

How to Visualize the Design Process

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Abstract: The research had involved in a watch design project that lasted for three months. We found that designers' design thinking usually leaped but associable during design process. And, it turned into continuous decision-making when been implemented during design process. However, designers executed works in a state to state jumping ways during design decision-making process. Yet, the discontinuation in design occurred from the leap of the state and this kind of discontinuation caused designers missing certain design information. By reviewing literatures focused on design process and thinking, we found that from the connected derivation graphs between the states point of view, the graphs could express fractional derivative state messages, which seemed to present a dynamic graphic design process. The research believed it did doable to recorded design process by aid tool. By adopting focus group method, we collected designers' need of aid tool to record design process during design process. Moreover, we transferred those data and requirements into the prototype planning and designing aid tool.

Key words: *Design Process, derivation graph, Information Visualization, Dynamic Graph*

1. Introduction

In this research, we participated at a three-month watch exterior design project; observe and record the whole design process. We found that the designer's design logic usually leaps but is able to be associated with during design process. But it turns into continuous decision-making when implementing the design process. The designer, however, performs and presents his/her work in a jumping ways, from state to state. Yet, the discontinuation in design occurs from the leap of the state. This kind of discontinuation causes the designer to miss certain design information.

This exist in the process of continuous action, some hidden state may be closer to the designer's original idea but not obvious. Therefore, finding out how to make continuous observation of the states, which is possibly explore any extension point from the continuous process, as well as developing a new starting point, or a new decision-making point. From the view point of the connected derivation graphs between the states (Figure 1), the graphs could express fractional derivative state messages, which seem to present a dynamic graphic design process.

In the current research of design thinking process and studies, thinking aloud and protocol analysis are the most common used research methods to aid and obtain the information of design process. Nonetheless, thinking aloud and protocol analysis emphasize on and record the designer's explicit inner design thinking. In our analysis, we capture retrospectively the participants' vocal record. Obviously, there is a risk by using these methods, because it

is hard for the designer to recall some ideas and the design judgments when designing. (Gero and Tang, 2001, p. 287).

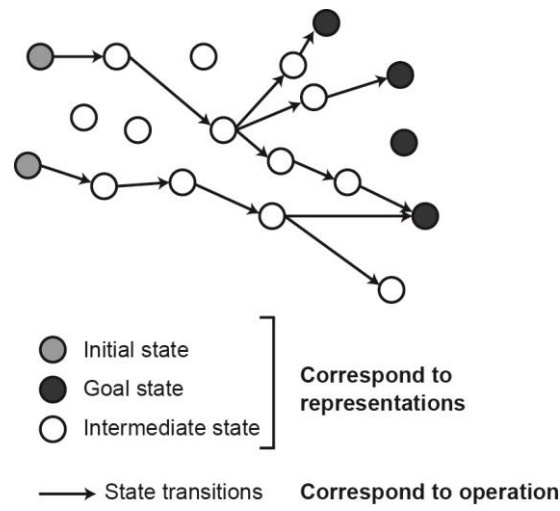


Figure.1 A generic diagram for search [Woodbury,1991]

Information Visualization has been used in various fields. In the past 15-20 years because of the rapid development and cheap prices of computers, it gets more and more consideration and attention to computer-based approach to digitalize information. Despite that, what is visualization? The definition of visualization from a dictionary is: to form a mental model or mental image of something. Spence (2007) suggests the process of information visualization can be simply summarized as Figure 2. He proposes that data and information are different, regardless of any forms of information, through human interpretation can be converted to graphics. The main task of information visualization is to transmit the data into information which spectators will discovery later because the data has been encoded into a visualizing graphic (Spence, 2007).

Therefore, this research utilized the method of derivation graph and information visualization to record the dynamic graph of the design process. We thought that it is feasible to apply assistance tools to record the design project, as well as helpful to the research of design process, after the end of the design project by focus group discussion. We also collected the designer’s demand of the assistance tools to record the design process when in process in the focus group discussion; additionally, transferred the gained information and demand into the prototype planning and design of assistance tools.

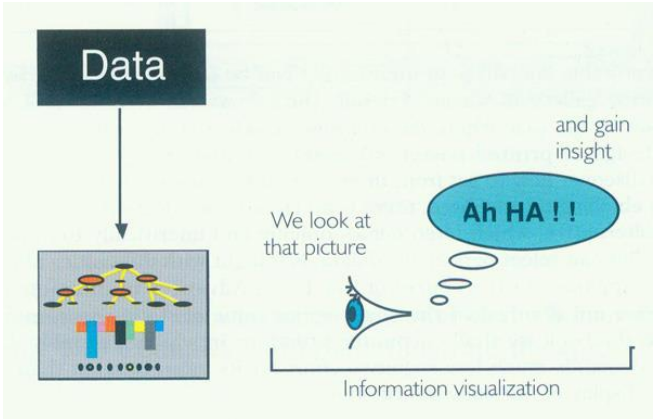


Figure.2 The process of information visualization (Robert Spence,2007)

2. Literature review

2.1 Design Process

Although the executing design process contains a large number of variables and possibilities, we can induct several general design models from some common design activities to represent the frequent logical structure behind the design activities.

The structure of the design process is constituted by the vertical structure of the continuous acts and the horizontal structure of the decision-making production cycle (Asimow, 1962). The vertical structure of the design behavior is the process from abstract to concrete and its horizontal structure shows as a flow status, Analysis→ Synthesis→ Evaluation→ Communication, following by the situation of design messages (Figure 3).

Archer's design process phase model from the viewpoint of design execution, design is considered as a continuous phase actions (Archer, 1965). Design contains its sources and commonly-seen types of tasks; as a result, design is described as a general form. The design process is a cycled feedback loop which represents the relationship between actions (Figure 4).

"Analysis→ Synthesis→ Evaluation" (Alexander, 1964) extendedly adds an evaluation to form the cycle. At the beginning, the designer will analyze the problems or the subject to discover the clues of solution. Compositing the experience and related information from database to capture a phase result; furthermore, identify its suitability. Design forms gradually in the repeat adjustment cycle.

"Conception→ Performance→ Test" (Zeisel, 1981) is the spiral structure consisted of the cycle of their three actions in designing process. With the progress of the design, the design scope and subject will become more and more narrow and obvious (Figure 5).

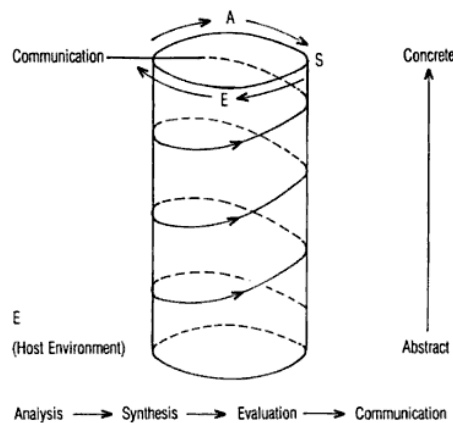


Figure 3. Asimow's model
(Asimow, 1962)

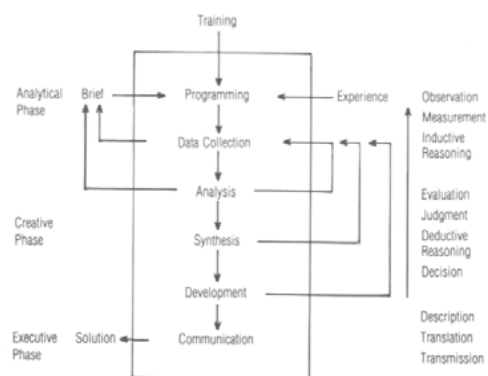


Figure 4. Archer's model
(Archer, 1965)

In the exploration and model of design process, it is the design problem to define ill-define problem. The problem space is unclear and no so-called correct answer. Therefore, the research of design starts to see the structure and properties of the design problem to recognize the problem solving of the internal state logics and decision-making process. Newell, Shaw & Simon (1957, 1967) initiates from the perspective of problem-solving behavior, and proposes the message handling theory of problem solving to denote that thinking is a process of

message handling. This description and process of analyzing human recognition explain the connection of action and consciousness.

Model 1: Search model (Simon, 1969; Rowe, 1987) is based on the problem-solving and information processing; design can be seen as a strategically searching process. The form of problem space and the knowledge state is demonstrated as “Decision-making tree” showing all possible results (Figure 6). The designer will use priority-selection and simplified assumption to make his/her process of decision-making easier to handle. Design state shows the variable trend of trial-and-error, and generate-and-test.

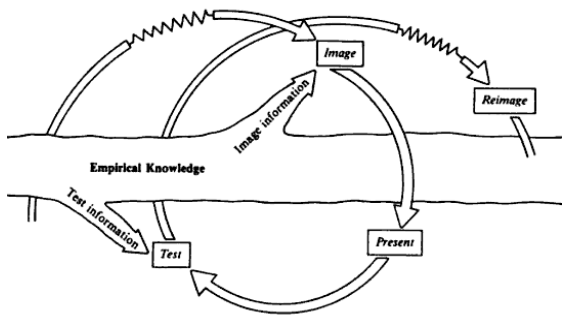


Figure 5. Zeisel's model (Zeisel, 1981)

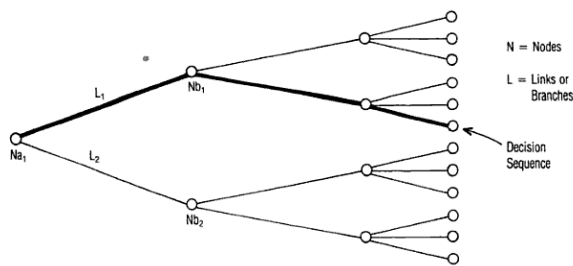


Figure 6. Decision Trees [after Rowe, 1987]

2.2 Information Visualization

Information visualization refers to the result of data processed after a series of handling transferred into an easier understanding pattern for human brain. It is usually applied into data which could not be immediately discerned. In order to be easily understood, the best way is to shown in figures, because, it's easier for human beings to accept graphics then texts.

Spence (2007) mentioned in his book “Information Visualization” that identification of the interaction with data governed by high-order cognitive processes (Figure 7). He deems that the process of information visualization is divided into several phases (Spence, 2007). The first phase must collect and store data. The second phase is the representation of data and presentation of the represented data. The third phase is to generate images on the screen by display hardware and graphic engine. The fourth phase is the human identification and consciousness of the image.

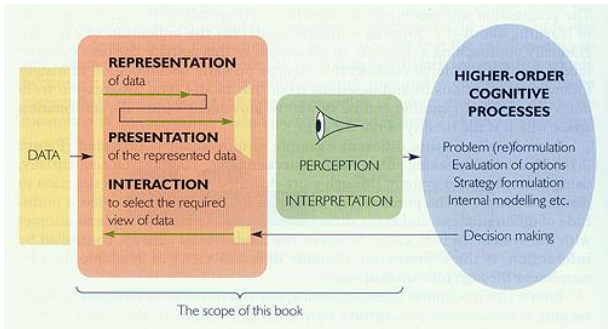


Figure.7 Identification of the interaction with data governed by high-order cognitive processes (Robert Spence, 2007, p.26)

2.3 State Space search

“State space search” was primarily introduced when we acknowledged that the design space is possibly infinite. This kind of viewpoint is usually concerned by people when describing the design state (Figure 1), including the regulation and restrain, in the space design.

It was Herbert Simon, the first one to propose using “State Space Search” as the design process. He made the definition in his book in 1980, “The Science of the Artificial” (Simon, 1980). Herbert Simon, in this book, deemed that it’s a very important part to own the effective inspiration in searching design ability. In his early-stage paper, “Style in Design” (Simon, 1971), he submitted this concept which he questioned the phenomena of human designer’s thought of design and behavior in process. And he concluded as following “he solves his problem by moving through a large combinatorial space in which he adds one element after another to his design...The richness of the combinatorial space in which the problem solver moves...is the hallmark of design creativity”.

Rob Woodbury presented his perspective to the further development of “State space search” in his research. He believed that State space search is a useful design model. You can track or discover a space design by adopting design-transforming operators. These design-transforming operations are appointed not only to express the current design but also check with the comparative design standard. (Teng-Wen Chang, 1999)

3. Methodologies

By the literature investigation, we can see that we can utilize Rob Woodbury’s theory ,which was further developed from State Space search, to transfer the recorded information from the observation of participating watch exterior design project into derivation graphs through the method of Information visualization; additionally, discuss the recorded design process and result in the focus group.

3.1 Participant Observation

The so-called “Participant Observation” is the observation that the researcher gets deeply into the life background of the object being studied and actually participate its day-to-day social life. Lofland and Lofland(1984) thought that “Participant Observation” is a kind of field observation or direct observation which in order to gain the so-called scientific understanding of a certain group, the researcher build and maintain multi-dimension as well as long-term relationship with it. Thereupon, this research adopts the method of Participant Observation to record the execution of a watch exterior design project. There are there designers in this project record. The project execution duration is three months. The complete record of the design project will be presented by derivation graphs after the end of the project.

3.2 Focus group

“Focus Group” is a sort of method of qualitative research. It refers that to capture its viewpoint and appraisal through the participants’ free and interactive discussion on some particular topic or the way of inquiring and interviews of a group. It is an investigation research method for the purpose of collecting comparatively deep and true views and thoughts. The members of the focus group are usually chosen by the experimenter’s judgment, and ensured that the objects will be able to share their opinions and assertion during the experimental process.

In this research, we conducted interviews by picking those with design relative background from the record result of involving the watch exterior design project. The interviewees are the 6 designers with the average age of 36.5 years old, 7~8 years average design experiences, and 2 hours interview duration. We also recorded the interview process by video camera. We discussed whether be able to use assistance tool, and collected the demand of using assistance tool to record design process when the designer in design process. Furthermore, transfer the gained information and demand into the prototype planning and design of assistance tools.

4. Results and discussions

This research adopted the method of Participant Observation to record the execution of a watch exterior design project. And then, it applied the method of Focus Group to collect the designer's demand of the assistance tools to record the design process when in process in the focus group discussion. Afterward, it transferred the gained information and demand into the prototype planning and design of assistance tools.

By Rob Woodbury's theory from further development of "State space search", we can transfer the recorded information from the observation of participating watch exterior design project into derivation graphs (Figure 8) through the method of Information visualization.

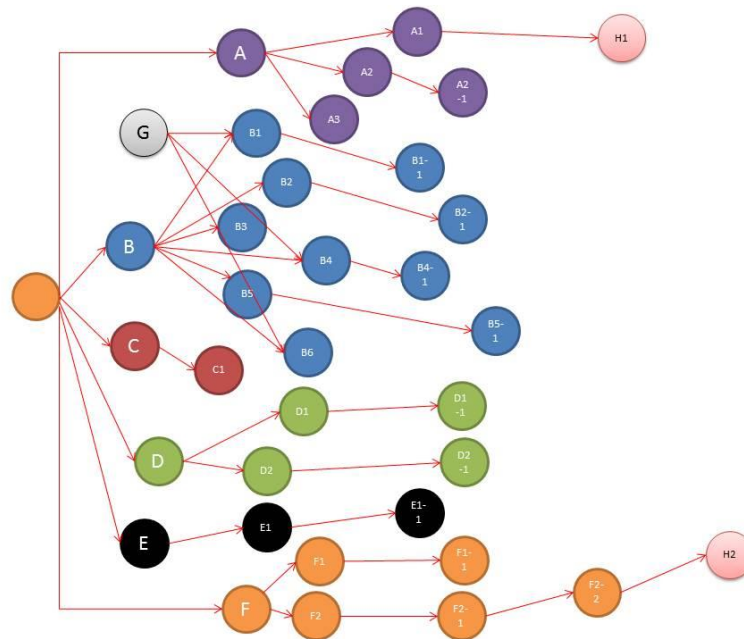


Figure.8 The derivation graphs of the whole design project

From Figure 8, we can clearly see the design process of the whole design project. The designers developed A、B、C、D、E、F、G, seven series of watch exterior drafts at the very beginning. There are different developed styles or meanings in each series.

1. A is unique! We discovered that the A series was evolved into A1~A3. Among these, A1 was progressed into H1, the final work (Figure 9); yet, A2 and A3 were discarding at the draft stage.
2. B is younger style, and G is feminization. B and G series, on the other hand, generated many different drafts because of overlaps on certain characteristics which resulted from mutually mixed design drafts. However, there were no final works from these two series ultimately.
3. C is universe planet. This concept development of this series was ended very soon.

4. D is Taichi numerology. It went on two phases and then ended without reaching the final work.
5. E is religious. E series also went on two phases and then ended.
6. F is Bagua shape. The shape concept of F series was more concrete. It also derived into two series and reached H2, final work, finally (Figure 10).



Figure.9 the final work1

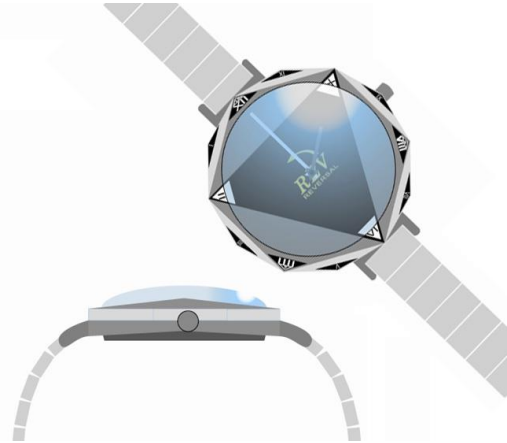


Figure.10 the final work2

Besides, this research also retained some outcomes from the discussing issues of the focus group.

1. It is feasible to record the design process by utilizing assistance tools.

The participants thought that it can certainly record the design process through derivation graphs. Therefore, we can also infer the feasibility to record the design process by using assistance tools. But, on the other hand, they also deemed that it has limitation to apply derivation graphs to record the design process; such as that its unidirectional derivation cannot record the designer's bidirectional and back and forth jumping design process. The generation of derivation graphs is drawn after the end of project, which means that it cannot provide the designers immediate feedbacks. Whether or not could it improve the assistance tools to provide the designers instant and bidirectional interactive record of design process?

2. The saving problem of record data.

It is pattern file of the record of derivation graphs, which is saved in personal computer, and not convenient to manage and share. Whether or not could the assistance tool be built in the cloud, and save the data in the cloud database to make it easy-to-manage and share? Moreover, in the aspect of saved record, could we record more information in addition to the pure derivation graphs of the design process? For example, the original file that we generated by using digital illustration software in the design process, or the writing of a moment of inspiration at every saving stage. Because we have record, we can go back and check our own design problems when encounter obstacle or does not work at certain stage. And we can capture some inspiration during the record check-up.

3. The visualization interface of the design process.

The participants thought that the meaning of each recorded state of current derivation graphs is not clear enough to the designer. It merely is a round record graph to the designer in which she/he cannot get what on earth it recorded at each state distinctly. Thus, could the new assistance tool discard the traditional shape, such as round, or square...etc., and use the thumbnail of the picture file to present the state of each stored state?

4. To save the file in the background of the assistance tool.

The participants thought that because it is often continuous thinking and movement when the designer in design process, she/he maybe forget or skip some to save some states. Forasmuch, the assistance tool ought to save the current state automatically in the background, for instance at each minute interval. These automatically saving figures are very helpful in checking the complete design process. The designer goes back and checks the last moment inspiration, and is further enlightened; moreover, the saved file could let the designer goes back to the state and stage to continue design into the more detailed design steps.

5. Conclusion

According to the literature investigation, the record of design project, and the discussion of focus group, this research come to the conclusion that we for sure can utilize some sort of assistance tool to record the design process. Therefore, we plan and design an assistance tool to record the design process. In this research, we call it “Dynamic Graph System”.

Dynamic Graph System is a set of system to record the design process of the designer based on Robert Spence’s information visualization theory and the architecture of the State Space. Users get access from Webpage interface to link cloud database (Figure 11). The designer uploads and downloads its each state of design process in the Dynamic Graph System. Each state is going to record the original file, graphics, and text data, of the designer when design, and then, generate the derivative dynamic graphs immediately for viewing and use of the designer.

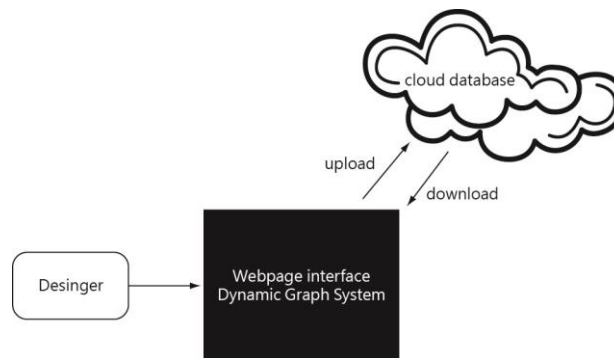


Figure.11 The user connects to the cloud database via Webpage interface

In the planning and flow of the system (Figure 12), the authorization defined into user and administrator when logging in. Users can choose to create a new project or open an old project if he/she is not first-time user. They finish the project record as the shown flow of Figure 12. Moreover, the administrator can choose usage management (create, delete, or modify user), or view the projects in the cloud database.

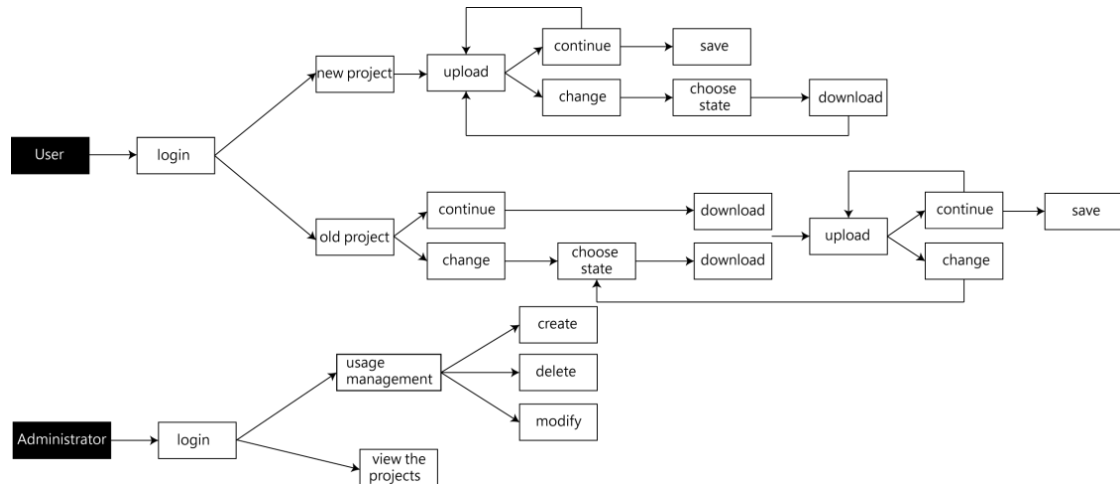


Figure.12 Operation flow of Dynamic Graph System

The result of this research is that Dynamic Graph System can record ideas when design, such as design at a glance. Because of the record, users can go back to view the dynamic graphs and see what is the problem when there are obstacles. They can get inspiration from viewing the process and go on with the design. That it is a better way to use the discarded shape at each state, like circle or square, as the file snapshot picture for the dynamic graphs because it is more convenient for the design to understand each state presents which shape. With the intention of that, they can choose whichever state to prolong the design more efficiently. In the aspect of the text record, the designer exclaims that the advantage is to record some unexpected ideas to record texts during design process; however, the drawbacks are that designers would like to find design process to some paragraph and perhaps has passed some states. Then, go back and imagine how to write the text record to avoid interruption of thoughts.

In this research, we can see that anticipate storing both the graph and the original file of the background recorded graph in Dynamic Graph System. Designers think the stored graphs are beneficial for viewing the completed design process, for example, deleted certain shapes which were deemed in appropriated at the design moment, until some state stored. He or she has forgotten creative shape but has been deleted. The background recorded graph in Dynamic Graph System can allow designers reviewing the idea at a glance and being inspired from it. On the other hand, the stored original file can let designers go back to more detailed step of the state and state to carry on design process.

The result of this research is that deliberate that connecting cloud database from Dynamic Graph System can become designer's design database. If designers do same or similar design projects, he/she can use the stored file as the base to modify in the future. Even though for a new subject, he/she can use the files in the database as the foundation for new design ideas, which will make design more efficiently. Nevertheless, some designer also points out that viewing those existing file will block the innovative thoughts of design.

Through the record and discussion, this study finds that the use of information visualization approach can make the design process becoming a series of animation which helps the beating state be recorded in the design progress between the information so that designers clearly see the evolution of modeling details of the design process. Through dynamic graphic design system, designers do not only have the finalized state record, but also reflect on the design process back the missing information after designing. Whether some information (such as the developing features or non-progressing idea) is helpful for the designer or not, these records will facilitate

designers to review the design process and thoughts to the future use. In addition, it provides a record of a state so that designers continue to develop ideas.

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