes the personal characteristics of the characters, such as the shape of sharp upward slants or round letters, and then memorizes it. Afterward, according to a user's preference, they can easily turn their handwriting into a font.

A number of important startups based on Keio's patents have also been made. V-cube [8] is a company established by Mr. Naoaki Mashita who invented the company's

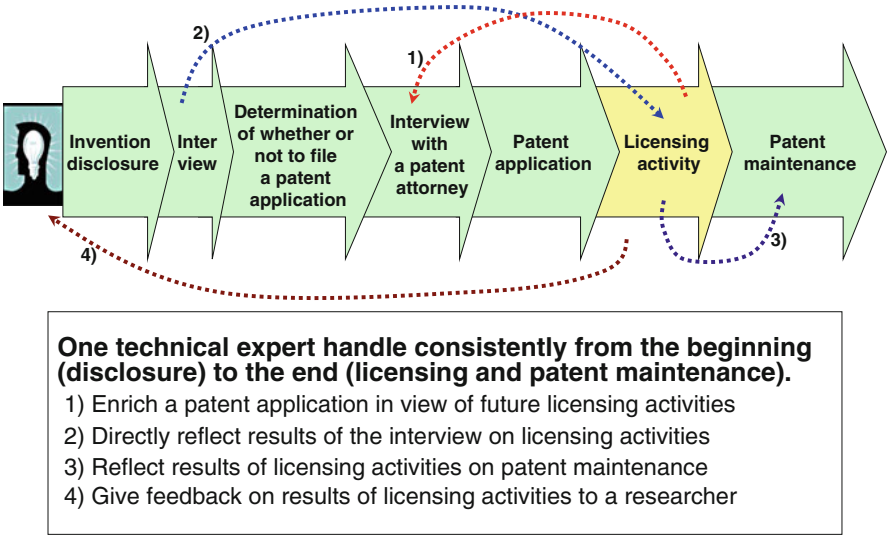
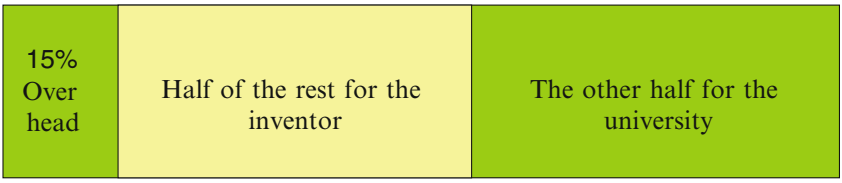


Fig. 1.6 Work Flow from invention disclosure to licensing and patent maintenance

1) Inventor receives reward of almost half of royalty



***Inventor can continue to get this reward, after he leaves Keio**

2) Keio Intellectual Property Award

Keio commends a researcher whose invention or creation is owned by Keio and most remarkably utilized in society in the year

Fig. 1.7 Incentives for inventor

fundamental technology when he was a graduate student at Keio. This company provides web meeting systems and has had the number one share for 5 consecutive years in the Japanese market. Users can easily hold a web meeting among multiple people, and can display figures and lists together. Its ability to be operated in the cloud, without the need for installing any software to the user's computer, has made it attractive.

Fig. 1.8 Metabolome analysis by CE-MS equipment

Human Metabolome Technology [9] is a company established by inventor and Professor Tomoyoshi Soga and Director and Professor Masaru Tomita of the Institute for Advanced Biosciences at Keio Tsuruoka campus. This company's main business is to receive consignments of metabolome analyses from industries such as the pharmaceutical and food industries. They can examine approximately 3,000 metabolites at once with capillary electrophoresis–mass spectrometry (Fig. 1.8). In addition to this consignment work, they have attracted attention because of the possibility of detecting early stage cancers using human blood or saliva.

Another startup called SIM-Drive [10] was established by Professor Hiroshi Shimizu of the Faculty of Environmental and Information Studies. Professor Shimizu invented in-wheel motor technology which is a structure that attaches a motor inside a car's tires. It runs on batteries. The company's purpose is not to manufacture electric vehicles by themselves, but to provide the highest level of electric vehicle technology and information, at the lowest cost, to all stakeholders dealing with electric vehicles. This company's main business is to design and develop prototypes of electric vehicles and to transfer their technology for customers.

3 Challenges of Many Universities in Japan

Looking back over the past 14 years of technology transfer activities, university–industry collaborations, and startups at Keio, a number of challenges arose and were overcome. These provide instructive examples from the viewpoint of Japanese universities.

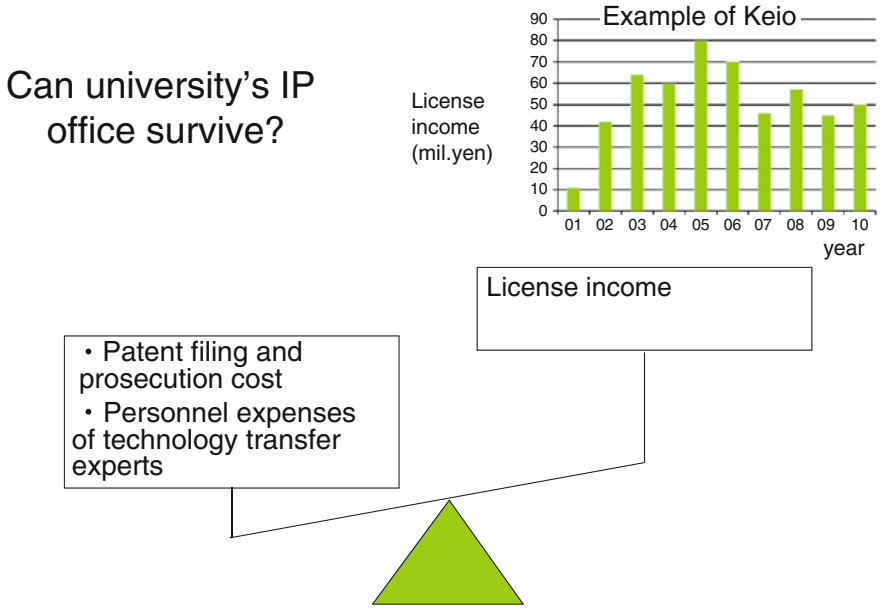


Fig. 1.9 Challenge of many universities

On the other hand, the balance of income and expenses in technology transfer at universities is a common issue. Many Japanese universities operate in the red if we consider the narrow meaning of income and expenses for technology transfer, where income consists of licensing revenue and expenses consist of patent application filing costs and employment expenses of experts (Fig. 1.9). For example, at Keio, this income has been only around 50 million yen whereas expenses have exceeded 100 million yen per year. Conversely, Stanford University and the University of California, as discussed in the previous chapter, are in the black.

Why are we in the red in Japan? We think there are several reasons. First, it has been more than 30 years since the United States established a system to use universities for industry development, including enactment of the Bayh–Dole Act and establishment of offices for technology transfer from universities to industry. Conversely, only 10-odd years have passed since the Japanese government established a similar system, including the Japanese version of the Bayh–Dole Act and a technology licensing office system.

Second, university research results are usually advances in basic knowledge, and the experiences of universities in the United States show that it takes about 10 years before basic research generates products and begins to benefit society. For example, research at Keio enabled development of a new outside-the-body diagnostic agent for the autoimmune disease systemic scleroderma. This became accepted by health insurance companies and began being sold as a diagnostic agent in 2010. It took about 10 years to reach this stage since Keio filed the patent application in 2001.

Based on this example, a period of at least 10 years is necessary to pay off a deficit. Even if the period exceeds it, it is difficult for many universities to move the licensing business (technology transfer in a narrow meaning) income and expenses into the black except at a very large university.

Do we thus abandon returning university's research results to society? We would like to say "no," because we believe that technology transfer is one of the important exits to foster innovation and a critical factor in resuscitating the Japanese economy. Additionally, the intellectual property of a university and its management plays an important role in sponsored research and startups in addition to the licensing business (Fig. 1.10). Therefore, we think it will become an important strategy for the mid and long term to continue managing the prosecution and exploitation of necessary intellectual property of a university. This includes balancing the income and expenses of all university–industry collaboration activities. Thus, we think that creation of innovation from universities can be promoted.

3.1 Required Professionals

To foster innovation and use university research results, a certain type of professional, in addition to organizational reform, is necessary. This professional should have the ability to grasp social needs and current/future issues and to plan the best matching strategy between a university's research results and industry's business/commercializing function. They must be able to execute this strategy, including bringing together stakeholders and acquiring sponsored funds from a bird's eye view to cope with these needs. We would like to name this professional the next-generation university research administrator ("Next-Generation URA") (Fig. 1.11).

Current URAs that are being deployed in some Japanese universities might be postdoctoral researchers, accountants, retired employees of companies, or other types of people not easily pigeonholed given the avant-garde nature of next-generation URAs. At Keio, we offer a leading graduate school program named "Science for Development of Super Mature Society" [11] as part of our graduate school reform. We believe that this program holds the possibility to develop a professional fulfilling the roles of this next-generation URA. This program was inaugurated in April 2012 and has started to develop a new generation of highly advanced doctoral students in a curriculum spanning 5 years. It also includes a dual Master's and doctoral degree program which integrates elements of both the sciences and humanities (Fig. 1.12).

In teaching and researching in these primary and secondary major programs, mentors from industry and government educate students and discuss with students real issues and challenges in Japan and the world based on their experiences and perspectives. Additionally, in these courses, students participate in self-planned overseas internships. This is meant to inculcate strong-willed leaders with an international outlook.

After having acquired appropriate experience in an international organization, government, and public institutions, some professionals trained in this manner might find a job in research administration or the university–industry collaboration division of a university. He or she would become a Next-Generation URA (Fig. 1.13).

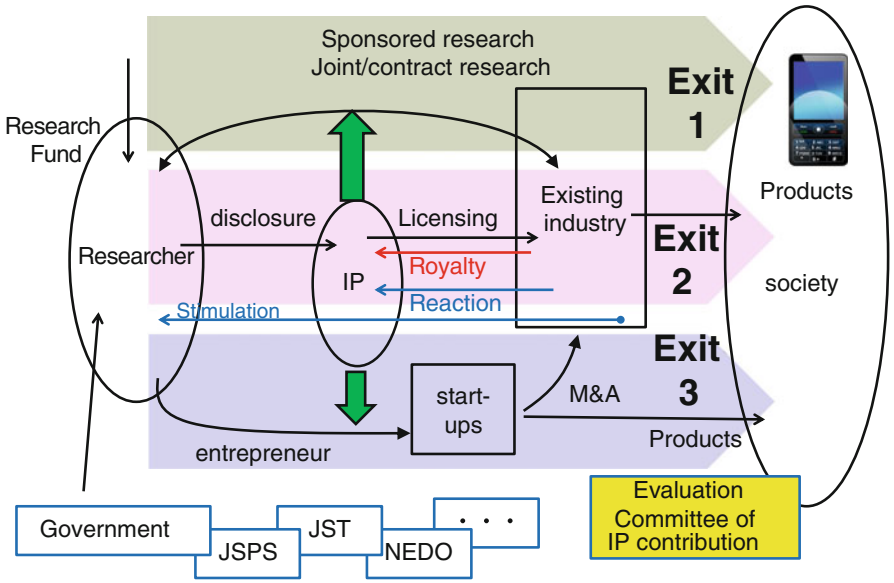


Fig. 1.10 IP for the benefit of society through three exits; joint research, licensing and start-ups

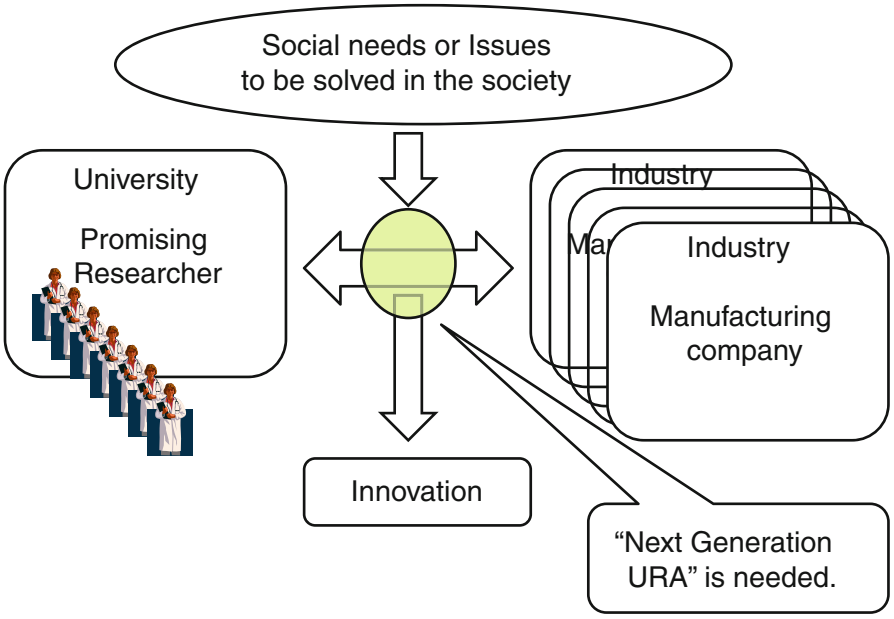


Fig. 1.11 Structure of creating innovation derived from university

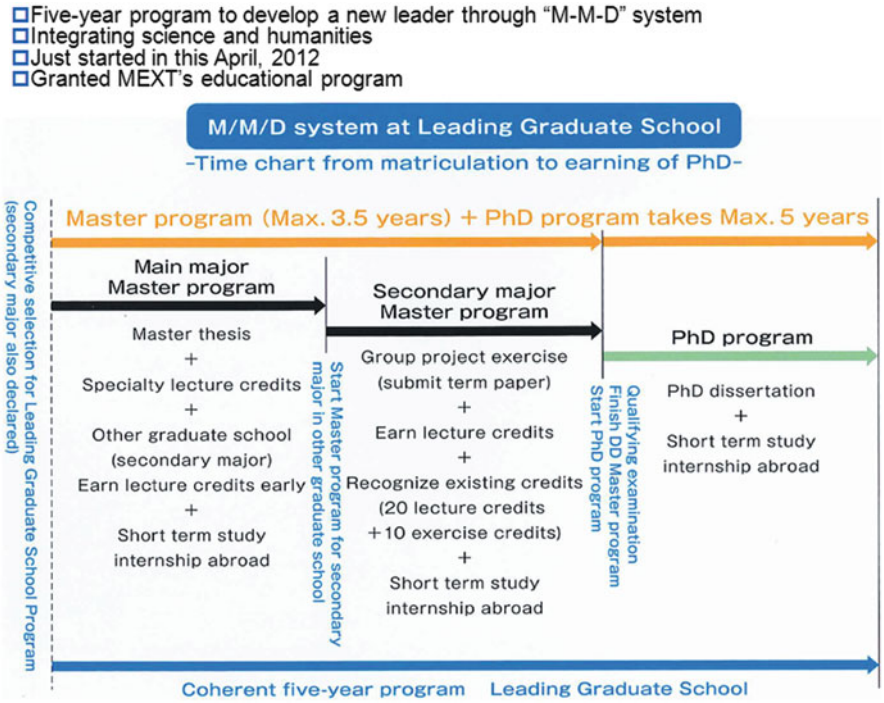


Fig. 1.12 Professional skill development—sample

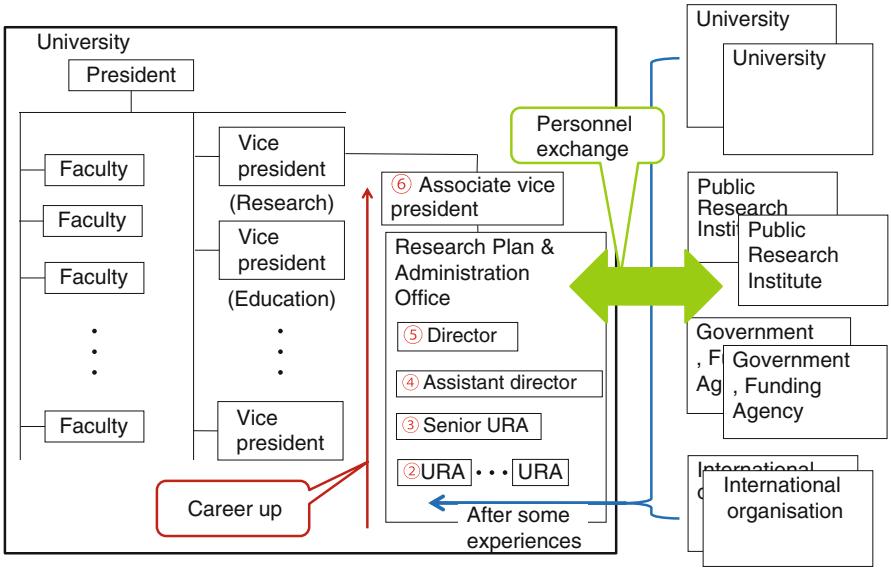


Fig. 1.13 One of the examples, "Next Generation URA"

At the university, he or she would fine-tune the outlook, planning ability, and international negotiations after interacting with a variety of people, organizations, other universities, and competitive funding agencies. In this circumstance, he or she would be expected to produce a new project tied to an invention which is a combination of the university's research results and industry's commercial ability based on societal needs.

Through his or her job, the third mission of the university "to return research results of university to society" would be carried out. It is our desire to foster innovation based on promising research results of a university on an outstanding level and he or she would enter the top of the research planning and administration office which supports the vice president responsible for the university's research.

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