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RESEARCH NOTE

Succession of intuition and pertinent engineering experience in an ageing society with a low birth rate

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This study examines the process of passing pertinent experience and knowledge from experienced engineers to younger ones, especially in Japan, which has an ageing society with a low birth rate. This study addresses three issues: (1) the intuition of experienced engineers regarding the types of experience and knowledge that should be handed down; (2) 'Mixed method cycle', which enables productivity improvement and (3) 'Lifetime goal management', which enables younger engineers to acquire such knowledge. Current situations and problems need to be resolved; therefore, governments should create mechanisms beyond existing company constraints to facilitate the succession of intuition and pertinent engineering experience in an ageing society with a low birth rate.

Keywords: ageing society with a low birth rate; succession of intuition; mixed method cycle; lifetime goal management; interview; study group

Introduction

This study examines the process of passing pertinent experience and knowledge from experienced engineers to younger ones, especially in Japan, which has an ageing society with a low birth rate. Many experienced engineers are approaching the mandatory retirement age, and there will be a significant vacuum unless advanced knowledge, expertise and practical wisdom are transferred to younger engineers.

The reasoning for this belief is based on three aspects: (1) in 2012, many baby boomers[1] reached the retirement age of 60; however, accumulated technology had still not been effectively transferred to the younger generation, (2) according to the Fertility Society of Japan, succession has been insufficient and information has been forcefully and selectively transmitted and (3) to inherit the techniques of engineers above 65 years of age in Japan, it is necessary to establish and realize a retirement age of 65 years or higher. Given these circumstances, this study addresses two issues: (1) the intuition of experienced engineers in terms of the type of experience and knowledge that should be transferred and (2) the employment of methods that enable young engineers to acquire such knowledge.

Finally, it is widely known that the Japanese construction industry is primarily responsible for infrastructure in addition to the safety and security of the country. However, few studies have focused on the succession of knowledge in this field. Therefore, this study investigates such knowledge transfer in the Japanese construction industry and examines the issues involved in maintaining the succession of intuition.

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Current situation and problems

The combination of a low birth rate and ageing baby boomers has resulted in Japan being the country with the oldest population in the world. In addition, a significant portion of baby boomers are approaching the mandatory retirement age of 60 years. As a result, the issue of 2007 was not given serious thought. However, 2012 witnessed an alarming portion of baby boomers approaching their retirement age. Therefore, the transfer of pertinent experience and knowledge to their younger counterparts has become particularly important. The following subsections focus on the current situation in Japan as well as its related problems, which have remained mostly unresolved.

Currently, Japan has the world's oldest population. According to the Cabinet Office (2012), 20.1% of its population is above the age of 65. A significant characteristic of Japan's ageing rate is its speed. According to the Cabinet Office (2012), France, Sweden, Germany and the UK required 115, 85, 40 and 47 years, respectively, for the proportion of their elderly population to the total population to double from 7% to 14%. However, Japan took only 24 years, growing from 7.1% in 1970 to 14.1% in 1994. It is, however, estimated that South Korea's ageing rate is faster than that of Japan. The speed of ageing is mixed but ageing itself is a global trend. As shown in Figure 1, from 2020, the proportion of elderly people in Europe as well as Asia will rapidly increase. Japan's rapid ageing rate is primarily due to the combination of its low fertility rate and population longevity. In addition, it is estimated that the working-age population (15–64 years) will be halved in the next 50 years. According to Fujimura (2013), Japan's rapidly ageing society can be considered as a model.

In 2007, considerable attention was placed on the fact that baby boomers were approaching the age of 60, causing concern regarding possible labour shortages. However, the impact of the implemented measures was less than expected because

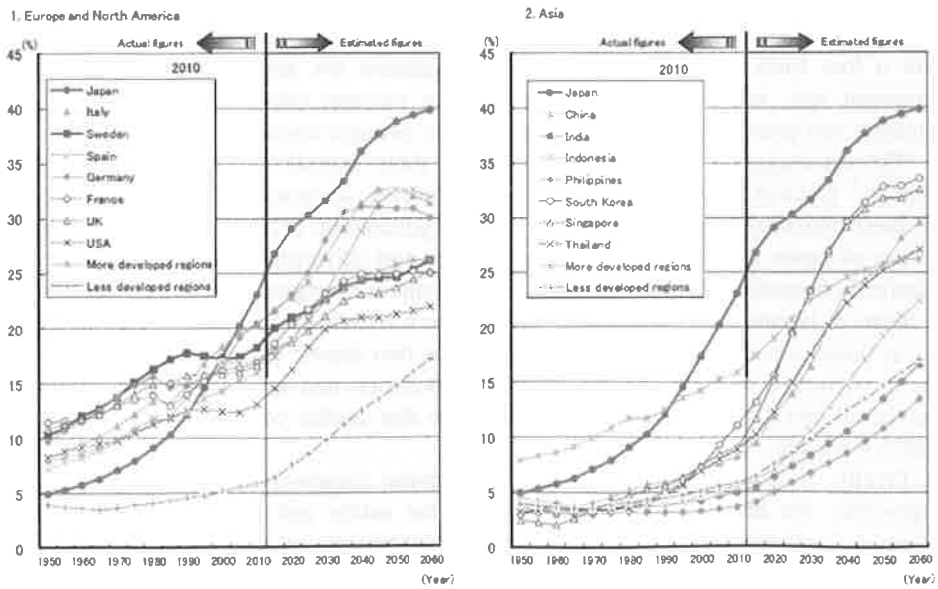

Figure 1. Ratio of ageing in the world.

Source: Cabinet Office Japan, Annual Report on the Aging Society, 2012.

companies had begun to increase the retirement age as well as expand the work extension and re-employment systems.

In April 2013, the revised Law for the Stabilization of Employment of the Aged was strongly criticized because of its interference with the employment of young people. However, such criticism was not necessarily accurate with regard to job-security measures for the elderly. According to Nabeta (2011), there are companies that continue to employ individuals after retirement, especially those with extensive work experience and pertinent skills. According to the Basic Survey on Wage Structure (Ministry of Health, Labour and Welfare 2010), annual wages totalled approximately JPY 4.5 million for the 60–64 age group as compared with approximately JPY 3 million for the 20–24 age group.

As seen in Figure 2, in terms of the number of employees under the age of 29, the construction industry witnessed a significantly greater decline as compared with other industries. In the under-24 age group, other industries witnessed a significant decline from 5.78 million people in 2006 to 4.75 million people in 2012 (18%). Furthermore, in the 25–29 age group, other industries witnessed a 14% decline from 6.62 million people in 2006 to 5.69 million people in 2012. However, the construction industry witnessed a 35% decline from 5.10 million in 2006 to 3.30 million in 2012.

In terms of the challenges, there are three major considerations. First, as seen in Figure 2, the attraction of construction industry-related employment has significantly declined, especially among the younger generation. This is perhaps because of the working conditions being portrayed as unhygienic and risky. More active promotion of the industry is required, especially in terms of employing younger workers. Second, busy experienced workers should dedicate themselves to provide the necessary high-quality guidance to their younger counterparts. Notably, tasks such as drafting and paperwork should not increase. The proportion of responsibility and technical accuracy has considerably increased with time, and experienced technicians are usually busy handling these tasks, thus having little time to provide technical guidance to young engineers. In addition, young engineers hesitate to interrupt because experienced engineers hurriedly

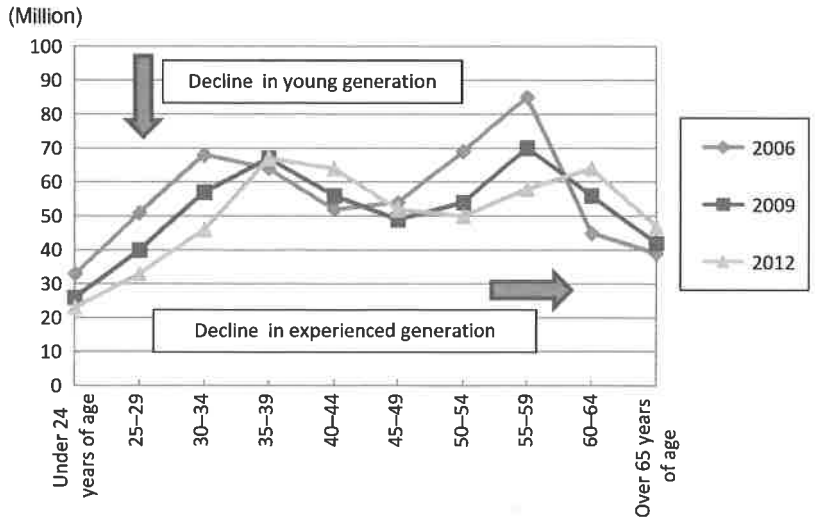

Figure 2. Employment by age group in the Japanese construction industry.
Source: Statistics Japan, Labour Force Survey, 2012.

provide guidance. This forms a vicious cycle of hesitant young engineers and busy experienced engineers. Third, it is important to have the entire workforce (both young and old) actively cooperating to maintain the succession of intuition. This aids in enhancing the skills of the younger workers as well as developing the technical prowess of the experienced workers.

According to Nonaka (2012), five aspects should be considered in terms of the efforts in 2007: (1) with experience, anyone can inherit knowledge; (2) with pertinent skills and the willingness to share them, anyone can support processes; (3) anyone can enthusiastically absorb knowledge; (4) anyone can think positively and support processes and (5) anyone can support the effort if they focus on enhancing the workplace. Although adherence to these five concepts can help maintain succession of intuition, it remains one of the most significant challenges.

Human-resource development is not solely dependent on experienced engineers. Promotion of succession of intuition must facilitate cooperation between experienced workers and their younger counterparts. In addition, experienced engineers must continuously transfer their knowledge and skills to facilitate the development of the younger generation, thereby creating an effective cycle enabling younger engineers to continue the process as they gain experience.

Concepts of intuition

With a declining rate of experienced engineers, the effective transfer of accumulated technology becomes difficult. In addition, the selectively conveying knowledge can also be complicated. Among all aspects of transfer, of particular importance is what is to be transferred in the world of technology, and according to Tips and Kang, the vital point[2] is the most important. Intuition is an ability that one acquires through training and experience. It forms the basis of ability in engineer's development. In this study, intuition[3] and its related concepts is the subject of focus.[4]

Researchers in the field of economics and business administration have focused on the concepts of intuition. According to Duggan (2010), there are two types of intuitions: professional (drawn by past experiences) and strategic (drawn by inspiration and creativity) intuitions. Koike (2005) states that intuition is related to intellectual skill and studies have begun to target intellectual skills, especially in terms of decision-making. Nonaka and Takeuchi (1996) propose formatting knowledge into explicit knowledge and tacit knowledge, which is knowledge based on experience and intuition, respectively.

In philosophy, Dreyfus and Dreyfus (1987) propose a technology-acquisition model, in which there are five stages ranging from beginner through expert. Michael Polanyi (1980) proposes the concept of tacit knowledge (tacit knowing), which is based on the concept by Nonaka and Takeuchi (1996). Both of these works grasp the concept of intuition through scientific discovery according to remote proximity.

In psychology, intuition deals with cognitive intuition, which includes cognitive psychology and cognitive science. Klein (1998) proposes the recognition-primed decision model, a decision-making model based on recognition, to reveal the process of decision-making in individuals. Intuition is composed of understanding and situational awareness. In other words, one must have the ability to understand without being conscious of the overall process. This concept was also the foundation of professional intuition advocated by Duggan (2010).

In education, the term 'intuition' has been used minimally, especially since it has not been researched as a serious concept. However, Ogura (1976) discusses the power of

intuition in mathematics. Although mathematics is a purely logical science, it actually requires a high level of intuition; this is supported by Ogura as well as the author of this study. In addition, the level of intuition in this particular discipline can be defined as the 'ability to simultaneously detect the problem, investigate its cause and solve the problem'.

Figure 3 presents an image of experienced engineers and their goals. As per the previous definition of intuition under education, experienced engineers can easily detect, investigate and solve a problem.

Figure 4 illustrates the range and level of intuition in terms of learning intuition by experience or by training. For example, L1 (preparation), L2 (connectability) and L3 (combinability) fall under 'learn intuition by training', while L4 (adaptability) and L5 (creativity) fall under 'learn intuition by experience'.

Figure 5 presents the level of intuition at which L1 does not fall under either of the ranges shown in Figure 4, as it is simply a preparation stage. Moreover, L2 and L3

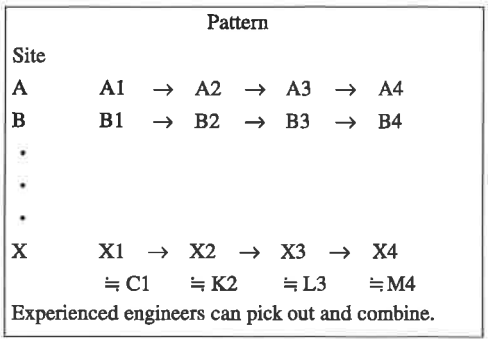

Figure 3. Image of experienced engineers.

Source: Succession of intuition study group from Hosei University, 2012.

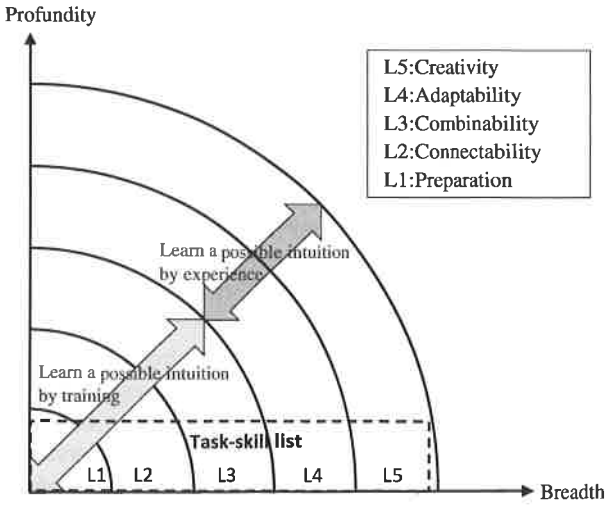

Figure 4. Level of intuition (1).

Source: Succession of intuition study group from Hosei University, 2012.

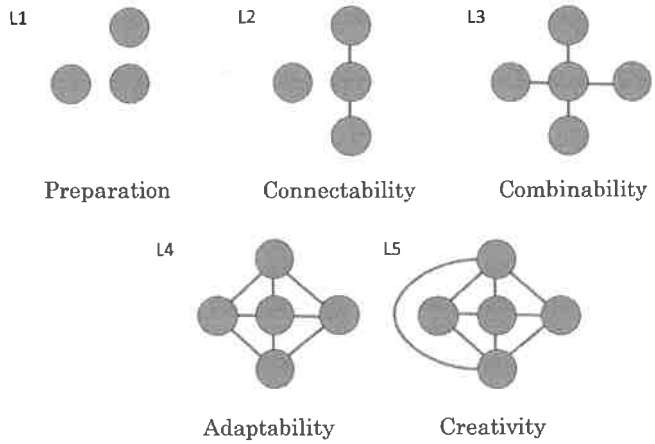

Figure 5. Level of intuition (2).

Source: Succession of intuition study group from Hosei University, 2012.

enhance the decision-making process, while in L4, the decisions are intuitively rearranged. Finally, in L5, new decisions are created.

Mixed method cycle

As shown in Figure 6, through the following five-part mixed method cycle, the intuition of experienced engineers can effectively be transferred to younger engineers:

(1) Task-skill list: It illustrates the procedure of a certain task.
(2) Keywords: It provides common recognition between experienced engineers and their younger colleagues.
(3) Case study: in which images of a particular scenario are presented.
(4) Case simulation: in which there is off-the-job training with experienced engineers to recognize intuitive skills.
(5) On-the-job training (OJT): in which younger engineers can gain experience and develop intuitive skills, as facilitated by experienced engineers.

Lesson skills analyse businesses on a daily basis and create a list of tasks; this has long been used as a tool for human-resource development in Japan. In the manufacturing field, it is a daily pursuit of improving efficiency in the workplace. Figure 7 introduces a task-skill list that is used for assembly work at several car-manufacturing companies.

The task-skill list primarily clarifies the responsibilities of each worker and visually confirms the current status of the organization. Effective management in the construction industry can be achieved by utilizing such lists since technology can be visualized through the use of charts and graphs. In addition, it helps engineers understand the so-called big picture, and the visualization contributes towards a mutual understanding between younger engineers and their experienced engineers.

As shown in Figure 8, the required items are classified into two categories: the importance of the lessons (①②) and importance of the work task (①). In terms of

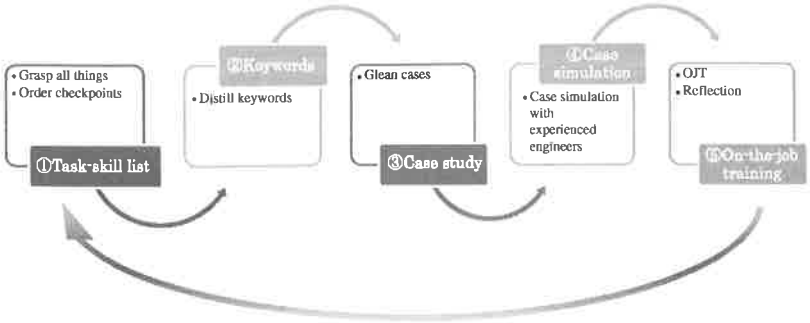

Figure 6. Mixed method cycle.

Source: Succession of intuition study group from Hosei University, 2012.

Name	Process of charge	Substitute	Learning situation (Process No.) EP	E1	E2	E3	M1	Development plan of all round skilled Oct.	Nov.	Dec.
Tanaka	EP	Oki								
Sato	E1	Yoshida								
Suzuki	E2	Kimura							E8	
Nakamura	M1	Yoshida,Yamashita								M6
Oki	Relief	—						E6	M8	E8R

Figure 7. Task-skill list.

Source: Sato, Fujimura and Yashiro, 2011.

Task-akill list Engineering department(Design) 「Detailed version for Rookies 」
Road detailed design

Assignment/ Head office Name/ A

Type of occupation : Engineering department (Road design), engineer

※Follow the flow

Work	Task	Detailed task	Category-weighting factor	Index: Priority 0.1~0.4 (Max 0.4)	Index: Level of achievement Level1~4(Max 4) 4 November 2010 A	Senior	Manager	Index: Level of achievement Level1~4(Max 4) 6 November 2011 A	Senior	Manager
Office work	Make out proposal	Out of considering for this level.								
	Prepare the order form	Follow the internal operations version.								
	Design planning	Design planning and examination of work priority based on the design criteria. ①Confirmation of business content. ②Confirmation of business overview,enforcement policy,business process,business organization planning and meeting planning. ③Planning to ensure the quality of deliverables. ④Confirmation of the design criteria books and reference. ⑤Confirmation of loan documents.	0.4	1	1	1	1	1	1	
	Examine materials	Make document to satisfy the specification. ①Confirmation of preliminary design and materials. ②Organize the results of the field survey. ③Based on the above documents, summarizes the questions or problems.	0.3	1	2	1	2	3	1	
Outside work	Field reconnaissance	Research in the field about lay of the land and related facility for road design. ①Confirmation of structure position, crossroads, alternated road road and drainage. ②Confirmation of geology, vegetation, land use situation and cultural assets.	0.2	1	2	1	2	2	2	

Figure 8. New task-skill list for construction industry.

Source: Succession of intuition study group from Hosei University, 2012.

achievement of work tasks (②), they range from 1 to 4, with 4 being the highest. Depending on the size of the organization, the evaluator alters the rating scale to provide an objective judgment. Such evaluation serves as a human-resource and communication tool between the management and their subordinates.

Figure 9 presents a skill analysis (technical version) to visualize the proficiency and expertise of technical personnel. Lesson skills, represented by the graph, can be utilized by each technician to establish long-range goals of up to a year. This serves as the basis for development as a well as a communication tool between experienced engineers and younger engineers.

Keywords help establish a common understanding between younger engineers and their experienced counterparts. As shown in Figure 10, there is the ongoing need to organize keywords used in day-to-day operations, which cannot be collected through data mining.

After examining the work-task skill lists and keywords, the work environment can be significantly enhanced and the risk of failure reduced. Furthermore, effective collaboration between younger engineers and experienced engineers is an important part of the process.

Lifetime-goal management

Appointing employees with a wealth of knowledge can effectively promote the development of younger employees. Allowing experienced workers to advise their young counterparts within the workplace will aid in such development. Examples of such a process in the manufacturing industry can be seen in three particular cases. First, according to the Nikkan Kogyo Shimbun (2012), the Gold Meister at the NTT Hometechno Corporation is a leader in technological development. With the goal of passing pertinent knowledge onto the next generation, the company hires experienced workers certified to oversee the process. Even after retirement, these experienced workers are re-employed for human-

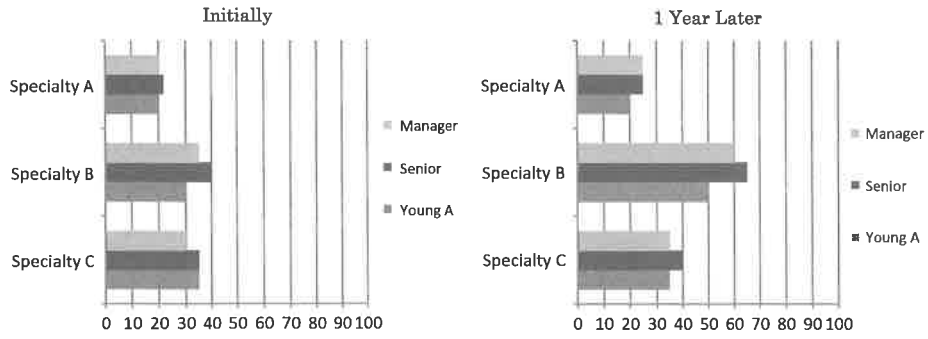

Figure 9. Skill analysis (technical version).

Source: Succession of intuition study group from Hosei University, 2012.

Topic words detection	Number of occurrences
mark	19607
blank	15841
common	1101
unknown	993
noun	567
particle	265
connection	218
stability	17
plan	139
road	98
strength	17
suffix	88
survey	81
verb	69

Topic words detection	Number of occurrences
agreement	31
schedule	29
month	28
line	28
section	27
conduct	27
vertical section	27
Heisei	27
width	17
salope	26
year	26
the nature of the soil	25
chief	22
name	24

Figure 10. Extraction words and number of occurrences.

Source: Succession of intuition study group from Hosei University, 2012.

resource development. Second, we consider the case of the established senior master system at the Nabeya Vitec Company. According to the Japan Organization for Employment of the Elderly and Persons with Disabilities (2012a), the system was created as a support mechanism in which experienced employees would be rehired after retirement to teach the younger generation. Third is the case of Suzuki Kako Company, according to the Japan Organization for Employment of the Elderly and Persons with Disabilities (2012b), in which an employment-support mechanism was established to combine work with education, especially in terms of acquiring skills from experienced employees.

Although the aforementioned cases have been relatively successful, such mechanisms in the construction industry are mostly honorary and limited. Even in companies such as Gold Meister, the system is not directly related to the employment of experienced workers. However, in 2009, the Tobishima Corporation established a system in which technology officers provide support and skills to employees to enhance the efficiency of field operations. These officers, who are at least 50 years of age, are appointed on the basis of their experience and knowledge. This system differs from that in other companies as it focuses primarily on technical capabilities.

Conclusion

This study examined the Japanese situation in which the transfer of pertinent experience and knowledge from experienced engineers to their younger counterparts has become affected because of the ageing society. To facilitate the succession of intuition, there is the need to create an effective mechanism for such knowledge transfer in which all parties are involved. Despite the several examples indicating that an effective mechanism has been established to train younger workers, this system has not become widespread in the industry.

For such a system to expand, it is important for top management to realize that such a mechanism can provide the following positive results: (1) it can intentionally develop the skills of younger workers while providing a sense of mission for experienced employees, (2) it can provide the necessary high-quality experience for younger workers and develop their work experience and (3) it can enhance overall capacity development.

Implication

Current situations and problems need to be resolved; therefore, governments should create mechanisms beyond existing company constraints to facilitate the succession of intuition and pertinent engineering experience in an ageing society with a low birth rate. I aim to create a society that enables active service throughout our lives in the next century. That means to create a 'place' to realize the smooth succession of intuition, where opportunities for young engineers and experienced engineers can coexist. To create such a place requires governmental-policy support. Regardless of the frame of the company, when young engineers and experienced ones come together, absorbing the thinking and mindset of the experienced engineers should be a goal for the novice engineers. To do so requires sufficient time to interact with experienced engineers. Further, in order to overcome the status quo, the promotion of (1) concepts of 'intuition', (2) a mixed method cycle and (3) lifetime-goal management is essential, and they have become the basis for succession of intuition in this field. The term 'intuition' is defined as the ability to simultaneously engage in problem detection, causal investigation and problem-solving.

In concept, this type of knowledge develops as a system of intuition. Experienced engineers are distinguished by this capacity. This is the ability to be handed down to younger engineers. It can be considered as a method of communication drawn from a mixed method cycle, which consists of five knowledge streams: (1) task-skill lists, (2) keywords, (3) case studies, (4) case simulations and (5) OJT. Experienced engineers are essential to the circulation of this methodology. In particular, the role of experienced engineers is significant in teaching through case simulations and OJT. Prolonging the time novice engineers spend with experienced engineers is important. Spending more time with experienced engineers effectively facilitates the formation of professional intuition through the synergy of working together. For the succession of intuition, experienced engineers must be ensured a continued work life through lifelong goal management. Experienced engineers must be an attractive symbolic presence for younger engineers. In addition, there is a need for novice engineers to have a goal to become seasoned professionals, so that they strive to educate themselves. Because technology is a source of competitiveness, the tendency of the majority is to stay at only one company. However, there are many techniques that have been accumulated in the period of rapid economic growth in Japan. The wealth of professional intuition is stored in the elderly experienced engineers who have worked in many companies who could be enlisted to create forums for young engineers and experienced engineers to spend time with them as an effective means to teach the succession of intuition. This is exactly the type of policy that the country should be pushing for.

Notes

1. According to the US Census Bureau, a baby boomer is a person who was born during the demographic post-Second World War baby boom, between 1946 and 1964.
2. The vital point, in some circumstances, is demonstrated when faced with a decision. It is sometimes expressed as an intuition.
3. Rather than being the results of thinking, judgment and reasoning, the effect of the spirit to grasp the intellectual is the target. This is often confused with intuition.
4. In the study group at the Hosei University Graduate School of Human Resources Development Institute, this concept is one that has been studied in collaboration with the company.

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