

# The Role of Key Person and the Reform of Laboratory in Connecting R&D with Commercialization Concerning the Case of Tokuyama Corporation

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**Abstract** When the low growth starts since the first oil crises, the importance of the research and development section will be reestimated for a lot of chemical corporations in Japan. A new business isn't achieved easily if there is no cooperation with the research and development. To connect directly the research with the product development, the research and development section was put on the business section. As a result, the disorganization of Central Research Institute comes to be measured. And the ratio of the corporate research has decreased, too. Here is analyzed the history of the research and development of Tokuyama corp. The polysilicon business making of Tokuyama is the project of the planning initiative type.

The existence of the leader who can adopt the best investment is important; Yuuji Fujii of director in the planning division succeeded polysilicon business. He was both an engineer and a manager, and his standpoint worked effectively. This business has grown up as the center business of this company, and the second place in the world that follows the Hemlock Semiconductor Corporation in the polysilicon business for the semiconductor.

In the environment surrounding chemical corporations in Japan, the laboratory reform is strongly requested, too. In the new Fujisawa laboratory of Tokuyama corp., a past linear model was stopped, and the reform simultaneously moving two or more functions for new market creation was done. Takashi Yoshioka of a new head declared the five "Management ideas in the laboratory". He didn't adopt the bottom-up type but the top down type, where the cooperation of the R&D section and the business section was done from the beginning.

**Key words** R&D, chemical industry, the laboratory reform, polysilicon business, university-industry cooperation, leader's role, commercialization

## 1 Introduction

After World War II, chemical corporations in Japan started from the revival by the defeat and the pursuit to Europe and America by technology licensing-in. Many enterprises constructed large-scale equipment, and aimed at the cost reduction by economies of scale until the high growth period of the 1960's in Japan. These occupied the center of company activities. There were not so many things that the research and development becomes main activities.

The growth strategy till then was urged on a lot of chemical corporations in Japan. But they began to review it through the first oil crises in 1973, the environmental pollution issue, and measures for safety due to the fire accident of industrial complex.

As the low growth starts since the first oil crises, the importance of the research and development section will be reestimated for a lot of chemical corporations. It came to be demanded to the chemical corporation to develop a new business in the 70's. A new business from this time isn't achieved easily if there is no cooperation with the research and development. This is why the product development became complex, being different from the general-purpose goods development. To maintain and develop the business, the support of the research and development is requested.

Enterprises had collected the grade at various levels according to the customer requirement. As the demand standard to customer's product went up, impurities became problems in production. It came to be requested to raise purity to the limit to comply with a high spec. Therefore, each company expanded the research and development section. To connect directly the research with the product development, the research and development section was put on the business section. As a result, the disorganization of Central Research Institute comes to be measured. And the ratio of the corporate research has decreased, too. This is a change in the age from a past system of Central Research Institute to the business section research. The change in the research and development strategy is expressed.

When the history of the research and development of Tokuyama corp. was analyzed, this company

had done making to the business by its own technology of an existing chemical product. It was chiefly done before the first oil crises. "Oil crises and the mercury contamination shock put a brake on the past expansion route. At the same time, the research section changed from accessories into the hopeful section," Shikata former director of Tokuyama corp. is describing looking back at that time. The theme was decided from the search theme, and the linear model (R&D → manufacturing → market making) came to be done. In addition, the section of both project and research has cooperated at the start-up, and it has advanced to the system of promoting the business.

In the 90's it became the depression of Japanese economy, and the company could not help sparing a lot of resources of the research and development of its company for their continuance and the upgrade of a present business. On the other hand, contradiction arises, and the company also must do the research and development that will be connected in the new future. As a result, the conclusion that has been reached in the situation is "University- industry cooperation."

Its own research and development resource cannot be actually distributed though the importance of a new research and development is recognized enough. Moreover, many of the new business are the one special and difficult in relation to two or more fields. They often treat a boundary area, and corresponding by one alone became impossible. In that case, a coordinated other party is acceptable in not only "University" but also "government", and there are actually a lot of "Industry". Additionally, the financial institution is requested to participate in. As a result, many of chemical corporations have learnt the management technique of "University- industry cooperation". The method of successfully connecting becomes important for the enterprises.

It is analyzed how the system of the research and development of the chemical corporations in Japan has changed according to the passing of an era. But the system doesn't function only by management, the idea, and the system in order to make the theme from the research and development to a business finally. The existence of the strong key person who promotes R&D to a business is necessary. Moreover, the reform of the system of the Laboratory is paid to attention here.

## **2 From the R&D of Polysilicon to Commercialization**

Tokuyama corp. had consistently persisted in commercialization by the development of its own technology since it establishes. However, surviving as a chemical corporation in such a research system became difficult in the 80's. The top management of this company also had recognized that.

This company had done the business based on cement, the electrolysis soda, and the petrochemistry resin in those days. In the situation with the remaining influences of the first oil crises, they newly established the energy conservation promotion headquarters. And they made an effort to efficiency improvement and the reduction of energy in the factory. They grandly enhanced the home generation of electricity, and did strongly. But they felt a sense of crisis in the corporate structure where a large amount of energy was consumed. And they felt the necessity for making a new business that became a new pillar that would contribute in the future. This company had to begin to move aiming at the establishment of a new business.

On the other hand, in order to strengthen the system of the research and development, Tokuyama corp. constructed a new laboratory in the Kanagawa Prefecture Fujisawa city. They participated in the research project of the Ministry of International Trade and Industry in Japan, and sent the researcher to a domestic and foreign university. And various research activities were done there. Moreover, they newly found planning division in the research and development headquarters besides integrated policy planning office in the company. The reason was for the necessity for generalizing some foreign projects. The activity of the research and development had become various and complex, and had to manage various themes of the laboratory. An organization with the intention of strongly promoting the theme of the research project type had been requested.

Yuji Fujii assumed the position of planning manager as chief of the organization in March, 1979. It was when the hangover from oil crisis had healed a little. Many chemical corporations were seeking a new product to the growth field that became the pillar of new earnings for survival.

The research and development headquarters planning division had some new themes in the field of the dental material etc. However, a big theme that converted the constitution of the entire Tokuyama corp. did not exist, and there was nothing for the theme that would bear earnings of the company in the future. And Fujii of director of planning division felt the necessity for producing the theme that became the pillar of 10 billion large-scale yen. Therefore, to change the theme of the laboratory, Fujii with originally strong needs oriented aims had the chance of a positive discussion with the laboratory

members. However, the members with a strong seeds oriented aims did not change their opinions.

It reached the conclusion that it was impossible to change the researcher's consideration from the inside in a laboratory, while as much as one year did not pass since he assumed the position of planning manager. And Fujii himself intended to plan the business project. He thought that it was more reasonable for him to command directly to complete the project than he indirectly revolutionized the organization, enlightened the laboratory members, and changed their consideration.

And 15 members in total were gathered in December 21, 1981. Six people from planning division, and nine people in the manufacturing know-how, the research, and the patent information sections from Tokuyama factories were gathered centering on Fujii. At first, the theme has greatly extended to the field of electronic industry material and biotechnology, etc. They brainstormed among members, and selected some ones from many themes. And they made a team in groups of two, and investigated them. As a result of the investigation, they reported on the hopeful themes. After half a year, the theme to which Fujii had paid attention was one theme in the reported themes that produced polysilicon with Shirangas. However, this theme was not selected for the reasons that realizability wasn't easy as the theme. The theme of the polysilicon manufacturing seemed to be hard to achieve with a difficulty and a risk. It had difficult reasons such as the risk at the exchange change, the silicon cycle, and a possibility that the manufacturing cost was not suitable so that the cost of the electric power was high. At that time, the monocrystalline manufacturer was producing polycrystals by itself, too.

However, Fujii decided this theme at once. He had already raised three standards. They were "Business that becomes 10 billion yen scale," "the expanding business," "Business for which its own strong point can be made the best use of". Fujii thought that manufacturing polysilicon met these three requirements. However, all project members at that time opposed it from respects of difficult achievement, the risk, and the cost. Fujii's confidence of success was that Tokuyama was producing the most low-priced electricity in Japan in the home generation of electricity. This business produces a departure material of the semiconductor expected to expand in the future, and uses chlorine and hydrogen, etc., which Tokuyama factory is manufacturing and using.

He thought this business was a content of the chemical plant in the majority of the manufacturing process, and they were able to use its own knowhow and had the strong point very much. Then, Fujii cancelled all other themes, selected the members further and ordered the reinspection. After all, the project book was made after half a year, and Fujii faced the management conference. In the conference the opinion separated into the agreement and opposite, and the meeting becomes complicated. There were a lot of directors who opposed making to the business in the managing board, but Fujii repelled the dissenting opinion. It is said that he was quite reckless, saying that "There is no good one that all members agree".

SE-PJ (Silicon Establishment Project) started in June, 1981. It aimed at commercialization of polysilicon. The development of the processing technology of polysilicon was a start from zero for Tokuyama corp.. The technical problem that had to be got over in manufacturing polysilicon was the problem how to treat four chloridization Silang that came out in the polysilicon refinement process. Existing companies adopted the method that four chloridization Silang was burnt by the hydrogen gas and dry silica was manufactured. However, a strong patent existed in this method. Tokuyama had to solve the problem of treating this by-product by its own technology. The start of the project is from 1981, but the goal of commercial production was set in 1984 after three years. As for the project, a severe process of completing it within two years substantial was targeted, including the research, development, the design, production, and the order of customers. It was not possible to research by spending time enough for this target made a business in a short term. Moreover, it was necessary to fix the design data by the experiment, from which the range was limited. The development and experiments, and experiments and a basic design were advanced at the same time. In order to commercialize by the deadline, they proceeded two or more works at the same time. Manufacturing polysilicon was the work to make metallic silicon of about 98% the silicon of the purity of the eleven nine. A basic content of the process was a refinement in chemical manufacturing. Therefore, the analysis of impurities was important. In this project, they needed to develop the technology that made driving of the entire plant change flexibly according to demand. As for consuming a large amount of electric powers, the development of the technology that suppressed power cost greatly was needed, too.

The research and development was done by the severe schedule. Leader Fujii helped the subordinate to take a necessary device. And, so as not to cause the delay of the research and development by the financial deficit, he was managing it. This project was given in the silica processing as it is lucky. The beginning of the dry silica commercializing was discovered from the data that

researcher Yoshio Mitani might throw away as an experiment error. As a result of the effort in a painful research and development, the plant construction of the polysilicon 200t in the annual output, and the dry silica 500t was started in November, 1983, and completed in July, 1984. This project achieved the target of commercialization from the start-up of the project for four years, and from project beginning in two and a half years. At first in the operation of the plant, the troubles were consecutive, and they dealt with the problems. As soon as the supply began, the plant became full operation at once, and the second stage construction was planned in December. And the production of polysilicon reached 1000 tons in the annual output in August, 1985. Until 1000t plant construction was finished, the business went well. But the appreciation of the yen inducement by Plaza Accord and the Japan-U.S. semiconductor friction happened after this. In addition, the profit was not suitable for this business against the wave at the silicon cycle. As for the polysilicon plant of Tokuyama corp., the operation had stopped for about one year by these factors.

Fujii had demonstrated a strong lead, and the project was commercialized in a short term. However, it was not possible to act against the economic climate, the demand decrease, and the exchange market price. And the polysilicon business faced the crisis. It fell into such a situation, with the result that business promotor Fujii determined himself to undertake all the responsibilities. He retired from the director of Tokuyama corp., and left the company. After Fujii left the office, the semiconductor industry had recovered also demand and started growing up well, and polysilicon businesses of Tokuyama have expanded along with it. The company has reinforced production capacity of 1500t in 1991, 3300t in 1995, 4800t in 2001. This business has grown up as the center business of this company, and keeps developing afterwards. The polysilicon business has become the second place in the world that follows the Hemlock Semiconductor Corporation in the polysilicon business for the semiconductor.

### **3 The Reform of Laboratory**

The new Fujisawa laboratory of Tokuyama corp. was established for the purpose of promoting to accumulate of its own technology based on the research and development. In the mass production of general-purpose goods by the introduction of a foreign technology, it was difficult for the company to continue. A lot of chemical corporations had recognized the necessity for developing its own specific technology and creating new market. The society and the economical situation had been greatly changed since the first oil crises. The management style of the chemical corporations had changed greatly from mass production and the big sale. The actions against the sudden rise in the price of the raw material, the saving resource measures, the antipollution policy, and responsible concern for the environment, etc. were requested from the chemical corporations. However, a new product from the research and development in the laboratory did not appear easily. There was a sense of crisis in the chemical corporations in Japan, which might be attacked on three directions from the United States, Europe, and Asian enterprises that were recently gaining power.

As a result, to deal with the new situation, many of companies in Japan came to aim at the constitution conversion all together. While observing the movement of a rival enterprise, they chose the road to collecting many kinds of chemical products by the research and development. Tokuyama corp. also did similar movement, and the Fujisawa laboratory was established in such a trend.

To create a new business, Takashi Yoshioka who assumed the position of the head declared the five "Management ideas in the Fujisawa laboratory" in the Fujisawa laboratory. They were "We must use information over time and the space. Do not shut oneself up in the laboratory," "The research aims at the home run in a baseball game. Do not plug away like a bunt," "Commercialization must enter uniquely to a market with R&D results as the weapon. It is uninteresting for us only to imitate it," "Money mustn't be spared, providing you want to utilize an existing technology effectively. Time is money," "On the occasion of making to the business, don't stick to an independent business. It is an age of making the compound forms supplemented with strong points each other." Head Yoshioka denied a linear model of the development sequentially advanced to the basic research, the applied research, commercialization, and sales. The research and development of the Fujisawa laboratory was to advance a lot of actions at the same time; doing the development of basic technologies, the production technology development, the patent strategy, and the marketing strategy to promote the creation of a new market positively. The way of thinking in the Fujisawa laboratory was a rejection on the movement for the reconsideration of such a past laboratory. This policy is one example of indicating a direction of R&D and development and the laboratory in Japan at that time.

The research and development was done under such a policy in the Fujisawa laboratory, and

various new businesses were invented in cooperation with the project development department. The laboratory denied a past way of the bottom-up type in which the theme was determined from the search research, and changed the way to the top down type. The cooperation with the laboratory and the operation division is necessary for the success in the top down type. If the research and development division doesn't cooperate in the operation division, it won't become making to the business.

#### 4 Conclusion

The polysilicon business making of Tokuyama is the project of the planning initiative type. If there is a plan that the other companies cannot adopt when thinking about investment earnings, the existence of man who can demonstrate a strong lead and deeply understands the technology, and has a managerial sense, is necessary when tying from the research and development to making to the business. The existence of the leader who can adopt the best investment is important; he will overcome the difficulty in the presence, forecast future, make the best use of its own strong points, and turn on management resources. It is difficult to reach commercialization if the decision of the research, the development, and the management strategy is made separately. In the form that the organization and the person in charge are independent, partial optimization will be achieved. Each other come to conflict by the division of business, and it doesn't function well. It is necessary to be united in one person, who gives the decision making from all company viewpoints. In the meaning, Fujii in the polysilicon business making was both an engineer and a manager, and his standpoint worked effectively.

The polysilicon business is forced to shutdown by the change in an external environment that appreciation of the yen inducement by Plaza Accord, silicon cycle and Japan-U.S. semiconductor friction. However, growth was expected as for the semiconductor industry if it saw in a long tendency. He thought that he was sure to restart the polysilicon business, and to do the expansion development if time passed. It seems that Fujii who had such a conviction thought about leader's role, and left the company to take a present responsibility.

On the other hand, though the process from R&D to making to the business is difficult either, it is not to do spending long time. This is a case shown that the concentration in a short term is good. And he is worth bringing up a lot of talents through forcibly researching, developing and making to the business. The leader's existence, the management of a short-term concentration, and the great capital resources support, etc. are an important conditions in making of a new product a business.

From the change in environment surrounding chemical corporations in Japan, the laboratory reform had been strongly requested. In the Fujisawa laboratory, a past linear model (basic research → applied research → commercialization → sales) was stopped, and the reform simultaneously moving two or more functions (development of basic technologies, production technology development, patent strategy, and marketing strategy) for new market creation was done. The five "Management ideas in the laboratory" that Yoshioka in the position of a new head declared expresses it. They didn't adopt the bottom-up type but the top down type, where the cooperation of the R&D section and the business section was done from the beginning.

However, many enterprises have had to request the basic research from another organization such as universities by the change in such a research system. But the partner doesn't limit it to "University". Cooperation with various partners came to be needed in the complex product development that extends to two or more fields. And the companies have to connect many partners with the contract, and do two or more projects simultaneously and concurrently. Therefore, the ability of management to do them comes to be requested in addition to the accomplishment of R&D.

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