VISUALISING THE DESIGN PROCESS WITH DYNAMIC GRAPH

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Abstract. Design Process is a continuous decision-making movement. Yet, the designer usually executes the process in a jumping way, from state to the other. Nevertheless, this kind of jumping process would cause loss of some essential information, such as a glance of design, or certain process of shape evolvement which designers want to know. Those unrecorded and therefore missing statistics information are very important to the research of design thinking and process. This study employs an animation and comic as research objects. In addition to utilising the methods of thinking aloud and protocol analysis, as well as recording the progress of this experiment, the information is digitalised. By using computer to develop a webpage-interface visualisation cloud system, called Dynamic Graph System which records and collects the evolving data generated from the space design process and stores this information into the cloud database. The system, then, uses the State space as a base, and utilises the derivative Dynamic Graph of spatial style which is evolved from the collected data of the Design Process. By studying and analysing the dynamic graphs, to investigate whether we can acquire more information of design process by using information visualisation approach to record of the evolution of the design process and helped the designers or not. This study intends to explore whether Dynamic Graph System helps and assists the designer to be more efficient in completing his/her work from the interaction between Dynamic Graph System and the designer..

Keywords. Design process; information visualisation; state space search; dynamic graph.

1. Introduction

In general, 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 emphasise 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). Consequently, this study uses video cameras to record the design process so as to assist any inadequacy of oral analysis. It applies Information Visualisation method to record the evolution of the design process, so as to gather more information on the design process.

Information Visualisation has been used in various field. 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 digitalise information. Despite that, what is visualisation? The definition of visualisation from a dictionary is: to form a mental model or mental image of something. Spence (2007) suggests the process of information visualisation can be simply summarised 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 visualisation is to transmit the data into information which spectators will discovery later because the data has been encoded into a visualising graphic (Spence 2007). Therefore, this study utilises digitalisation tool to develop a webpage-interface visualisation cloud system, named Dynamic Graph System. The system records and collects the evolving data generated from the space design process and stores it into the cloud database. The system, then, uses the State space as the base, and utilises the derivative dynamic graph of spatial style which is evolved from the collected data of the design process. This study intends to find the following topics:

1. By using Information visualisation approach to record of the evolution of the design process, whether we can acquire more information of Design process and help the designers or not.
2. Whether the Dynamic Graph System helps and assists the designer to be more efficient in completing his/her work from the interaction between the Dynamic Graph System and the designer or not.
3. What are the differences from the dynamic graph of designer’s conscious use of dynamic graphics system to the one that background recorded automatically at a fixed time (one minute once)?
4. Whether the automatic records are surplus information ones or those certain information could be useful to the designer?

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 behaviour 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 analyse 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 the three actions in the design process. With the progress of the design, the design scope and subject will become more and more narrow and obvious (Figure 5).

“Programming → Design” (Pena et al. 1987) is similar to the process of analysis and then integration. The designer normally plans before design, and use it to do the design.
2.2. DESIGN THINKING

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 recognise the problem solving of the internal state logics and decision-making process. Newell et al. (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 analysing 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.

2.3. INFORMATION VISUALISATION

Information visualisation 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 than texts.
Spence (2007) mentioned in his book “Information Visualisation” that identification of the interaction with data governed by high-order cognitive processes (Figure 7). He deems that the process of information visualisation 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.

3. Methodologies

This study utilises computer to develop a webpage-interface visualisation cloud system, called Dynamic Graph System which records and collects the evolving data generated from the space design process. Furthermore, we employs the methods of thinking aloud and protocol analysis, as well as video camera to record the progress of this experiment to assist on the data capture.

3.1. 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 visualisation theory and the architecture of the State Space. Users get access from Webpage interface to link cloud database. 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. In the planning and flow of the system (Figure 8), the authorisation 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 8. Moreover, the administrator can choose usage management (create, delete, or modify user), or view the projects in the cloud database.

3.2. EXPERIMENTAL DESIGN

Participants Experimental subject is the junior students of Yunlin University of Science and Technology Department of Architecture and Interior Design, who are in certain degree familiar to space design and is able to use Google Sketchup software as the space design tool competently.

The design task In this experiment, we use a design task. The experimenter must design a space, an innovative one hopefully, for the usage of animation and comics. As to the experiment time, Goel (1995) gave his chosen
professional participants more design time, but they have to generate more, including the elements of patterns, scripts, and concepts. On the contrary, Prats et al. (2009) only gave theirs 10 to 15 minutes. The above researches contain human factors, because there is no standard time to imitate natural design process. This research does not limit the design time to the participant after the experimental explanation because this experiment expects to record complete space design process. The experiment is considered finishing until the participants think its space design work is done and store the project. The experimenter spent two and half hours in total to finish the design task.

Experiment set up There is installed Google Sketchup 8 software in the experimenter’s computer as the space design tool. Participants know that all of their design activities will be video recorded in all design process. Furthermore, the record of Dynamic Graph System will be divided into two parts: one is the state which is stored consciously by the experimenter, and the other is the graphic change recorded every minute in the background. The participants will be requested to watch the video and discuss their design activities after finishing the design task.

4. Results and discussion

Figure 9 shows the recorded derivative dynamic graphs in the Dynamic Graph System which is generated by this experiment. We can clearly see the designer’s three different space designs through viewing the dynamic graph and the video record:

1. A series: the development stops at a 1-2. Designers want to develop an innovative space different from the past one. There is an irregular roof and three pillars inserted into the space titled.
2. B series: the development stops at b1-1. Designers attempt to make some changes of the roof style.

3. C series: divided into c1 and c2, but c1 is stopped. Instead, c2 continuously developed to c2-6. Designers of C series use magical space and start from the prism shape. The wall in the space is divided into crushed pieces and removed partial pieces of it to be visible, attempting to make the entire space with the illusion of virtual reality staggered so that space in the shadow looming (Figure 10).

Additionally, Dynamic Graph System also stores some un-stored graphs in the background. The user only needs to select the arrow between state and the state in Dynamic Graph System to view those not-consciously-stored graphs (Figure 11). We discuss the design activities after the experiment. Designers think 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.

Designers reflect that it’s 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’s 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. Designers 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/She has forgotten crea-
tive 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. For instance, in C series, designers use crushed pieces to make the wall partially visible. They can use these recorded detailed original file to amend and change various crushed shapes design. Designers 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.

5. Conclusion

Through the record and discussion, this study finds that the use of information visualisation 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 finalised 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. Efficiency in design process, designers interact with others through Dynamic Graph System, can be quickly generated within the design process of uploading and downloading relevant files to the cloud database. This is to say, the designers through dynamic graphics can jump back and forth freely in design process and not worry about file storage problems or the loss of information, such interaction will improve efficiency in design process. When designers apply Dynamic Graph System consciously to generate dynamic graphics which will automatically record within a fixed time (per minute) for verification of the graphics, designers’ reaction, perhaps, are wondering or questioning the function of these automatic records. However, when we present automatic records to the user, the user found there were many glances of design ideas. Designers have often forgotten after the completion of the design, but throughout viewing these recorded graphics can evoke their memory, and provide more inspiration to and thoughts. We also find that when users apply Dynamic Graph System in
design process. This system can not only become a platform for data storage, but also can be linked to the other cloud database and shaping this platform as a “design database”. In general, each designer has his/her own unique design database, but these unique internal design database is often not explicit. There will be no official record and storage, so through Dynamic Graph System, the date can become explicit information, which is recorded and stored. Moreover, the explicit information will be of great help towards designers themselves or developing ideas in design process. In addition, we found an interesting phenomenon during the experiment, which designers will merge different ideas together. For example, the designer took the a1-2 some portions of its components are combined with b in our dynamic graph a1-2 and b. This phenomenon often occurs in design process, but in Dynamic Graph System currently cannot render such a merger and dynamic graphics, so we will try to follow-up study of the phenomenon of merging records and showing the dynamics of the merger graphics, hoping to record a more complete design process, allowing designers to get more information about the design process.

References