A Methodology for Archiving Technological Knowledge

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Abstract

There are signs of a trend towards passing down knowledge about past technological innovation to future generations. With this in mind, this paper proposes an approach for archiving technological knowledge based on a methodology of knowledge integration and creation which was developed in Japan Advanced Institute of Science and Technology. As a concrete example, the paper briefly introduces the archiving technique for technological innovation in a traditional craft industry in Japan.

Keywords: knowledge archive, technological innovation, traditional craft industry

1 Instructions

For the miraculous economic growth in Japan after the Second World War, the role of technological innovation has been very important [1]. Japan has got the position of a technology-oriented nation. More than half a century has passed since the war, and a huge number of technology developers who took part in the technological innovation have retired from active duty. This means that Japan has been losing much wisdom of forerunners.

A part of the wisdom of forerunners is saved by working papers or articles. But contents written in the working papers or the articles are small portion of the technological innovation. That is, there were various twists and turns that are not written in the working papers or the articles to lead technological innovation. It is important to pass the knowledge that is not written in the working papers and the articles to the future generations for technological innovation.

In recent years, there are signs of a trend towards collecting knowledge on technological innovation, and passing down it to the future generations [2], in the fields of optical industry [3], electric industry [4], steel industry [5, 6], traditional craft industry [7], etc.

However, they do not focus on methodology of collection and organization of the information about the past technological innovation. This paper suggests an archive development methodology to collect and organize the knowledge on technological innovation.

2 Knowledge Integration Methodology

When transferring experience in technological innovation of the 20th century to the 21st century, the problem of "what kind of data, information and knowledge to collect, organize and transmit" arises. In this paper we use a knowledge integration methodology called "the *i*-System" [8, 9] to the issue of collecting and organizing the information about the past technological innovation.

The *i*-System is a "methodology for synthesizing, integrating and creating knowledge", which integrates the "structure-capability paradigm of the West" and the "dialectic thinking of the East". It consists of the fronts of "cognitive-mental", "social-relational" and "scientific-actual". In each front there are actors with the capabilities of "intelligence", "imagination" and "involvement", respectively. The methodology unifies "Intervention" and "Integration"; the abilities of leaders and analysts to take action and to integrate their knowledge are inseparable (see Figure 1).

As shown in Figure 1, the *i*-System consists of five subsystems:

- *Intervention*: For a problem to face, it is considered to solve a problem (problem establishment) that what kind of knowledge is necessary. Then, three subsystems (Imagination, Involvement, Intelligence) are asked to collect those knowledge.
- *Imagination*: Personal feeling and experience for the problem create ideas and hints.
- *Involvement*: Situation of social and cultural

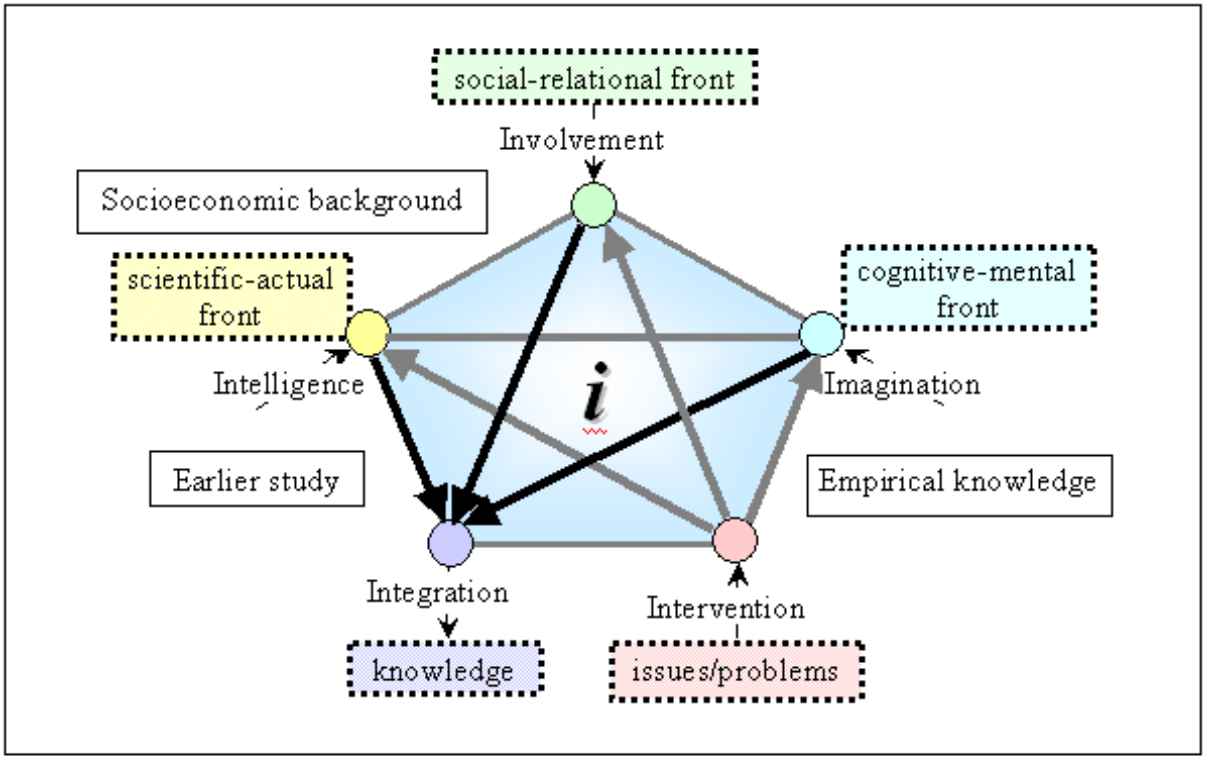

Figure 1. Conceptual diagram showing the *i*-System

background and opinions of people are collected by meeting and interview.

- *Intelligence*: Findings of scientific problems solving is created by an objective data collection and analysis.
- *Integration*: Findings of three capabilities (Imagination, Involvement, Intelligence) are integrated, and the result is evaluated

This paper proposes the methodology of collection and organization regarding the technological innovation of information based on the *i*-System.

3 Resource of Knowledge

We first investigate from what kind of resource we should collect knowledge with the use of the *i*-System. In the following three subsystems: Imagination, Involvement, Intelligence play a key role.

- *Intervention*: Here we collect information for problem establishment about the technological innovation.
- *Imagination*: We interview persons who have been involved in technical development for many years. They might tell us about what they have focused on while engaged in technical development, and their ideals and thoughts. This enables us to gather knowledge to carry out the technological innovation.
- *Involvement*: To obtain information about individual technological innovations, previous research and case examples are investigated through the use of literature and interviews with people involved in the industry. The mutual relationship between society and culture is also focused on.
- *Intelligence*: Here we collect information mainly from articles and working papers about the technological innovation. We collect and organize the information such as experiment contents or results.
- *Integration*: Here we summarize collected knowledge and information.

In each subsystem of the *i*-System, we considered above from what kind of resource we should collect knowledge. However, just clearing up the target is not enough to solve the problem of "what kind of data, information and knowledge to collect, organize and transmit, and how to go about it." That is to say, we have to investigate what kind of information we collect in each subsystem of the *i*-System.

4 Contents of Knowledge

For the case of archiving technological innovation in a traditional craft industry in Japan, we first carry out brain storming to look for concrete words. As a result of brain storming, 71 key-words were obtained in total. Table 1 shows the number of words in each subsystem.

Table 1. The number of keywords

Subsystem	The number of key-words
Intervention	16 words
Imagination	13 words
Involvement	15 words
Intelligence	12 words
Integration	15 words
Total	71 words

Then, we classified words obtained by brain storming with the KJ method [10]. According to the procedure of the KJ method, the close words are compiled in one place. We give a category name for the set of words collected in one place.

- In the subsystem Intervention, 16 words were divided into three categories. We named them "Spontaneous undertaking," "Requests from outside," and "Establishment of the problem." (see Table 2).
- In the subsystem Imagination, 13 words were divided into three categories. We named them "Hints/Ideas," "Difficulties," "Establishment of the problem." (see Table 3).
- In the subsystem Involvement, 15 words were divided into four categories. We named them "Budget," "Collaboration," "Industry situation," "Social/Cultural background." (see Table 4).
- In the subsystem Intelligence, 12 words were divided into three categories. We named them "Research content," "Research equipment," "Previous research." (see Table 5).
- In the subsystem Integration, 15 words were divided into five categories. We named them "Research results," "Discussion of results," "Evaluation," "Discontinuation," "Practical application." (see Table 6).

Table 2. Categories and words in Intervention

Category	Words
Spontaneous undertaking	・Aim ・Objectives ・Scientific information to be clarified by this research ・Mission ・Motivation ・The kind of product he wanted to develop
Requests from outside	・Needs/Requests ・Project ・Demand/Requests
Establishment of the problem	・Issues ・Improvements to be made ・Change of direction

Table 3. Categories and words in Imagination

Category	Words
Hints/Ideas	・Brainstorming to solve the problem ・Hints/ideas obtained for solving the problem ・Brainstorming to solve the problem
Difficulties	・Difficulties encountered ・Failures during the development process
Thoughts about research and development	・Thoughts and ideals (objectives) pertaining to the research ・Enthusiasm ・Changes in feelings during the research ・State of motivation ・Thoughts about carrying out the research

Table 4. Categories and words in Involvement

Category	Words
Budget	・Budget/Support ・Financial aid
Collaboration	・Collaborating companies/organizations/individuals ・Collaborating institutions / people involved ・Relationship with the production area
Industry situation	・Situation of the production area ・Situation of other production areas ・Financial situation
Social/Cultural background	・Social and cultural background of the research ・Trends

Table 5. Categories and words in Intelligence

Category	Words
Research content	・Types of tests carried out ・What he actually did ・Research method ・Improvement
Research equipment	・Special equipment used
Previous research	・Scientific information known up until now ・References ・Related research

Table 6. Categories and words in Integration

Category	Words
Research results	・Contents of presentation ・Results obtained through tests ・Discoveries ・Results created ・Achievements resulting from this research ・Influence of the research results
Discussion of results	・New issues raised by the tests ・Failures
Evaluation	・Outside evaluation of the results (production area) ・Self-evaluation
Discontinuation	・Discontinuation
Practical application	・Commercialization ・Transfer of technology ・Patents

5 Interview Survey

We carried out interview survey to technology developers based on the *i*-System in order to collect and organize technological knowledge.

The interview started with basic, easy questions pertaining to the person's personal history (number of years of work experience, job description, area of specialization), the trigger for starting the research, the production area's needs in terms of research, information on the production area and the flow of the research. It continued with questions that gradually zeroed in on the essence of the research-about ways of solving problems that arise, the situation in terms of

collaborators and cooperating organizations, the influence of research results on the production area, and thoughts about the research and changes in feelings at various stages. Questions tailored to each research project were added to these basic questions.

The subjects of the survey were eight people involved with technical development in the Kutani ware industry, who belonged to public organizations in Ishikawa Prefecture.

6 An Example of organizing knowledge

Part of result collection and organizing pertaining to knowledge of technological innovation in Kutani ware industry based on the *i*-System is shown in Figure 2 and Figure 3. Collection and organizing pertaining to knowledge of technological innovation is part of "the development of translucent porcelain" here.

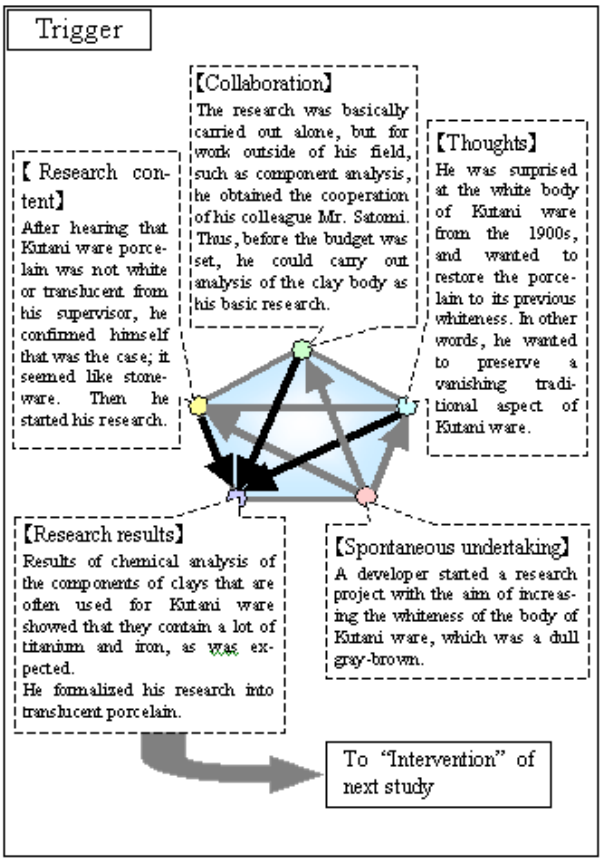

Figure 2. Trigger for development of translucent porcelain

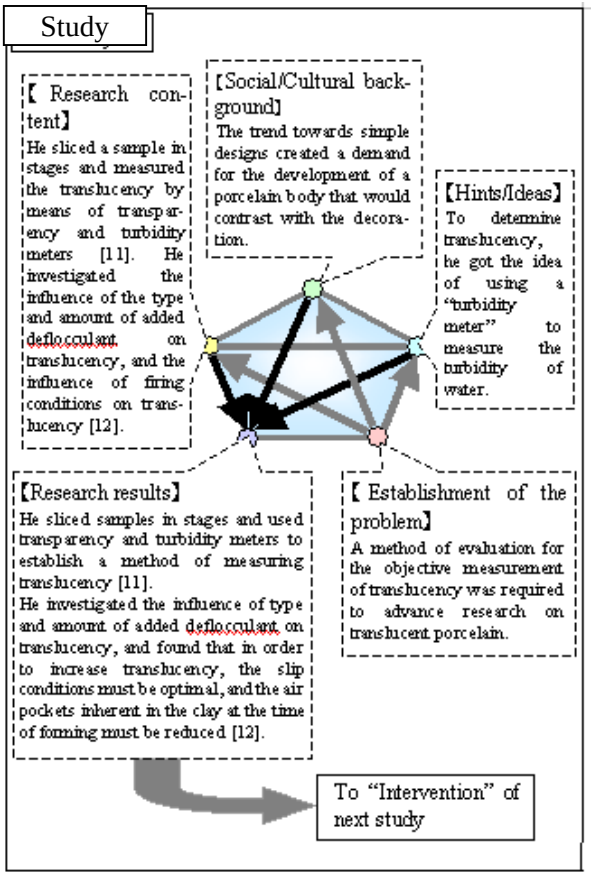

Figure 3. Research and development of translucent porcelain

7 Conclusion

There are signs of a trend towards passing down the knowledge about technological innovation to future generations. For this to develop a methodology of "what kind of knowledge to collect, and how to pass it down the generations" is very important. This paper applied the *i*-System to the issue of collecting and organizing the knowledge.

First, to let the *i*-System apply to this problem, we investigated from what kind of target we collect information and knowledge concretely. Second, in five subsystems of the *i*-System, we tried to find more concrete words for carrying out collection and organization of the information easily. As a result, it became easy to collect and organize the information about the technological innovation.

In the future, based on these findings, it is necessary to test the availability of this study by collecting and organizing information of the real technological innovation.

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