
Pivot chain to create the pairing in Needs solutions pairs" : G-Shock 1st model development by design thinking approachⁱ

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Abstract: This study covers product development to realize market creation. The early stages of development of market-created products are generally highly uncertain. Therefore, there are situations where the development staff cannot clearly define what to develop at the initial stage.

We focus on "experimental behavior" in trial and error (Dyer and Christensen, et al. 2011). And we report the result of the research which paid attention to experimental behavior by prototyping. The product development process investigated is the first model of G-SHOCK by Casio Computer Co., Ltd. G-SHOCK created the shock-resistant watch (toughness watch) market.

Trial and error involves the actions of failure and correction. Such actions are called "Pivot" (Furr and Dyer 2014). We analyze the development process of G-SHOCK from this "Pivot" as a clue. Based on this analysis, we will consider the contribution of Pivot to the pairing of Needs Solution Pairs (Von Hippel and von Krogh 2016).

Keywords: Need-Solution Pairs, Pivot, Pivot chain, Design thinking, prototyping, pairing process, dialogue, product innovation, market creation, G-Shock

1 Product development in an uncertain environment

This research covers product development to realize market creation. It covers areas that find problems in the early stages of the product development process and their solutions. The early stages of development of market-created products are generally highly uncertain. Therefore, there are situations where the development staff can not clearly define what to develop at the initial stage. And even if you carefully listen to the customer's opinion, it is impossible to set a clear goal at this stage (Lester and Piore (2004) p. 53). Therefore, the developer finds the problem through trial and error (Ishii (1993), Lester and Piore (2004)).

This study focuses on "experimental behavior" in trial and error (Dyer and Christensen, et al. 2011). And we report the result of the research which paid attention to experimental behavior by prototyping (prototype development and experiment). The object of the research is the development of G-SHOCK's first model by Casio Computer Co., Ltd., which created the shock resistant watch (toughness watch) market.

Trial and error involves the actions of failure and correction. Such failure and correction actions are called "Pivot" (Ries 2011, Steinert and Leifer 2012, Furr and Dyer 2014). We analyze the development process of G-SHOCK from this "Pivot" as a clue. Based on this analysis, we will consider the contribution of Pivot to the pairing of Needs Solution Pairs (Von Hippel and von Krogh 2016).

2 Innovation and developer behavior

Innovator DNA and "Experimental Behavior"

In recent years, many problems have been repeatedly found and solved through social experiments in fields that are not in the conventional extension, and many examples have been reported. For example, public road experiment and share ride service in automatic driving correspond to that. Dyer and Christensen, et al. (2011) conducted interviews with about 100 entrepreneurs, business executives, and a questionnaire survey of about 500 innovators and about 5,000 executives in 75 countries. From the survey, we clarified that it is five action requirements (question, observation, network, experiment, association) to produce innovation. Five requirements were classified into four action skills and association ability, and four skills (question, observation, network, experiment) showed the structure supporting the association ability. He suggested that the most important requirement in behavioral skills is "experimental power". The behavior linked to product development through conducting experiments is referred to herein as "experimental behavior". There are three types of experimental behavior (Dyer and Christensen, et al. 2011). First, to experience new things by putting yourself in a different environment. Second, understand the structure by decomposing existing objects such as products and business models. The third is to verify the idea through the prototype. According to their research, good innovators were performing at least these three types of experimental behavior.

Experimental behavior and "pivot"

Trial and error are indispensable for the creation of new markets and businesses, and the necessity of trial and error (Ishii 1993, Lester and Piore 2004) is necessary to realize the problem by finding and solving problems that have not been found before. Sex is pointed out. Similar points are: excellent entrepreneurial research (Sarasvathy 2008, Ries 2011), design thinking (Kelly and Kelly 2013), frequent behavior and correction (Steinert and Leifer 2012), architecture (wide area spatial design) (Alexander 2013) is also done.

Trial and error is not a single action. Create new customers and values, and the products and services needed to realize them, by repeating multiple actions and modifications. Use the phenomenon created by the action and correct the action. Trial and error are repeated actions and corrections. Based on the phenomenon generated by experimental behavior, the corrective action is "Pivot" (Ries 2011, Steinert and Leifer 2012, Furr and Dyer 2014).

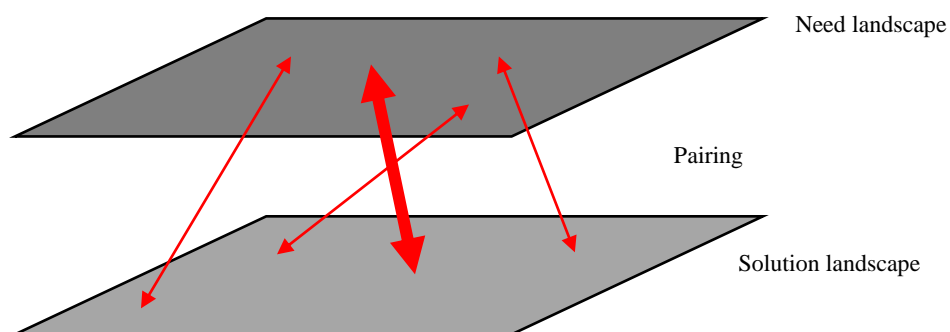
"Pivot" perspective and market creation product development

In the linear and waterfall development models, it is assumed that in the development step, the possibility of occurring in the next step is predicted, and the process proceeds to the next step without going back. However, in product development in uncertain situations, it has been pointed out that there is a trial and error behavior especially in the early development stage (Ishii (1993), Lester and Piore (2004)). Under these circumstances, the following two points are pointed out. First, it can not be clearly defined what to develop. Second, developers can not clearly define their development goals, even if they listen to customers. (Lester and Piore (2004)). However, even in such a situation, the developer can not help but find clues to some information and find development goals. One of the solutions is "experimental behavior" (Dyer and Christensen, et al. 2011). The experimental behavior is to develop a minimal prototypeⁱⁱ, use the information actually obtained from it, review the conventional behavior, and repeat creating the next behavior. A series of actions accompanied by such experimental actions can be positioned as pivots.

Needs Solutions Pairs

Needs Solutions Pairs (Von Hippel and Von Krogh 2016) is a framework that simultaneously handles the discovery of customer problems (needs) and their solution (solutions). And it is a framework different from the viewpoint that focuses mainly on problem solving, which is the central idea of conventional product development research. The main points are the following three points. First, he pointed out the existence of innovation in which problem discovery and solution are simultaneously realized without the problem being defined. Second, the combination of needs and solution (pairing) is mutually selected from among the needs and knowledgeⁱⁱⁱ accumulation (solution) of the solution. Third, pairing selects the combination of the greatest need for benefits generated by the solution in the needs landscape and the lowest cost solution in the solution landscape.

Figure 1 Need-solution pairs



Source: prepared by the author based on Von Hippel and Von Krogh (2016)

And in Needs Solutions Pairs, problem finding and problem solving actions point out the following two features. First, it is not necessarily done separately. Second, problem finding may not always precede resolution. Ishii (1993) makes a similar point. The phase in which needs and solutions (seeds) are linked presents a perspective of protocol phases in which undetermined and unambiguous needs and solutions are mutually identified and combined. The protocol phase is not a one-way process in which a problem is raised and an answer is sought, but a two-way process in which an answer searches the question at the same time as the question searches for the answer (Ishii 1993) And). Furthermore, it is pointed out that these processes are "processes in which menus of various solutions and menus of various needs are accidentally related and crystallized" (Ishii 1993).

Managing pairing in needs and solution pairs

Needs Solutions Pairs is an excellent model that illustrates the structure of needs and solution coupling. However, it can be read that it is premised that the need candidate and solution candidate can be listed in advance. Also, pairing (joining) of the needs candidate and the solution candidate is described as follows. That is, a combination is selected from a candidate with a large profit resulting from being solved out of the needs candidate and a candidate with low cost in the solution candidate. This indicates the dynamism (dynamic point of view) in which combinations of bindings are determined while looking at each other from a plurality of candidate lists of needs and solutions. However, it is not always possible to predict the magnitude of profits and costs in advance. Also, it does not mention the combined process or the process of landscape transformation. Therefore, I think that further explanation is necessary about the relationship between needs, creation of landscape of solution and pairing. It is worthwhile to explore the possibility of explaining the combination of the pairing, although the expected benefit and the expected cost are important factors in considering the combination of combinations.

Role of pivot for creating pairing

Based on the premise that the problem can not be solved unless the problem can be expressed in a solvable form (Anzai 1986), the problem finding action must be repeated until the problem is reached. Furthermore, if it becomes a premise that the problem solving action is not performed except after the problem finding action, the problem solving action will not occur unless there is a solvable problem. However, in many development sites, it has been confirmed that prototypes are developed and experimental behavior and correction are repeated without revealing problems at solvable levels (Hirota 1999, etc.). Alternatively, actions have been identified to resolve with an understanding of the wrong problem (Hirota 1999).

Needs Solution Pairs (Von Hippel and von Krogh 2016) is a concept that incorporates the fact that problems may be found while solving problems. It is not always true that such actions are false inefficient development actions. Even if it is based on the recognition or understanding of a false problem, it will be physicalized by developing a prototype, and the value will be realized by using a prototype, rather than spending time discussing whether it is a correct problem. It has been confirmed that the possibility of finding a problem can be broadened by the transformation (Hirota 2016, 2017a, b, 2018).

It is the pivot that attracts attention. The importance of pivoting is pointed out in lean start-up that needs to open up new markets (Ries 2011, Stainert and Leifer 2012, Furr and Dyer 2014). It is important to accept pivot as a measure to deal with uncertainty (Furr and Dyer 2014), and learn and modify the original plan (hypothesis) based on the information obtained from the reality created by the experiment. And, the correction may not only correct the path to the goal, but also the goal that was initially set by experiment and pivot may be revised (Stainert and Leifer 2012). Changes in pivots do not always reset everything, but repeat learning and correction based on previous experimental behavior and information obtained (Furr and Dyer 2014). And the utility of pivoting is to discover insights that can not be gained by changing many factors at once (Furr and Dyer 2014). Under uncertainty, “errors” or “failures” always occur (Furr and Dyer 2014). Pivot is the creation of a “mistake” or “failure” caused by experimental behavior, from which to learn and create a new direction to go. The pivot is an important step to repeat learning from experimental behavior and generated phenomena, and consequently to find and solve the correct problem as well as to solve it.

The importance of action and pivoting to create new markets is pointed out. However, although the creation of pivot is pointed out that the importance of action and failure is pointed out, there are few studies that accurately describe the actual state of pivot. There is also no discussion of how pivots are created, the relationship between behavior and pivot, and what behavioural changes pivots create.

3 Creation of shock resistant watch market

Casio G-SHOCK Referencing, and text styles

G-SHOCK, released by Casio Computer Co., Ltd. in 1983. The total number of shipments exceeded 50 million in 2009 (Toshio Sugao Invention Memorial). And at the end of August 2017, 34 years after the release, the cumulative shipment volume reached 100 million (more than 120 million in total with BABY-G) ([https://www.casio.co.jp / release / 2017 / 0901_g-shock /](https://www.casio.co.jp/release/2017/0901_g-shock/)). Furthermore, in Japan, the recognition rate exceeds 95% (Casio Computer Survey. Hitotsubashi Business Review 2015 p. 114. <http://g-shock.jp/identity/history/spring>). It is currently marketed in 138 countries worldwide.

G-SHOCK has not clearly progressed in development with clear goals. Furthermore, it is not recommended to discover needs from market research and to develop to meet those needs. Intuitively imagine the development of a watch that won't break even if it is dropped, which comes to mind from the developer's experience and ideas. The developer is almost alone, and repeats trial-and-error of development and verification of a prototype (prototype) for two years on the vague problem that is never clear, “a watch that will not break even if dropped” that he set himself. The number of prototypes developed is about 300. Find the problem and the solution at the same time.

Figure 2 First model of G-SHOCK (DW-5000C-1A)



Source: https://products.g-shock.jp/_detail/DW-5000C-1A/

Why pay attention to the toughness watch

Why pay attention to the category of shock resistant watches. The reason is that, until then, the watch was a precision machine, and it was prioritized to accurately indicate the time in a compact shape (thin, lightweight). At that time, shock resistance was rarely noticed in the industry. Diver's watches that already existed in the early 1980's were limited to special uses such as divers and fishing. At that time, the diver's watch was a watch with increased waterproofing ability against water pressure, and was not a product focusing on shock resistance. Therefore, there was a common sense that watches at the time were generally products that were vulnerable to shock. And the user was asked to handle it carefully. At that time, he developed products that overturned common sense and succeeded in creating a new market.

The shock resistant watch market created by G-SHOCK consists of two markets. First, there is a market for watches used by people working in a place where there is a high possibility of contact with a building, such as a firefighter or a construction site, or a place where a device with severe vibration is used. The second is a market for people who adopt watches that can be used in dangerous and severe places as function items. The first market, at the time, could not be worn at work because the watches were vulnerable to shock. G-SHOCK was developed and they can now wear the watch during their work. The second was the creation of a category called "shock resistant watch" ("Toughness Watch" Casio PR Department) in the watch market in everyday life with a strong, tough image backed by the people who make up the first market. G-SHOCK. G-SHOCK did not have clear goals and was systematically developed. The developer is intuitively setting up a self-set "unbreakable watch that never gets broken" intuitively, repeating the trial and error of development and verification of a prototype (prototype) for two years. Find the problem and the solution at the same time.

Data collection

Data related to the development of G-SHOCK exists as a newspaper, a magazine article, and a web article covering a developer's book and the developer. There are also studies that record and consider the development process of G-SHOCK. In this research, we used newspaper article search database, magazine article search database, and web publication article search for these data. We also secured the developer's lecture record from research collaborators. Furthermore, the patent application platform was used to confirm G-SHOCK patents and utility models.

Based on these document data, we listed the developer's actions and the facts that occurred in chronological order. Then, we interviewed the developer and converted the interview voice into text. In addition, I made a list of facts that lead to pivot from the interview text. And it classified by Grounded Theory.

Developer's original experience

The developer drops and destroys his precious watch on contact with others in 1981. Mr. Ibe still clearly remembers his watch falling and breaking. It is triggered by this original experience, and it applies as a theme of the plan proposal system that was obliged at the time at that time. Two or three months after the watch was dropped and broken. However, until then, the theme was clearly different from the one suggested by the developer. On the day, I was in charge of the structural design of the thin and light watch that was the mainstream of the market. Therefore, themes such as the back cover structure of the watch and the new forming method of the watch case have been proposed. However, those themes were not adopted in the plan proposal system.

In the wake of the experience of falling and breaking the watch, I intuitively submitted a written plan describing only one line, "a durable watch that will not break even if dropped."

The proposal is approved by the department. It was the first experience for developers. And above all, developers were surprised at the approval of the intuitively written Onesentes proposal.

Creation of solution ideas and experimental methods *This is an example of the style for a third level heading*

The developers first thought that the problem was solved by attaching shock absorbers to the square of the module of the existing watch. No shock absorber was used between the module and the case of the conventional watch. The problem was that the conventional watch had no function to absorb shocks. And I thought that the problem was solved by the means of attaching the shock absorber to the square of the module.

Another thing I thought was the experimental method. From the experience of dropping and destroying your own watch, intuitively select the experiment method by natural fall. The developer who is an engineer was also able to select an experiment using an experimental apparatus. But I did not choose that method. The impact that occurs in a naturally falling situation is all possible, and it was impossible to predict what kind of a possibility. Therefore, there is a possibility that the experimental device could not be

designed. The developers say that the theme "unbreakable watch" did not arise if we were actually experimenting with the experimental device.

Development of prototype

Repeat prototype development (make) and drop experiment (use). We do falling experiment from the bathroom window on the third floor. The developer goes down the stairs and moves to the fall point. And check the status of the prototype. If it is broken, think about the reason as you go up the stairs back to the laboratory on the third floor. When the laboratory returns, it disassembles the module and checks what parts are broken. This work was repeated every day. However, even if the amount of sticking the shock absorber around the module is increased, the module is broken. However, a prototype is finally completed that does not break the module. However, the prototype was stuck on several layers, leaving only the LCD screen part of the module. And the size was about the size of the ball used in the softball game.

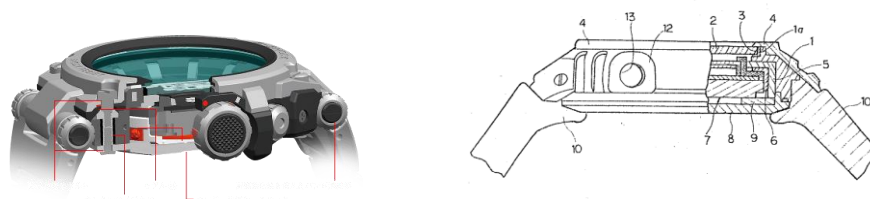
Simultaneous creation of discovery and solution of new problems

With softball sized modules and shock absorption features, it is difficult to make a watch product. However, "a module that is not broken even if dropped" has been realized. At this stage, the developer became aware of the problem of making the soft-ball-sized impact-absorbing function suitable for a watch. And at the same time, create a solution idea by the shock absorber structure with five steps. Experience in the process of winding the shock absorber leads to the creation of this solution idea.

Discovery of target customers brought about by different environments

The five-stage shock absorbing structure was effective because the size could be reduced. As I was repeating prototype development and experimentation, I encountered a worker who does road construction outside the company's building. They were digging the road using a jackhammer. The developer notices that not all the workers have watched. The developers thought that they could not use the watch as the rocking machine's vibration would break the watch. For the first time, developers have identified customers who will need shock resistant watches.

Figure 3 G-Shock Shock register structure



Source: <http://g-shock.jp/products/mt-g/> Source: Utility model patents JPU_19841490

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Unsolvable problems and clues to solutions created by different environments

However, no matter how many times the experiment is performed, there is a problem that only one component inside the module is broken.

The results were the same even if the impact absorption method and the position and size of the impact absorber were devised. The developer is prepared to give up development because no solution can be created.

The last day I decided to give up development. The developer went to work in spite of Sunday and was doing experiments. When I went out of the office building to buy lunch, a kindergartener was playing ball at a performance. Looking at the ball created a scene in the head of the developer. It was a scene where the clock module was floating in the ball. Furthermore, another scene was created in the head of the developer. It was a scene where a glass of wine floated in the bowl.

From the view created in the head, I think of a structure that supports the point with the whole module instead of covering it with buffer material. In other words, float the module in the air. In the five-step shock absorption, the module is fixed, so the shock which can not separate absorption is transmitted to the module. The situation in which the module floats in the ball reveals this problem and also creates a solution. That is, by supporting at a point, the module can be in the air. Therefore, the module can evenly distribute the vibration by moving.

The developer will develop a structure that combines point-supported air structures and five-step shock absorbing structures. This structure leads to the realization of a shock resistant watch. And, it is the structure of current G-SHOCK.

4 Discussion

“Hunter-Gatherer Model”

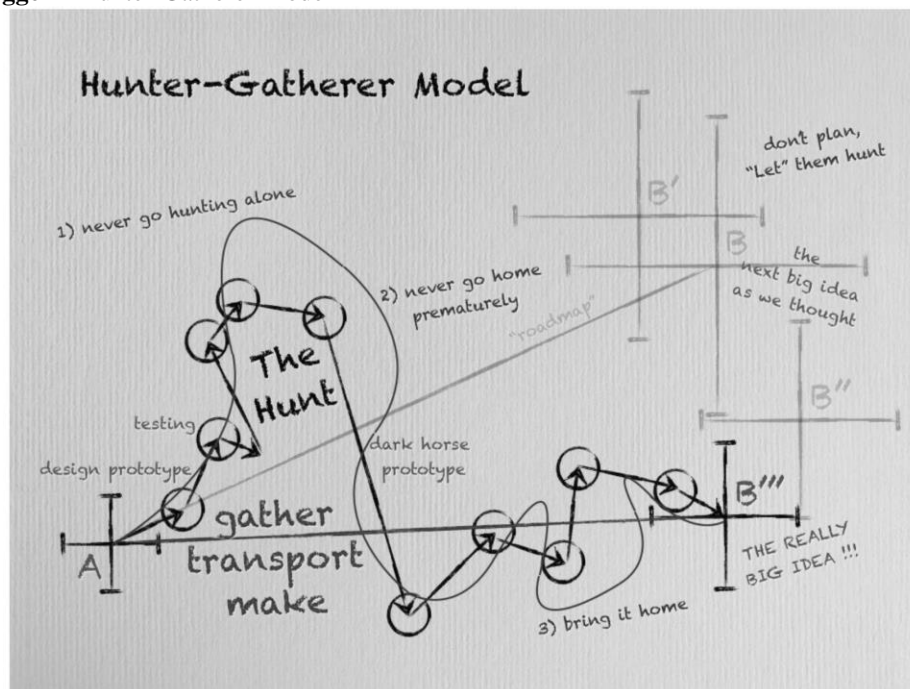
At Stanford University, ME 310 is a program that applies design thinking to project-based learning. ME 310 is a program that enables companies and Stanford University to collaborate and utilize design thinking to realize innovation. A dynamic model is the “Hunter-Gatherer Model” (Stainert and Leifer 2012), from the research of design thinking application of ME 310 for 10 years. The "Hunter-Gatherer Model" repeats the experiment and corrects the target and development behavior to be developed based on the information generated from the experiment. And experimental behavior is a combination of prototype development and realistic demonstration tests. It is characterized in that it positively recognizes the change (pivot) to be developed initially. Naturally, the information that comes out of the experiment includes the consequences of failure.

The model of Stainert and Leifer (2012) shows that experimentation and pivoting are the engines of innovation. He also showed that experiments create pivots, and that through multiple pivots, they lead to changes in development goals that were initially set, and the creation of new development targets. However, it has not been described how multiple pivots exist in the development process. Such creation of pivots in the development

process is limited to experimental behavior. Also, in the creation of pivots, it is pointed out that the idea that is not judged to be correct at that time is not selected, but the idea that is not judged to be correct is selected (Dark horse). It has not been fully explained.

The pivot can be thought of as projecting (creating) the next direction through interacting with the prototype through making and interacting with the behavior of the prototype and the phenomena (information) obtained through it through use. . And the information created by prototypes and experiments is always realistic. And the pivot created by realistic information is considered to include new problem and solution clue or solution itself.

Fugger4 Hunter-Gatherer Model



Source: Stainert and Leifer (2012)

Insight chain and pivot chain

As a research focusing on situations where the problem is not clear, there is the research of Ishii (1993, 2009). Ishii (1993) presented the existence of a protocol phase in which unambiguous and unambiguous needs and solutions are linked to each other while the needs and solutions (seeds) are linked. In addition, Ishii (2009) points out the existence of the moment when a new cut is seen in the experience of the main actor of the scene which opens a new market. And I called such a moment a creative moment (business insight) (Ishii 2009). The significance of the existence of a creative moment (hereinafter, insight) is regarded as an action that overcomes the limitations of positivist action. Markets that cannot be captured by positivistic behavior will emerge (Ishii 2009). As one

of the limitations, Ishii (2009) states that the power to see something that can not be seen is neglected.

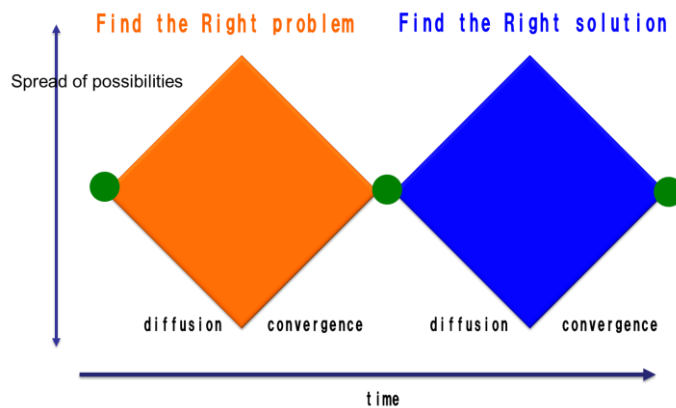
Pairing in Needs Solutions Pairs is each a creative moment (insight), and a creative moment creates a pivot. And creative moments and pivots are not necessarily created only once in the development process, but may occur multiple times. And multiple creative moments (insights) exist in a chain, leading to pairing at the same time as final insight.

Innovation and "problem finding" behavior

Product development consists of two actions: finding the right problem and solving the right problem (Norman 2013). And conventional product development research has mainly focused on problem solving (Clark and Fujimoto 1991). In recent years, the need for new marketing needs in addition to marketing of problem solving from technological innovation and environmental opacity (Kotler et al 2009, 2017), the need for attention to problem solving in addition to problem solving (Kotler and Takaoka 2016) There is an indication of). In research that focuses on conventional problem solving, it is an assumption that the problem has become clear. Therefore, even if you take into consideration problem finding, you will stand on the line of problem finding before the action of problem solving. The problem-finding behavior and the problem-solving behavior are separated, and the problem-finding behavior is a premise that precedes the problem-solving behavior.

Furthermore, the problem that the customer needs to solve is not always the correct one. Therefore, understanding the real problem is necessary to realize the innovation (Norman 1998, 2013). At the same time, in order to solve the problem, it is necessary to express the problem at a solvable level (Anzai 1985, Suzuki 2016a). For that purpose, it is necessary to express in some way the situation that you do not know how to put your hand on it. Understanding this problem is the most difficult process in problem solving (Anzai 1985 p. 141). If the situation is not understood, the problem can not be expressed properly. Therefore, depending on the degree of understanding of the situation at present, if you express the problem (at a possible level) and try to solve it, understanding of the situation you are confronted by becoming unclear or not correct Go forward (Anzai 1985). This point is important in two ways. First, the understanding of the situation leading to the problem understanding is not clearly classified by "clear" or "not clear", but it is clear that there is a state of partial clearness or stepwise It is also necessary to pay attention to the state of progress. Second, in situations where the problem is not clear, it is necessary to focus on the action of solving the problem at the current level of understanding.

Fugger4 Double diamond Model



Source: Norman 1998,2013

Combination of problems and solutions that support experimental behavior

Needs Solutions Pairs explores creation of a combination of specific needs and specific solutions among needs and solution knowledge (landscape). If it is considered that repetition of experimental behavior is related to the creation of combination, each experimental behavior is considered to be performed in a certain dialogue structure. And the experimental action showed the dialogue structure (the triangle of dialogue) performed in the action to use, the action to use, and the customer experience (Hirota 2016, Hirota 2018, Hirota 2018).

According to the framework of needs solution pairs, interaction between a certain problem (necessity) and a solution pairing is repeated, development of prototype (action to create), experiment (action to use), and interaction of customer's experience. It is thought to support. Here, "dialogue in action" dialogue in action accompanied by the prototype. Dialogue by combination of problem and solution that supports action is called "dialogue in thinking". Here, we focus on "dialogue in thinking" and consider the relationship between the creation of a combination of problem and solution and the creation of a pivot.

Pivot and dialogue

In Needs Solutions Pairs, trial and error are repeated to create the final pivot. It is thought that the final pairing can be imagined through repetition of multiple experimental activities and failures. In the process, the existence of multiple "provisional pairings" and each "provisional pairing" are considered to be connected to the final pairing.

While G-SHOCK is the mainstream of thin and light watch products, development starts from the situation where customers can not confirm the need for shock resistance on watches. And because there is no such thing as a watch that won't break if dropped, no one can define what kind of product it is. In the case of developing a product that solves the needs that the customer has not noticed, as in the development of G-SHOCK, the problem is not defined for the developer as well. And in the early stages of development, even if you carefully listen to the customer's voice, it is difficult to evaluate the outcome or to classify or isolate the problem due to "radical uncertainty", and clearly define the

problem to be solved Things are difficult (Lester and Piore 2004 pp. 53-55). But even in this situation, the developer needs to define the problem to be solved. And depending on how the problem is defined, it has a great influence on development results (Lester and Piore 2004 p. 55). In such a situation, the developer finds problems from among trial and error, in principle, chance, and ad hoc clues (Ishii 1993 p. 34, Lester and Piore 2004 p. 56). And in finding solutions while defining problems, the process of "dialogue" is important (Ishii 1993, Lester and Piore 2004, Ishii 2009). In "dialogue", dialogue with people is assumed. However, there are also "dialogue between people and resources" (Ishii 1993) and "dialogue between people and things" (Ishii 2009) by people getting into objects.

If the customer and the developer are separated, the customer tries to express something in their daily activities and the developer tries to interpret it (Lester and Piore 2004). We can express something by means of language and non-language, and convey it by the dialogue that the other developer interprets. However, as long as they are others, the developer's interpretation is not always correct. We developed prototypes frequently in situations where we don't know what these problems are, and suggested that repeating use and development is effective for innovation using a dialogue framework (Hirota 2016). It is not clear which information should be selected from the solution landscape (It is considered to be based on cost. However, in the case of the cost standard, it is limited to the case where the problem is clear and the solution information selection candidates can be cost compared.). The clue for that is searching for the related technology and processing method from solution landscape through the interaction between the information acquired through the action using prototype and the experience to be realized. At the same time, it is thought that solutions and landscapes will be accumulated through the dialogue between the information that acquired the action to be created, the action to be used, and the experience to be realized (Hirota 2016).

The experimental behavior is to repeat the development of the prototype, that is, the "make" behavior, the use of the prototype in the actual field, that is, the "use" behavior (Hirota 2016). In these actions, there is a dialogue between the action to create and the action to use and the customer experience (Hirota 2016). Also, when considered from the perspective of cognitive science, the action to create and the action to use are the projections from the developer (Suzuki 2016), and the developer repeats the dialogue between the external representation and the internal representation through the projection (Suzuki 2016) . Furthermore, through these dialogues, the dialogue between "use procedure" on how the user uses and "development procedure" on how the developer should be created is repeated (Hirota 2018)Information creation and pivot by experimental behavior

Information and pivot creation by experimental behavior

Pivot is a framework that emerged in the analysis of start-up success models targeting unforeseeable areas (Ries 2011, Blank and Dorf 2012, Blank 2013).

Pivot presupposes the creation of failure, and leads to the creation of products and services through repeated experiments. No one can make the right guess when faced with uncertainty. Therefore, pivot is to create an action that changes from the conventional action based on the information obtained through the action called experiment. The premise is that if you act (experimental) under uncertainty you will always get a failure

(Furr and Dyer 2014). Based on the information obtained from the failure, create a different target from the past and connect it to a new action.

Kelly and David described the effects of the prototype on innovation as follows: "One picture deserves 1000 words. Prototyping is a way to get a design catchball activated and get feedback from others. If you make a prototype, someone can help you" (Dyer and Christensen, et al. al. 2011). However, traditional pivoting research has focused on startups and the areas in which startups create business models. Therefore, the change of the pivot is to create not only the product but also the business model, the underlying hypothesis on the growth engine, and the structure to test the hypothesis (Ries 2011).

The pivot is positioned in a customer development model (Blank and Dorf 2012, Blank 2013). The customer development model was developed as a complement to the linear product development model (Blank 2013 p. 30). In the conventional product development model, construction of a business model and organizational operation of a business model have not been sufficiently considered for the process of developing a product. And because the development process is one-way, the process of backtracking was not considered. Therefore, the customer development model is classified into two phases of search and execution, and the search is composed of steps of customer discovery and customer verification. The implementation consists of two steps: customer development and organizational development (Blank and Dorf 2012, Blank 2013). And pivot is applied in the process of customer discovery and demonstration of the phase of search. Based on the results of customer demonstration, apply pivot to customer discovery and lead to customer discovery that seems more correct. In the customer development model, "backtracking" to customer discovery based on customer-proven information is an important process in learning and discovery (Blank and Dorf 2012).

It should be noted in these studies that trial and error do not end in one. Furthermore, trial and error involve experimental behavior. And the result of experimental behavior is that failure is included. Startups that create new markets "repeat over and over again until they succeed" (Blank and Dorf 2012) (Experimental behavior creates the phenomenon of success as well as the phenomenon of success. And the phenomenon of failure brings new information to the developer. Based on the information obtained from this phenomenon, Create the next action.

5 Conclusion

Two type pivots chain, close type pivot and open type pivot

Focus on the development process of G-SHOCK and the pivot generated there according to the framework of needs solution pairs. Then, focus on the combination of needs (problems) and solutions (solutions) to check the developer's behavior before and after the occurrence of pivot. From there, two types of pivots were identified for the occurrence of pivots in G-SHOCK. When the experimental behavior in the development of G-SHOCK is considered in the framework of dialogue, the existence of at least two kinds of pivots was confirmed. That is "closed pivot" and "open pivot". And in realizing innovation, it is realized by combining two pivots. Two pivots are essential for

innovation. In the double diamond model pointed out by Norman (1998, 2013), the pivot that shifts from convergence behavior to diffusion behavior corresponds to "open pivot". On the other hand, a pivot for continuing the convergence action and deepening the combination of a certain problem and solution corresponds to the "closed type pivot".

Two type pivots and dialogue structure

The difference between the two pivots, closed and open, can be explained by the concept of interaction. Dialogue is a framework of what developers are thinking about for dialogue. As a framework, what is the issue to tackle development, and by what means will you solve the problem. And the problem is a solvable problem (Anzai 1986). The dialogue structure is considered as a combination of a solvable problem and a solution. It is "closed pivot" that development action advances by this combination. A pivot that occurs as the combination of problem and solution continues.

On the other hand, another pivot can be confirmed in the development of G-SHOCK. That is the "open pivot". An "open pivot" is the creation of a new solvable problem, as well as the creation of a new solution combination with the problem.

Pivots and Needs Solutions Pairs

"Closed Pivot" explores the possibility of pairing exploratorily in the context of needs-solution pairs and in the landscape of limited needs and solutions. But with a "closed pivot" alone, a deadlock occurs somewhere. There are cases where the combination of pairings is at a limit. Unbreakable modules have been realized. However, it became a prototype of a size that can not be used as a watch. At this stage, the problem of "reducing to the size possible for a watch" is created. At the same time, the new knowledge accumulated by previous experimental actions creates a solution idea that gradually absorbs shocks by the five-stage shock absorption structure as a method of solving the problem. This is the "open pivot".

Repeating the experiment of the idea of the five-step shock absorbing structure, only one component in the module is faced with the problem of failure. The problem of miniaturizing the shock absorbing system has been solved by the five-step shock absorbing structure. However, no matter how many times the "closed pivot" is repeated, a new problem arises that only one particular part breaks down. And I can not understand the cause of the problem. In other words, the situation is not clear at a solvable level.

In order to solve the problem, it is necessary to set up an environment different from that of prototype development, experiment and repeated verification. In an environment where information is in contact with developers, such as company buildings and premises, "closed pivots" place themselves in a state where children play ball games in the park. Alternatively, even when the target is specifically clarified, it is confirmed that the developer is in contact with an environment different from the environment in which the "closed pivot" continues.

Two approaches to creating an open type pivot

How is a pivot that creates a new pivot created? At least two approaches can be identified in the development of G-SHOCK.

First, MVP (Minimum Visible Prototype (Ries 2011)). Is to confirm the effectiveness. Second is the different experience of the developer. Dyer and Christensen, et al. (2011) are similar to the realization of the different experiences being one of the three types of experiments. In different experiences, the parties put themselves in different environments. Cooperation with different fields or use in different environments is assumed.

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- ⁱⁱ For example, experiments with MVP (Minimum Viable Product) proposed in lean start-up, experiments with simple prototypes such as cardboard at the initial stage of development by Dyson, and simple prototypes in design thinking.
- ⁱⁱⁱ The information that composes the landscape includes implicit elements (Tacit elements) (Von Hippel and Von Krogh (2016))