Proceedings of
The 1st European Workshop on Chance Discovery and Data Synthesis in ECAI2012 (EWCDDS12)

Date: 28 August, 2012
Venue: Campus de Triolet - Université Montpellier 2 (University of Sciences)
Place Eugéne Bataillon – 34095 Montpellier cedex 5

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Meta-Cognitive Approach to Finding of Lost Properties

Yukio Ohsawa

Abstract. It is difficult to find lost properties, because a loss occurs when we do not pay much attention to objects we possess. The situation is sometimes quite subtle, especially when the object is linked to secrets of one's belonging organization, therefore one tends to hesitate to go over to see a psychologist for analyzing one's dream, or to be treated with other methods requiring the assist of someone else. In this paper I show two cases where a person lost a property and found it at niche places - where the object had been released unexpectedly and was hard to be discovered. From these cases, we show the usefulness of linking acts in multiple and parallel task scenarios, where one tries to link things in one's eager/urgent and routine activities via the lost property. In this method, metacognitive visualization of the lost situation sometimes work.

1 INTRODUCTION

It is irritating to notice it that one lost something which should be in one's pocket, in the bag, on the desk, etc. In such a case, it is hard to recollect the place or the time where and when one released the object from hand, from the pocket … it is even difficult to finish writing this sentence because one cannot recollect how the object has been possessed before lost.

Some previous studies and methods have been contributed to this kind of event. In psychology, we find relevant work in the old literature by Freud: The loss of properties is one kind of failure actions, that are due to the effects of unconscious intentions and constraints [1]. In order to analyze unconscious latent dynamics in the mind, Freud invented several methods including the interpretation of dream and the free associations [2,3] - he assumed the dream reflects the unconsciousness as well as failure actions do, and the latent context can be externalized by the linkage among recollectable words. In the interpretation of a dream, keywords and scenes are extracted via interviewing the patient about the dream, and these fragments are connected (with referring to the patient's real life) in order to reveal the unconscious factors which had not been externalized. In this process, the connections are expected to be revealed by free associations, and the connections reinforce the further recollection of the dream. It is noteworthy that Freud's method differs from Jung's dream interpretation in that Jung aimed to aid the patient's creation of living visions and future scenarios via the imagination of good future relevant to the dream.

However, these interpretations require assists by psychologists, because facing with the interpreted unconsciousness often produces a heavy load on the patient's mental situation. In the real cases of losing properties such as USB memory or room keys, one desires to hide the fact because these objects are linked to the secrets of the organization one belongs to – if the object cannot be found, penalties may be expected. In spite of this problem, we regard one's self-assist focusing on the unconscious part of mind, where weak attention has been paid by oneself or about which verbal externalization has not been executed, is meaningful for finding lost properties. Recently sensor-based tools came to be developed and sold (e.g. http://headlinesandheroes.com/tag/lost-item-tracker/) to keep tracking noteworthy properties. However, it is not easy to attach such a sensor to all the huge number of things in our busy business environments. Even worse, we do not notice the importance of an item until we lose it, i.e., we cannot put a sensor on an item until we lose it.

Revivals or transmission of information in the situation where parts are lost have been studied in other domains such as artificial sensing, data transmission and social data mining/visualization [4,5]. Even in these domains about artificial information systems their research aims include to revive the contextual information rather than fixing the broken fragments.

We can position the finding of lost properties as a significant subgoal of chance discovery [6], that has been initiated and continued since year 2000 developing methods for detecting and explaining events significant for making creative decisions at least in two senses. That are,

(1) The event that one released an object from one's belonging (hand/body/bag./…) itself is a chance, because detecting such an event leads one to decide to check if important objects stay possessed by oneself.

(2) As in previous work in chance discovery, the detection of items which are not outstanding but imply hidden values is a significant research goals. A lost property is a target of chance discovery in this sense.

In the later section, another meaning of this study in chance discovery shall be revealed.

2 HYPOTHESES ABOUT OBLIVION AND A PROPOSAL FOR RECOLLECTION

My hypothesis to be validated by the cases including the two in this chapter is simply put as in the two below:

Hypothesis 1) The memory tend to be lost when multiple tasks are running in parallel: Because one cannot pay attention to all tasks that should be accomplished, items involved in tasks to which sufficient attention is not paid, tend to be lost. This is not so strong as Freud's saying that unconscious intention affects failure actions, but is relevant to that unconscious constraints play a role. That is, the physical constraint that one's consciousness cannot fill all tasks.

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This hypothesis is expected to stand especially when an outstanding task overwhelms others running in parallel e.g., one writing a paper may forget where he put the coffee cup.

Hypothesis 2) Human tends to pay strong attention to where it is required: Because human is good enough to do what one is used to do, one does not have to pay much attention to routine/daily tasks. For example, one does not pay attention to drinking coffee for waking one's own mind in the morning because it is a routine task to do every day. On the other hand, if he is trying to finish an urgent task assigned urgently, his attention will be addressed to the unusual task. Thus, one tends to pay attention to a high-necessity, low-frequency work. Relevant literature, about selective attention, can be found in [7].

Hypothesis 3) Human tends to lose memory with time, and the memory is reinforced if the action using the memory is repeated: This is an established theory rather than a hypothesis – oblivion due to the passing of time [8] and the reinforcement of memory due to trying to recollect presented information (recollection is essential for reusing memory) [9]. Although a low-frequency tasks may capture human's attention tentatively according to hypothesis 2, items or events involved in the task are forgotten as time passes due to the effect of oblivion by time in this third hypothesis.

Combining the three hypotheses above, we are based on the simple single hypothesis below:

Hypoethsis 4 (the central hypothesis hereafter) : Human tends to activate memories of only high-priority tasks, among other tasks running in parallel. Memories of items and events involved in other tasks tend to be weakened, although some may be recollected due to repetition of the same task.

On this hypothesis, we can explain such troubles as follows:

Trouble example 1) An officer is filling a document urgently assigned to him, the deadline set to 15:00 of the day. He stores the tentative version of the document in his USB memory and goes out for lunch. He is thinking about the urgent task even in eating – when he come back to the office, he cannot find his own USB memory which is really in his pocket

Trouble example 2) A policeman patrolling near the campus of the University of Tokyo finds a child almost being kidnapped, by men pushing the child into his car and running away. The policeman chases the car, and successfully catches up with the car carrying the child – but he cannot find the handcuff.

In Example 1, even though the USB itself is quite important, its location is not easy to identify because the item is involved in the trivial routine task (eating lunch is a *task* for feeding energy in a worker's body). However, this not a heavy situation because the office really as the USB in the pocket. On the other hand, in example 2, the policeman cannot arrest the kidnappers without finding the handcuff immediately. Although the handcuff is required in such a case, the policeman's memory about it is sometimes lost because it is in the box of the police car in the routine task of patrolling the city, and cannot be reinforced because it is not used repeatedly in a safe city.

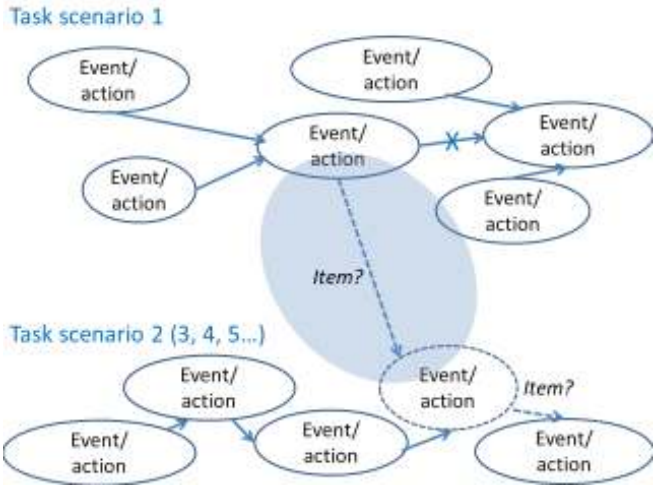


Figure 1. Task scenarios running in parallel

A clue for finding the lost item can be an event in task scenarios 2, 3 or 4, rather than in task scenario 1 in Figure 1. The point here is that the item is included in the tasks to which the attention is weak or not paid, dropped from the important task (scenario 1).

That is, the item is positions close to the cross point of task scenarios 1 and the trivial routine one i.e., the task scenario 2. For activating the lost item, therefore, learning from the free association of Freud, I propose the method below:

Step 1) Write down the task scenarios, in the order of priority,
Step 2) Collect events in each scenario until it comes to be connected to form one sequence, in the following manner. Continue the following two sub steps iteratively, until you identify the events from/to which the item in problem has been passed.

2-a) List up all events in the task to accomplish a goal, that is a task scenario of the highest priority. Try recollecting when and where the item in problem had been passed down to the lower priority task scenarios.

2-b) Do routine tasks as daily done, for collecting events in the routine task scenarios that are of lower priority. Try recollecting when and where the item in problem had been passed down from the higher priority task scenarios.

If the recollection is still hard even if one does the procedure above, the meta-cognition based on visualization of words of the subject may reinforce the effect of this method as we show in Chapter 4.

3 EXAMPLES IN TWO REAL CASES

In this chapter, let me show two cases where the subject lost his item and found it later. Let us explain the processes in these successful cases with regard to the method of Step 1 and 2 above.

Case 1) A key lost on a rainy day

The subject is a teacher who planned a class of five hours from 13:00 till 18:00 on Saturday. The class was for the training of creativity by project based learning, so the teacher had to prepare things for the class: Specially designed items such as cards, training sheets (papers), etc., magic pens, post-it, etc. Because such a hard class is not a routine work, the subject had to pay strong attention to each action in this task for the preparation.

On the way of the task, he recollected he had to unlock and open the door of the classroom because it was Saturday and the classrooms should be opened by the teacher himself – rooms are normally locked for security, and the secretary had borrowed the key of the classroom the day before. At the very moment in the morning when he started the preparation task, he checked the point where the secretary placed the key – it was in the drawer of the office desk. In order to unlock the classroom, he tried to get the key from the desk drawer. However, could not find the key down there. He continued to search the key, going both to his own office and to the laboratory, taking away all books and paper put on the desks and in all drawers where he thought he may put the key himself. However, he could not yet find the key – after 40 minutes of this fruitless effort, he gave up and decided to go out for lunch.

On reaching the main entrance of the building, just before going out, he found some people walking outside with umbrella, which made him recollect the fact it was raining. That is, he in the morning came with an umbrella. He recollected the forgotten task he had been done himself, i.e., walking upstairs to his office with the umbrella, to pick some hand-outs (printed papers) he had prepared on Friday. The key had been put quite closed to those hand-outs. Thus, we can say he applied the method mentioned in Chapter 3 as:

Step 1) He noticed two tasks scenarios were running in parallel as in Fig.2, i.e., making the contents of the class and moving up and down.

Step 2) One and half cycle of step 2: (2-a) He checked all the actions in preparation for the class, connected them via essential events on the way, and (2-b) just went out for lunch, that is a routine daily task. (2-a) He continued to think over of the preparatory tasks relevant to the key, and finally paid attention to the cross of the two task scenarios, where the umbrella and the lost key co-existed.

Furthermore, in this case, he noticed he cannot recollect the umbrella. That is, he noticed multiple tasks below, and found he did not pay strong attention to Task 2 - his memory about parts of these tasks were vague at the points of the "maybe" below.

Task 1) Preparing for the class, including the carrying of the hand-out, and *maybe* of the key

Task 2) Moving up/down with the umbrella, *maybe* to the office

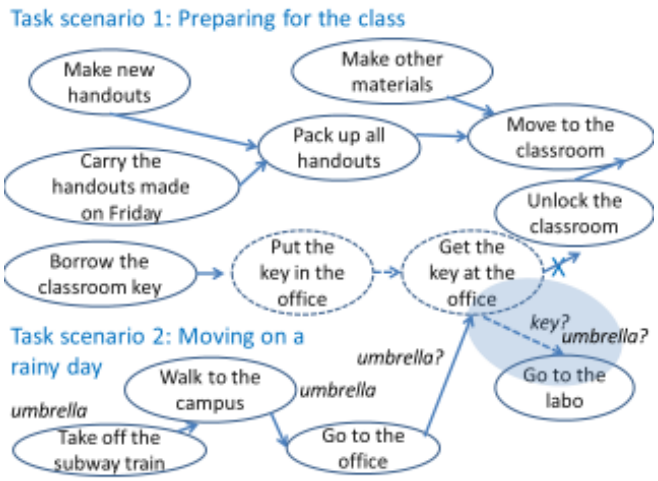


Figure 2. Task scenarios running in parallel, in Case 2

Figure 3 The snapshot where the lost key (in the center of umbrella frame) has been found

He then created a hypothetical scenario i.e., the co-existence of the key and the umbrella, somewhere on his path moving up and down, back and forth. Because he could think of only two rooms he may put the umbrella, and because he could not find the umbrella in his office, he went to the laboratory and found the umbrella. Opening the umbrella, he really found the key in metal frame (Figure 3).

Case 2) A USB memory lost on a busy day

This is a more fatal case. The subject was working in an office. He was making a document in preparation for the meeting planned after lunch (13:20). On the way, he had an expected guest and spent 30 minutes with her. Then he went to lunch, and after lunch continued a bit for completing the document, and finally finished it just after noon. He searched the UBS memory for saving the document file, but could not find it in the bag he usually put it in, even though he remembered he saw it in the morning.

Considering the significance of this fatal event (the USB had important data about the official secrets of the institute), he contacted offices he should, both as his duty in such a case and for calling for co-operations for searching the priceless item. Having learned some methods for meta-cognition [10,12], he wrote down what he can recollect among all his behaviors from the morning (let me show the details about this in the next chapter). Although he searched hard with returning to all places he went, such as his office desk, the restaurant he had lunch in, the toilet he used after lunch, etc, he could not find it for five days since losing. On the sixth day, he returned to his daily life, and started to apply the method proposed in this paper:

Step 1) He noticed he was involved in multiple tasks, (1) the documentation for the meeting, (2) moving in daily routines (using the restroom etc), (3) talking with guest, as in Fig.4.

Step 2) (2-a) He checked actions in the task of documentation, although he could not completely connect events on the way, and also (2-b) did the same for the other tasks he noticed in *Step* 1. He then used the toilet as in the way he used when he lost the USB memory. He then found a dropped coin, thought of wiping it with the role paper, and similar actions were recollected to fill in the task scenario 3 in Step 1.

That is, he noticed multiple tasks below, and found he did not pay attention to Task 2, 3, or 4 - his memory of these tasks were uncertain. In the restroom, He did task 2 as in daily routine, not focusing narrowly to simulating how the USB memory moved:

Task 1) Preparing for the meeting, with completing and saving/storing a document

Task 2) Having lunch, using the restroom, etc

Task 3) Meeting the guest

Thus, his attention involved the coin and his imagination about wiping it with the paper, with recollecting his behaviors on the first day. As a result, he remembered he was doing a similar behavior on the first day – he dropped the USB memory onto the floor of the restroom because he had it in the pants pocket, and wiped it with the roll paper. He also remembered he used the road water to clean it, and then went to an office room. Thus, he went back to the corresponding office and finally found the USB memory under the arm rest of the chair used in the office (See figure 5).

A point in Step 2 here was that he went to use the toilet as he usually do, whereas for the preceding five days he was keenly focusing on where the USB memory might have fallen and if he lost it near the toilet, for identifying the location of the USB memory and for estimating the probability it is in the restroom. When he looked at the floor to find a coin there, the wide range of weak attention rather than a strong focus on things relevant to the USB memory enabled him to link the coin to his recollection of picking and wiping the USB memory on the first day.

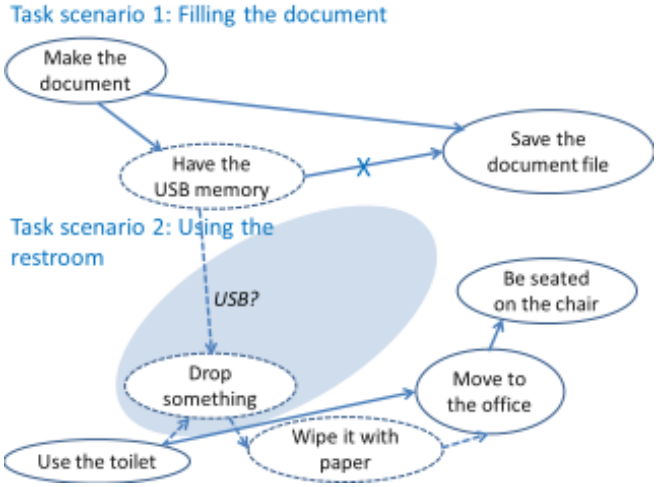


Figure 4. Task scenarios running in parallel, in Case 2

Figure 5 The snapshot where the lost USB memory has been found: See under the arm rest.

4 VISUALIZATION AIDING META-COGNITION

Reader may be skeptical because there are some points in the above cases where the causality of applying the method and the successes are not clear. A remarkable missing causality can be pointed out before the final moment of finding the USB memory in case 2. That is, here the finding of the USB memory under the armrest of the chair among all niches in the office is a non-trivial hard step. The subject, as wrote in Chapter 3, was writing what he recollected as he did, whom he talked to, and what he looked at, into as much details as possible with efforts for recollecting all the events and actions in the five days. Figure 6 shows a part of the raw data in Japanese – the time, the actor' s name corresponding to each event/action, and the details of the events and actions are written in each line.

The text was incremented by adding the new sentences every day, and was visualized by applying KeyGraph [12], a tool developed in 1997 for visualizing the correlations of items (words in this case) based on their co-occurrences in the given data (text in this case). Especially Kamishibai KeyGraph visualizes the temporal changes of the graph, where a sequence of graphs are shown corresponding to the sequence of data sets (text stored by the 2nd, the 3rd, the 4th, the 5th, and the 6th day in this case) with showing the same words at the same positions in the 2D image. As in Figure 7, the graph changed drastically from the fifth to the sixth day, in comparison with other day-to-day changes. Especially, we find words such as "wipe," "pants," "put in," and "get out of" at the bridge between the 6th-day graph and the graphs before (the graph did not chance so drastically for the 1st through the 5th day). By looking these graphs, the subject noticed he himself had a weak but important interest in the pants pocket, where he may have put the UBS memory in – however, he could not remember when, where, why, or how he took it out from the pocket afterward. He thus came to consider situations where the memory could have dropped out the pocket in the office, and came to the conclusion that it was when he was seated in the chair in the office. That is, it is hard for any small objects to fall out of the pants pocket as far as one is standing. On the other hand, it may fall out if one is seated in a deep chair (See figure 8).

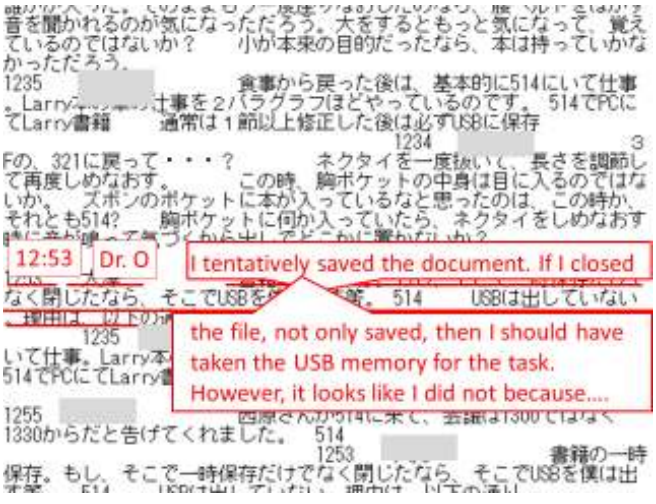
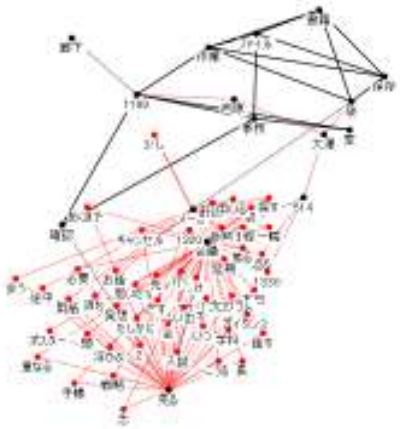
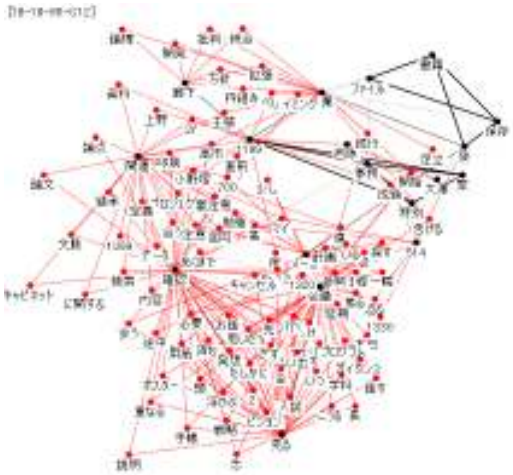


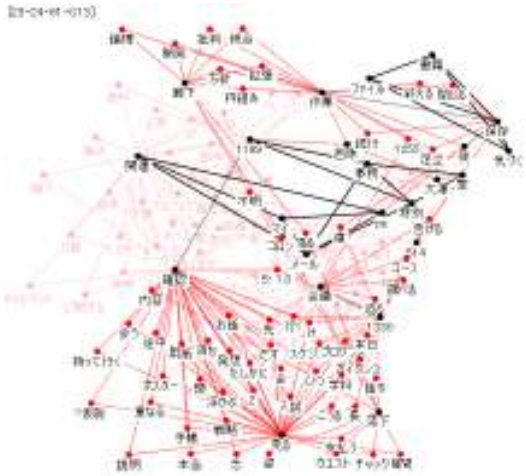
Figure 6 The written text by the subject: The time, the actor, and the details of the behavior are put here.



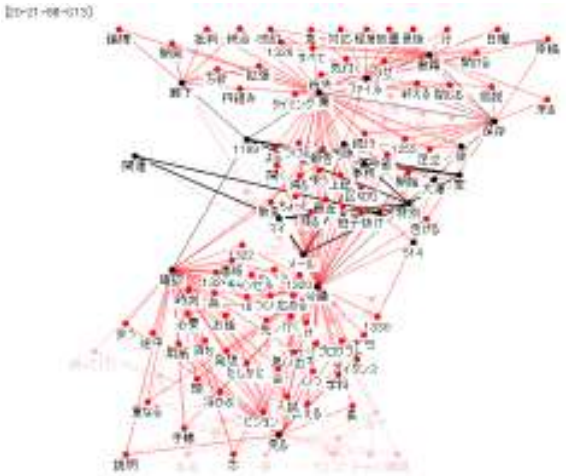
Day 2: Visualizing the words written on the 2nd da, i.e., the day next to the day USB memory was lost



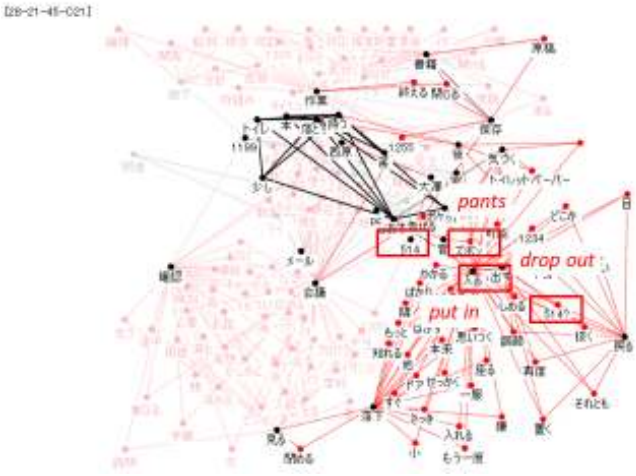
Day 3: Visualizing the words written on 3rd day



Day 4: Visualizing the words written on 4rd day



Day 5: Visualizing the words written on 5rd day



Day 6: Visualizing the words on the day of discovery

Figure 7 The changing graphs visualization the daily recollection of scenarios

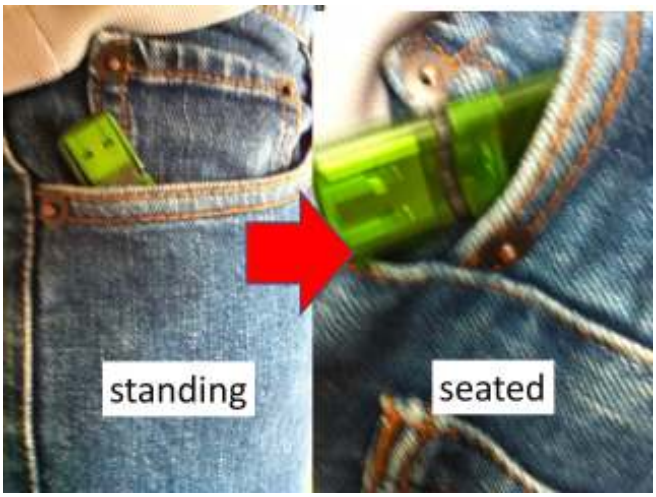


Figure 8. USB memory may fall out of the Pants pocket only when one is seated

5 STATISTICS OF LOST ENTITIES

This method has been applied to a few cases yet, but the pattern of losing properties is valid for more a large number of cases: Most entities are lost and found at unexpected places where the entity should has not been used. Here I collected answers from 25 subjects about where they found their lost items, to the following two anonymous questions:

Question 1: Have you ever looked for any property for 30 minutes longer? What was it, if I may ask?

Question 2: Did you finally find it? Where?

X: No I did not find it – still lost.

A: Found at the place where it is usually put

B: Found at the place where it should have been used

C: Found on the route where it was carried in your routine movement (but not used)

D: Other places

Here, subjects are allowed to answer multiple answers to this question. As a result, 28 answers were collected, and distributed as: A: 2 (answers), B: 7, C: 13, D: 4, X: 2

Among them, two answers in D had detailed information, one was "in the trash" and the other "in the bicycle parking lot" which should have been answered as C. That is, the distribution was biased to C, i.e., lost items tend to be found on the route where it was carried in one's routine movement rather than in places where the item is used for intentional way of use. In this sense, the method shown in this paper - i.e., look for your lost item with listing and connecting your task scenarios, especially highlighting the routine living route.

6 CONCLUSION

A meta-cognitive approach to finding lost properties has been proposed.. In this paper I focused on two cases where a person lost a property and found it at niche places. From these cases, the usefulness of linking acts, where one tries to link things in one's multiple tasks including routine activities via the lost property. In this method, the metacognitive visualization of the lost situation works in case some parts of the task scenarios are hard to identify. This method has been applied to a few cases yet, but the pattern of losing properties is valid for more a large number of cases: Most entities are lost and found at unexpected places where the entity should has not been used. We expect the development of this kind of method can be helpful in reducing errors and fallacies in various working contexts of human such as in medical treatments [13].

Finally, as predicted in Chapter 1, the finding of a lost property requires the noticing of some events, or some particular event, that is linked to the subject's action taken in losing the property. Finding such an event as a trigger for the finding will be an interesting research goal for chance discovery.

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A Scenario-Based System Approach for Idea Discovery in Market Innovation

Hao Wang[1] and **Yukio Ohsawa**[1]

Abstract. Chance Discovery, initiated by Ohsawa in 2000, focuses on detecting rare but important events or situation for decision making in complex real world, which has attracted wide attentions and is extensively applied in many research areas, especially in business arena. In this paper, we propose a scenario-based system approach for idea creation, integration and evaluation, as an extension of Chance Discovery. There are two key components in the approach: (1) *IdeaGraph*, an algorithm to discover more latent information for human insights; (2) Market Innovation Storming (MIS), a scenario-based creativity support technique for actionable ideas generation. We have realized this system approach in a Web-based collaborative creativity support system named *iChance* where enterprises can make collaborative innovation with their customers. A case study has validated the effectiveness of proposed approach and system.

1 INTRODUCTION

Chance discovery is a human-computer interaction process to detect rare but important chances for decision making. A chance is defined as an infrequent but significant event or situation which strongly impacts on human decision making. In the past few years, chance discovery has attracted wide attention and been extensively applied in many research areas, especially in business arena [2].

KeyGraph [3] is as a vital tool to generate scenario map for aiding human value cognition in the process of chance discovery. Some companies have developed new products with the help of *Keygraph*, and succeeded in the market [4]. However, a new problem in chance discovery is realized that *KeyGraph* failed to visualize a latent structure behind observation. Therefore, Ohsawa proposed a method of data crystallization where dummy nodes corresponding to unobservable events are inserted into the target data, and then are visualized by *KeyGraph* [5]. Maeno and Ohsawa subsequently presented a new method named human-computer interactive annealing for revealing latent structures and discovering dark events [6]. This method has been used to design new products in a real company, and the result illustrates its effect for industrial decision making [7].

In order to further improve human understanding of *KeyGraph* scenario graph, Innovators' Market Game (IMG) and Innovators' Marketplace are invented as a tool of chance discovery [8, 15]. IMG is a kind of table game and has been successfully held separately in the special section of international symposium in China and international workshop in the USA [9, 10]. Due to the limitations of IMG, a customer-centric creativity support technique named 4W-IMG is designed and has been implemented in a Web-based creativity support system-*iChance* regular version [10-12].

Many creativity techniques have been developed to support creative thinking, such as brainstorming, morphological analysis, checklists and mapping process, and have also been classified some ways, such as divergent thinking and convergent thinking, individual creativity and group creativity, analytical techniques and intuitive techniques. At present, interests have increasingly focused on computer support for creative problem solving [17]. Moreover, research has shown brainstorming and other creativity techniques supported by a computer system are more effective [18]. Many computer systems have integrated various creativity support techniques for creative individuals who work in isolation, but group interaction and collaboration is more critical [19]. With the rapid development of Internet technology, individuals can access to the Web 2.0 applications easily to get together, share ideas, spread and share their knowledge in various ways [20].

Although previously mentioned research has achieved good performance, there are still two problems to be settled:

(1) *KeyGraph* algorithm is originally designed for extracting keywords in a document. Thus, scenario graph generated from *Keygraph* is machine-oriented so that sometimes it is hard for users to understand and interpret. Moreover, *KeyGraph* fails to capture more rare and significant event points and especially event relationships.

(2) Enterprises are eager for an efficient creativity support technique to generate more actionable idea since fewer ideas are eventually accepted by enterprises to further invest in.

Therefore, we propose a scenario-based computational systematic approach for high-quality ideas cultivation, construction and generation through human-computer and human-human interaction. Figure 1 shows a research framework of idea discovery as an extension of chance discovery. In this approach, latent information and structure can be shown in a scenario graph generated by *IdeaGraph* algorithm introduced in Section 2. In Section 3, we introduce a creativity support technique where designers and technical experts in enterprises, collaborating with their customers, obtain valuable insights from *IdeaGraph* scenario graph, and creative and actionable ideas are obtained finally. In Section 4, we implement this system approach in a Web-based creativity support system called *iChance*. Section 5 presents a case study to validate the effectiveness of proposed approach and system. The conclusion is summarized in Section 6.

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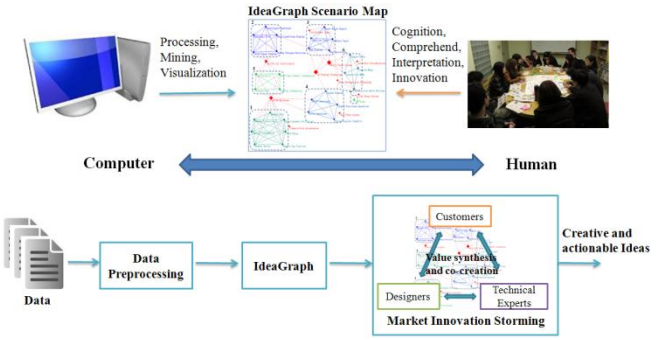

Figure. 1. A research framework for Idea Discovery

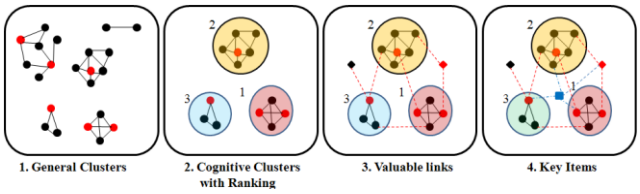

Figure 2. The creation process of a scenario map using *IdeaGraph*

2 IDEAGRAPH: A NOVEL ALGORITHM FOR ELICITING MORE HUMAN INSIGUTS

KeyGraph algorithm is originally designed for extracting keywords in a document. Thus scenario graph generated by *KeyGraph* is a machine-oriented graph so that *Keygraph* scenario graph sometimes is hard for users to understand and interpret because of its complexity and inadequate information. In this section, we introduce a human-oriented algorithm called *IdeaGraph* which can generate a rich scenario graph for users' comprehension, interpretation and innovation. *IdeaGraph* not only works on discovering more rare and significant chance events, but also focuses on uncovering latent relationship among them. Suppose that data has been preprocessed into *D'*

D' = item 1, item 2, item 3, item 4
item 2, item 7, item 5
item 3, item 6, item 9, item 10, item 5
……

Figure 2 shows a scenario map creation process by *IdeaGraph and* the algorithm is presented as below:

Step 1: Generating general clusters. The relationship between two items is measured by their conditional probability. That is, the relationship of any two items, I_i and I_j, is calculated by Eq. (1). And then the pairs whose $R(x,y)$ are greater than preset threshold r are linked by line in the graph *G*. Finally, general clusters are obtained and denoted by C_i.

$$R(I_i, I_j) = P(I_i|I_j) + P(I_j|I_i) \quad (1)$$

Step 2: Obtaining cognitive clusters. *Cognitive Cluster* is defined that a cluster embraces rich information but should be small enough for human cognition and interpretation. To obtain cognitive cluster, two indicators, *information and information density*, are employed to quantify general clusters generated in Step 1.

The definition of *information* is the sum of $R(I_i, I_j)$ of all the edges in a general cluster. The *information density* is defined that the *information* of a cluster is divided by the number of items in the cluster. That is, the *information density* of a cluster is the information of each item in this cluster. Thus the equations of *information* and *information density* are

$$Info(C) = \sum_{I_i, I_j \in C} R(I_i, I_j) \quad (2)$$

$$InfoDen(C) = Info(C)/Ne \quad (3)$$

where I_i or I_j is an item of a cluster C *and* N_e indicates the number of items in the cluster *C*.

Therefore, each general cluster is measured by the harmonic average of these two indicators. Eq. (4) is derived from merging Eq. (2) and Eq. (3). Finally, the value of each general cluster is measured by the harmonic average of these two indicators, see Eq. (6).

$$ClusterVal(C) = 2Info(C)/(Nc + 1) \quad (4)$$

Eq. (4) indicates it favors the cluster which has fewer items when two general clusters have the same *information*.

Therefore, all general clusters are ranked by their *ClusterVal(C)* in a descending order and parts of them are chosen as cognitive clusters denoted by CC through picking up top N_c clusters.

Step 3: Capturing valuable links. Calculate the relationship between each item and each cognitive cluster by Eq. (5)

$$PR(I_i, CC) = \sum_{c_k \in CC} R(I_i, c_k) \quad (5)$$

Item-cluster pairs are sorted and top N_i pairs are selected to be linked by red dot line. New items are added if they are not in the graph *G*.

Step 4: Extracting key items. A key item is the item which has strong relationship with all other cognitive clusters and newly added items in Step 3. It is calculated by Eq. (6)

$$Key(I) = \sum_{i=0}^{N_c} PR(I, CC_i) + \sum_{I_k \notin CC, I_k \in G} R(I, I_k) \quad (6)$$

All items are sorted by their $Key(I)$ and top N_k items are taken as key items which are shown if they don't exist in the graph *G*.

3 MARKET INNOVSTION STORMING: AN EVOLUTION OF CRREATIVTY SUPPORT TECHIQUE

Many relevant techniques have been proposed to foster creativity of individuals or groups, such as *brainstorming, mind mapping, morphological analysis, patent mapping, IMG and 4W-IMG* etc.

These technologies for innovation employ different scenario graph, different interactive rule, different role-centric playing or idea source, but the same interactive pattern is found that new product ideas emerge through cooperation and communication between firms and their customers. In other words, new value is co-created by interaction between designers and customers see Fig. 3(a).

(a) Current Model (b) Tri-circle innovation model

Figure 3. Value synthesis and co-creation model

3.1 Tri-circle innovation model

Research has defined some stages as the "fuzzy-front-end" of the product innovation process before a new product is decided to develop, even though firms have their own product innovation processes [13]. Several studies have shown that product innovation activities conducted at the fuzzy-front-end of product innovation process identify successful and unsuccessful new products based on the most important factors [14, 15]. However, it's widely recognized for firms that fewer ideas are eventually accepted to invest in, when technical experts further evaluate these ideas which are generated by these innovation technologies. Therefore, how to build an effective breakthrough method for more accepted ideas generation remains to be settled.

As Figure 3(b) shows a tri-circle innovation model is developed. The design of accepted idea is considered as the sum of the triple bottom line of customer, designer, and technical expert.

3.2 Market Innovation Storming

Based on tri-circle innovation model, a new method of market innovation storming (MIS) is designed for generating more accepted ideas, obtaining clear voice of customers and design ideas of designers, accelerating the innovation process.

The Roles

Market innovation storming is also a customer-centric innovation process where technical expert as a new role is added.

- **Customer**. Propose potential demands or complaints.
- **Designer**. Create innovative ideas.
- **Technical Expert**. Verify ideas from designers, such as the realizability, cost, development cycle, etc, and point out valuable information from customers to designers.
- **Facilitator**. Manage and control the whole of innovation process.

3.3 Creativity Support Methodology

We show the interactive process of market innovation storming among customers, designers and technical experts.

Step 1: Make sure of objective, collect relevant data and make scenario graph at last. Facilitator prepares to set up MIS.

Step 2: Based scenario graph, customers propose new demands or complaints which should be recorded by 4W-Demand format. Here demands or complaints are divided into internal and external ones. If proposed demands or complaints are related to scenario graph, they are regarded as internal demands or complaints; on the contrary, they are external demands or complaints.

No. & Name (Expert)
Who: demands or complaints
What: customer base
When: time
Where: place

Step 3: Technical experts recommend useful complaints or potential demands although all requirements and complaints are sent to designers. In Fig. 5, labeled complaints and demands means they are strongly recommended to designers.

Step 4: Based on scenario graph and customer demands or complaints, designers create new idea (solution or strategy) by H-W idea format presented in 4W-IMG. Similar to demands or complaints, ideas also have two prosperities: internal and external. If an idea is generated due to scenario graph, it is an internal idea. Otherwise, it is external idea. If possible, designers make the design sketching for clearly expressing their ideas.

No. & Name (Designer)
How: to build new ideas or concepts
Why: reason of design

Step 5: Technical experts validate each idea from designers. If an idea is considered valuable and practical, technical experts will further give technical information on this idea, such as technical implementation, development cycle, cost, etc. Validated ideas will be suggested to customers.

No. & Name (Expert)
Technical Implementation:
Cost:
R&D Period:

Step 6: Customers and designers communicate and interact with each other about their demands/complaints or innovative ideas. Customers will score their favorite ideas, and designers will mark useful complaints and demands for their new ideas generation.

Step 7: Repeat Step 2 to 5.

3.4 The Evaluation of Roles

The evaluation method is designed to encourage customers to propose as more demands as possible, and to trigger inventors to create more high quality ideas. The customer who achieves the most number of product certificates will win in all of the customers. The designer who creates the most high quality ideas will win in all of the inventors.

Customer. The evaluation of each customer is to use Eq. (7) to calculate the total number of product certificates each customer obtains from designers.

$$PC\_Num = m\_i \quad (7)$$

where m_i means the number of product certificates the ith customer obtains.

Designer. The performance of each designer is assessed by Eq. (8), which evaluates the quality of ideas that each designer creates.

$$IdeaValue = T\_i/n\_i \quad (8)$$

where T_i indicates the total number of virtual money the ith designer earns; n_i is the number of ideas the ith designer creates.

4 ICHANCE: A CREATIVITY SUPPORT SYSTEM FOR COLLECTIVE INTELLIGENCE

4.1 System Overview

The approach of *IdeaGraph* and MIS has been integrated in a Web-based creativity support system called *iChance*. Compared with regular version in [10-12], *iChance* business version provides more powerful functions for better user interaction and experience. The layout of the interface in these two versions is nearly similar. As shown in Fig. 6, there are four modules:

- Scenario graph module. It provides users to make insights and cognition. Users can obtain useful basic information, publish their views and evaluate each other's comments.
- Knowledge management module. Ideas and demands as important knowledge are managed in this module. Besides, a ranking function is provided to users to check.
- Communication module. Users can communicate each other by using different font, color or size.
- Toolbar. Some function buttons are in this module for users to operate.

4.2 The operation and interaction of roles

The following contents will explain how they operate and interact with each other on *iChance* Web platform.

Facilitator

The *facilitator* should configure necessary information in *iChance* before they start a MIS for a creativity activity, see Figure 5. First, they should register users' basic information, set username and password for each user to log in system and group them into different role. Second, they need to fill up necessary information about project (project name and project content), and upload scenario map into the system. Finally, they choose users to join in MIS through dragging a user item from user list into selected user list.

Customer

Customers make value cognition to scenario map and proposes their potential demands/complaints. They click the button 'Add Demand/Complaint' in toolbar module and a dialog box is popped up, see Figure 6. *Customers* firstly should determine whether they will propose a demand or complaint, and then fill up 4W demands or complaints. Scecondly, they should make sure if the demand or complaint is internal or external, and internal demand will be shown on the scenario map. Finally, a demand/complaint icon will be created and appear on the map and *Customers* then drag the demand/complaint icon to an appropriate place of the scenario map.

Designer

Designers make value creation according to *Customers'* demands/complaints and scenario map, and creative ideas are created finally. *Designers* click the button 'Add Idea' in the toolbar and an idea information box is popped up, see Figure 7. Then they fill their idea information up in the box with the format of how and why. They also need to indicate the idea is either internal or external. Most importantly, *Designers* ought to upload design sketching for better describing their ideas. All ideas are shown in the idea list of idea/demand management and evaluation module.

Technical Expert

Technical Experts take charge of verifying the realizability and effectiveness of creative ideas from designers. That is, technical experts will confirm if current existing technologies can shape designers' ideas into business. Once an idea is proved, technical expert will further provide necessary technical information, such as development circle, costs, and relevant technologies, see Figure 8. In addition, technical experts also recommend useful complaints or potential demands to *Designers*.

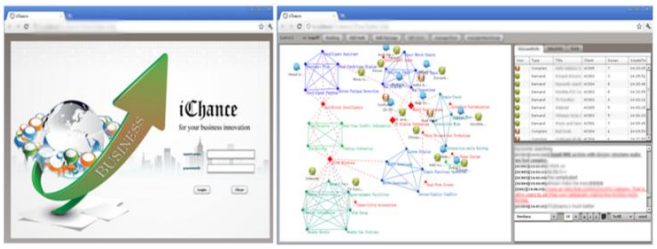

Figure 4. A screen shot of *iChance* log-in and main interface

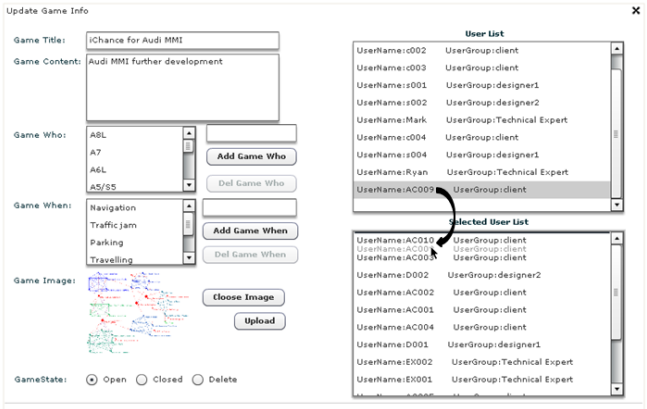

Figure 5. Setting up a MIS in *iChance* system

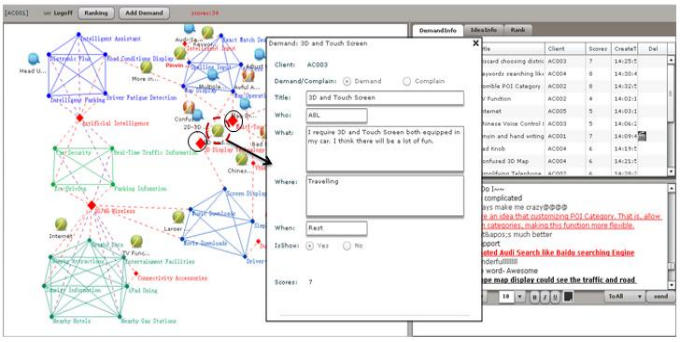

Figure 6. A *Customer* proposing a 4W demand or complaint

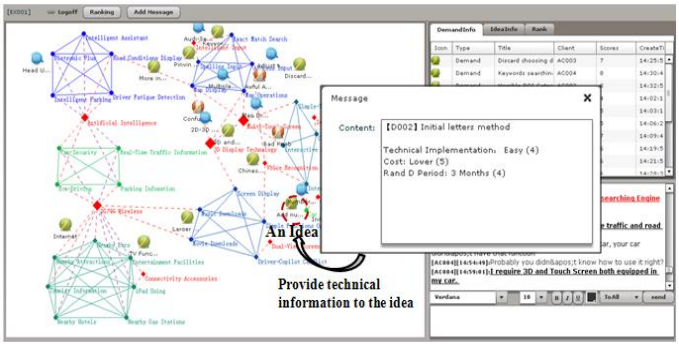

Figure 7. A *Designer* creating an idea with design sketching

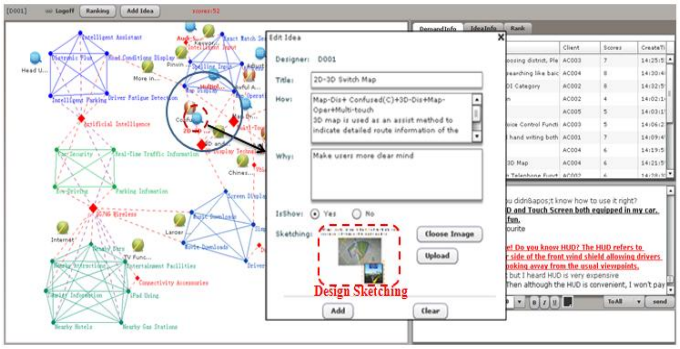

Figure 8. A *technical expert* verifying a creative idea

5 CASE STUDY

We have successfully carried out a project in a famous auto company. The objective of the project is to explore Chinese users' preference on human-machine interface (HMI) system for further development. We provide Idea Discovery system approach as a complete innovation solution to help the company discover potential business opportunities. There are two sections to support the company's innovation:

(1) Group Brainstorming**.** Thirty-one members of the company participate in discussion with brainstorming method. The topic of discussion is focused on creating new ideas on product functions for MMI further development. The discussion went on for one hour. We obtained twelve ideas and some of these ideas cover and repeat each other. These ideas are summarized into 4 ideas at last. We find these new product ideas are fuzzy and still need to further explore their details. However, we consider that 4 of 12 ideas are accepted since summarized ideas are very useful information data. The acceptance rate of ideas is 33.3 percent.

(2) *iChance* Creativity Support**.** Firstly, according to the project objective, we selected relevant data - 96 questionnaires from market investigation. The data is preprocessed into 650 basket data sets where each item represents a specific function of HMI. We also obtained valuable data from group brainstorming and finally collected 733 basket sets and visualize them into an *IdeaGraph* scenario graph, see Figure 9. Secondly, *IdeaGraph* scenario map is employed by *iChance* for company making collaborative innovation with their customers on the Web. Five customers are invited to join in *iChance*, and one *Facilitator*, two groups of *Experts*, two groups of *Designers* from the company participate in *iChance* as well. This section lasted for one and a half hour, *iChance* introduction for thirty minutes and *iChance* creativity for one hour.

In the end, 9 of 10 product ideas are accepted and used by the company for further development. The acceptance rate of ideas is up to 90 percent. Moreover, these product ideas are very clear and beneficial for further development.

Figure 10 shows a comparison of group brainstorming and *iChance* creativity support. It indicates *iChance* creativity support has more high-quality ideas accepted by the company, and achieves much higher acceptance rate, although the total number of created ideas is a bit fewer than group brainstorming.

In addition, the following dynamic discovery helped the enterprise discovering additional creative ideas regarded as potential business opportunities and timely develop their new strategies to respond ever-changing customer demands and market opportunities.

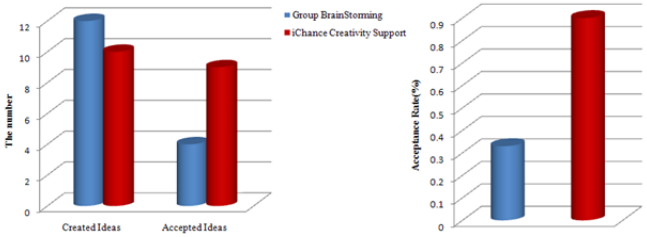

Figure 9. A scenario Graph generated by IdeaGraph

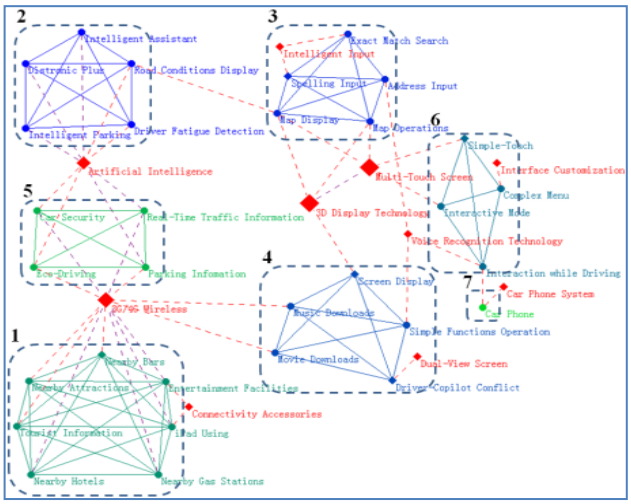

Figure 10. The comparison of group brainstorming and *iChance* creativity support

6 CONCLUSION

Although many studies on innovation have paid more attention to customer knowledge, fewer effective ideas are decided to invest in by firms. Most innovation methods follow a general pattern: set a topic or a fixed scenario graph, and then generate creative ideas through some innovation activities. However, real world data-driven innovation technologies are regarded as the best practice for firms. According to the practical problems enterprises encounter, select necessary data and then make scenario graph by analysing the data. At last, generate creative ideas are emerging through make insights to scenario in a game-like environment.

In this paper, we propose a scenario-based systematic approach which is a dynamic process for idea cultivation, construction and generation through human-computer and human-human interaction. *iChance*, a Web-based collaborative creativity support system has integrated *IdeaGraph* scenario graph and MIS creativity support technique to provide an online platform where enterprises can make collaborative innovation with their customers. A case study has validated the effect of Idea Discovery.

This research contributes new knowledge in such fields as creativity support system, decision support system, chance discovery, knowledge discovery, data mining, data synthesis and visualization, knowledge acquisition and management, etc.

ACKNOWLEDGEMENTS

The author was supported through the Global COE Program "Global Center of Excellence for Mechanical Systems Innovation," by the Ministry of Education, Culture, Sport, Science and Technology, Japan.

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The Influence of Stay Time on Purchase Behavior in a Supermarket

Yi Zuo[1] and **Katsutoshi Yada**[2]

Abstract. In this paper, we present a study on the shopping behavior of customers based on the RFID(Radio Frequency IDentification) data in a Japanese supermarket. Through RFID data, it is possible to capture the individual difference of customers how to spend time on shopping in a certain area of the supermarket. Firstly, we deal with the RFID data of the customer shopping behavior and transform it to the stay time for each area of the supermarket. Then, we describe a criterion to evaluate the stay time and illustrate the influence of the stay time on purchase of customer with examples. Finally, through the examples, we discuss what kind of customer is knowledgeable consumer who has a high-level knowledge about the supermarket.

1 Introduction

In strategic management of retail industry, the point-of-sale(POS) data has been considered to be playing a central role and most of business proposals in this field are applied to analyze the POS data to lead to the customers loyalty and profitability. For example, by using the historical POS data, Guadagni & Little(1983)[1] and Gupta(1988)[2] proposed a logit model to explain the purchase behavior in the brand choice. Also, in order to handle larger volumes of POS data, the data mining technology has been conducted in many models[3][4][5]. Although, these researches indicated that these models had an effect on sales increase and brand loyalty, it is impossible to shed any light on the decision-making process of the customers why or how they come to purchase.

For overcoming this difficulty, a wireless non-contact technology named RFID (Radio Frequency IDentification) has brought a new perspective on this situation. An object attached with a small tag can be identified and tracked automatically. One of the main advantages of RFID technology in the research field of marketing is that it can accurately track the in-store behavior of the customer in a certain area of a grocery store.

Among studies which have employed RFID data to analyze the consumer behavior, Larson et al.[6] presented an exploratory work on RFID data of shopper travel path and by clustering the customers in three groups(low, medium and high shopping time) they identified a total of 14 canonical path types of the grocery store travel. However, until now they have no studies to take into consideration of purchase behavior with them. Also, In our previous studies, we applied a character string analysis technique named EBONSAI to shopping path data so as to analyze the in-store behavior of the customer. By analyzing the "High-Volume" customers who purchase a relative large number of items, we supposed some hypotheses on product section visiting patterns of them in terms of character string. Nevertheless, as an important information the time spent at a certain product section was not reflected in the previous study.

Therefore, in this paper, we discuss the influence of the time spent on shopping in a certain area on the purchase in the same area by individual customer. The experiment was carried out in a Japanese supermarket from May 11, 2009 to June 15, 2009. With a small RFID tag attached to the shopping cart, the movement trip of the customer who uses it can be tracked precisely. According to floor layouts of the supermarket, we transform the trips to the stay time in each area and select some typical customers as the examples to analyze the relation between it and purchase behavior. The purpose of the analysis is to clarify the decision-making process of the customers' purchase behavior from their stay time. By exploring these samples, we suggest a number of hypotheses on how to identify a knowledgeable customer who has a high-level knowledge(sensitivity) about the supermarket.

The remaining part of this paper is as follows. Section 2 is the preliminary stage of RFID data. Then, the movement data is transformed to stay time in section 3, and the influence of it on purchase is discussed in section 4. In section 5, the results of the samples are summarized and a number of hypotheses are suggested. In section 6, we discuss the availability of stay time to be applied in the graphical model.

2 Preliminary

2.1 Floor layout of the supermarket

The experiment was carried out in a typical supermarket in Japan. The floor layout be divided into 16 sections by product category are shown in Figure 1. These sections are household & kitchenware → A, food to go → B, sweet & savoury snacks → C, alcoholic drinks → D, entrance → E, fresh fish → F, vegetables → G, Central Aisle → H, western deli → I, Japanese deli → J, frozen foods → K, soft drinks → L, fresh meat → M, register → R, entertainment → S and fruit → V as shown in Table 1.

2.2 Analysis of RFID data

In order to record the trip of customer, the layout is reproduced into a picture from x and y coordinates on the scale of 15.7 pixels per meter. While the customer passes a certain area of the supermarket with a shopping cart attached RFID tag, the information of his position can be received by RFID sensors around the shelves and be transformed to a pixel point into our dataset using the floor layout matching. RFID tag number attached to shopping cart, shopping date, time stamp, x and y coordinates of that time stamp, section of that coordinate

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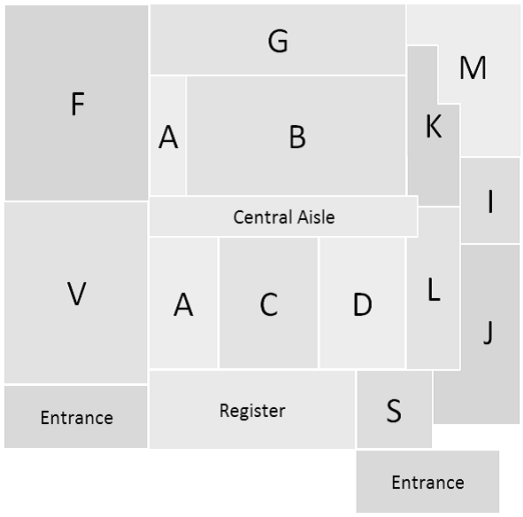

Figure 1. Layout of the supermarket

Table 1. Floor layout mapping of the supermarket

No.	Section	Notation
1	Household & Kitchenware	A
2	Food To Go	B
3	Sweet & Savoury Snacks	C
4	Alcoholic Drinks	D
5	Entrance	E
6	Fresh Fish	F
7	Vegetables	G
8	Central Aisle	H
9	Western Deli	I
10	Japanese Deli	J
11	Frozen Foods	K
12	Soft Drinks	L
13	Fresh Meat	M
14	Register	R
15	Entertainment	S
16	Fruit	V

and elapsed time are recorded, and Table 2 shows the sample data obtained using RFID

Table 2. RFID data of the movement

RFID Tag No.	Date	Time	X	Y	Section	Elapsed Time
1234567	2009/05/11	12:03:51	79	487	V	1
1234567	2009/05/11	12:03:52	85	488	V	1
1234567	2009/05/11	12:03:53	86	489	V	2
1234567	2009/05/11	12:03:55	87	487	V	1
1234567	2009/05/11	12:03:56	95	488	V	1
1234567	2009/05/11	12:03:57	99	488	V	1
1234567	2009/05/11	12:03:58	98	488	V	10
1234567	2009/05/11	12:04:08	92	488	V	1
1234567	2009/05/11	12:04:09	91	489	V	1

When the customer comes to the checkout register and purchase, the POS data what he has bought is recorded and transformed into our dataset as two tables. One table is the shopping details as shown in Table 3. There are customer number, shopping date, purchase time, category of the item(section shown in Table 1), volume and unit price, 6 columns in this table. The other is the shopping amount as shown in Table 4. There are customer number, shopping date, purchase time, start time of shopping, end time of shopping and amount, 6 columns in this table.

Table 3. Detail of the POS data

Customer No.	Date	Time	Category of Item	Volume	Amount
a	2009/05/11	12:12:00	F	1	330
a	2009/05/11	12:12:00	M	1	232
a	2009/05/11	12:12:00	V	1	50
a	2009/05/11	12:12:00	B	2	196

Table 4. Amount of the POS data

Customer No.	Date	Time	Start Time	End Time	Amount
a	2009/05/11	12:12:00	12:03:04	12:09:05	1560

From the customer coming into the entrance until finishing the purchase, we define it as a basic unit of shopping and give a unique ID to identify this unit. After pre-processing of the RFID data and POS data, we get 6609 shopping units(purchase) from the experiment, in which there are 3389 customer be tracked with the amount sold of 24,643,207 yen.

3 Analysis of stay time

In this section, we analyze the movement data of customers how they spent time in each section of the supermarket, and illustrate the influence on the purchase behavior.

3.1 Background

In another one of our studies[7], Takai et al. proposed a definition of the time spent in the supermarket and call it “stay-time” which is measured by the seconds. For a given section, the whole time of all the customers who buy one item at least spent in this section is summed up and considered as the stay time to this section. Also,

Takai et al. proposed a model to explain the relation between the purchase probability and stay time $P(X|Y)$ as follow.

$$P(X = 1|Y = y) = \alpha_0 + \alpha_1 y \tag{1}$$

In equation 1, X is the purchase behavior in boolean value that $X = 1$ if a purchase occurs and $X = 0$ otherwise and Y is the stay time. α_0 and α_1 are the parameters determined by a regressive process.

(a) Movement of customer a (b) Movement of customer b

Figure 2. Movement of the customer behavior

The results[7] support the supposition that longer stay time leads to a higher purchase probability in most of the sections. As the stay time is a mount of all the customers spent, the characteristic of shopping behavior in individual customer is not discussed enough. For example, we choose two customers a and b who has a similar purchase of 1489 yen and 1380 yen individually. But, the movements of them are quite different from each other as shown in Figure 2. The Figure 2 shows the locus of the customers' movements in each section as points, and one point denotes the customers spent at least 1 second in a certain area. In Figure 2(a), customer a spent 5363 seconds on shopping and the locus is almost over all the sections. In contrast to Figure 2(b), customer b only spent 81 seconds at D(Alcoholic Drinks) section. Therefore, if these two type of stay time are summed up, it would be leading to the anergies(negative effect of interaction).

3.2 Definition of stay time

In this study, we explain the definition of the stay time for each customer. For a customer, his stay time $\mathbb{T}$ which is tracked from he coming into the entrance until coming to the checkout register to purchase is defined as follows:

$$\mathbb{T} = \sum_{w \in U} T^w \tag{2}$$

where

$$U = \{A, B, C, D, E, F, G, H, I, J, K, L, M, R, S, V\}. \tag{3}$$

The notation $\mathbb{T}$ denotes the total time that the customer spent in the supermarket and the notation T^w denotes the time spent in the section w of the supermarket which is divided into 16 sections as shown in the table 1 and equation (3).

In the equation (2), the stay time T^w is given as follows:

$$T^w = \sum_{i=0}^{n} t_i^w \quad w \in U \tag{4}$$

where the notation t_i^w denotes the "Elapsed Time" at one time stamp which is shown in the table 2. By using the equation (2) and (4), we can get the stay time of the individual customer in the 16 sections, respectively. The sample data is shown in the table 5 below.

3.3 Influence of stay time on purchase

3.3.1 Definition of the Amount and Volume

In order to discuss the influence between the stay time and purchase, we also deal with the POS data in the table 3 to transform them into two patterns by the customer individually. One is the amount that means how much been spent, and the other is the volume that means how many been bought. As the same as stay time, amount and volume are clustered into 16 sections. By using the equation (5) and equation (6),

$$P^w = \sum_{i=0}^{n} p_i^w \quad w \in U \tag{5}$$

$$Q^w = \sum_{i=0}^{n} q_i^w \quad w \in U \tag{6}$$

where the notation P^w and Q^w denotes the amount and volume in the section w respectively, the notation p_i^w and q_i^w denotes the "Amount" and "Volume" shown in one of the records in table 3 respectively. We can get the amount and volume of the 16 sections for a given customer. The sample data is shown in the table 6 and table 7 below.

3.3.2 Illustration

As a result, we illustrate the influence of stay time on amount and volume in the figure 3. The figure 3(a), 3(c), 3(e) and 3(g) are plotted with the section as the horizontal axis, the stay time as the primary primary vertical axis and the amount as the second vertical axis, respectively. The figure 3(b), 3(d), 3(f) and 3(h) are plotted with the different axis of volume as the second axis.

In the comparison, we know that the customers have their own shopping behavior by themselves on the stay time, purchase of amount and volume in the different sections, but the distribution of stay time is similar to the amount and volume in the comparison of the individual customer. Furthermore, as shown in figure 3, each customer has at least one peak in stay time, amount and volume. In comparison of peaks, the peaks of stay time are much more similar to that of amount and volume than the distribution.

In this section, we have discussed the relation between stay time and purchase of amount and volume, qualitatively. In the next section of Numerical example, we will select some typical customer clusters and analyze the relation among them, quantitatively.

4 Numerical example

In the numerical example, the correlation coefficient(CC) is employed to compare the stay time with amount and volume in each customer cluster. The estimator CC is defined as follows:

$$CC = \frac{\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \overline{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i - \overline{Y})^2}} \tag{7}$$

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i \tag{8}$$

$$\overline{Y} = \frac{1}{n}\sum_{i=1}^{n} Y_i \tag{9}$$

Table 5. Stay time in each section of the individual customer

Customer No.	Section(second)															
	A	B	C	D	E	F	G	H	I	J	K	L	M	R	S	V
a	78	397	247	0	267	145	44	106	29	23	44	1	10	316	43	106
b	7	0	1	8	57	0	0	35	0	37	11	18	0	186	30	136
c	7	5	1	14	532	385	262	40	4	118	108	123	29	345	72	330
d	0	0	2	0	25	45	43	0	15	53	23	10	0	154	10	141

Table 6. Amount in each section of the individual customer

Customer No.	Section(yen)															
	A	B	C	D	E	F	G	H	I	J	K	L	M	R	S	V
a	398	1309	0	0	0	398	0	0	198	294	0	0	256	0	0	724
b	0	533	0	0	0	248	0	0	238	208	0	0	782	0	0	1220
c	0	298	0	0	0	944	658	0	0	306	0	0	374	0	0	164
d	0	0	0	0	0	28	0	0	238	550	0	0	288	0	0	1772

(a) Shopping amount of customer a (b) Shopping volume of customer a

(c) Shopping amount of customer b (d) Shopping volume of customer b

(e) Shopping amount of customer c (f) Shopping volume of customer c

(g) Shopping amount of customer d (h) Shopping volume of customer d

Figure 3. Comparison between stay time and purchase behavior

where (X_i, Y_i) is a sample of paired data, $\overline{X}$ and $\overline{Y}$ are the arithmetic mean of X_i and Y_i, respectively. The notation n is the total number of sample data. The value of equation (7) is given between -1 and 1. The value of -1 indicates perfect negative correlation and the value of 1 indicates perfect positive correlation.

4.1 Classification of customers

In marketing research, customer loyalty is a very important key to lead to more enterprise's profitability. Generally, the customers who purchase in a large amount are considered as the loyal customers. As well as a retail perspective, the shopping frequency has been recognized as another important role, increasingly.

In the experiment data, there are 3389 customers with 6609 times of purchase, and the maximum times of purchase in one customer is 18 which has the same meaning as the shopping frequency. Therefore, 3389 customers are clustered by the shopping frequency from 1 to 18, and the clusters are shown in the table 8 below. The label "Shpping Frequency" denotes the purchase times of the customer, and the label "Size" denotes the number of customers in the cluster C_i who have purchased in the same purchase times i.

Table 8. Classification of the customers by the shopping frequency

Cluster No.	Shopping Frequency	Size
C_1	1	2018
C_2	2	641
C_3	3	300
C_4	4	177
C_5	5	105
C_6	6	48
C_7	7	39
C_8	8	24
C_9	9	8
C_{10}	10	9
C_{11}	11	6
C_{12}	12	5
C_{13}	13	1
C_{14}	14	5
C_{15}	15	0
C_{16}	16	0
C_{17}	17	2
C_{18}	18	1

Table 7. Volume in each section of the individual customer

Customer No.	Section															
	A	B	C	D	E	F	G	H	I	J	K	L	M	R	S	V
a	1	11	0	0	0	1	0	0	1	3	0	0	2	0	0	3
b	0	4	0	0	0	1	0	0	1	1	0	0	5	0	0	10
c	0	1	0	0	0	3	5	0	0	2	0	0	1	0	0	4
d	0	0	0	0	0	1	0	0	1	5	0	0	1	0	0	5

4.2 Analysis and Discussion

In the section 3.3.2, the relation between the stay time and purchase of amount and volume has been analyzed, qualitatively. In this section, we discuss it with a estimator of correlation coefficient, quantitatively. As the stay time, amount and volume have the different criteria of unit individually, we transform them into the percentage by using the equation (10), (11) and (12)

$$\widehat{T}^w = \frac{T^w}{\sum_{u \in U} T^u} \tag{10}$$

$$\widehat{P}^w = \frac{P^w}{\sum_{u \in U} P^u} \tag{11}$$

$$\widehat{Q}^w = \frac{Q^w}{\sum_{u \in U} Q^u} \tag{12}$$

T^w, P^w and Q^w are given in equation (4), (5) and (6) which denote the stay time, amount and volume in section w. $\widehat{T}^w$, $\widehat{P}^w$ and $\widehat{Q}^w$ denote the percentage of T^w, P^w and Q^w, respectively.

By using the equation (10), (11) and (12), stay time, amount and volume are transformed into percentage.

Table 9. Correlation coefficient of purchase amount

Cluster No.	Correlation Coefficient
C_1	0.60
C_2	0.66
C_3	0.67
C_4	0.71
C_5	0.74
C_6	0.74
C_7	0.69
C_8	0.68
C_9	0.76
C_{10}	0.68
C_{11}	0.78
C_{12}	0.79
C_{13}	0.59
C_{14}	0.84
C_{17}	0.68
C_{18}	0.93

4.2.1 Comparison between stay time and amount

Firstly, we discuss the relation between the stay time $\widehat{T}^w$ and amount $\widehat{P}^w$. By using the equation (7), the correlation coefficient between the stay time $\widehat{T}^w$ and amount $\widehat{P}^w$

$$(X_i, Y_i) = (\widehat{T}^w, \widehat{P}^w) \quad w \in U \tag{13}$$

is calculated for all the sections in U which is defined in equation (3). The total number of the customer is 16 except the cluster C_{15} and C_{16} with no object. In each case, all of the customers are estimated individually, and the average values are shown in the table 9.

Generally, if this value of correlation coefficient between two variables is over than 0.6, a strong correlation between them can be considered. In the table 9, the value of correlation coefficient in all the clusters are over than 0.6 except cluster C_{13} whose value is also approximate to 0.6 extremely. therefore, a strong correlation is indicated between the stay time and amount.

Table 10. Correlation coefficient of purchase volume

Cluster No.	Correlation Coefficient
C_1	0.65
C_2	0.72
C_3	0.75
C_4	0.76
C_5	0.79
C_6	0.79
C_7	0.76
C_8	0.75
C_9	0.78
C_{10}	0.78
C_{11}	0.78
C_{12}	0.81
C_{13}	0.95
C_{14}	0.83
C_{17}	0.75
C_{18}	0.94

4.2.2 Comparison between stay time and volume

As the same processing shown in section 4.2.1, the correlation coefficient between the stay time $\widehat{T}^w$ and volume $\widehat{Q}^w$

$$(X_i, Y_i) = (\widehat{T}^w, \widehat{Q}^w) \quad w \in U \tag{14}$$

is calculated for all the sections in U. For each cluster, all of the customers are estimated individually, and the average values are shown in the table 10.

In the table 10, the value of correlation coefficient in all the clusters are over than 0.6, and a strong correlation is indicated between the stay time and volume. Also, we compare the correlation between the stay time and volume with it between the stay time and amount in each customer cluster as shown in the figure 4. The x coordinate the customer clusters from cluster C_1 to cluster C_{18} except cluster C_{15} and C_{16} and the y coordinate denotes denotes the value of correlation coefficient. The solid line denotes the value of correlation coefficient between the stay time and amount, and the dashed line denotes the value of correlation coefficient between the stay time and volume. Through the figure 4, the correlation coefficient between the

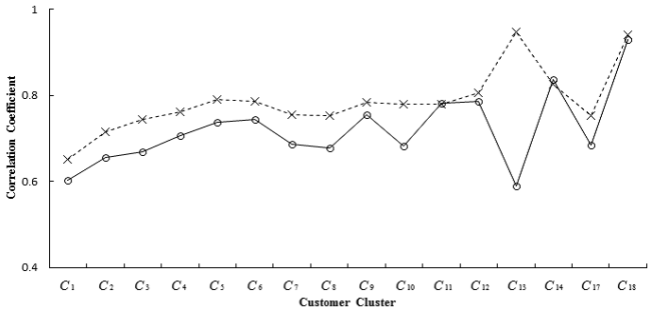

Figure 4. Comparison of correlation coefficient in different customer clusters

stay time and volume shows a stronger correlation than it between the stay time and amount in almost all the customer clusters except the cluster C_{14}, however the value is just 0.01 below.

5 Conclusion

In the present study we discussed the influence of the stay time on the purchase behavior. By dividing the layout of supermarket into 16 sections, we transform the customer's movements into stay time which is obtained using RFID. In order to understand the decision-making process of purchase behavior from the stay time, we also gain the POS data of the shopping amount and volume in each section.

In the numerical example, 3389 customers are clustered by their shopping frequency from 1 time to 18 times in the period of this experiment. In all of the customer clusters, the results show a strong correlation between the stay time and purchase behavior of shopping amount and shopping volume and also provide support for two hypotheses below.

H1. The stay time has a positive effect on both of the shopping amount and the shopping volume.

H2. The effect of the stay time on the shopping volume is bigger than it on the shopping amount.

Furthermore, as shown in the figure 4 the dashed line shows an increasing tendency from cluster C_1 to cluster C_{18}. However, there is a little deviation from this tendency around C_{13}, C_{14} and C_{17}. The results provide support for one hypothesis below.

H3. The effect of stay time on the shopping volume is more conspicuous in the customer clusters with high-frequency shopping than it in the customer clusters with low-frequency shopping.

In the next study, we would like to improve hypothesis H3 with more experiments.

6 Discussion and further research

Recently, the ability and the importance of customer knowledge is indicated in some researches[8][9]. Magi and Julander[10] proposed an implementation referring to consumers' store-level knowledge. For this purpose, we cluster the customers by their shopping frequency and the customer who has a high-frequency shopping is considered as a knowledgeable customer rather than a loyal customer. We suppose that the knowledgeable customers would spent time on shopping in a optimal way and their purchase behavior in a certain area would be reflected in the stay time, sensibly. However, only the shopping frequency is not enough to define the knowledgeable customer, extremely. Therefore, we would like to propose a criteria or an evaluation function including the elements of shopping frequency and some other ones, especially the stay time.

Moreover, through this study, we also recognized the effect of stay time on the purchase behavior. But, the sensitivity of the stay time when it changes how does it reflected in the purchase is not discussed at all. To resolve this issue, a graphical model of bayesian network would be introduced which is also a probabilistic model based on bayesian inference. In the bayesian network, the probability of purchase and stay time in each section are denoted as parent node and child node respectively, and the relation between them is denoted as the link. By using the bayesian inference, Equation (15) is given as follows.

$$Pr(P^w|T^u) = \frac{Pr(P^w = 1)\prod_{u\in U} Pr(T^u|P^w = 1)}{\sum_{p^w\in(0,1)}(Pr(P^w)\prod_{u\in U} Pr(T^u|P^w))} \quad (15)$$

$Pr(p^w)$ and $Pr(T^u|P^w)$ denote the prior probability of purchase and likelihood function, respectively. The denomination is the marginal distribution of the purchase in the purchase state and non-purchase state which are denoted by the boolean variable with the value of 1 and 0. $Pr(P^w|T^u)$ is the posterior probability depend on the stay time. If there is a change of stay time in a certain section, it will lead to a reflection in the probability of the purchase which might increase or decrease. We hope to construct a modeling of consumer behavior and purchase behavior in our future study.

Acknowledgement

This work was supported by MEXT. KAKENHI 21013032, and "Strategic Project to Support the Formation of Research Bases at Private Universities": Matching Fund Subsidy from MEXT, 2009-2013.

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Processing Combinatorial Thinking: Innovators Marketplace as Role-based Game plus Action Planning

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Abstract. It is difficult to invent the new innovative ideas, i.e., of potential impact to the human society. There are many products and services in the world, but epoch-making products or services are rarely created. Innovators Market Game is a method for creating new ideas by combining existent ideas. Players participate in the game and think of the new ideas. In this study, players take part in the game acting the roles. These roles are selected from the real world, for example engineers, police officers, transportation authority, government and so on. We name this way of the game Role-based Innovators Market Game. The strict rules, acting roles and communication make players more creative and imaginative. This study proposes not only the way of creating new ideas, but also the process of making them practical, by including the step for Action Planning. By using this method, players can cultivate these ideas. These two methods formed the refined process of Innovators Marketplace®, help in contriving innovative ideas for the human society in discovering and solving practical problems.

1 INTRODUCTION

People demand new system of society. On 11th March 2011, the Tohoku Earthquake in Japan happened. After this unprecedented disaster, many problems rose. There remain a lot of problems such as radioactive contamination from the nuclear power plant in Fukusima, the problems of recovery of cities broken by tsunami, and so on. Many specialists continue discussing, however, in the present condition, there are no fundamental solutions for these problems. What are necessary in Japan are the drastic reforms, the change, and new ideas.

Based on methodologies of Chance Discovery [1], where problems such as marketing and designing of new/rare products have been solved, we created Innovators Market Game® [2] as a method for creating new innovative ideas. In this paper we improves Innovators Market Game (IMG hereafter) in creating feasible ideas, i.e., ideas which can be embodied in the real actions in real business. This method encourage players create high-value ideas for the real market and trains their creativity. In this manner IMG gives the solution for practical problems. The game board is the miniature of our society, and specialists from broad fields can take part in the game to discuss and make solutions. Innovators Market Game is expected to be, and introduces as, the method of creating ideas that can propose strategies for changing the world-wide social systems [3, 4].

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2 RELEVANT STUDY

2.1 Innovators Market Game (IMG)

Since the birth of the first human being, innovations have been demanded in various domains. Among the large number of definitions of innovation, let us consider the creation of potential impact to the human society. IMG is one of the methods for creating new innovative ideas. A feature of IMG is that it has a mechanism for natural selection of ideas. That is, players criticize, contradict, or evaluate the ideas, which are created in the game, at each standpoint through the communication in the game. IMG may look like a card game – we may be able to discuss the difference of IMG and Innovation Game [5] which existed since before IMG about the approaches to reflecting values in the market. However, a remarkable difference is that IMG introduces a game board obtained by KeyGraph® [1, 6]. On this board, visualized relations and connections among various words in the society are printed. Players have the cards, which various existent technologies are printed on, and imaginary (toy) money in the game. Players combine these cards based on the lines connecting potentially relevant ideas on the game board, to create new ideas. Others may buy the ideas with paying money or criticize/evaluate the ideas with giving comments orally. This is the basic rule. Innovators Market Game has no strict rule, therefore, players can change rules flexibly according to their needs or purposes.

2.2 KeyGraph®

KeyGraph [6] is the algorithm designed by Ohsawa in 1998 before the invitation of Chance Discovery. Properly formed data, such as a document – words constituting the sentences – are put in KeyGraph, and the strength among these words or frequency of appearance are calculated. Among other network-based visualizations that came into fashion after around year 2000, the features of KeyGraph are (1) it can extract and visualize the keywords which is low (including even zero) frequency but important in the document with respect to clusters of frequent events, and (2) the tool of KeyGraph evolved for assisting chance-seeking users' metacognition [7] by enabling to edit (move/cut/compare/etc) the graph. These features help players find the hidden relations among words. Players read the visualized network map, and create ideas for externalizing potential

connections among observable events/words/items. In IMG, KeyGraph is used for aiding the generation of innovative ideas.

2.3 The difference between other methods

There are many other methods for creating ideas such as brainstorming [9] and KJ method [10]. Innovators Market Game is different from these ways because this method does not aim at inventing many ideas divergently. Moreover, the rule of IMG encourages players to say negative comments to ideas; on the other hand brainstorming restricts negative comments. Compared with KJ method, IMG is similar at the point of using cards. However, it is different in the point that IMG is based on the concept of Chance Discovery - players connect their various experiences and scenarios for future through data-based metacognition, communications and thoughts for creating the new scenarios or ideas to be sympathized by other members.

2.4 The Rules of Innovators Market Game

IMG generally proceeds as in the following steps.

1. Players choose one of three roles, an entrepreneur, an investor or a consumer. Consumers can choose their jobs such as governmental officers, university faculty, or doctors, etc.
2. Entrepreneurs buy a preferable number of cards on which existing technologies are printed, paying the imaginary money.
3. Consumers speak out their requirements in their real lives, and request entrepreneurs to invent ideas to satisfy their needs.
4. Entrepreneurs view the game board and create the new ideas to fulfill consumers' requirements, by combining their own cards.
5. Investors evaluate these ideas and put their imaginary money into the ideas they prefer. Consumers buy the most favorite ideas created by entrepreneurs. Investors and consumers can comment freely to entrepreneurs about their ideas to improve or change.
6. Repeat above 1 to 5 several times for about 2 hours.
7. Finally, the entrepreneur who obtained more money than others wins. Also the investor will win on the amount of money. Consumers have a speech about how their life will get better by the ideas which entrepreneurs create. Entrepreneurs and investors give their vote to consumers and decide the winner.

2.5 Features and Advantages of IMG

IMG has several features as follows.

1. IMG is the combinatorial thinking method for creating innovative ideas, by which players can invent high-value ideas for the real market.
2. It is recommended to present critical comments on the ideas.
3. IMG is the workshop-style serious game.
4. Created ideas are considered and evaluated from various angles by the roles which players act.
5. Ideas worthy buying are selected via strict evaluations.
6. Players can train their creative and imaginative skills.
7. The rules can be changed flexibly according to players' purposes.

IMG is utilized for several companies and universities in Japan. Companies use this method to create new products or services, universities use it for further study and certain institute planed science policy-making by using IMG.

2.6 Problems of IMG

As mentioned, there are unique features and several advantages in IMG. However, some problems have been pointed out. First, IMG tends to be money-oriented game. Because investors are apt to get imaginary money, their interest in the quality of ideas declines. Second, the procession of IMG is real time; players can speak whenever they want. Therefore, someone who is not good at speaking has difficulties in joining the game, loses their timing to get in conversation and reduces their motivation for the game. Third, there are few clear rules about the way of conversation in this game. There is fear that players' conversations tend to be idle talk. Fourth, the ideas created in IMG lack in feasibility - concrete possibility of realization. Players aim at creating new and unique ideas, however most of them are not feasible enough even after improvements via criticisms and selections.

3 HYPOTHESIS

3.1 The Aim of Study

In this study, we propose an improved process of thoughts and communication (we call this overall process Innovators Marketplace® because we may abandon the air of gaming on the way), including Role-based Innovators Market Game (Role-based IMG), and Action Planning. By Role-based IMG, the above problems of IMG are solved. The system of IMG is redefined and this system makes it possible to create more innovative ideas. The introduction of Action Planning to IMG enables players' ideas to be cultivated and improved. We show those two new methods are useful for creating better ideas. In this paper, we call the previous type of IIMG Item-based IMG for comparisons.

3.2 Hypothesis: Five Factors in Creating Ideas

It is necessary to set the rule of IMG to create the high market value ideas. In IMG players create ideas under its rules and process. In the rules and the process, there are factors to create ideas, which we can divide roughly into five. These five factors are chosen from the rules and the process of IMG. To generate ideas in IMG, following five factors are important; Identification, Restriction, Gaming, Communication and Information (Figure 1). In this study, we define these factors as follows and search the relations of 5 factors.

Figure 1. Five Factors in Creating Ideas

Identification: The word that contains the meaning of absorption. We define the word Identification as "a strong feeling that

oneself is someone else or that one is strongly interested in something and shares the feelings." Identification is the state of mind that one feels strongly put in the situation for creating ideas, consciously or unconsciously.

Restriction: Usually, restrictions or difficulties prevent people from generating new ideas. However, it is known that constraints can enhance creativity, as R.A. Finke says in [11], "the likelihood of discovering a creative invention is greater if the component parts are restricted." In this study, I define that Restriction is the rules which help players create innovative ideas.

Gaming: Everyone knows games are fun - we can enhance our creativity and imagination considerably by adopting the factor of games in order to solve the practical problems. Games are the parts of reality, or the things that make reality simple. Generally, gaming is known as an activity in which people compete with each other according to agreed rules. We add the factor of enjoyment to say gaming is "an activity in which people compete with each other enjoyably according to agreed rules." Gaming means to realize simplicity, competition and enjoyment at once.

Communication: Although it is important to think deeply by oneself, we can often hit good ideas by conversation among over three people. As in studies for innovations, it is said that through the communication among over three people, people tend to generate the unique ideas in the same period of time and increase sympathetic remarks for others [12]. Communication is the important factor for creating ideas.

Information: It is difficult to generate ideas without any knowledge or information. To create ideas, basic knowledge and information about a certain field is essential. In the combinatorial thinking, it is important to know about basic technologies. Also to solve practical problems, we should know about them.

3.3 Hypothesis: Spiral Growth And Value Enhancement Model (SGAVE-Model)

As in book [2], we defined Innovators Marketplace as a process to innovation involving IMG and its players. Players can improve their creative and imaginative skills by Role-based IMG. Here we propose Spiral Growth And Value Enhancement Model (SGAVE-Model) by introducing Action Planning. Action Planning is the stage in which players brush up ideas that are created in IMG. This stage is carried out after IMG. SGAVE-Model is the model of the growth of players' skills for creating ideas and the enhancement of ideas' market value (Figure 2). By practicing IMG and Action Planning, players can develop their imaginative and creative skills, and ideas are getting more practical and possible to realize. Therefore, the market values of ideas also rise. This is Spiral Growth And Value Enhancement Model (SGAVE-Model).

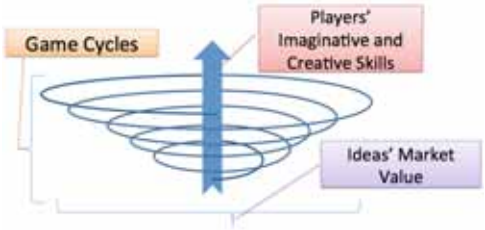

Figure 2. SGAVE-Model

4 ROLE-BASED IMG

4.1 The Outline

Role-based IMG is the new way of IMG based on the hypothesis; to create the high market value ideas, Identification, Restriction, Gaming, Communication and Information are important. The main purpose of this method is to offer a place where players can create more innovative ideas, and to improve players' imaginative and creative skills. To create innovative ideas, Role-based IMG has several different points from previous type of IMG (Item-based IMG). First, there are strict rules in Role-based IMG. The role of Investor is abolished, as we often did in Item-based IMG. Entrepreneurs and Consumers are unified. These are because all these 3 roles, Investors, Entrepreneurs and Consumers, have different requirements to win in the game. To enhance players' Identification and the motivation for creating ideas, in Role-based IMG, all the players take part in the jobs whose standards of winning are equal. Second, the game board is made of the connections of jobs and keywords by KeyGraph (Figure 3). Jobs are ideally the same jobs which players act in the real society, or chosen from the society familiar to the players. Keywords are extracted from the explanations of these jobs by KeyGraph. The input information to KeyGraph is, for example, a published outline, the history, or the social function of each job. Third, Role-based IMG proceeds by the turn system, on the other hand Item-based IMG proceeds by the real-time system. In the turn system, each player has the time to imagine ideas, to present their ideas to others, and to cultivate ideas co-creatively through communication. These strict rules are the Restriction stated in the hypothesis. In the strict rules, players can feel that their actions are evaluated all the time, and stay creative, communicative, and competitive. Gaming, Communication, Restriction advance Identification with roles and the motivation for creating new ideas.

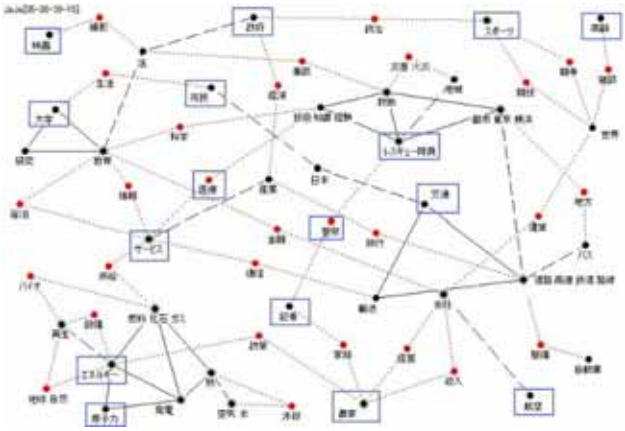

Figure 3. One example of the game board, KeyGraph

4.2 Role-based IMG in Practice

Role-based IMG proceeds as following steps.

1. Players choose roles which they want to act, from the role names appearing on KeyGraph.
2. Players have some imaginary money and 3 cards on which the existent technologies are printed.

3. From the role names on KeyGraph, each player chooses a preferable neighbor, i.e., a role linked to one's own role's node.
4. Each player writes down how one is satisfied/unsatisfied in the daily life/business, using the keywords on the graph to appeal the requirement to the neighbors.
5. Each player creates the ideas that satisfy the requirements addressed to oneself, by combining their technologies on cards.
6. Players present their ideas to other players in turns. Other players can state their opinions to others' ideas.
7. Players evaluate all the ideas. They give their imaginary money to the player who created the best idea.
8. Every player gets another card.
9. Players choose the next neighboring role node to create ideas. Players must choose the node which is linked to their own roles, including the one they already choose.
10. Continue these processes several times and finally the player who gets imaginary money the most comes to be the winner.

Figure 4. The situation of IMG

5 ACTION PLANNING

5.1 The Outline

We also propose Action Planning as a method to brush up ideas created in IMG. By practicing Action Planning after IMG, players can develop their skills for imaginative and creative thinking/communication, and ideas are getting more practical and feasible. In Action Planning, ideas are estimated in 5 criteria; the possibility of realization, the novelty (how new the idea is), the marketability (how well the idea can sell), the impact on the world (the influence on the society when the idea comes true), the originality (how unique the idea is). Players continue their roles and practice Action Planning at least 2 times. That is because Action Planning is the stage to brush up ideas and to improve the market values of ideas. Multiple times of practicing is necessary for realizing SGAVE-Model.

5.2 Action Planning in Practice

There are the following two phases in Action Planning.

Action Planning Phase 1: Players choose one or more ideas created in IMG, and make scenarios for embodying the ideas. Technologies, specialists, materials, budget, terms to realize the ideas, must be considered. The supporters, the competitors and the preventive measures or solutions also must be thought. Players write down these items to Action Planning Sheet 1. Writing is useful for reinforcing the effect of metacognition, which has been an essence for insights in Chance Discovery. In this phase, players think deeply about their ideas, and increase the feasibility of the ideas created divergently.

Action Planning Phase 2: In the practice of Action Planning 2, players plan the details of the idea's outline which is deepened in Action Planning phase 1. In this phase, players fill the sheets called Action Planning Sheet 2. There are the 4 steps to complete Action Planning 2. First, players visualize the relationship among "essential materials, technologies and specialists", "supporters", "competitors" and "customers". Second, players plan the project team to realize their ideas. Third, players divide the process to realize each idea into 4 stages ordered in the time sequence to reach the realization of the idea. They think about how much money and the terms are necessary to complete each stage. Fourth, players plan the business models. In this step, players make it clear the services or products they are going to supply, and determine their marketing strategies and how to measure the value. Through these 4 steps, the ideas created I IMG are getting more practical and possible to realize as the projects, and players can develop their imaginative and creative skills.

6 EXPERIMENRTAL DETAILS

6.1 Role-based IMG in the Experiment

The subjects are the ones who did not have any knowledge about IMG before the experiment. They are men and women around 20 years old. The Subjects experienced Item-based IMG and Role-based IMG. After the experiment, they answered to a questionnaire about the difference between the two types of IMG. The result of this experiment shows whether the designs and the rules of the game are proper. The criteria for the comparison are (1) the degree of absorption in the game, (2) the degree of your speech and discussion, (3) the degree that communication helped you create ideas, (4) whether you can make the most of basic information about your roles into creating ideas, (5) the degree that Gaming help you create ideas, (6) the degree that Restriction like rules of the game help you create ideas, (7) the degree that you are competitive in the game, and (8) the degree of satisfaction with presenting your ideas ("you" means the subject player). These criteria are scored by the points from 1 to 5.

6.2 Action Planning in the Experiment

The same subjects as those played Role-based IMG experienced Action Planning. After practicing Action Planning, they answered to a questionnaire what kinds of abilities players feel being improved by Role-based IMG and Action Planning. The following items are the kinds of abilities; (1) creativity (the ability to create something new), (2) imagination (the ability to propose what does not really exist), (3) communication (the ability to tell others what

one wants to say smoothly), (4) presentation (the degree of satisfaction with presenting ideas clearly to others), (5) logic (the ability to think or speak logically), (6) solution (the ability to solve problems), (7) advice (the degree that others' opinions are useful to create ideas), (8) discussion (the ability for discussing). These items are scored by the points from 0 to 5.
The ideas which players brush up are called projects. After Action Planning, these projects are inspected by the degrees of value. The value of the projects is scored by the points from 0 to 5.

7 RESULTS

7.1 Role-based IMG

The result of this experiment shows whether the designs and the rules of the game are proper. After the game, subject players wrote down how they concentrated in the game, how they felt tired during the game, and how they identified with their own role. Subjects wrote down the process of these three criteria from the point 0 to 5 in a line graph. As the game proceeds, players are getting tired (Figure 5). The concentration and Identification with roles increase until turn 2, and decrease from turn 3. Each turn takes about 1 hour. It can be said that 2 turns (about 2 hours) are suitable to play Role-based IMG, and players can participate in the game with high Identification with their roles.

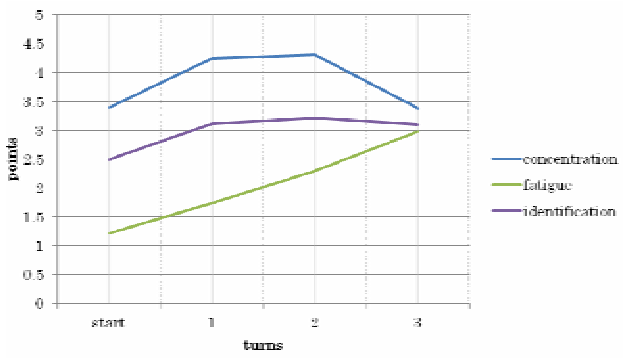

Figure 5. The process of turn in Role-based IMG

Table 1 is the result of comparison between Role-based IMG and Item-based IMG. In almost all the items, Role-based IMG gets higher marks than previous IMG. Item-based IMG is higher in the degree that communication helps you create ideas. There are two peaks in the graph of Item-based IMG (Figure 6). It shows that there are two types of players, who are good at communicating and who are not. Those who are good at speaking create ideas through the communication, but it is easy to tend to the idle talk. Those who do not speak too much create ideas silently. For reticent players, communication is not important. That is why the result is as follows. On the other hand, Role-based IMG has only one peak. We regard these as results of the strict rules of Role-based IMG where the time for communication and presentation is fixed. As players' chance to talk is equal, it is thought that the estimation of Role-based IMG does not vary widely.

Table 1. The comparison between Role-based IMG and Item-based IMG

	Role-based IMG		Item-based IMG	
	average	median	average	median
the degree of absorption in the game	3.8	4	3.1	3
the degree of your speech and discussion	3.5	3	3.1	3
the degree that communication helped you create ideas	3.1	3	3.4	4
whether you can make the most of basic information about your roles into creating ideas	3.3	3.5	3.1	3
the degree that Gaming help you create ideas	3.9	4	3.6	4
the degree that Restriction like rules of the game help you create ideas	3.8	4	3	3
the degree that you are competitive in the game	3.4	3.5	2.6	3
the degree of satisfaction with presenting your ideas	3.3	3	2.9	3

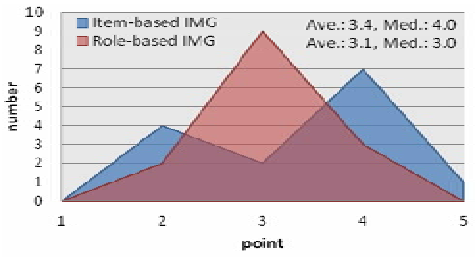

Figure 6. The degree that communication helped player create ideas

7.2 Action Planning

Table 2 is the result of the players' improved abilities. The abilities for creativity and the talents of imagination and communication are better trained in Role-based IMG, because in IMG ideas are generated through the combination of technologies and the communication with other players. Players recognize that these abilities are developed. On the other hand, it shows that the abilities for presentation, logic, solution, advice and discussion get higher marks in Action Planning. We interpret these results that players think these abilities are developed through brushing up and enhance the ideas' possibility of realization and concreteness. The process of cultivating ideas forces players to discuss with others and persuade others to admit their ideas.

Table 2. The comparison of the abilities

	Role-based IMG		Action Planning	
	average	median	average	median
creativity	3.7	4	2.9	2.5
imagination	3.6	4	2.8	2.5
communication	3.4	3	2.6	2.5
presentation	2.2	2	2.6	3
logic	2.7	3	3.3	3
solution	2.7	2.5	3	3
advice	4.1	4.5	4.3	4.5
discussion	2.3	2.5	2.9	3

Table 3 is the result of estimation of the projects. The average point of 6-grade evaluation is 2.5, and the median is 3. All of the averages are over 2.5 and the median are 3 or over 3. It can be said that projects brushed up in Action Planning are useful comparatively.

Table 3. The estimation of the projects

	average	median
novelty	3.56	4
possibility of realization	3.55	4
marketability	3.39	3
impact on the world	3.73	4
originality	3.58	4

8 CONCLUSION

In this paper, we proposed two improvements of Innovators Market Game; Role-based IMG and Action Planning. Role-based IMG is designed by the hypothesis that 5 factors take important roles in creating ideas. 5 factors are Identification, Restriction, Gaming, Communication and Information. We use the game board on which relations and connections among various existent jobs or keywords are printed, introduce the turn system and set strict rules for players to identify with the roles in IMG. In the experiment, it is shown experimentally that Role-based IMG works properly by examining "the process of turn in Role-based IMG" and "the comparison between Role-based IMG and Item-based IMG". According to the survey, the relations of 5 factors are clearly shown. First, knowledge about roles, Identification with them, understandings toward existent technologies and Communication among players in the turn system make players aware strongly of Restriction. Restriction is often thought that it prevent people from generating new ideas. However, it is known that proper constraint can enhance creativity. Evaluation of the ideas by the turn system and the imaginary money motivates players to keep them taking part in the game; an activity in which people compete with each other enjoyably according to agreed rules. These motivations and the awareness of the roles increase the players' senses of Gaming through Communication, and players can enhance their Identification with roles; strong feelings that you are like someone or that you are very interested in something, and share the same qualities or feelings. Therefore, players' motivations for creating new ideas can last. Enhanced Identification increases players' interests in roles, and these interests lead the motivations for creating new ideas (Figure 7).

Figure 7. The relations of 5 factors

Action Planning is the method that enables players' ideas created in IMG to be cultivated and improved. Through the discussion and presentation, players add further information to their ideas, design the details of ideas and make these ideas into the projects which are much more possible to realize. It is shown that the ideas, which are brushed up in Action Planning, get high marks in concretion and possibility of realization. Moreover, by practicing Action Planning players can enhance their skills that are difficult to achieve only by IMG. Action Planning can work not only as a method of brushing up ideas, but also as an educational technique. Although further study is needed whether the ideas created and brushed up by Role-based IMG and Action Planning can be the business ideas, it is clearly shown that the possibility of realization of ideas get stronger by Action Planning, and players can get the satisfaction with the advancement of their abilities through Action Planning.

As mentioned in the Introduction, Role-based IMG and Action Planning can be used in creating ideas that can change the world, especially we put the realization of super-resilient society, such as going beyond the recovery to further development of Touhoku in Japan as a concrete target. When the specialists, for example the experts of nuclear, gather and practice Innovators Market Game, then, innovative ideas that would solve any problems can be created.

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Silent Knowns, Bricolage, and Chance-Seeking

Emanuele Bardone[1]

Abstract. As an opportunity whose real impact will be assessed in the future, a chance deals with what we know, but also with what we do *not* know. This paper is meant to be a theoretical analysis on the relationship between what we know and what we do not know – knowledge and ignorance – and how they are related to chance-seeking. Indeed, knowledge and ignorance are not two distinct and separate domains, but they actively influence each other. In exploring how that happens, we will illustrate the notion of silent knowns. Building on Lévi-Strauss' contribution on the matter, we will show how silent knowns are phenomenologically coupled with the activity of the chance-seeker as a *bricoleur*. We will list five elements characterizing the chance-seeker as a bricoleur, in which this connection appears to be theoretically fruitful, namely, open-endedness, historicity, narrativity, antifragility, and situatedness.

Introduction

By definition, a chance is a new event or situation conveying both an opportunity and a risk in the future [14]. As an opportunity whose real impact will be assessed in the future, a chance deals with what we know, but also with what we do *not* know. This paper is meant to be a theoretical analysis on the relationship between what we know and what we do not know, that is, between knowledge and ignorance, and how this affects the activities of *chance-seeking*.

Since a chance offers an opportunity for action, something that, by definition, is not and cannot be immediately epistemically justified, we should look into the the way in which knowledge engages ignorance, and vice-versa. What we implicitly assume is that knowledge and ignorance are not two distinct and separate domains, but they actively influence each other. In exploring how that happens, we will introduce and illustrate some example of *unknown knowns*. Unknown knowns are instances of an intriguing cognitive phenomenon – mostly ignored in favor of other forms of knowledge – in which, as we will see, we know something but at the same time we do not know it or we believe we do not know it.

After a brief illustration of various types of unknown knowns, namely, forgotten knowns, secreted knowns, and tacit knowns, we will specifically focus our attention to a particular case of unknown knowns that we will call *silent knowns*. In the second section we will provide some example and a theoretical characterization, which is meant to shed light on the importance of such a phenomenon with relation to chance-seeking.

In the third and last section, we will connect the concept of silent knowns with that of *bricolage* (or *tinkering*). Building on Lévi-Strauss' contribution on the matter, we will show how silent knowns are phenomenologically coupled with the activity of the chance-seeker as a bricoleur. We will list five features, in which this connection appears to be theoretical fruitful.

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1 Unknown Knowns: Things We Do Not Know We Know

During a press conference in March 2003 on the problem of weapons of mass destruction allegedly being developed by Saddam Hussein, Donald Rumsfeld tried to explain the American strategy by engaging the journalists in a sort of philosophical discussion. Rumsfeld said that there are things we know we know – *known knowns*. For instance, we know that we know that now it is raining. Known knowns belong to the realm of certainty. Then we have things we know we do not know – *known unknowns*. We know that we do not know if the next summer will be warmer than usual. That is the realm of Socratic ignorance, which brings us to doubting. Finally we have things we do not know we do not know – *unknown unknowns*. We ignore something and we do not know that we do that. That can be the case of *black swans*, that is, highly improbable events that usually people do not take into their account [23]. For example, mainstream media financial experts had completely ignored that a financial crisis was going to hit the entire globe in 2008. They did not know when the crisis could strike, *and* they did not even think that something like that could happen. Unknown unknowns are all instances of *ignorance of ignorance* [7].

In commenting Rumsfeld's amateur attempt of philosophizing, Slavoy Žižek claimed that there is a fourth category that the former secretary of defense missed, which is also the most enigmatic one: things we do not know we know, that is, *unknown knowns* [30]. Indeed, that there are things we do not know we know may sound a little bit paradoxical. But it is not so. The idea of unknown knowns may tell us something quite important about human cognition and the way we know.

	knowns	**unknowns**
known	known knowns	known unknowns
unknown	unknown knowns	unknown unknowns

Saying that there is something we do not know we know means that in some sense we know something and in some other we do not know it. Clearly, unknown knowns are not things that we simply *ignore* the way we ignore what the weather will be like next summer. They are *knowns* after all. At first approximation, we may say that unknown knowns are all cases in which we lack *reflective* knowledge. In a way, we may say that unknown knowns are cognition without *meta*-cognition. Metacognition is usually defined as higher order thinking, which allows us to gain active control over certain cognitive processes like, for instance, learning [13]. Metacognition grants us the possibility to develop a reflective attitude towards what we know (or what we do not know). And in so doing it improves thinking as well as decision-making. Unknown knowns lacks this important dimension. But there is something more to add.

In providing a general characterization of unknown knowns, we

refer here to a cognitive dynamic that we may call *reverse epistemic embubblement* [1]. *Epistemic embubblement*, along with the notion of epistemic bubble, was introduced by John Woods and it is defined as follows:

> Whenever it is true for *Y* to say of *X* that *X* believes that *P*, it is also true that *X* takes himself as knowing that *P* [29, p. 738].

Epistemic embubblement is that process of *knowledge ascription* to belief and its main outcome is that a person believes she knows P, when she does not know P. We claim that unknown knowns are exactly the product of the reverse process:

> an agent A believes she does not know P, when she does know P.

In this case the process of epistemic embubblement is somehow reversed. That is, we are not in presence of knowledge ascription, but *ignorance* ascription so that (we believe that) we do not know when we do know. In this case it is not knowledge which is apparent (or faked), but its contrary, namely, ignorance. Such a reverse epistemic embubblement brings us into a sort of bubble, in which it is not our ability to know that become problematic, but our ability to ignore or being ignorant.

In some respect this might sound a bit weird, as ignorance is traditionally conceived as mere absence of knowledge. However, as Proctor put it, "ignorance is more than a void" [17, p. 2]. That is, it is not a uniform block either. In this respect we do agree with Proctor when he encourages scholars and researchers to know more about ignorance and its various manifestations – the so-called *epistemologies of ignorance* [21].

As far as we are concerned here this reverse embubblement we have just mentioned has some important cognitive consequence that we want to introduce here with relation to our main topic: chance-seeking. When we say that we know something when we actually do not, our ignorance is not cognitively fecund, since we just have the facts wrong. That is what Rescher called error of *commission* [18]. Conversely, in the case of unknown knowns our *ignorance* might turn out to be a chance. More specifically, an unknown known may point to something that might be helpful to solve a problem, even though, as we will point out in this paper, we do not *yet* how it could be so. In the rest of this section we will provide a list of unknown knowns. That will be meant for introducing the category of unknown knowns that are going be our focus in this paper – those unknown knowns that we will term *silent knowns*.

1.1 Forgotten knowns

When talking about unknown knowns, the first category that may easily come to one's mind is the so-called *forgotten known*. As simple as it may sound, we do not know, because we forgot something we used to know. The interest for forgotten knowns is related to the paradoxical concept of "problem- solving": in order to solve a problem one must in some sense already know the answer, there is no real generation of hypotheses, only recollection of them [9, p. 1].

According to Plato's doctrine of *reminiscence*, such paradox can be solved by resorting to the idea that we ignore some truth, not because we really ignore them, but simply because we *forgot* them. For Plato research and learning are *wholly recollection*. In the Plato's dialogue *Meno*, Socrates leads a slave boy to the recollection of a conclusion equivalent to the Pythagorean theorem from examples, in terms of constructions, and appropriate questions [9, p. 3]. That is meant to prove that the slave – when appropriately guided by means of cognitive scaffolding – may come to knowing what, however, he *already* knows, but he somehow has forgotten.

Plato's doctrine of *reminiscence* is just a philosophical example of forgotten knowns. Another example – much less philosophical but nonetheless intriguing – is the process of unlearning as a way of forgetting. For instance, people may unlearn how to use a technology, because it becomes useless or it has been superseded by a more efficient one (for example, typing skills on a typewriter). Unlearning may be even an indispensable part of a learning process [19]. In other cases, unlearning can be the product of *ochlocratization* and so leading to quite detrimental social outcomes [12]. That is, people may spontaneously quit on adopting some morally and/or cognitively virtuous habits or attitudes, because society no longer actively supports or incentives them. This process of ochlocratization is not the product of a group of persons, but it is a process that is *collectively* enacted, and in so being it cannot be entirely controlled.

In all cases, however, the process of unlearning does not reset our memory to default, as what has been forgotten has not *gone*. There are indeed situations in which forgotten knowns can be brought back to light, for instance, by re-learning activities, which are meant to re-activate previous amnestic traces in our brain. Even in science some past but forgotten discovery may be re-discovered once again like in the case of fatty heart (lipotoxic cardiomyopathy). Such a disease was once questioned and then abandoned. Now it has been reconsidered thanks to the development of better diagnostic tools like magnetic resonance spectroscopy, which allows noninvasive screening for fatty heart [22].

1.2 Secreted knowns

There is another type of unknown knowns, which differ from forgotten knowns, although they bear some resemblance. Such unknown knowns mostly refer to the notion of the Freudian unconscious. They are disavowed beliefs and suppositions that are nonetheless causing certain behaviors to emerge without our conscious adherence [30]. Such knowns become unknown by means of *repression*. According to Freud, *repression* is the first mechanism of defense that is responsible for banishing unpleasant *knowns*, which, therefore, become inaccessible from consciousness [20].

Like forgotten knowns, this second type of unknown knowns are not simply ignored, but repressed or, better, *secreted* in one's psyche. In principle, they can become known. That was the great insight of Freudian psychoanalysis. In fact, a secreted known generates a symptom, which is nothing but "a coded message about my innermost secrets, my unconscious desires and traumas" [30, p. 11]. As coded messages, secreted knowns do not appear as they really are. They are like *camouflaged*, so to say. However, they may come to light – and so become known, but that happens if another person – usually the analyst – can identify them and therefore appropriately decode them as clues of traumas or one's innermost fantasies. In this case, the process of *recovery* is mediated chiefly by another human being specifically trained to do so.

1.3 Tacit knowns

The third category of unknown knowns is the category of *tacit knowns*. Here the term tacit refers to Michael Polanyi called "the tacit dimension" [16]. Tacit knowns can be described by the famous motto: we know more than we can tell. Which means that what is unknown is not something that is *ignored*, but something we are *not*

aware or or we cannot fully describe *in words*. That is, we cannot have an explicit and fully comprehensive sentential representation.

In order to clarify the nature of tacit knowns, consider the case of face recognition. Suppose that we see a friend of ours. Indeed, we can easily recognize her face. Though, if we are asked to tell why we can do that, we may easily get into trouble. What makes our friend's face *her* face? Is it her pronounced nose? Her pale cheek? Her haircut? The color of her eyes? Her personality? Or what? For Polanyi what makes us recognize our friend's face remains tacit and therefore inaccessible to explicitation and awareness. In his own words:

> we are aware of the proximal term of an act of tacit knowing in the appearance of its distal term [16, p. 11].

That means that knowing things is a process mediated by signs which we are aware of only in terms of what they *produce* in our mind. So, we recognize our friend's face as the result of a *sign activity* [11], which, however, remains tacit or simple inaccessible to our awareness.

The paradox of tacit knowns precisely resides on this very fact of cognition: we are aware of the result of an inference we perform, but not the inferential process itself. In Polanyi's terminology, attendance does not come along with awareness. Therefore, for anything we know there is always something that we do not know (or we are not aware of). In this sense, tacit knowns always tend to be displaced away from ourselves.

Building on Polanyi's idea of the tacit dimension, we argue that tacit knowns cannot become known knowns. In other words, what is tacit remains tacit, it cannot be fully made explicit. As OToole fairly noted, when we focus on a proximal term, that changes the proximal term to a distal term [15]. In so doing, some proximal term may be simply ignored or simply not stated . This is a crucial problem, for instance, in building a model of a certain phenomenon or practice.

However, tacit knowns can be shared and/or communicated. And, as long as that can happen, we can identify them. Polanyi refers to the act of *pointing* as the one enabling us to share our tacit knowns. For example, suppose that we are gossiping with a friend about a person that at the moment she cannot recall in her mind. If we are lucky enough and the person in question is passing us by, we can point to him so that our friend can easily understand whom we are talking about. This activity of pointing, which is a form of *disembodiment*, [10] allows us to share that which we attend to – the proximal terms – and so our tacit knowns. On a more sophisticated level, something similar to that is used by the police for allowing eyewitnesses to share what they know but cannot fully express in words.

1.4 Silent knowns

The last category of unknown knowns is the one we are going to deal with in this paper, as it bears an important relation to chance-seeking. We mentioned that certain things are unknown not because they are *ignored*, but because they have been forgotten. So, they are floating in the past waiting. It is only be means of recovery or re-learning that we come to know what once had been forgotten. There are also things that, on the contrary, it seems that we don't know *yet* we know. What kind of unknown knowns are those? We argue that such unknown knowns are those pieces of knowledge apparently useless and irrelevant at a certain point in time, but which turn out to be relevant only in a *later* point in time. Usually that happens in conjunction with other pieces of knowledge or events that come about afterwards. These unknown knowns may be called *silent knowns*.

Silent knowns are not to be mistaken for tacit knowns. As already mentioned, tacit knowns are known, but cannot be told or made explicit. For nobody doubts about their relevancy. The problem is how to communicate or share them. Conversely, with silent knowns relevance is what is at stake. That is, they are *known*, but we are not immediately able to say when they can be relevant, that is, when they can be fruitfully employed and for what.

Silent knowns are our major interest in this paper, because they may shed light on the phenomenon of chance-seeking. What we are going to show in this paper is how silent knowns help us make sense of an important feature of chance-seeking. Silent knowns drastically differ from any other form of ignorance (Socratic ignorance or ignorance of ignorance, for instance). As already mentioned above, unknown knowns do not lead to errors of commission. And in a way, we may also say that they do not lead us to errors of *omission*. Unknown knowns – in the form of silent knowns – merely offer a *potential chance* for knowing, which, however, does not appear immediately evident or at one's disposal. As we will see, time is a major factor determining whether a silent known is going to remain silent or it will turn out to be a good chance.

2 Silent Knowns: Two Examples

In the previous section we have briefly illustrated various types of unknown knowns paying particular attention to one of them: silent knowns. Our main interest in this section is to show how silent knowns are particularly relevant to chance-seeking. In order to do that we are going to present two examples, which, hopefully, will help us make our point clear.

During his 2005 commencement address at Stanford University the American Entrepreneur Steve Jobs proudly told an interesting story[2] which is worth recalling here. After one semester at Reed College, Jobs decided to quit. As a college dropout he did not have to take the normal classes. So, he decided to take a calligraphy class – the best calligraphy class in the country, as he later recalled. What he learnt during this class remained basically unused for about ten years, until Apple started to design the Macintosh computer. It was only at that time that he decided to design beautiful typography all into the Mac, and thus exploit his knowledge in the field. He proudly concluded his story saying that no personal computer would have multiple typefaces or proportionally spaced fonts, if he as a college dropout had never taken a calligraphy class.

Another interesting example of silent knowns is given by the quite remarkable story of the invention of post-it note – a piece of paper coming in various sizes with a re-adherable strip of adhesive on the back, so that one can temporarily attach it as a reminder or bookmark on any other object – be it a sheet of paper, a book, a table, and so on. Spencer Silver – the inventor of post-it note – at the time was working at 3M, a company producing tapes and other forms of glue. At the time Silver's goal was to try to develop a new adhesive, which had to be stronger than the one already available on the market. After some attempt Silver failed miserably: what he did was to develop not a super-strong adhesive, but a super-weak one. As a result, any object on which this super-weak adhesive was applied could stick to other objects, but at the same time it could easily be lifted off.

For four years his invention was shelved until another 3M scientist named Arthur Fry found out the way to make use of it. Fry was part of the church's choir and he realized that Silver's invention could be

[2] The prepared text of the commencement address can be found at http://news.stanford.edu/news/2005/june15/jobs-061505.html. The story is analyzed in detail by Jay Elliot [4]

used for creating markers which could keep his place in the hymnal without failing out of the book every now and then. Fry successfully applied Silver's super weak adhesive to his markers and that was the first step towards one of the most useful inventions in the history of office equipment.

Both stories are quite interesting. As one can easily notice, innovation can hardly be reduced to a *linear* collection of events, in which all the dots can be seen as clearly connected with each other *before hand*. They can only be connected *looking backward*. As the examples clearly show, there are some piece of knowledge that may remain silent for quite a long time before one can see their utility and relevance. What is interesting here is that silent knowns are no longer silent, when an event – usually unexpected and disconnected – sets them off. This is somehow precisely the opposite of what usually happens in detective television film series like *Columbo*. In the first scene of each episode the spectators are shown who is the murderer. And in a way Columbo himself knows it. But then the whole deal is to see how he manages to *prove* what we *already* know. In our case, we do not have any foreknowledge and the murder *will* be committed only at the end of the story.

As a concluding remark for this section, it is worth noting that silent knowns do not exclusively refer to propositional knowledge or knowledge necessarily put into words. We may also refer to pieces of knowledge that are in the form of *know how*, that is, things that we know *how* to do like riding a bike, driving a car or swimming. We include here also all those pieces of knowledge that we actually display *through doing* [11] – all those skills related to active manipulation of objects. For example, in diagnostic setting a physician knows how to engage the patient's body in a chain of feedback loops in search for confirmation or for acquiring additional symptoms in case he has not yet made up his/her mind. In general, such manipulative skills can be considered as environmental interrogations and they are performed, as already mentioned, through doing.

In the next section we will introduce the notion of bricolage or tinkering. We will claim that silent knowns are exploited by the chance seeker as a bricoleur or tinkerer. Or, to put it another way, in order to make the best out of silent knowns one can only act like a bricoleur.

3 Bricolage, Silent knowns and Chance-seeking

In this section, we now introduce the concept of bricolage (or tinkering). This concept is supposed to provide an interesting theoretical bridge for connecting silent knowns with chance-seeking activities. By definition tinkering is the process in which the product of one's activity is not the result of a plan like in the case of engineering. Conversely, it is something that mostly relies on contextual and therefore partly accidental and/or unpredicted elements. As Jacob put it, a tinkerer is a person "who uses everything at his disposal to produce some kind of workable object" [6, p. 1163]. A similar conception is held by Lévi-Strauss [8] who is our the main point of reference for the present discussion. Lévi-Strauss describes the bricoleur - the French word for tinkerer - as the one who is:

> adept at performing a large number of diverse tasks; but, unlike the engineer, he does not subordinate each of them to the availability of raw materials and tools conceived and procured for the purpose of the project. [8, p. 17]

Lévi-Strauss goes on listing a number of features characterizing the bricoleur, which may be fruitfully used for describing the chance-seeker and the way he or she exploits these silent knowns we have been describing.

3.1 Open-endedness

Lévi-Strauss argues that the engineer starts with a project and, on the basis of that, he or she goes out to find the set of instruments that is most suitable for his or her task. So, tools and instruments are procured for the project and only for that. Conversely, the bricoleur tries to make use of *whatever is at hand* trying to solve problems as they arise. As mentioned above, the availability of instruments and tools constrain the type of project that can be conceived and carried out *here* and *now*.

Something similar can be noted for silent knowns. Silent knowns are those pieces of knowledge that we make use of, because that is what we happened to stumble upon. This is clearly shown in the first example. Steve Jobs decided to build multiple typefaces and proportionally spaced fonts into the Mac, because that kind of knowledge was *already* available, though it was silent. The same can be said about Fry in our second example. The idea of using the super-weak adhesive came after Silver invented it. What we see in both cases is a sort of *open-ended* attitude. Like in the phrase "whatever is at hand", the chance-seeker does not organize and filter his/her experience according to some kind of knowledge, which pre-exists action.

This attitude is quite similar to Varela and colleagues called "an embodied (mindful), open-ended reflection" [27, p. 27], whose main purpose is "open-ended examination of experience" [27, p. 85]. Or, to put it another way, the chance-seeker as a bricoleur "tends to recruit, on the spot, whatever mix of problem-solving resources will yield an acceptable result with a minimum of effort" [2, p. 13]. This open-ended dimension characterizing silent knowns and chance-seeking is in line with the idea that our experience is contingent upon further actions. In this sense, silent knowns can be fruitfully recognized as relevant and thus exploited by means of *enaction*, which is the process in which knowledge is organized and constructing in the interaction with the environment [27, 5].

3.2 Historicity

Lévi-Strauss mentions a second very important element. The set of tools and materials that is used by the bricoleur is heterogeneous in its nature, because it does not bear any relation to a particular project. Lévi-Strauss points out that it is so because the bricoleur's set of tools is:

> the contingent result of all the occasions there have been to renew or enrich the stock or to maintain it with the remains of previous constructions or destructions. [8, p. 17]

We may interpret this quote in the following way: one's equipment is more the result of one's history – a temporal sequence of events – than a manifest plan. There are in this case some similarities with the way natural selection functions, although we stress that bricolage is not an evolutionary process in itself. By definition natural selection is goalless and purposeless. However, it displays *apparent design*. Building on Turner's idea on tinkering, we may argue that apparent design is displayed by all those systems that are "immediate, contingent upon the past but with no view to the future" [25]. In natural selection this is accomplished by "cobbling together slapdash solutions to adaptive problems as they arise, using whatever materials happen to be at hand" [25]. In the case of the chance-seeker, this element is captured by the fact that silent knowns are intimately related to nothing but one's personal history. That is, silent knowns go hand in hand with the contingencies of one's life and, as such, they cannot be planned ahead.

This *apparent* design we just mentioned is shown in our examples. Jobs decided to take the calligraphy course as a consequence of his decision to quit university. In Jobs' own words "[b]ecause I had dropped out and didn't have to take the normal classes, I decided to take a calligraphy class". That was not part of a plan, but part of his own history, which made available certain chances while making others disappear. In our second example Silver had to develop a super-strong adhesive, and that was part of his ordinary routine work at 3M. The same about Fry. He used to sing in the church's choir during his spare time. Here again there is no foresight, no plan, but everything found unity as part of one's history.

We may call this feature *historicity*, because chances are provided as the result of a temporal sequence of events as they actually happen. What is important to stress here is that silent knowns provide chances that are as such *by means of events*. That is, it is not one's knowledge structuring an event like in the case of the engineer: he or she has knowledge to build a bridge, and therefore he or she makes that happens. Conversely, it is an event which structures his or her knowledge in terms of silent knowns as future opportunities for action.

3.3 Narrativity

There is another element that is – again – related to time, but also unpredictability. In both our examples, there is a sort of delay between the moment of discovery and that of implementation. That is because silent knowns always invokes something of a *later point* in order to get activated – to cease to be silent, in other words. Jobs could not foresee the importance of what he learnt at the time he was taking the calligraphy class. That was not sufficient. A later event had to come about. The same happened in the second example. Although Silver did not trash his invention, it was only after some time that he could figure out what to do with it. In this case the help of his friend and colleague Fry was decisive. Here again, the potential of one's silent knowns could only be assessed in conjunction with a later event.

We may call this element *narrative*. Consider for instance the following sentence: "then the Hundred years' war began". Apparently, such a sentence is obvious but only in the light of foreknowledge. In fact, making sense of this sentence requires a person to know what happened after the Hundred years' war. So, the moment we utter it, and if what we are saying is true, we are already referring to something that happened after that. That is the condition of possibility of the sentence. As Danto argued:

> It will then not be enough simply to be able to predict future events. It will be necessary to know *which* future events are relevant, and this requires predicting the *interests* of future historians [emphasis in the original]. [3, p. 169]

Analogously, silent knowns cease to be silent in due course. Following Danto's insight, one would be able to predict his or her future interests in order to make silent knowns no longer silent. But no *forward-looking* way of thinking can grant this. In a way, we may just say that "we just won't know until we know" [28, p. 132].

3.4 Antifragility

Lévi-Strauss argues that the bricoleur retains or collects his or her instruments on the basis of the rule of thumb they may always come in handy. This is again coherent with silent knowns. One should not consider only those pieces of knowledge that appear relevant at first sight, otherwise he or she might miss something important, that is, those pieces of knowledge that may turn out to be relevant only later. In this respect, the chance-seeker is *antifragile*. Antifragility is a neologism introduced by Taleb to refer to those systems that are not fragile but in a specific sense [24]. That is, systems which are not simply immune to randomness, volatility, and uncertainty (that is what Taleb calls "robustness"); but systems which actually *benefit* from them. To use a metaphor, if something fragile carries the label "please, handle with care", something that is antifragile carries the label "please, mishandle". The former gets broken, if mishandled; the latter gets *stronger*. Chance-seeking is antifragile in a rather specific sense: it takes advantage of irrelevancy.

Already Sun Tzu acknowledged that the pair relevancy/irrelevancy is not necessary a dialectic opposition. In his words: "[i]f we do not know what we need to know, then everything looks like important" [26]. When one's task is clearly defined, the use of heuristic search methods inevitably filters out information and even piece of knowledge that might turn out to be useful *afterwards*.

Conversely, if the epistemic task at hand – for instance, explaining a certain phenomenon – changes or is later re-defined due to its nonmonoticity (i.e., we simply get more information and data), silent knowledge acquires a heuristic value. In this sense, silent knowledge is not only immune to situations in which relevance cannot be clearly distinguished from what is irrelevant, but it also benefits from them. In this regard, luck plays an important role. Let us see how.

On those occasions in which the distinction between what is relevant and what is not is clear-cut, our beliefs become less immune to all that information which falls off our focus. That is, we may fail to notice what might later become the major source of inconsistencies or falsifications as our epistemic tasks proceed. Inconsistencies and falsifications are unexpected events, which emerge by luck in the course of one's investigation. Conversely, silent knowledge survives inconsistencies, and luck is precisely what may help us find out new and meaningful connections. This may clarify Sun Tzu's argument based on what may be called *transparent* relevance: when we do not know what we need to know, luck may show to us something potentially relevant, namely, *good chances*. It follows that silent knowledge exhibits its values especially when the impact of luck is significative. Or, better, luck *detonates* it.

3.5 Situatedness

The last element worth mentioning here is related to specialization. Lévi-Strauss fairly points out that the skills and knowledge used by the bricoleur are specialized but *up to a point*. That is, the bricoleur has skills and knowledge belonging to a variety of trades and professions, without the bricoleur himself being an expert in any of them *specifically*. That is to say, the bricoleur can employ certain skills and knowledge as long as they are useful for solving problems at hand. This set of knowledge or skills can be labeled as silent knowns. Consider again the example of Jobs. He was far from being an expert in calligraphy. But what he learnt was enough to suggest him to see the importance of building multiple typefaces and proportionally spaced fonts into the Mac.

More generally, we may argue that silent knowns are not in the form of a *systematic body* of knowledge – what is usually termed as *expertise*. Rather, silent knowns are activated *on the spot*, that is, when a particular situation provides a connection. Such a connection is totally contingent and the employment of knowledge is dependent on that particular situation, although it can be potentially applied in other cases. What the bricoleur and the chance-seeker do not posses, and not make use of, is a knowledge repertoire that is primarily de-

rived from abstraction and generalization – a sort of textbook-like repertoire, which is, conversely, a major characteristic of experts'.

We may call refer to this last element as *situatedness*. By "situatedness" we mean that silent knowns are deployable *in situations*. That turns out to be a major limit for their generalization. It is worth noting that the bricoleur should not be mistaken for a *know-it-all* – a person who just pretends to know everything. And this is an important distinction, because what the bricoleur precisely lacks is an *explicit* and *comprehensive* understanding that goes beyond the single cases which she or he happened to be involved in.

4 Conclusions

In this paper we have tried to show how the intriguing phenomenon of silent knowns can be related to chance-seeking as a specific case in which knowledge engages ignorance and vice-versa. By referring to the idea of bricolage as it was presented by Lévi-Strauss, we have argued that the chance-seeker ultimately acts like a bricoleur. In describing the reasons of such an analogy, we have treated five important features characterizing the chance-seeker: open-endedness, historicity, narrativity, antifragility, and situatedness. All these shed light on a particular dimension of chance-seeking with relation to making the best out of silent knowns.

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An Analysis of Insight Process for Concept Creation Using Handwriting Features

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Abstract. In order to support concept-creation, we focus on handwriting assuming that it should contain the information on the process toward insight. As a result of intensive analysis of handwriting in concept creation process, one observation is that pen speed gets faster on insight after the period in which pen speed is relatively slow or time gaps get increased. Another observation is that pen pressure gets higher on insight after the same kind of period as above. Based on those observations, we derive a hypothesis on relationship between insight process and handwriting. In some situations, we could create new concepts by getting aware of inconsistency or constraints, by making our viewpoint changed, and then by getting an insight. We think those processes can be visualized through handwriting by monitoring some features like writing speed and pressure, and this could be effective support for concept creation.

1 INTRODUCTION

Globalization and evolution of ICT have changed business environment in recent years. But creating novel ideas and concepts is still crucial and fundamental in planning new products and business models. In order to support concept creation, various methods have been proposed. KJ-method and brainstorming are well known and widely used in meetings in offices. And visualization tools of personal thinking process, such as "Mind Map," are very popular among business persons and students. These methods and tools help us to create new ideas and concepts by providing snapshots of our understandings at the time. But there are still wide gaps between the visualization of intermediate status and ideas to be created finally. We owe getting new ideas to our experiences or tacit knowledge.

The purpose of this research is to realize a concept-creation support tool which can be useful at the deeper cognitive level in terms of technical point of view based on the analysis of human's concept creating process.

As a model for concept creation in cognitive psychology, Finke proposed Geneplore model [1]. This model defines human's cognitive process in creative activities as an interaction of the generation phase and the exploration phase. In generation phase, initial mental representations known as the preinventive structures are generated by retrieving memory and synthesizing fraction of idea. In exploration phase, the preinventive structures are interpreted so that they become consistent in some context, and novel concepts are created and eventually refined through these two phases working repeatedly. When a person comes up with a germ of new idea, she or he brings it up to a new concept by continuing to refine and modify it. In such situation, we can say the generation process and the exploration process of the Geneplore Model operate by affecting each other. But in real situation, we often have the experiences that we struggle for going out of the stagnation of thinking before reaching a new idea. We know it is difficult to expand a germ of new idea. This kind of stagnation is known as impasse [3] in insight problem solving. And exit from impasse is explained as a result of switching from the inappropriate problem space to the preferable problem space. The next generation of supporting tool for concept creation needs to help us to switch from the generation phase to the exploration phase of Geneplore model.

We focus on handwriting as a clue to solve this problem. We make discussions while drawing diagrams on blackboard in meeting room, for example. Underlines and circles for highlighting keywords on printing documents are also written in intensive reading. Handwriting plays important roles in concept creation. Handwriting visualizes the germs of ideas, which are the representation of the psychological status. New concepts can be created not only by viewing the handwritings but also by writing itself. Based on above consideration, we hypothesize handwriting data should contain the information on process of concept creation. Note that handwriting data means not only trajectory of pens but also information on when and how written.

In this paper, we analyze handwriting data in concept creation process, especially in the case of transfer from generation phase to exploration phase in Geneplore model, and of switching out of impasse. And we try to set up a hypothesis on insight process in concept creation.

2 HANDWRITING IN CONCEPT CREATION

Pen and paper are indispensable tools for creative work [12]. Most of people might realize that meetings become more productive by writing out issues and remarks on the white board in the meeting room rather than only by oral conversation. In the meeting, issues and remarks written out on the white board enable attendees to share them and to look down on the whole discussion process. Taking a comprehensive view to the remarks could help us come up with an unnoticed concept that covers or represent the remarks. This is a situation where we find a new axis in the problem space. We may find missing parts in the set of the already presented

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remarks by considering on the new problem space. This is another situation where we find a new variable in the problem space. These remarks are often underlined, circled, or linked with lead lines. These kinds of handwritings help us to create new ideas by making combination of annotated remarks. Furthermore, on reading documents, we sometimes write out interpretations at the time, and visualize the semantic structure through annotating the document. These annotations are effective for building up understandings to the document.

Handwriting works like auxiliary lines in solving mathematics problems in that it gives hints or new viewpoints to the current understandings. We think these handwritten annotations should contain information on catalyst characteristics for transfer from generation phase to exploration phase.

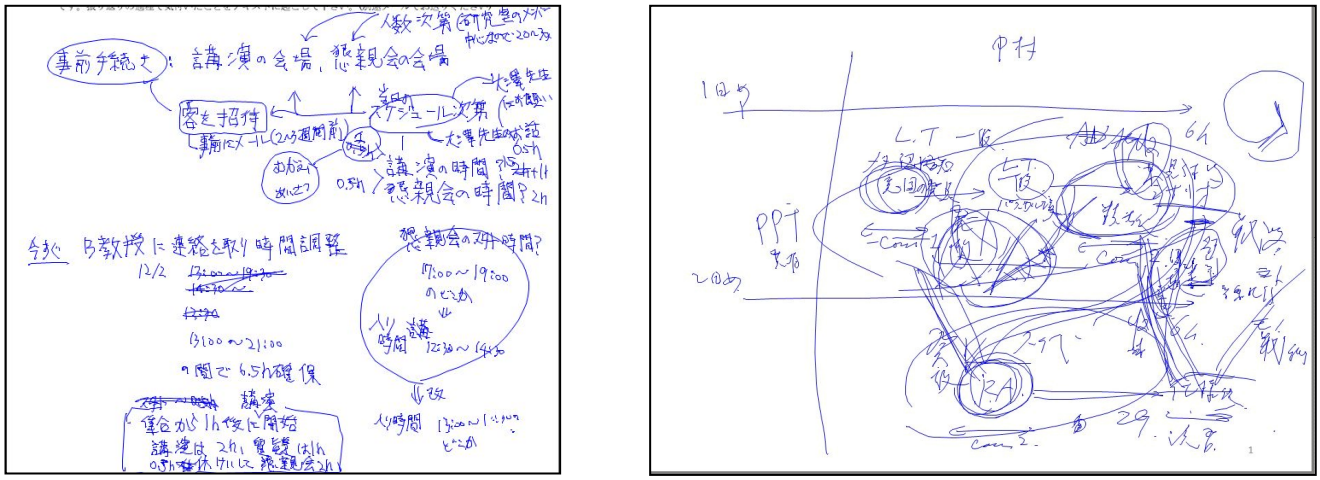

Fig. 1 Examples of handwriting in meeting

3 ANALYSIS OF HANDWRTING

3.1 Tool for Digitizing Handwriting

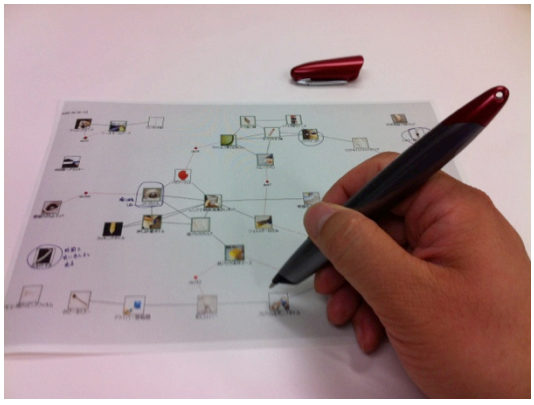

Fig. 2 Digital pen and paper

For the purpose of seeking clues to understand insight process in concept creation, pen trajectory is not enough. Information on how written is necessary. Therefore we cannot take pictures of the white board nor scan the sheets of paper. In order to acquiring handwriting data during the concept creation process in digital format, we introduced a digital pen and its application software "iJITinOffice." [11][13] As shown in Fig. 2, all examinees have to do is to write on paper with the pen. The digital pen which is implemented by ANOTO technology [14] has a camera and a memory chip inside. A pattern of tiny dots that is unique to every piece of paper is printed on the surface of the paper. Pen trajectory is digitized by capturing the dot pattern by the camera in the pen top more than twenty times per second. In addition to the pen position, time stamp at the position and writing pressure are also digitized. The pen position is represented as XY-coordinate value in accuracy of less than 0.1mm. The pen pressure is a relative value in 128 steps. This digital pen looks like just a normal pen, and user doesn't need to care about anything but writing. It is not necessary to consider any influence to writer's insight process from using this digital device.

3.2 Experimental Setup

To obtain handwriting data in the insight process in concept creation, we organized a workshop in a way similar to Innovators' Marketplace [8][9]. Eight nuclear engineers who are involved in the research project on an aging management of nuclear power plant discussed around the table to develop a method for thinking about hazardous scenarios and for highlighting noteworthy events linked to safety of nuclear power plants. They are from different organizations, and have their own background.

Before the workshop, we prepared a text-based event graph. Event words such as "FAC (Flow Accelerated Corrosion)" and "flow pattern" etc. are extracted from the technical manuals and papers on nuclear power plant, and linked based on the causality described in those documents by computer program. One of the causes for FAC, for example, is flow pattern, which is stated in the technical paper "paperPT1." The event words are visualized as a graph. This event graph is printed on the large sized paper, and put on the table, while it is also printed in the small sized paper and distributed to each engineers.

In the beginning of the workshop, engineers are explained that the purpose of the meeting is to discuss about whether we could prepare a finer scenario map or not in about two hours.
In first thirty minutes, they are asked to survey the distributed event graph without talking with other participants. If necessary, they can refer to the manuals and papers. They are also encouraged to write anything they want on the paper for assisting consideration. Next 1.5 hours, they are invited to the discussion around the table. While they debate referring to the event graph on the table, they are also encouraged to use pen and paper at hand for consideration and forming opinions freely during discussion.
After the workshop, digital pens are handed back and handwritten data is uploaded to the server for analysis. An example of the digitized event graph with annotations is shown in Fig. 3.

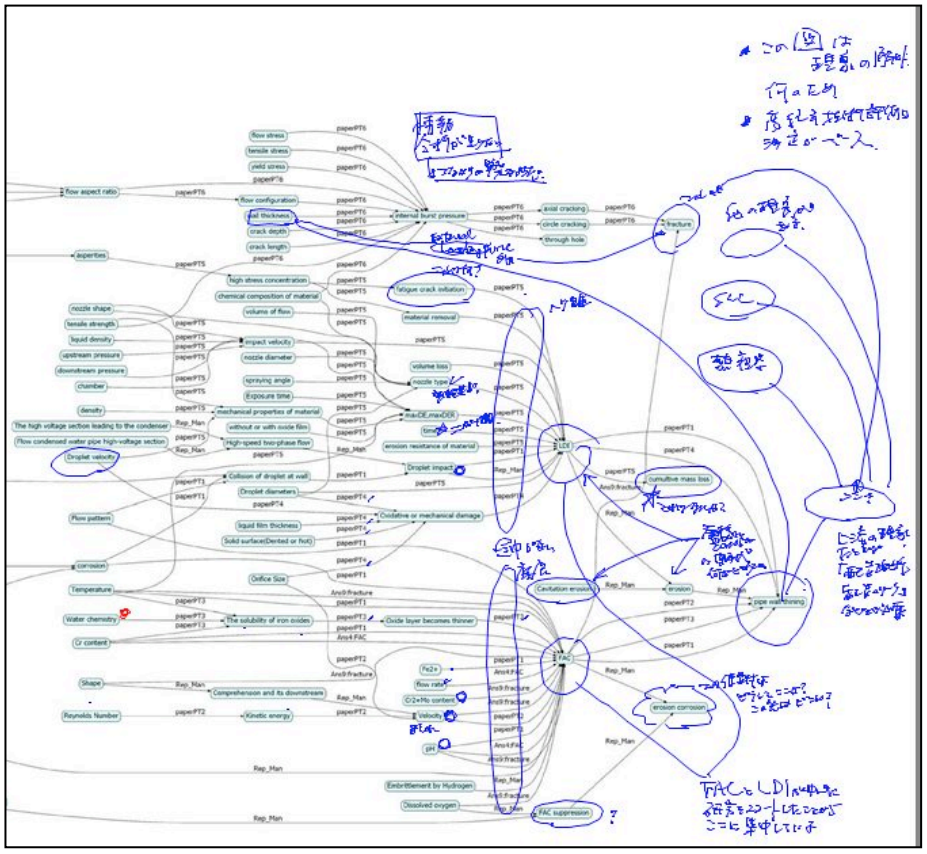

Fig. 3 Example of text based event graph and handwritten annotations

3.3 Cases of Insight

We conducted an intensive analysis of every sheet of the text-based event graphs with handwritten annotations. Let us have a closer look at one of them. Fig. 4 shows the event graph with handwritings.
This workshop participant spent 30 minutes before discussion in writing in following 7 stages.

1. He paid attention on the major keywords of the research project “FAC (flow accelerated corrosion),” “LDI (liquid droplet Impingement erosion),” and “pipe wall thinning.”
2. He thought that there should be surface layer phenomena rather than pipe wall thinning and trying to write out such phenomena.
3. He focused on the words such as “erosion corrosion,” “cumulative mass loss,” “cavitation erosion” which are listed at the right side of the sheet and understanding these words can be related with “corrosion erosion.”
4. He moved his attention to other words such as “time,” “fatigue crack initiation,” and “fracture” which are on the upper part of the sheet and noticing that the word “fracture” should be the unrevealed phenomenon annotated in stage 2.
5. He found causality among the existing words “pipe wall thinning” and “wall thickness.” After digesting his thought, he got noticed that an unknown phenomenon “loading force” should be assumed between “wall thickness” and “fracture.”
6. He got back to two words “FAC” and “LDI”, thinking that there must be causal phenomena between “FAC” and the phenomena listed at the left and between “LDI” and those at the left.
7. He found that aging management technology should be evaluated based on measurement.
8. The pen pressure and writing speed during the stage 1 to 5 are shown in Fig. 6. Pen pressure and speed are calculated for every single stroke of handwriting. Point of pen pressure is an average of that of all the sampled points in the stroke, and points for the strokes in the same character line or strokes written continuously during a short period are connected into one group. Points of pen speed are calculated in the same way as pen pressure.

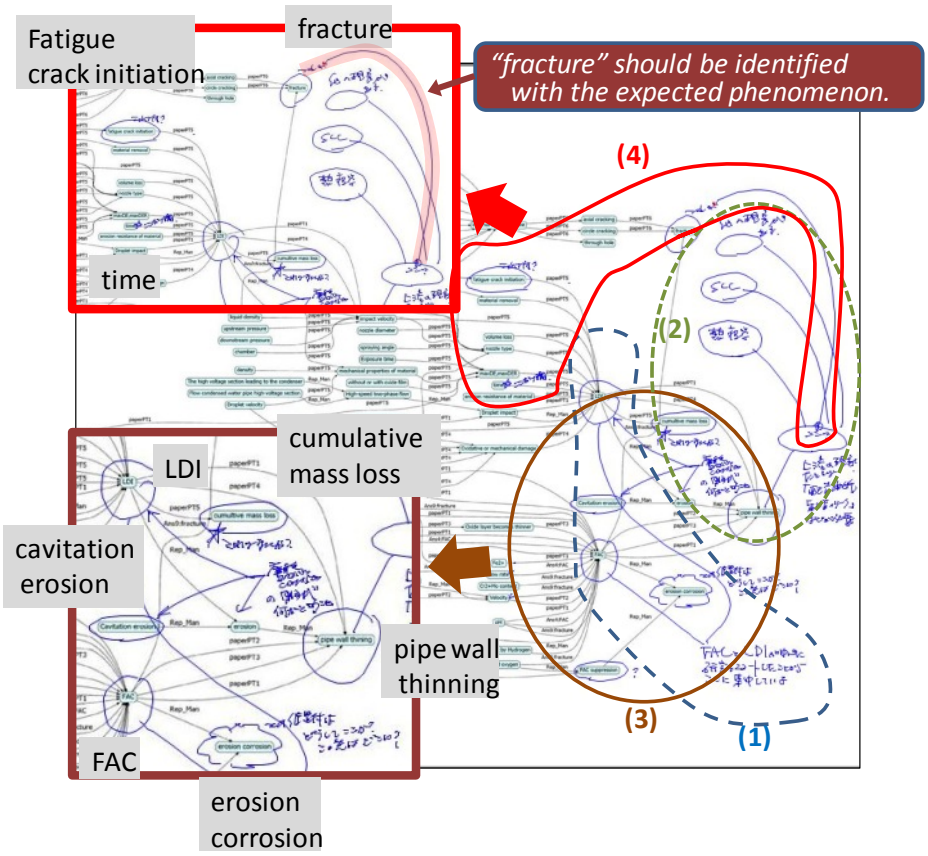

Fig. 4 Handwriting in stage 1 to 4

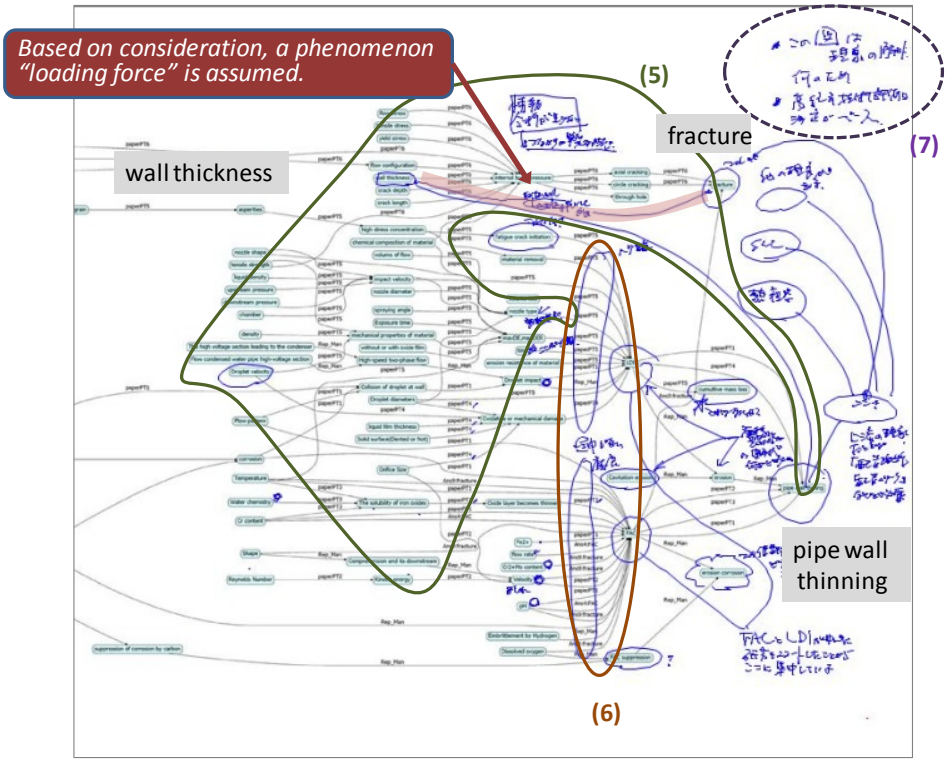

Fig. 5 Handwriting in stage 5 to 7

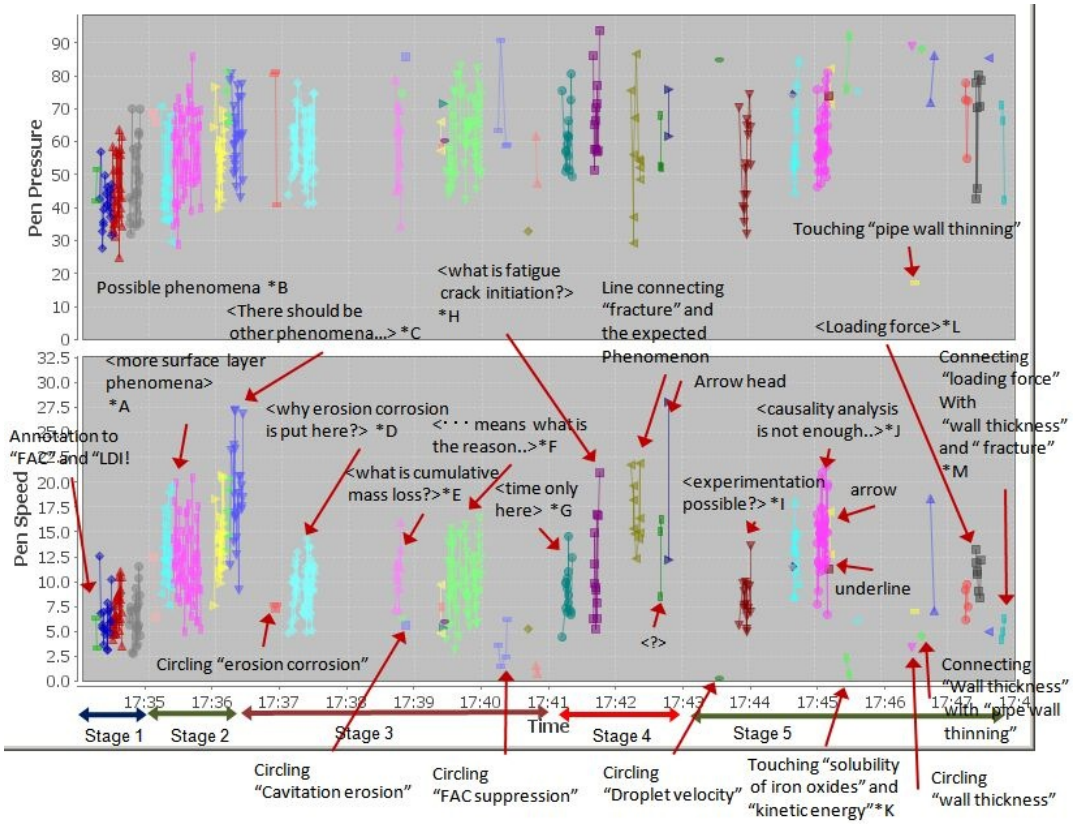

Fig. 6 Pen pressure and pen speed of the handwriting on the event graph sample

Roughly speaking, variance of the pen speed for character lines is bigger than that of the pen pressure. We focus on pen speed for further discussion.

In stage 1, the examinee tried to understand what the event graph represents, and seemed to be unconvinced while feeling not only FAC and LDI but something are crucial in nuclear power plant maintenance. Writing speed is relatively slow, and the variance is small.

In stage 2, he got a little bit confident that there should be surface layer phenomena, and wrote out such phenomena to make the event graph more general. Writing speed is relatively fast and getting gradually faster according as the event graph becomes concrete.

In stage 3, he tried to understand the event words and relation among them in the graph by writing out questions or by annotating the words. This stage is in the process of his building up understandings by repeating questioning, getting convinced, and structuring his understanding. Pen speed is relatively slow, and time gaps, which are the period without writing, are recognized in this stage.

In stage 4, he did not seem to get clear understandings in the beginning because he still kept on writing questions such as "what is fatigue crack initiation?" After the time gap around 17:42, he seemed to get an insight that the phenomenon "fracture" can be identified with the expected surface layer of phenomenon, and annotated the event graph. Pen speed of the annotation is quite faster than that of before. We should note that pen speed up could not be regarded as a sign of insight and that it must be the result of insight.

In stage 5, he seemed not to be convinced in the beginning as same as stage 4. He concluded that the event graph was not complete and that more precise causality analysis was necessary after annotating the phrase "droplet velocity," and writing a question. Pen speed of this part is faster than that of beginning. Then he seemed to get an insight that the undescribed phenomenon "loading force." Pen speed of the insight part is quite slow, which is different from the case in stage 4. But pen pressure of the strokes in annotations such as circles that highlight the words "wall thickness" and lines for connecting the words is high comparing to other annotations. This could be another characteristic in insight process.

4 HYPOTHESIS ON INSIGHT PROCESS

Base on consideration above, we propose a hypothesis on relationship between insight process and handwriting. Left part of the Fig. 7 is thinking process, and right part is presentation process by which we can recognize what thinking process produces. In this paper, handwriting is regarded as a media for presentation. In thinking process, new idea or concept is embodied in conceptualization step. In case of getting into impasse, especially, we could get out of impasse by being aware of inconsistency or existing constraints, by making our viewpoint changed, and then by getting an insight. This could be one possible model for concept creation process.

Handwriting can be presentation of concrete idea or concept created in conceptualization step. On the other hand, a lot of handwritings are presented also in the remaining three steps including insight step. But it is difficult to associate the handwritings with the process in those three steps as we have seen in the former chapter.

We found that, in some case, pen speed is getting faster according as writer gets convinced, that is he might be close to insight step. We think that those three steps that produce the germs or signs of new ideas can be monitored through handwriting by observing some features like pen speed and pen pressure.

In order to verify this hypothesis, further analysis of more handwriting data should be conducted.

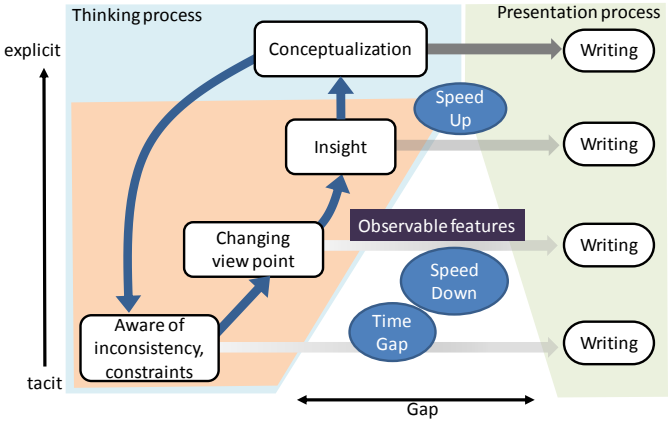

Fig. 7 Hypothesis on the relationship between insight process and handwriting

5 CONCLUSION

In order to realize a concept-creation support tool, we focus on handwriting assuming that it should contain the information on process of concept creation, especially insight process.

Taking handwriting data in a workshop as examples, analysis of handwriting in concept creation process was conducted. As a result, one observation is that pen speed gets faster on insight after the period in which pen speed is relatively slow or time gaps get increased. The other observation is that pen pressure gets higher on insight after the same kind of period as above. Based on the observation, we propose a hypothesis on relationship between insight process and handwriting. In some case, we could create new concepts by being aware of inconsistency or existing constraints, by making our viewpoint changed, and then by getting an insight. We think that those processes can be monitored through handwriting by observing some features like pen speed and pen pressure.

In order to elaborate the hypothesis, it should be necessary to distinguish the internal aspect like thinking by oneself from the social aspect, such as interactions with other people. Then, further analysis of more handwriting data will be conducted.

ACKNOWLEDGEMENTS

Authors would like to thank all the attendees of the workshop on nuclear power plants for intensive discussion with professional knowledge and experiences, and for providing very insightful data of the discussion including handwritings with us. Authors would also thank reviewers for beneficial comments.

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Curation in chance discovery again

Akinori Abe [1]

Abstract. Last year, for business and information market, Katsumi, Sasaki and Rosenbaum etc. pointed out the importance of curation. Actually, I have previously pointed out the importance of curation in chance discovery and extended the definition of curation for chance discovery. I will compare curation in business and chance discovery and give a certain scope and improved definition to curation in chance discovery.

1 Introduction

In several papers, I have been stressing the importance of curation in chance discovery [4, 5, 6]. Actually, in chance discovery a chance is defined as "*a novel or rare event/situation that can be conceived either as an opportunity or a risk in the future*" [20]. That is, it can also be regarded that a chance is an alarm or a symptom such as an inflation of money supply or unusual big difference between the Nikkei average price of futures and spots that will change the middle or long term economic "bubble" situation (Japan, in 1990). Many did not realize it as a chance. Some who realized it as a chance made a big money. On the contrary those who could not predict the changes where financial crises occurred became unhappy. Thus it "was" very important to discover and determine chance before serious situations. Then it is very important to offer opportunities where receivers can be aware and obtain chances in various situations. Many applications on chance discovery have been proposed in these 10 years [2, 21]. For instance, visualization systems for making users aware of unconscious preferences [10, 17], an analogy game which varies a construction of concepts according to perceptions, categorizations, and areas of focus derived from the expertise of the observer [19], a deposit overflow determination system to prevent various financial crises [27], ISOR-2, a combination of case-based reasoning and statistical modeling system which can deal with medical exceptions [26], and a web-based interactive interface which can check hidden or rare but very important relationships in medical diagnostic data sets [3] have been proposed in [2]. Those applications are real world applications where a discovery of chances plays an important role. However, strategies how to display chances have not been explicitly discussed in many applications.

Therefore, I proposed the importance of display of chance by means of curation. As I pointed out, curation *was* regarded as a task in (art) museums or galleries. Actually I extended the definition according to the feature of chance discovery.

In addition, recently (last year) for business and information market, some pointed out the importance of curation [15, 24, 25]. I will review them in the following, but their concepts of curation are rather different from my definition of curation in chance discovery.

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In the rest of this paper, I will compare curation in business and chance discovery and give a certain scope and improved definition to curation in chance discovery.

2 Curation

I introduced in my previous papers, but I review the original curation in art galleries and museums and e-Science Data Curation are reviewed. In addition, as a recent trend, I introduce several curation concepts in the business area.

2.1 Curation in (art) museums

There is at least a person who is responsible as "curator" in (special) exhibitions, galleries, archive, or (art) museums. Their main task is a curatorial task, which is multifaceted. Curator comes from a Latin word "cura" which means cure. Then originally it used for a person who take care of a cultural heritage.

In the report by American Association of Museums Curators Committee (AAMCC) [9], they pointed out "curators are highly knowledgeable, experienced, or educated in a discipline relevant to the museum's purpose or mission. Curatorial roles and responsibilities vary widely within the museum community and within the museum itself, and may also be fulfilled by staff members with other titles." Then they showed the definition of curator as follows;

- Remain current in the scholarly developments within their field(s); conduct original research and develop new scholarship that contributes to the advancement of the body of knowledge within their field(s) and within the museum profession as a whole.
- Make recommendations for acquiring and deaccessioning objects in the museum collection.
- Assume responsibility for the overall care and development of the collection, which may include artifacts, fine art, specimens, historic structures, and intellectual property.
- Advocate for and participate in the formulation of institutional policies and procedures for the care of the collection that are based on accepted professional standards and best practices as defined by AAM, CurCom, and other relevant professional organizations.
- Perform research to identify materials in the collection and to document their history.
- Interpret the objects belonging or loaned to the museum.
- Develop and organize exhibitions.
- Contribute to programs and educational materials.
- Advocate and provide for public use of the collection.
- Develop or contribute to monographs, essays, research papers, and other products of original thought.
- Represent their institution in the media, at public gatherings, and at professional conferences and seminars.

- Remain current on all state, national, and international laws as they pertain to objects in the museum collection.

In addition, AAMCC showed curatorial responsibilities as follows;

A: Research, Scholarship, and Integrity
B: Interpretation
C: Acquisition, Care, and Disposal
D: Collection Access and Use
E: Replication of Objects in the Collection

Thus curators have responsibilities for various aspects of exhibition activities. However, the most important activity will be a plan of exhibition. For that the above activities such as research, interpretation and acquisition are necessary. They should properly exhibit a truth which is result of their researches and interpretations.

2.2 e-Science Data Curation

The above curation is for actual museums. That is, curation is conducted mainly for actual art works. However, curation in this section is for digital data. There are several differences between digital curation and analogue curation.

JISC pointed out an importance of curation as "promoting good curation and an information infrastructure to capitalise upon and preserve expensively gathered data means bringing together varied technical and managerial resources, and managing these over time. This activity needs to be supported by clear strategies for resourcing and support [14]." They compare curation with archiving and preservation.

- Curation: The activity of managing and promoting the use of data from its point of creation, to ensure it is fit for contemporary purpose, and available for discovery and re-use. For dynamic datasets this may mean continuous enrichment or updating to keep it fit for purpose.
- Archiving: A curation activity which ensures that data is properly selected, stored, can be accessed and that its logical and physical integrity is maintained over time, including security and authenticity.
- Preservation: An archiving activity in which specific items of data are maintained over time so that they can still be accessed and understood through successive change and obsolescence of technologies.

That is, they pointed out that curation is more creative task. Then they showed aspects of curation as follows:

- Trust: Trust can be enhanced by the existence of qualified domain specialists who curate the data.
- Utility: Certain information about the data —where it came from, how it was generated, for example— is necessary to enable future users to gauge the utility and reliability of the data, and indeed any annotation of the data. Data utility also depends on the ability of users to manage and analyse it; data mining tools and algorithms, visualisation tools, user interfaces and portals will play a crucial role in accelerating research.
- Discoverability: How will future users find data, in particular data they do not know exists, in other domains, or archived according to terminology which has fallen out of use? Data access is often organised through portals; how will those portals be organised? What tools will users need to read or use the data, and who will provide these tools?
- Access management: A significant proportion of data involves confidentiality issues. Ownership and rights management also need to be taken into account.
- Heterogeneity: Not only is this data revolution creating a deluge of data, the data itself comes in very many different and often specialist formats, some created by the researchers themselves.
- Complexity: The data can be composite in nature, with links to external objects and external dependencies (such as calibration information), and be highly complex in structure. This complexity represents a significant challenge for the preservation of data.

They use "data curation" because they think data have value. Not only for keeping data but also usability of data for the public, they use the word "curation." Actually, most of data are neither art works nor archaeological artifacts. However, is is important to view data from the aspect of what should be preserved. The main difference between data and art works or archaeological artifacts is that data do not have a shape and cannot exist alone. It is necessary to prepare a container such as a cdrom and a hard disc drive system. Therefore for data curation, "Discoverability" plays a significant role.

2.3 Curation in business and information market

In 2011, several books on curation were published. In Japan we had at least two publications which I noticed by Katsumi [15] and Sasaki [25]. In addition, Rosenbaum published "Curation Nation" [24] in the same year. They discuss a "curation" in "business" and information market field. I do not know why in 2011 such publications on (information) curation appear simultaneously.

2.3.1 Sasaki

Sasaki defined curation in [25] as follows:
Curation: From huge amount of information source, according to the curator's sense of value and world view, picking up information, giving a new meaning to it and sharing it with many persons.

Sasaki used a metaphor of biotope[2] to illustrate the promotion of a unknown or less known but a good artist. His main point to successful promotion is to recognize:

- Where those who need a certain information live?
- How to offer the information to those who need the information?
- How to make them impressed by the information?

He gave a metaphor the place where those who need a certain information live as a biotope. Actually strategies he illustrated are very intentional because they are business that should be successful and that were succeeded. In addition, he pointed out the importance of a human as a media. That is in order to generate sympathies, there should be a certain context and the context will be generated (aware) not only by a viewpoint such as search keyword, place and program but also by the specialized person's sense of value and world view. His viewpoint is based on Social Network System (SNS), then his curation can be regarded as a generation of explicit, multi-core circle type, and indefinite relationship supported by social media.

[2] Biotope is an area of uniform environmental conditions providing a living place for a specific assemblage of plants and animals. Biotope is almost synonymous with the term habitat, but while the subject of a habitat is a species or a population, the subject of a biotope is a biological community. (from Wikipedia)

2.3.2 *Katsumi*

Katsumi seems to extend a task of curation in museums. He uses a framework of a curator's task. He illustrates a curator's task is as follows [15]:

1. Reconsider meanings of existing works etc.
2. Select contents and add relationships to them.
3. Offer a new meaning and value to customers.

He compares a river model with a well model in recognition of customer's needs in business world. In a river model customers are on the opposite side of a river. (information) providers, based on their previous experience, existing concepts, and various sorts of surveyed data, expect customers' position and throw a ball. In a well model, if providers dig their own well, they will discover a new underground stream and it might be connected to customers' underground stream. In this underground stream potential needs which customers are not aware exist.

Katsumi illustrates a new curation model in business based on innovators' successful examples such as the strategy of Seven-Eleven.

2.3.3 *Rosenbaum*

Rosenbaum gave features to curation as follows [24]:
Curation comes in many shapes and sizes. It is critically important to understand two things. First, curation is about adding value from humans who add their qualitative judgment to whatever is being gathered and organized. And second, there is both amateur and professional curation, and the emergence of amateur or pro-sumer curation isn't in any way a threat to professionals. He continued that "Curation is very much the core shift in commerce, editorial, and communities that require highly qualified humans." Accordingly he mainly discuss curation in the field of magazine and networks. He characterizes curation as the future of consumer conversation. He mentions that "as curated customer conversation take hold, there will not be a brand, a service, or a company that will emerge to give feedback and filter customer reaction to goods and services. [...] Indeed, reasonable and balanced communities curated to be about honest feedback and customer solutions will emerge as a new and powerful force in consumer-and-brand interaction." In addition, he seems to extend curation tasks to quite different type of jobs, for instance DJ. His definition of curation seems to cover quite a large field.

At the end of [24], he states "We are all curators. We all will be sharing into the ecosystem of our friend and families. For some, it will become part of who we are. And for a few of us, curation will become our livelihood. It's exciting for me to see that we're turning a corner. The network is built. The data center are in place. The next step will involve the human piece of the equation—humans are more-valuable machines."

2.3.4 *Curation in business?*

A "curation" for business in the internet age seems an interaction between customer (user) and goods. There will not be a system to insist trends from big companies, but trends will be constructed or selected according to customers' interaction on (inter)networks. In addition, a (small) company or community can use this system to give rare goods a certain trend. Thus the strategy of information delivery in business has changed in recent year and they call this type of information delivery as "curation." Curation in business means not only an information display system but also an information delivery strategy.

3 Curation in chance discovery

In this section, I review curation in chance discovery. Before that I briefly review chance discovery.

3.1 Chance discovery

Though in various articles, the definition of a "chance" is described which was introduced by Ohsawa [20], I wish to introduce it here again. In fact, it rather differs from the original definition in [20] to reflect the recent research interests.

> A chance is rare, hidden, potential or novel event(s) / situation(s) that can be conceived either as a future opportunity or risk.

Then "chance discovery" research is a type of research to establish methods, strategies, theories, and even activities to discover a chance. In addition, it aims at discovering human factors for chance discoveries. Therefore not only researchers in computer science and engineering but also researchers with different expertise such as psychologists, philosophers, economists and sociologists take part in chance discovery research.

3.2 Curation in chance discovery

Thus I defined a new definition of curation in chance discovery as follows [4, 5, 6]:

- Curation is a task to offer users opportunities to discover chances.
- Curation should be conducted with considering implicit and potential possibilities.
- Chances should not be explicitly displayed to users.
- However, such chances should rather easily be discovered and arranged according to the user's interests and situations.
- There should be a certain freedom for user to arrange chances.

The above definition is based on my experiences in a market store and several exhibitions. As I pointed out in my previous papers [4, 5, 6], my experience in a market can be regarded as a type of chance discovery application, because the strategy generated a hidden or potential purchase chance to customers. Customers who were inspired by the combination of chicken and asparagus would have bought either or both of them for dinner. Thus a certain *affordance* can be selected by customers in the market store. In addition, my experience in the exhibition "Bacon and Caravaggio" gave a certain policy to the definition of curation in chance discovery. For the exhibition, Coliva pointed out "this exhibition proposes a juxtaposition of Bacon and Caravaggio. It intends to offer visitors an opportunity for an aesthetic experience rather than an educational one... [11]." In addition, Coliva illustrated "an exhibition of generally conceived and prepared with a historicist mentality, but when it materializes, the simultaneous presence of the works — in the sense precisely of their hanging — opens up parallels and poses very complex and spontaneous questions, which may even be unexpected and not all stem exactly from questions initially posed by art-historical motives and theses. There are parallels that appear by themselves to the visitor's sensibility and are not imposed by a theory of the curator. This is certainly one aspect of the vitality of exhibitions, which make the works live and in this are necessary for the works. The display itself, in the sense of the presentation of the works that appear in an exhibition —the spectacle of their being on display — creates trains of thought

that are independent of the interpretations provided by art-historical scholarship. And since for a profound experience of understanding a work these ramifications sometimes are more surprising and significant than the achievements of a specialized scholarship in its own field of action, an art raised to the status of an enigma like Bacon's seems to require the gamble of provoking these parallels. And since at the time, and again because of its qualitative greatness, Caravaggio's art deserves a similar provocation, the juxtaposition thus satisfies a legitimate aesthetic desire. On the other hand, the juxtaposition is a modest and prudent solution, not so much for demonstrating, but for offering the attribute of "genius" — which the expressive common language attributes to the great artist of the past — opportunities to manifest itself. And the juxtaposition is induced by the Galleria Borghese itself, one of the most sensitive spaces with the simultaneous presence of genius."

I thought the most important point was the statement "There are parallels that appear by themselves to the visitor's sensibility and are not imposed by a theory of the curator." That is, though actually a curator has a certain philosophy, he/she does not insist his/her philosophy but audiences will be able to discover additional meanings as well as the curator's intended philosophy. This concept is very important in chance discovery.

Thus originally a curation was an activity for offering an explicit education to audiences. However a contemporary curation offers audiences a certain freedom or opportunity such as deep thinking and new discovery, which can be regarded as a chance. Sometimes a situation without information or with a few information offers us chances which might become important factors for our future. Curation should be performed with considering such implicit and potential possibilities. In addition, such possibilities should be rather easily discovered and arranged according to the user's interests and situations. For this I discussed in [5] as a communication between users and systems. That is, chance can be regarded as a missing communication between users and the system which is ignored or is not aware by users, and from the system users can discover and select chance with a guidance of an affordance selection.

4 Curation in chance discovery again

4.1 Curation of the business situation in the internet age

In the previous sections, I illustrated several curation in business and chance discovery. I summarized that a "curation" for business in the network age seems an interaction between customer (user) and goods. There will not be a system to insist trends from big companies, but trends will be constructed or selected according to customers' interaction on networks. In addition, a (small) company or community can use this system to give rare goods a certain trend. That is, no curation is directly performed by a "system manager." Instead a "system manager" tries to use a certain community effectively. A "system manager" provides a certain information to those who will be interested in it. The information will be shared in the community and sometimes it will be delivered to other communities having the same or similar interests. There exist a certain intention, but the feature of curation is rather vague and changeable. Perhaps the task as a curation is to offer a certain environment for communication among customers. Thus generation of customers communication is important in this type of curation.

Akiyama and Sugiyama discussed holistic communication in advertising [8]. In a holistic communication, an advertiser seeks active consumers and makes them a sort of hub from which a lot of information will be delivered and exchanged to other consumers (B to C to C model[3]). Such an active consumer usually offers good opinion or information which is believed as a better news source by many other customers and is sometimes a charismatic consumer. This model is similar to the above curation strategy (by Sasaki).

4.2 Curation in chance discovery

Actually curation in business is rather different from that in chance discovery. For instance, the curation in business explicitly aims to show rare or hidden but important matters to consumers. In the strategy, they seek a central or key person to give information and expect that he/she will deliver the information according to his/her interpretation or criterion. This type of interpretation or criterion is very trustful and general customers tend to believe the (filtered) information. In chance discovery, however, we do not perform such an explicit activity with intentions. Instead we try to hide such intentions and adopt implicit strategies. Because we think such implicitness will offer users a certain freedom of deep thinking and possibilities. However, communication is also an important factor in chance discovery. Because curation is a type of communication between curator and audiences. In the previous paper [5] I introduced affordance and communication to chance discovery. Actually, the previously proposed application for dementia person [1] is base on the concept of affordance[12, 13], which can be regarded as communication between human and environment. The concept of affordance emphasized the environmental information available in extended spatial and temporal pattern in optic arrays, for guiding the behaviors of animals, and for specifying ecological events. Gibson defined the affordance of something as "a specific combination of the properties of its substance and its surfaces taken with reference to an animal." Thus we communicate with an environment and ecologically selected affordance which will be better or the best for our lives. Chance discovery can be formalized by means of affordance selection. In [7] I showed the following formulae with considerig the effect of affordance:

$$F \cup chance \cup affordance \models future\ situation. \quad (1)$$

$$F \cup chance \cup affordance \not\models \Box. \quad (2)$$

The above formula shows that with referring to a guidance of affordance, chance will be effectively and properly generated.

In addition, the strategy in business can be referred to in chance discovery. Actually, in the curation in chance discovery I did not consider the effect of communication among audiences. I defined curation style for individuals. A curation in business has a strategy to use the effect of communication among communities. Of course the strategy was introduced to expand the area of information delivery. A cuation in chance discovery does not aim such strategy, but communication among users is very important to reorganize or improve their thinking. In addition, sometimes even new idea might appear. For instance, in [22] and continuing researches, the effect of communication among participants is reported and discussed. This type of communication is thus important in chance discovery.

In addition, the other type of communication can be considered. I think another type of *holistic communication* shown above can be effective in chance discovery. That is, a key person, matter, thing or event plays a role as a media or guidance between curator and general or novice audiences. This type of key person, matter, thing or event functions as a hub of communication. That is, it sometimes

[3] B: business, C: customer

functions as a help or a guidance to discover chance. Such discovery is sometimes achieved by a certain communication among users. In addition, such discovery strategy might be learnt by referring to the other's activities. Of course no explicit intention should be displayed from curators. Of course interpretations of the keys by users are free. Rather such free interpretation should be encouraged. Then various chances according to users situation or interests will be discovered, generated or selected.

Accordingly such keys function as a guidance of affordance. For instance, yellow marks in a type of interface shown in Figure 1 will function as keys.

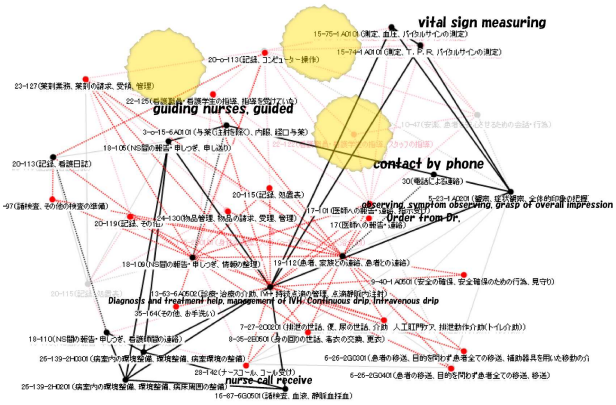

Figure 1. Result from $Kamishibai - KeyGraph^{®}$ with suggestions (yellow colored marks)

Actually the mark might be intentional, but if several marks in the same size and shape are provided close to the place to be focused, it will function as a certain assistance for novice persons. If we provide additional marks in the place which are rather different from that to be focused, they probably function as certain influences or disturbances but offer users possibilities of an active or deep thinking. In addition, they can be removed for experts. Of course a decision of how many marks should be provided will be one of problems. If there were too many marks, they might disturb users appropriate selection and thinking procedure.

Accordingly the previous definition of curation in chance discovery can be redefined as follows:
[New definition of curation in chance discovery]

- Curation is a task to offer users opportunities to discover chances.
- Curation should be conducted with considering to offer implicit and potential possibilities.
- Chances should not be explicitly displayed to users.
- However, such chances should rather easily be discovered and arranged according to the user's interests and situations. This can be achieved for instance by affordance.
- There can be a certain holistic communication environment. This type of *holistic communication* might function as media to discover chance for novice users.
- There should be a certain freedom for user to interpret a key person, matter, thing or event, which should only stimulate or assist users' thinking procedure.
- There should be a certain freedom for user to arrange chances.

The effect and assistance of (holistic) communication and affordance in chance discovery is added to the new definition of curation. By addition of (holistic) communication, during chance discovery users will be able to have the other (perhaps better) opportunity compared with a solo chance discovery.

Perhaps new task for curator is how to determine an implicit "hub" in holistic communication which will assist chance discovery.

5 Conclusions

In this paper, I continuously discuss curation in chance discovery.

First I review curation in an art gallery and e-Science. In addition, as a recent trend, I review curation in business. The aim of curation is rather different from that in chance discovery. However, this type curation gave me a certain hint in curation in chance discovery. (Holistic) communication is a new keyword to be added. Previously I discussed the importance and effectiveness of affordance in chance discovery. In this paper, based on a concept of holistic communication, the effect of affordance is clearly illustrated by means of holistic communication. Of course, there are several types of holistic communication such that shown in [18], [16], [23], and [8]. They fundamentally aim an efficient communication among customers. For instance, to seek a key person and via the key person, information is efficiently delivered to general customers. In addition, hence the information comes from the key person, customers will trust the information. That is, information filtered by a key person is trustful. For advertisement, such strategy is used for trustful and efficient communication between customers. Of course for such communication, the internet plays an important role.

In fact, holistic communication in chance discovery is rather different from that in business and marketing. First it is not intently set up. In addition, a "hub" can be anything including person. Even marks on display can be a "hub" with which users can be assisted in chance discovery. I think this is a new type of curation considering such communication. Sasaki showed holistic communication in curation [25], but it is an intended and explicit strategy to obtain targeted users. Curation in chance discovery also offer an environment to assist chance discovery. It should not be an explicit situation. Curators should not explicitly express their intention but offer an implicit guidance. This type of scheme or criteria can be applied to a dementia person support system proposed in [1].

In this paper, I illustrated example of curation by using my previous works. In fact the marks are not displayed automatically. In addition, it is a result generated by using KeyGraph®. The strategy is not general, but one of possibilities. It is necessary to give a general strategy for curation.

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