

Enhanced and Continuously Connected Environment for Collaborative Design

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This paper describes our current study in the development of a collaborative design environment which considers Information and Communication Technology (ICT) and architectural space. Our study group has been developing a computerized prototype environment for collaboration, which attempts to support a synchronous design collaboration in a face-to-face meeting at a local site and also in a continuously connected project-room at distributing sites. The authors focus on communication in order to evaluate the collaboration environment. The objectives of this study are listed below:

Objective 1. The evaluation of using the multi-screen and sharing console applications in the face-to-face design meeting at the local site.

Objective 2. Finding problems and its factors of the continuously connected project-rooms in the distributing sites.

In our conclusion, we have verified the relation between the communication and the applications of the environment in the objective 1. With the objective 2, we have realized and extracted four major issues towards improving the distributing project-rooms environment in our future study.

Keywords: *Continuously connected; ICT; distributed site; communication; face-to-face group work.*

Introduction

Using white boards and projection screens in a meeting room is a typical style of a face-to-face meeting. The projector becomes a valuable tool because people use digitized information to work on PC, and project it to share information and discuss issues in a meeting. Although one of the ways to guarantee successful collaboration is to install more tools and

applications which are developed through ICT, there is another way of focusing on the space itself.

By projecting on a large screen and on white boards of a wall, the entire space is transformed into a "display". It is in fact a case where the form of information display expands in three dimensions and begins to create an environment that envelops people. When one attempts to implement those kinds of display, there is a noticeable difference in the way

that information appears between cases in which snippets of data appear on small displays at regular intervals and ones in which data is displayed in three dimensional space and seen at a single glance. To put it strongly, when displays are given spatiality new possibilities in collaboration can be pioneered.

When one operates a specialised display that expands in three dimensional space we stand up, raise our heads and show our abilities. Our eye lines meet and new conversations are initiated. The data structure can be taken in at a glance, understood by repeatedly moving through it, and internalized into the body.

Our study group has been developing a computerized prototype environment for collaboration, which attempts to support synchronous design collaboration in a face-to-face meeting at a local site, and also in continuously connected project-rooms at distributing sites. This paper describes our current study of the development of the collaborative design environment.

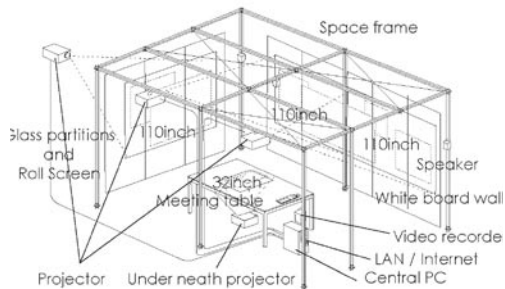


Figure 1
The configuration of the prototype

The Prototype Environment for Collaboration

In order to develop the prototype environment for supporting effectively the exchange and sharing of information in order to create ideas, the authors have studied the factors of collaborative design work considering ICT and spatiality (Yamaguchi, 1999).

The specifications of the prototype environment (Figure 1) are:

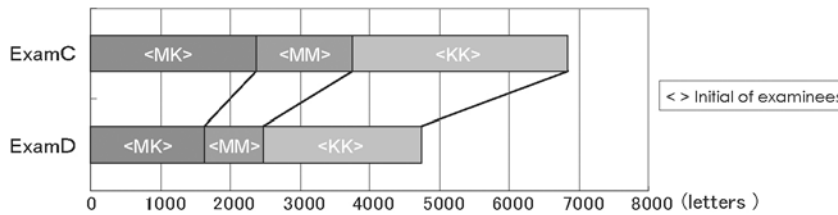
1. Space frame: various instruments such as projectors, speakers, cameras, microphones and lightings can be attached and released easily. Additionally, it envelops people gently as a collaborative space.
2. Four big size multi-screens are on the white board wall, the glass partition and the roll screen, and the glass top table:
 - The White board wall that can be used for a wide screen projection. (190inch)
 - The Glass partition and the roll screen made by a white permeability film for rear-projection. (110inch) One can write in the glass partition by marker pens.
 - The Glass top table on which surface is filmed for underneath projector has a function for drawing like a white board on the projected surface.

There is a central PC which is connected network and controls this environment, and it consists of applications for keyboard-mouse sharing, downward camera controlling, etc. Additionally, in order to support distributed collaboration, this prototype also provides the desktop sharing application, the analog document sharing system with scanner, the scheduler for groups and WebHD which is data storage via internet.

A Face-to-face Local Meeting Environment

The authors focus on “operation” and “visualization” in a face-to-face meeting at local site. Two experiments as shown below have been carried out to

Figure 2
The number of Japanese letters
Table



evaluate the environment on the basis of a communication analysis.

1. Sharing the keyboard and mouse for the “operation”.
2. Using the four big size multi-screens for “visualization”.

Experiment 1: Sharing the Keyboard and Mouse Operation

In order to evaluate sharing the keyboard and mouse operation in a meeting, “the picture mapping” is carried out as the subject of the exam. Two different situations (exam A and exam B) are arranged to compare the result.

- Exam A: All examinees own the sets of keyboard and mouse individually in this exam. They can control PC at the same time.
- Exam B: Only one set of keyboard and mouse is supplied to this exam. Only one examinee can control PC with it in the meeting.

Three graduated students of the examinees are participating in both exams. All pictures are selected from some architectural magazines before the exam starts. The exam A is implemented at first, and then the exam B is carried out with same examiners. The assigned time is 30 minutes. The steps of the exams are; first, the examinees reviews 20 given digital pictures and discusses what is the concept of the mapping, and second, the examinees categorize pictures into quadrant of the mapping screen and lay out the results on the mapping-chart. All the processes in the experiment are done on Microsoft Powerpoint.

The Result of the experiment 1

All conversations that have taken place in the exams were recorded on voice recorder. When and how the keyboard and mouse were operated were recorded during exams. In order to see the relation between communication and the experimental environments, all utterances of each examinee are reproduced on MSWord data sheet. Figure 2 shows the numbers of Japanese characters that each examinee spoke out in each exam.

The total number of Japanese characters counted 6847 letters in exam A is much higher than one of exam B which is counted 4733 letters. Additionally, it can be seen that each member of exam A talked a lot more than exam B. In the result of questionnaire survey, we observed positive comments which may indicate possibility to activate interactions in the meeting. For example, one of the comments says that it is easier to reflect their own opinion to the meeting directly with own keyboard and mouse. Another comment is that sharing the keyboard and mouse environment create a sense of belonging in the meeting.

The authors realized in the observation during the exams that conversations tended to occur just after someone operated the keyboard and mouse, which seems to make the meeting warm up with like the situation someone laughing or the tone of voice changing. However, the data we collected this time doesn't show this phenomenon quantitatively. The phenomenon will be captured clearly in our future study.

Experiment 2: Using the four-multi screen

The prototype environment is configured by the four-multi big size of screens. This configuration can be switched easily to one projection screen by the central PC. Exam C “four-multi screen use” and exam D “only one screen use” were carried with these two ways to evaluate visualization effectiveness towards communicating in a meeting.

The subject of these exams is “the poster evaluation”. Three fourth-year students participated in these exams. Although this subject of experiment 2 is similar to the one of experiment 1, the authors arranged the contents of exam to suit to undergraduate student level. At first, the examinees discuss and evaluate 20 given digital posters in the environment. Second, the examinees create a list of the poster ranking and the evaluation remarks on the Microsoft Excel and submit the result.

The posters which have been created by second

year students in a class of “digital design through the computer applications” are used in these exams. The experiment time is unrestricted so that the examinees have to decide the end of discussion. The exam C is implemented at first, and then the exam D is carried out with same examiners.

The Result of the experiment 2

The numbers of Japanese characters in all conversations are counted in the same way of experiment 1. Figure 3 shows the sum of the Japanese characters recorded on exam C and exam D. The total number of it in the exam C is counted 16888 letters in the meeting period of 77 minutes. The number of letters and the meeting time in the exam D are 9588 letters and 53 minutes. Therefore the number of Japanese character counts per one minute is 219 counts for exam C and 181 counts for exam D, which may explain that four-multi screens makes the meeting more active than one screen.

The authors analysed the words of conversations which took place in the exams, and then categorized it into three communications types; “discussion”, “arrangement” and “others”. The “discussion” is the communication which includes words relating to the subject of the exams. The “arrangement” is the conversation when the examinee talks about arranging the computer operations and environments. The “others” is the communication which is neither the “discussion” nor the “management”.

Figure 4 shows the percentages of these three types for each exam C and exam D. This indicates that the “discussion” of the exam C is more active than the exam D in the result of Figure 3 into consideration.

In addition, the status of application windows on the screen such as size of window, position of window, and the number of the active-windows are recorded. When more than two application windows executed in the meeting of exam A, the communication for the “discussion” takes place rather than the communication for the “arrangement”, but on the other hand many execution of the application windows create more “management” than “discussion” in the exam B. It is likely that the multi screen can lead users seamlessly to the discussion

Figure 3
The number of Japanese letters about “discussion”

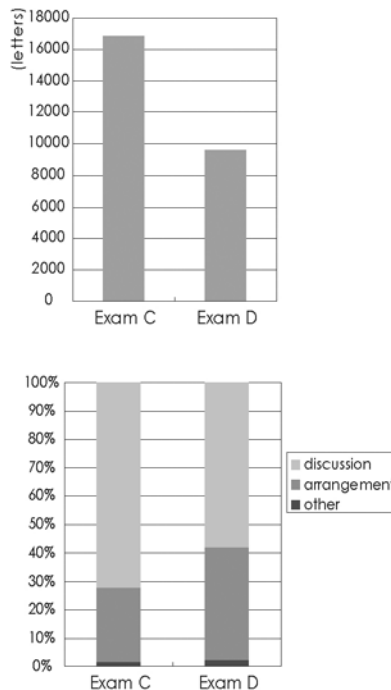


Figure 4
Communication types

level of communication due to projecting many application windows at the same time. But executing many application windows in one screen as the exam B needs to spend a time to manage application windows such as moving, minimizing, maximizing and arranging the windows in the conversation of the meeting.

Continuously connected distributed project-rooms

The prototype environment attempts to support not only a face-to-face local meeting but also distributed project-rooms. Although the TV conference systems via network has developed and been used as a common tool at an office or a home, the function of these systems tend to design connecting people to people for a face-to-face meeting of distributing sites, which means people connect the system when they want to have a meeting with distributing people for a certain time. On the other hand, our approach to develop the prototype is to connect space to space

continuously. What we expect is that visualizing other site on a big screen informs a situation and gives an awareness, which may produce communication effectively to collaborate between distributed sites.

In order to understand that the continuously connected environment affects daily activities, the authors have carried out the experiment in comparing local environment and distributed environment for ten days; first five days is local collaboration and second five days is distributed collaboration. The examinees are six postgraduate students engaging in architectural proposal project. Configurations of collaboration environment are as follows:

- Distributed environment; three personal desks are in each sites. The main screen connects two distributed project-rooms via TV conference system. The live images at another site are rear-projected on the big screen look like the same room (Figure 5)
- Local environment; six personal desks are in the prototype environment (Figure 5)

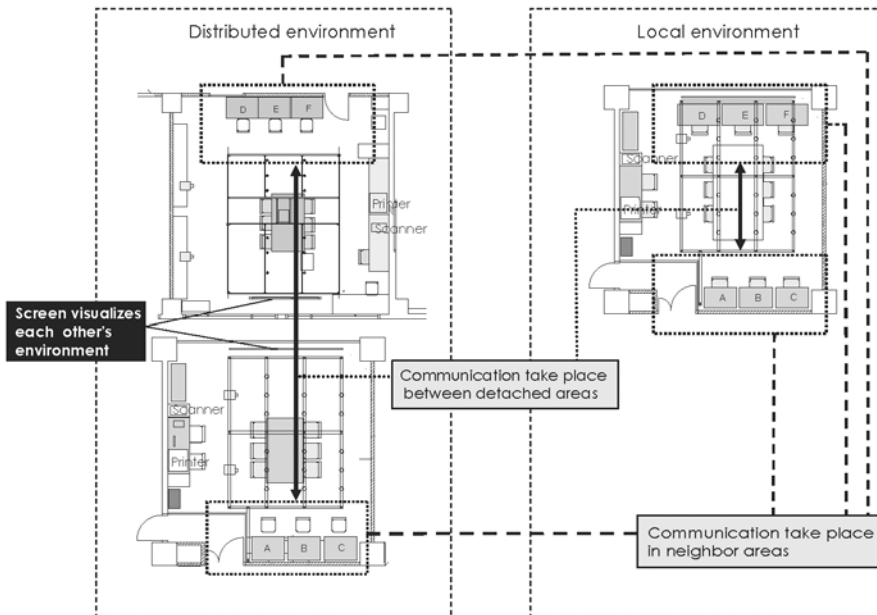


Figure 5
Distributed environment and
Local environment

Figure 6
The sum of communication running time

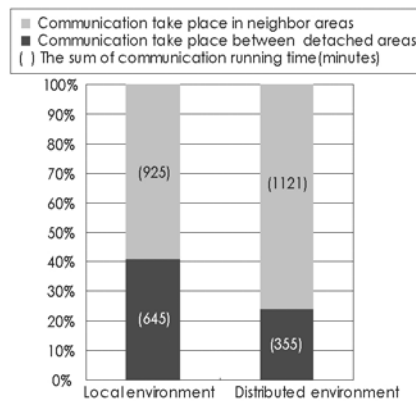


Figure 7.
The number of communication take place

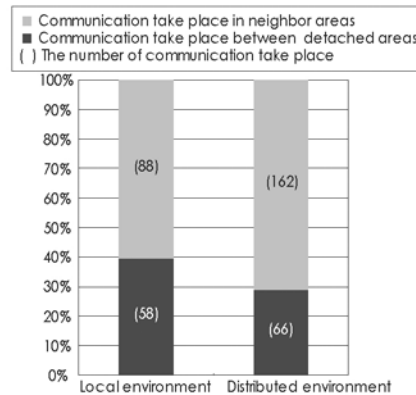
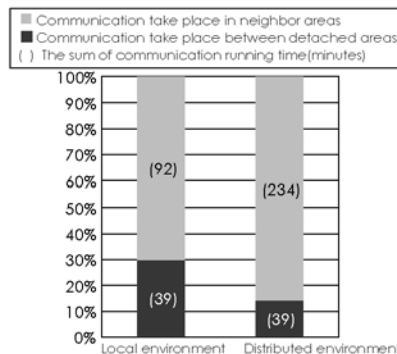


Figure 8.
Informal communication



Analysis of the contentious connected distributed project-rooms

The communication that is observed from field survey, self-photo survey, and a questionnaire survey are analyzed. Examinee takes a photograph about problems of environment and comment with it in the self-photo survey. This will enable us to understand problems picked out by user about environment.

The authors classify all communications into “Communication take place in neighbour area” and “Communication take place between detached areas” according to the place where communications happened (Figure 5).

We pick out three aspects about collaboration based on the researches, and consider the factor:

- The quantity of communication
- The quality of communication
- The place where communication has taken place

The quantity of communication

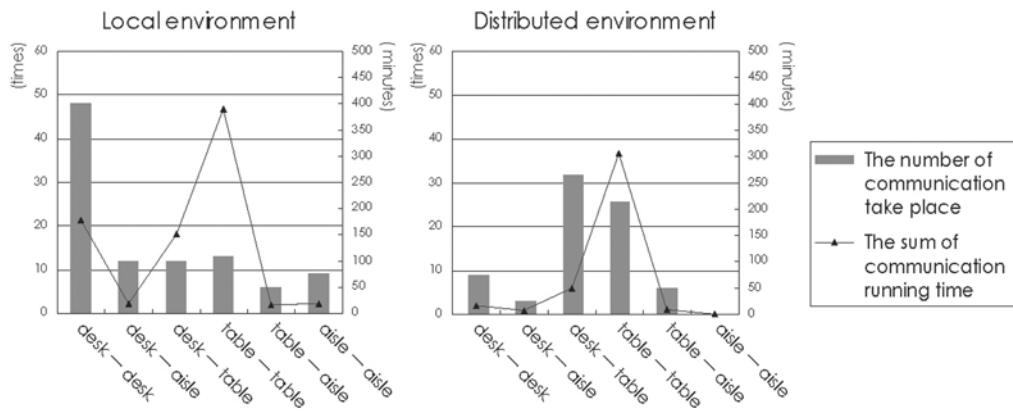
Comparing local environment and distributed environment, the rate of “communication in detached area” about time and frequency are lower in distributed environment than in local environment. (Figure 6 & Figure 7) So, project members tend to communicate in local site. It is easier to communicate locally.

The reasons are:

- The examinees understand the appearance of the distributed member’s work. They do not understand the atmosphere of situation and the place. So they fear to talk in case they obstruct the distributed member’s work progress. Those psychological opinions appear a lot from the questionnaire and the self photo.
- The sound of local conversation is too low to listen, and the sound breaks due to network problem so that member at other site can not follow the conversation.
- The examinees hesitate to talk excluding a thing necessary for the research activities, because it is difficult to recognize voice by mike and speaker.

The quality of communication

Figure 9
Positional relationship of communication



Distributed environment is difficult to support informal communication. (Figure 8) In such an environment, communication except research activity differed between roommate and distributed member. It is difficult to communicate casually. The informal communication is set low priority of conversation.

We guess the reason, pointed out by the self photo survey and questionnaires, is also Voice recognition and awareness. Members feel possibility to interrupt and disturb the progress at the other site due to less understanding of the context.

The place where communication has taken place

Communications that took place depended on a particular place. Figure 9 shows that communications are done around the table between distributed members. We guess that communication depends on video-conference systems' placement because this is the only means of communication.

Additionally, it is pointed out that the conversation excluding around the table are difficult by the self photo survey. More than two conversation groups cannot communicate in the same screen. The screen which shows the other site is the only channel to communicate to distributing members. Members need to move the position where microphone and camera can capture their voice and figure.

The results of continuous connected distributed project-rooms

The Effects which continuous connected environment give to communications and their factors we considered are collected as follows

Communication problems between distributing sites	The factors to occur the problems
It is difficult to communicate casually.	The casual communication is set low priority of conversation. Members feel possibility to interrupt and disturb the progress at the other site due to less understanding of the context.
More than two conversation groups cannot communicate in the same screen.	The screen which shows other site is the only channel to communicate to distributing members.
Communication take place depend on particular place.	Member need to move the position where microphone and camera can capture their voice and figure.
Project members tend to communicate in local site.	It is easier to communicate locally. The sound of local conversation is too low to listen, and the sound breaks due to network problem so that member at other site can not follow the conversation.

Table 1
The results of continuous connected distributed project-rooms

Discussion

In order to evaluate the face-to-face local meeting environment, the console applications of keyboard and mouse and the four-multi big size of screens are focused and studied on the basis of communication analysis. From the evaluation of sharing console applications, the authors verified that communication was activated if the input device of the keyboard and mouse can be owned individually to control central PC. Additionally, we observed the phenomenon that the meeting during the exams gets warmed up gradually just after the console applications are operated. In the result of the four-multi big size of screens evaluation, executing several applications and viewing information at a glance on multi-screen cut a time to arrange applications and create much time to discuss issues in the meeting. All of these amounts to saying that four big size multi screens and sharing console applications make collaboration proceed seamlessly.

The environments of the continuously connected project-rooms at distributing sites are also evaluated. Through the self-photo and questionnaire survey, and communication analysis, we extracted four major problems which explain communication barrier between distributed site, and considered and listed the factors that related to the problems.

Future studies might consider examining awareness support between distributing sites of continuously connected project-rooms based on the result of this paper. Furthermore, the Augmented Reality (AR) interface can be developed considering not only local meeting environment but also continuously connected project-room.

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