Serendipity Management Model for Technology Companies

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Abstract—This paper aims to present a management model to promote serendipity in technology companies. First, we analyzed six cases of serendipity that had been collected over two years of participatory observation in a Japanese technology company. Evaluating each case from the point of view of collaborative activities, it is revealed that the key factors are different according to the type of serendipity (pseudo or true). For pseudo-serendipity, “loose communication” or “informal exchanges among engineers having similar background knowledge” is important. Meanwhile, for true serendipity, it is desirable to show the element technology that is the result of pseudo-serendipity to a “gatekeeper” operating in subsystems or system hierarchy, and to promote collaborative activities around him/her at its center. A management model that encourages and promotes serendipity based on these factual findings is presented, as well as considering a strategy for effective and successful collaborative activities for gatekeepers.

I. INTRODUCTION

Companies aiming at growing and competing in the forefront of international competition need to create their own new products and businesses. This is especially true for technology companies. Strategies that were once successful at helping a company take the lead, such as improving manufacturing technique and technical approximation, are no longer effective. Companies need to learn how to create innovative new products and businesses using their own potential technology to aid their growth.

How then, should the technology companies address this issue? First, there is the use of marketing methods. Researchers have sought for the most desirable way of marketing for technology companies. von Hippel [17], for example, studied an example of developing new products in cooperation with lead-users who went a step ahead of the latest needs to create new products or solutions. However, there is a point where expressing needs is difficult even for lead-users [15]. Furthermore, there was a concern that the idea of “needs oriented” production, which was the basis of marketing, would no longer be valid in the advanced technology society [12]. The method of marketing based on needs-orientation has its own limitations.

The second method introduced was technology-leading creation of customers [12]. Customers cannot imagine what they want in the advanced technology society. Engineers, however, are in the position where they can create new technologic products that will meet interests and needs of customers in the future. Customer creation means that engineers, viewing the trend of the world and technology together, offer customers new life opportunities based on new technology. One of the examples is the latest personal mobile assistant. Generally speaking, however, engineers are not effective at creating life opportunities. The problems include determining how to propose the measures for supporting this customer creation by engineers and how to train “new” engineers who can create life opportunities.

The third method studied was the use of serendipity. Serendipity means leading an accidental encounter to some invention or discovery, sometimes by interpreting data from a different point of view. At the technology company’s site where trial and error is conducted every day, there are chances for engineers to have accidental encounters. By leading these accidental encounters to inventions or discoveries, they could find a new objective, a seed for unprecedented epoch-making products and businesses. If serendipity can be promoted effectively, it will be a valuable strategy to help technology companies to become front-runners. Now, let’s review the precedent studies on serendipity, including discovery research, practical use, and support of serendipity in a technology company.

To begin with, it is necessary to understand that there are two types of serendipity [13]. One is called pseudo-serendipity, which is the chance to discover what was being sought. The other is called true serendipity, which refers to a discovery made by chance of something that was never considered before.

Examples of pseudo-serendipity are the discoveries of new materials and new drug candidates. By reviewing case studies dealing with the discovery of new materials and new drug candidates [5, 6, 14], we can identify the important factors in the processes to the serendipity. It is important when setting assumptions and considerations, “to stick to your hypotheses and ideas” [5, 6, 14], and “to deepen the insights for the accidental and unexpected results” [5, 6]. In addition, when conducting experiments, it is also clear that “trial and error free from the established theory and emphasizing your own hypothesis and experience” [5, 6] is important in researchers’ behavior. It can be said that hypotheses of researchers’ or engineers’ own, as well as trial and error behavior, are important for pseudo-serendipity.

True serendipity, on the other hand, can be said to include a conceptual change, which leads to an unexpected result. This conceptual-change-approach, which doesn’t assume any specific goal, is considered to be effective in creating targets for unprecedented products and businesses, which was a key concern throughout this study. Regarding conceptual change, Dunbar [4] showed by participatory observation on-line, that communication among researchers played an important role in generating hypotheses and collaborative activities. Ueda & Niwa [16], through case studies on past
Serendipity, thus, has been studied, mainly regarding its process of occurrence and important factors for it. Studies from the point of supporting serendipity occurrence have been started recently. Cunha and others [3] tried extracting important factors from the aspect of organizational learning. Andre and others [2] examined the ways of supporting serendipity from the aspect of surroundings of it. McCay-Peet & Toms [11] tried extracting conditions that 'facilitated' serendipity and considered about the ‘trigger’ that was the starting point of serendipity. However, there has not been done enough research on the measures to encourage serendipity in technology companies from the practical point of view, especially with a focus on the importance of practical support management. Itaya & Niwa [7, 8, 9] proposed Discovery-Site-Leading Management, which promotes discovery-oriented intentions of researchers in exploratory research fields and tried to validate its effect by experiments in technology companies. Although it has been one of the preferred studies on serendipity in technology companies, it deals with only scientific and technological discoveries as the object of its empirical research and the range of its suggestion and discussion is limited to pseudo-serendipity.

In order to elicit management that supports serendipity comprehensively in technology companies, it is important to investigate empirically the relation between serendipity of both types. Additionally, a thorough investigation of different management approaches to the generation of serendipity in technology companies provides a deeper analysis of the factors that impact serendipity, as well as exploratory discussions of methods that encourage serendipity.

In this study, the authors, aiming to demonstrate a management model to promote occurrence and application of serendipity in technology companies, investigated several cases of serendipity in a Japanese leading technology company through interviews and participatory observation for two years. After classifying the two types of serendipity, exploratory analysis for each case was done with collaborative activities as a framework, important factors for serendipity were extracted and a hypothetical management model was presented.

II. METHODS

In this study, participatory observations were conducted in one of the major Japanese technology companies belonging to the manufacturing sector, with more than 3,000 billion yen in capital size (alone), employees numbering over 30 thousand (alone), and with annual sales of 3 trillion yen or more. The cooperation for participatory observation was obtained from a laboratory in the material field in this company’s Central Research Center. In this laboratory, research and discovery of materials are undertaken to break through the limitation of conventional semiconductor devices, or to revolutionize material properties using nanotechnology. From January 2009 through December 2010, one of the authors stayed there for two years as a staff member in charge of work restructuring. He was permitted to participate in the meetings, and to make complementary interviews, as well as observe the process of serendipity centering on collaborative activities among researchers. Before the participatory observation, researchers and leaders were interviewed regarding their current research topic, frequency of meetings, communication partners for collaborative activities, and the quality of their meetings.

Table 1 shows the attributes of the teams for the participatory observation. The author attended the meetings as often as possible and recorded the reports and information exchanged there. While staying at the laboratory, when he had a chance to get information about what could be inferred to be a case of serendipity, interviews were set with relevant members. Researchers may not remember each stage of concept formation and conceptual change [4]. Therefore, the interviews were conducted as soon as possible, approximately within a month after the serendipity occurred. The interviews were performed by semi-structured interview method. Furthermore, in order to improve the reliability of the data, we referred to the researchers’ notes and memos confirming the consistency of the results. The results of the survey data were analyzed with the methodology that Yin [18] carried out. From the survey data, filed in text, we extracted the key data regarding the exchanged information, assumptions and proposals (narrative), coded them and analyzed them to clarify the relationship between serendipity process and management factors.
III. RESULTS OF PARTICIPANT OBSERVATION

A. Overview of the cases of serendipity

Table 2 lists the cases of serendipity collected and categorized into true or pseudo type and related data are also shown. Within the observation period, six cases were obtained. According to the definition by Roberts [13], three were classified into pseudo-serendipity, and the remaining three were into true. Collaborative activities observed here involved two examples of conversations with colleagues and four cases of information exchanges with the persons belonging to the operation division or group companies. In these four cases, both formal and informal information exchanges were observed.

In the cases of pseudo-serendipity classified to the case 1 and 2, team members were participating in generation of serendipity. In the case 3, the leader of another laboratory and a member of the operation division development department were involved. On the other hand, in true serendipity cases classified to the case 4 through 6, the leader in charge of the team was involved in the serendipity in all cases. Furthermore, one characteristic is that there involved were the attendees of senior positions, such as a leader of the operation division or the group company, a fellow, and the manager.

B. Case details

The following describes the approach to the occurrence of serendipity in each case by narrative segments and its related description of the narrative sections is also involved.

Case 1 (team A):

Mr. A1, whose target was to realize a unique material with nano-structure for wiring of semiconductor devices, had not succeeded in making even material itself, not to mention targeted nano-structure at that time. Most of all experiments he tried resulted in failure. He told that the clue to the discovery of an effective process was information exchanges with one of his colleagues, Mr. A2, who was also tackling experiments under different conditions. Mr. A1 said, "We were discussing mutually almost everyday, asking how the result of yesterday was, or saying it was like this under such conditions and so on". One day, Mr. A2 mentioned his conditions to Mr. A1, saying, "I am able to grow the material for the purpose of 'growing' itself under any conditions." For Mr. A1, who had been aiming at low power conditions as possible, Mr. A2's conditions seemed strangely different. He, adhering to low power conditions, said, "Mr. A2's method and conditions looked like to be 'retreat', not 'advance' but 'retreat' for me." "Although there was a conflict, "Mr. A1 said, "A change of perspective happened on me then. An idea came to me of raising power for a moment only at the beginning for carrying out 'seed' attachment. Then, after that, we should grow them beautifully under low power condition." Finally, this change of perspective resulted in the discovery of an effective process for a targeted nano-structure for wiring of semiconductor devices.

Case 2 (team B):

Mr. B1, whose target was to realize the amplifier with environmental free material was devoted himself to and deadlocked at the elucidation of the mechanism of an anomalous unstable phenomenon. Mr. B2, one of his coworkers, was advancing his research to Mr. B1 who suspected the cause of heat paying. Mr. B2 wrestled with attention to a behavior of the electron of a high energy state
which was a completely different hypothesis. Mr. B1 said, "Mr. B2 suggested me, 'the effective action could be same in the stage of a trigger whether by the heat or by a high energy electron state,' and then, the change of the perspective arose." He continued, "Basic assumption itself remained as it was, and if I think that the electron of a high energy state bears the first trigger, while it was primitive, but I found that it proved to be effectively explanation for the anomalous unstable phenomenon of an amplifier." It has resulted in the discovery of the first stage mechanism of the anomalous unstable phenomenon acting as the obstacle for applying to amplifier with environmental free material.

Case 3 (team B):
For Mr. B1 and Mr. B2, who had continued research of the amplifier by environmental free material, although the elucidation of the first stage mechanism for causes of an anomalous unstable phenomenon was progressing, the complete elucidation was still in the mist. Guessing two persons' such situation of impasse, the leader set up the meeting for informal information exchange with the researcher of a leader class of other laboratory engaged in research and development of similar technology, and the researcher of a development department of operation division. They went to hear it and they received "it may be subsided when measurement is changed. Do you come to measure?" Although, instability was not able to be controlled when re-measured based on advice, it came to obtain change of a new viewpoint. It has resulted in discovery of the synthetic model explaining an unstable phenomenon by narrowing down to the mechanism which may be influenced by measurement environment and advancing search.

Case 4 (team B):
The serendipity in this case was occurred at the meeting (set up for another purpose) for exchanging information regarding the amplifier by environmental free material. Mr. B1 who was present with leader L2 was performing the presentation about the anomalous unstable phenomenon generated when an amplifier was tried to be fabricated with the environmental free material, which has become clear by then, and the elucidation of the mechanism. It was a time of addressing the mechanism of unstable phenomenon generating which he traced "Whether do heat and the electron of a high energy state serve as a 'trigger', and it is generating either the wave which goes back and forth in the material, or vibration." Mr. G2, one of the members of the development department in the operation division, who was an expert of the surrounding subsystem of the amplifier, said, "It is interesting. When using the wave and vibration, was not an amplifier but another function realizable?" Furthermore, Mr. GL1, a leader of the development department in the operation division who was engaged in the system layer, and good at the technology trend or customer needs in this field said, "all the radio functions may be able to be realized rather than substitution of some of element functions by this environmental free material. Of course, discussion for the marginal of performance is required. Whichever it makes, this is likely to become an epoch-making radio system." It was the moment that the unexpected idea and assumption generated.

Case 5 (team C):
The place where this case of serendipity occurred was set up as a formal one in which even the director of the research center and a division vice president attended. Leader L2 was reporting the research topic of an organic material by Team C as a planned presentation. Mr. GF1, a fellow of the department who took charge of the card business, said, "It is interesting. Regarding the chip put into a card in our business, there are several technological problems to be solved, and this technology is likely to become a key for the solution." The discussion was carried over at the social gathering at the night of the day. Leader L2 said, "This technology could effectively enable to integrate multiple-devices into one chip module. Can't it be helpful for your chips?" Mr. GF1 replied with a disagreeable attitude, "Gathering chips could make it easy to carry out an alteration to improper use." Then, Mr. L2 proposed, "If our material (… omitted…) is well spread around in a card with our original process, it might look like one chip." Mr. GF1 said with an excitement, "That sounds good. It is likely to become an epoch-making card system in which both security and individual setting functions could be realized at the same time. Why don’t we have a further discussion for details with the expert engineers?" It was the moment of serendipity was born. There conceived was a proposal of a new technology that realized both security and new functions together, starting with a researchers’ report.

Case 6 (team C):
This case was occurred at the development department of subsidiary where the energy saving home electronics are developed. In order to share the technology road map of related issues, leader L2 visited the subsidiary, and had a presentation of the technical outline of products by team C. Leader L2 pointed out a possibility of applying an organic material developed by Team C for the miniaturization of the apparatus aiming energy saving. The scene was then shifted to free information exchanges. Mr. GR1, senior manager of the development department of the subsidiary, said, "(Your proposal) sounds interesting, but isn’t it possible, Mr. L2, … I mean I’d like just to know if it’s possible in the future…” He, then, asked if the unique function his team was aiming for a certain kind of home electronic appliance could be improved by this technology. Although his idea was a leap in itself, before Mr. L2 answered, Mr. GR2, senior manager of another development department of the subsidiary division, said, "Interesting. Not only improving its original static function
but also changing that static function to moving one, like following a person as he/she moves, means that we could offer a totally new added value, doesn’t it?” Information exchanges for the purpose of sharing a technology road map unexpectedly induced the idea of an epoch-making energy-saving household electric appliance.

IV. DISCUSSIONS

In this chapter, we performed an exploratory analysis for occurrence of serendipity. Further, important factors making management which promotes serendipity were extracted, and the management model based on these findings was presented.

A. Findings and important factors

From the case 1 to case 3, which were categorized as pseudo-serendipity, it was a key to serendipity to have resolved the impasse which was induced through the trial and error based on his hypothesis and model by change of perspective or remediation of the hypothesis. It is possible to say that collaborative activities gave this change of perspective and a "clue" to the remediation of the hypothesis rather than having played a positive role. It also shows the validity of a characteristic element, "loose communication," in the management model which Itaya & Niwa (2007, 2009, 2011,) presented. Furthermore, in this research, it became clear as a new fact that urging positively "informal exchanges among engineers who has close background knowledge" was also effective in order to resolve an impasse. On the other hand, in the case of true-serendipity which was observed in the case 4 to the case 6, positive collaborative activities were performed with high frequency. Focusing on the feature of the persons concerned with the collaborative activities, performed as one of the coding, we can see the fact that there involved were the attendees of senior positions, such as a leader who keeps the team, a leader of the development department, a fellow, and the manager, rather than the members directly engaged in the research. Below, analysis and discussion are deepened by making an additional framework of a hierarchy (it being systematic) of a technical field in which the persons concerned are engaged.

Introduction of the element technology as a result of the pseudo-serendipity serves as a starting point. The “feeling of excitement” to the new-born discovery stimulates intellectual excitement of the attendees who engaging in a subsystem or a system hierarchy, and could lead to occurrence of the provisional “temporary idea” in a subsystem hierarchy. This temporary idea serves as a step to the leap to conceptual breakthrough in the system hierarchy, which, further, could cause serendipity. In this process, the intention that such a leap is more important than precise technical judgment is crucial, and in some cases, it could be a key to the breakthrough to misunderstand the effect of the element technology, or to be tolerant to the uncertainty of the realization of it.

The attendees of a senior position who bear a big role in the collaborative activities in true-serendipity occurrence turn out to contribute as something like a gatekeeper Allen [1] recited, rather than to demonstrate leadership as a manager representing the mission [10]. While they recognize the present technology’s limits and problems correctly as a node of communication in their field of technology, they lead the collaborative activities to make the maximum of the emerging innovative element technology. In this process, it is considered that changes of hypothetical constraints of condition are made with high frequency. Furthermore, it is also the feature of this process that they give a loose recognition of regarding that serendipity as important.

B. Proposal of a serendipity management model

The management model based on the important factors extracted from the findings above, which promotes serendipity in technology companies, is proposed as shown in Fig. 1. In this model, collaborative activities are set as the object of management. First, the target technology should be judged in which stage it is. When it is in the stage of element technology targeting pseudo-serendipity, we should keep the atmosphere that promotes “loose communications” with colleagues and promote “informal exchanges” with other engineers who have close background knowledge, based on the management model that Itaya & Niwa [7, 8, 9] showed. If the element technology is judged to have reached the stage of pseudo-serendipity, it is desirable for us to share that information positively as a “seed” of true serendipity. In this case, it is more desirable to exchange information with “gatekeepers” operating in subsystems or system hierarchy rather than with the engineers engaging in the element technology with close background knowledge. Even without the proper gatekeeper, though, the following guidelines could make it possible to cover for the functions of a gatekeeper toward true serendipity in collaborative activities with the engineers working on a subsystem and a system hierarchy; 1) to lay more emphasis on a leap of imagination than precise technical judgment, 2) to be tolerant to misunderstanding element technology or to the uncertainty of realization, 3) to permit changes of various constraints against generating ideas, 4) to respect the serendipity, when once occurs.
V. CONCLUSION

This paper aims to propose a management model to promote occurrence of serendipity in technology companies. First, we investigated and analyzed the cases of serendipity by two years of participatory observation in a Japanese technology company. Analysis of the six cases collected from the point of view of collaborative activities revealed that the key factors were different according to the types (pseudo or true) of serendipity. For pseudo-serendipity, "loose communication" and "informal exchanges among engineers having similar background knowledge" is important. Meanwhile, for true serendipity, it proved to be desirable to show the element technology, which is the results of pseudo-serendipity, to a "gatekeeper" operating in subsystems or system hierarchy, and to promote collaborative activities centering on the gatekeeper. A management model prompting occurrence of serendipity based in these factual findings was presented, and also proposed was the strategy to replace the functions of gatekeeper to collaborative activities with following guidelines;

1) to lay more emphasis on a leap of imagination than precise technical judgment,
2) to be tolerant to misunderstanding element technology or to the uncertainty of realization,
3) to permit changes of various constraints against generating ideas,
4) to respect the serendipity, when once occurred,

The contribution of this study is that the process of the serendipity occurred in the research site of technology companies which has seldom been clarified before was investigated in an exploratory way by participatory observation, and that a management model which supports the occurrence of serendipity was proposed from a practical viewpoint. It is desirable that managers and leaders of technology companies support serendipity occurrence effectively on the basis of this management model, which could be a seed to a new product or a new business. In this research, however, it should be remarked that its objective fields for investigation were limited to the material research and that its viewpoint was chiefly focused on collaborative activities. Other important factors should be extracted for other technology fields and other viewpoints. Moreover, at present, the effect of the management model has not been proved yet. Further investigation and analysis for the general validity of the management model and systematization of its important factors are considered to be necessary and remain our next challenge.

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REFERENCES


