Abstract. The evaluation of design alternatives is important phase for quick design decision and new design conception, and it is repeatedly processed. For smooth and fast process lots of design alternatives are provided within the limit of possibility and it must be evaluated appropriately. It can be possible through evaluating design alternatives using various media. This paper describes the characteristics of Shared Virtual Space which have developed for evaluation of design alternatives, and evaluates Shared Virtual Space based on the findings of case studies.

1. Introduction

The evaluation of design alternatives is important phase for quick design decision and new design conception, and it is repeatedly processed. To proceed design process in standard, the repetition is reduced to minimum. And design must be optimized in limited cost and time. For smooth and fast process lots of design alternatives are provided within the limit of possibility and it must be evaluated appropriately. It can be possible through evaluating design alternatives using various media.

We have conducted collaborative design among remote participants in recent years. Through those research we found that more effective evaluation method was needed for the evaluation of design alternatives on network. This paper describes the characteristics of Shared Virtual Space which have developed for evaluation of design alternatives, and evaluates Shared Virtual Space based on the findings of case studies.

2. Shared Virtual Space

Shared Virtual Space (Woo, CAADRIA97) was synchronous communication media for communicating with remote participants in different place on network. Also, it was work space on network where participants could compare, modify and review 3D object synchronously.

But we found some problems when we applied Shared Virtual Space to some design projects for evaluating of design alternatives. They were (1) representation from same viewpoint, (2) comparison by multi windows and (3) change of attributes. For solving those problems, we suggest New Shared Virtual...
Space for the evaluation of design alternatives. The system satisfies following requisites.

1. It's possible for remote participants to join in the design project on network.
2. When remote participants review design alternatives on network, the change of viewpoint is delivered to each browser of participants and they can review it at the same viewpoint.
3. When remote participants review design alternatives on network, the change of attributes like a shape and color is delivered to each browser of participants and they can review it with same shape, color and so on.
4. When remote participants review design alternatives on network, it's possible to review them using multi window at the same time.

New Shared Virtual Space is developed as client-server format with Java applet and Java application. It use technology of socket for communication between server and client. It is composed of 4 elements such as Client, Receiver, Server and Dispatcher for delivering information about the change to other participants (Figure 1.). Client delivers information about the change to Server. Receiver receives information about the change of other Client and changes attributes of local object. Server play a role as contact point that all the Client can connect. When server receives information about the change from Client, it generates thread and starts up Dispatcher. Dispatcher receives information about the change from Client and delivers it to another Client.

\[\text{Figure 1. Concept of Shared Virtual Space.}\]
3. Project Ohkura

Project Ohkura was complex plan to develop leisure facilities and restore the beach on the Ohkura coast of Akashi in Japan. We took part in designing resting place in the west side of site. We used various media for evaluation of design alternatives in each phase of design process. They were model, CG still image, CG animation and VRML. We applied proper media based on the project specialty and evaluated design alternatives effectively.

Resort facility was composed of central resting place, east resting place and west resting place. Each resting place was built using 2 membrane roof. Design participants decided to use same membrane except symbol of central resting place. We evaluated design alternatives according to variation of height and angle of standard membrane. In the design of membrane, the height and the angle of membrane were important variables for entire design. The entire atmosphere was influenced to a major degree, though the height and the angle was little changed. Therefore we needed to evaluate many design alternatives at the same time.

Design alternatives was made into VRML for evaluating it effectively.(Figure 2.) Therefore we could review it in height and angle interactively from various viewpoint. It was flexible in comparison with design alternatives made by sketch and draft. But we found a problem in it. When we reviewed plural design alternatives from same viewpoint, we could not synchronize them with VRML. We could not precisely review height and angle of design alternatives from same viewpoint with VRML browser only. Then we needed proper media which make it possible to synchronize viewpoint for reviewing design alternatives.

![Figure 2. Evaluation of design alternatives with VRML.](image-url)
We used new Shared Virtual Space for solving this problem (Figure 3.). First, Server for new Shared Virtual Space was started, and VRML data of design alternatives was inputted into new Shared Virtual Space. Finally, same design alternatives was displayed on windows of all monitors participants were gazing at. Participants could review it on their monitor with same point of view simultaneously. Also, we could change viewpoint, shape and color in standard membrane simultaneously. We got some findings as followings;

(1) It is possible to communicate with one another synchronously in different place with new Shared Virtual Space.
(2) It is possible to synchronize viewpoint of design alternatives on the plural windows with new Shared Virtual Space.
(3) It is possible to modify attribute of 3D object such as shape and color simultaneously with new Shared Virtual Space.

4. Conclusion

Design process is a set of activity for refining design and fall into 4 phases such as recognition of problem, design alternatives for solving problem, evaluation and selection, and optimization. Also, design participants must understand the problem of project by analysis of the situation. Then design alternatives or idea which can solve the problem is suggested by product maker and/or designer and/or client. Participants select the best out of design alternatives using a variety of evaluation method. Finally the refining of selected design is processed. To proceed design process smoothly it's needed to find various design alternatives which can solve the problem of project within limited time. Also
how to evaluate design alternatives is important.

In Project Ohkura, various media have been used for evaluation and each decision was made timely and adequately. According these experience it is desirable for designer to have the ability and attitude of applying appropriate media and of developing media for requirements of project. We found that the development of media, if they were needed, in design process promoted efficiency of design work in Project Ohkura.

![Figure 4. Resting place designed by CG.](image)

![Figure 5. Completed resting place.](image)

In Project Ohkura, when design participants reviewed plural design alternatives, they had a little problem to compare it one another. They wanted to see plural design alternatives from same point of view on network, but it was impossible using VRML only. Shared Virtual Space let many VRML data be operated simultaneously on network. Also remote participants can operate it interactively and review it at the same viewpoint. Finally, we could review lots
of design alternatives with it precisely and quickly. Therefore it is effective evaluation media in decision making process.

Figure 1. is a image produced by CG before completion and Figure 5. is a picture after completion.

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