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On the Dynamic Pattern of the Remote Collaborative Design Team

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Abstract: This study seeks to find the team work dynamics and the critical communicative issues in the design process of RCIDS. The purposes are: (1) the participation and commitment shall affect the performance of the teamwork and (2) the participation of the individual team member is dependent on the positive appreciation and acceptation of the other members. Two separate design teams with the RCIDS were tested and observed successfully. Five issues were concluded: (1) Motivation and commitment: team members become more committed when their design ideas were accepted; (2) Team management: the team with ideal 'all type' networks dynamic tends to have better design outcome; (3) Communicative issues: team dynamics focuses on the issues of modification, suggestion and description turned out to have better design result than the team on other issues; (4) Peak hour: two main preferable time, one is between the hours from 9-18 and the other from 21 h till next day on 3-4 h; (5) Deadline effect: the communicative frequencies before or after the deadline are higher than other dates in average.

Key words: Virtual team, remote collaboration industrial design system/ RCIDS

INTRODUCTION

The impact of the internet and e-commerce has brought the remote collaborative design platform into a new horizon with great convenience. Concurrently, rapid development using digital technologies has put an end to the constraints of time and resources. Therefore, with the help of the internet-oriented medium including synchronous and asynchronous design communication channels, the dynamics in designing framework, such as design process and communicative tools, has been changed revolutionarily. This has forced the competition to become even more antagonistic than ever before.

Thanks to the effective communicative features, Remote Collaborative Design System (RCIDS) has become one of the key competitive supports for design industry. Nevertheless, the design professionals must evaluate their short-term or long-term plan regarding the existing resources before building or implementing the RCIDS. Despite the practical know how remained, one of the most critical problems is how the team dynamics are when using this system. There were many theories to explain the dynamic patterns of teamwork, yet only few examples on the practical observation of RCIDS. The questions such as what should the communication network look like; how is the communicate dynamic flow of RCIDS, can only be revealed through a practical experiment of design case and design teams within the RCIDS.

This research is to study and observe the team dynamics of RCIDS in association with a design case and two teams. The focus issues are the communicative pattern of the design team, commitment of the team members and communicative issues. The outcome will be beneficial for the RCIDS related teamwork dynamics observation, user test and knowledge construction.

BACKGROUND REVIEW

Remote collaboration industrial design system/RCIDS: From Computer-Aided Drawing/CAD, Computer-Aided Manufacturing/ CAM, Computer-Aided Industrial Design/CAID, to Rapid Prototype which had shown the significance of the computer technology on design industry. The drastically progressed world wide internet can be further integrated with the Computer-Aided Industrial Design/CAID to form the Remote Collaborative Design System. By using synchronous and asynchronous communication with particular design software and net meeting device, both of the 2D and 3D digital design image or model can be modified through internet remotely. The designers may communicate with their oversea customers and colleagues freely regardless the limitations of time and distances, that will not only raise efficiency of design task but also reduce painstaking of traveling cost. Moreover, the quality and process of the design can be better controlled because of the

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digitalized approaches. The design missions may come from any country in the world and design communication can take place from the remote ends via all the alternative channels.

On the issues of feasibility and plausibility of the RCIDS, some conflict and incompatibility still need to be resolved among various design software and file formats. Yet these problems will not sustain for long due to the rapid technology evolution. The related research studies (Hicks, 2004; Laframboise and Reyes, 2003; Li, Lau and Ng, 2003; Riboulet Marin and Leon, 2002; Simoff and Maher, 2000; Smith Bohner and McCrickard, 2005; Sun, 2004; Tang and Frazer, 2001) in comparisons of method, architecture and finding of RCIDS were summarized as following:

- Method: design research methods are mostly case study oriented. Interviews and protocol analysis can be applied to study the dynamics and process of the design activities;
- Architecture: there were three types of the systems, including existing software, in-house developed web platform and integration of the existing and new developed software
- Finding: the related hardware and software of RCIDS were matured technically, yet the issue of team dynamics, with more than 2 team members and design interaction inside the RCIDS were not discussed in depth.

Communication of the design team: Collaboration is one of the positive and good nature for human social interaction. The reason to form a collaborative team is because people want to make profit in an effective way through cooperation. Many works, such as baseball game and orchestra, can only be accomplished in teams and an effective and harmony atmosphere team is considered as the key base for expected successful result (Droz, 1991; Goodwin, Hundley, Fox and Wolter, 1999; Linder and Ibrahim, 2000; Rosenman and Gero, 1997; Rowland, 2002; Smith and Bidwell, 1991).

However, to deal with the conflicts came from the team dynamics are sometimes more difficult than the design assignment. Different communicative network structures are created due to the different situations and problems and each style has its own effects and features. Figure 1 shows most of the possible communicative networks of teamwork. The chain type is a constrained and linear network, yet the network in practical world rarely remains so limited. Pyramid type is similar to linear plus the leader, member A as a managerial role, receiving and giving information from the other teams. In the circle type, none of the member takes the dominant role and each member can only communicate with the other two. While in the wheel type, A is on the dominate position

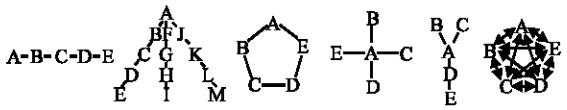

Fig. 1: Networks of communication, (Dimbleby and Burton, 1998)

and all the others dependent on A. In the y type, A occupies a key position as filter for communication and B and C are higher ranked supervisors. In the all type, the network is free from constrain and people can communicate with each other.

Teamwork dynamics can be decoded into two dimensions: participate attitudes (high or low) and interactive style (higher authorities or sharing). The team with low participation and higher authority interactive style will produce less creative power than the team with higher participation and sharing styling interaction (Biggs, 2000). This research is meant to understand the team dynamics in RCIDS. The objectives are: 1) commitment of the team; 2) commitment of the team members; and 3) communicative dynamics. The hypotheses are: the participation and commitment may affect the performance of the teamwork; and the participation of the individual team member is dependent on the positive appreciation and acceptation of the other members.

MATERIALS AND METHODS

Research plan: Through a practical remote collaborative design platform two design teams with assigned task were observed. Figure 2 is the entrance page (for team A) of the constructed RCIDS. People can login into specific design section by clicking on the top menu, or respond to preferable topics via the searching list. The participants were authorized and trained to use the system. With this system, the designers can communicate, download/upload data and make decision remotely. There were three divisions of the design process. The period and requirements of each design stage are: (1) Design analysis (day 1-6): two image boards are required-lifestyle analysis and existing product analysis; (2) Idea Development (day 7-13): every design members are asked to upload ten idea sketches (in jpg format; resolution: 74 dpi, file size up to 500 kb or less) before date thirteen; (3) 3D Digital Modeling (day 14-20 by 12:00 am): the chosen design work would be further developed and uploaded after 3D model completed before day 20. The architecture of the RCIDS and the study profile can be categorized into two main parts: one is the team member

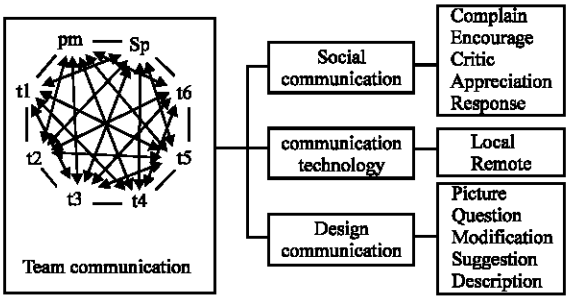

Fig. 3: The diagram of the coding scheme

Fig. 2: The entrance page of RCIDS (team A as an example)

role arrangement. Others are the design process and the main structure of the RCIDS: step1. design analysis; step2. idea development; and steps 3. 3D modeling.

Participants: A total of 13 designers and one supervisor were recruited. The participants were divided into two teams, Team A and Team B. Each team could only access to its own data and all communication within the system were recorded for further analysis.

- Supervisor (code: sp): a senior design researcher, responsible for mission explanation and troubleshooting.
- Project Manager (code: pm): a senior designer with more than ten years experience who was in charge of schedule and quality control for both teams.
- Project Leader (one per team, code: t1): each team's project leader, with 5 year work experience, was responsible for teamwork encouragement and coordination.
- Team Members (code: t2-t6): there were ten people, averaged in 28 years old. And 6 members, 2 males and 3 females, were allocated in two teams, team A and team B. They were assigned for opinions sharing, idea developing and model constructing.

The coding scheme: To study the dynamics of the team communication, three main issues of the design communicative activities were deplore from the previous research studies (Cross, Christiaans and Dorst, 1996; Ericcson and Simon, 1993; Gabriel and Maher, 2000; Maher and Simoff, 2000; Maher, Simoff and Gabriel, 2000; Rowe, 1987) (Fig. 3).

- Social communication: on the social issues, including complain, encouragement, critic, appreciation and response.
- Communicative technology: a category relates to the local and remote technical communicative issues during the design process.
- Design communication: a category on design task, such as picture, question, modification, suggestion and design description.

As known, protocol analysis is one of the practical methods for the analysis of design activity (Gero, 1990; Gero and McNeill, 1998; Kavakli and Gero, 2002; McNeill *et al*., 1998; Suwa, Purcell and Gero, 1998). By tracing how designers solve the design problem in the system with pre-defined coding scheme, the design process can be coded and analyzed.

The dilemmas: The design case, chosen participants and the RCIDS network are based on single particular situation. The limitation of this research is to maintain the realistic of the team dynamics. Thus the research outcome is qualitative oriented.

RESULTS AND ANALYSIS

Team commitment: Figure 4 shows the average percentage of frequencies on both teams' communication in association with the three design sections: Design analysis; Sketch/Idea Development; and 3D Digital Modeling. The peaks of communication percentage were reached on day 15 (18 %) by team A and on day 13 (22 %) by Team B. The secondly high points by team A were day 13 and 19, while happened on day 6, 16 and 20 on team B. There were also none communication happened in both teams, day 2, 3, 4 and 16 by team A and day 1, 2, 9 and 12 by team B. As can be seen, Team B seemed to be more involved than team A on the first section, yet not as active as on the latter stages. This can also be retrieved by the recorded number of communicative texts on each design section.

The pattern of team member commitment: Figure 5 shows the average percentage of the team roles commitment

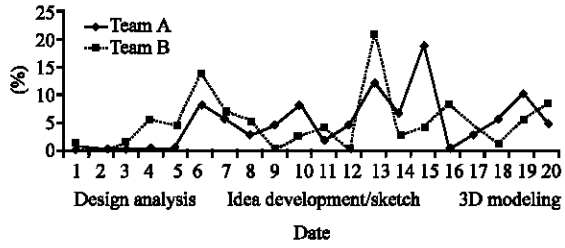

Fig. 4: The average percentage of the design action based on dates

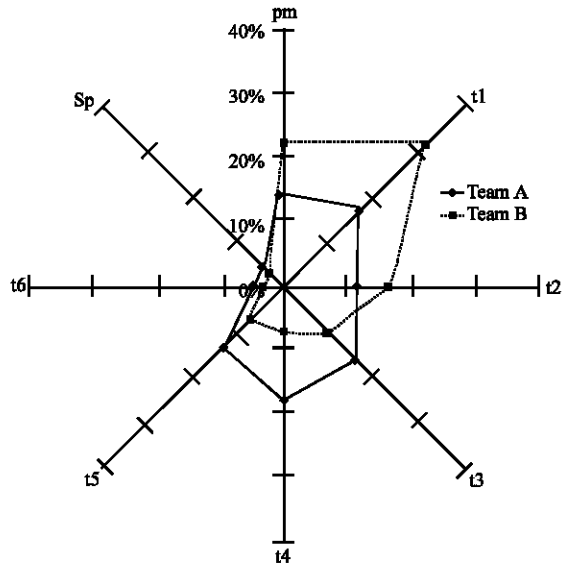

Fig. 5: The average percentage of the team roles

during the design process. It was found that project manager and team leader had more communicative actions than other team members. On the dynamics pattern of team A, despite member t6 and sp/supervisor, the scores of communicative frequency among the members are very close, which indicates a ideal output of the all type networks, while the team leader in team B tended to be more active in comparison with the other members. As also found from the analysis that team member 3, 4 and 5 on team A and members 2 and 3 on team B had higher action frequency than other members. Some team members were very active on certain design sections but inactive on the others, while some team members were simple reluctant on RCIDS commitment (member 6 on team B for example).

Communicative dynamics: On the average percentage of design dynamics during the design sections, team A has more interaction on appreciation, modification, while team B was more on picture and description. Figure 6 further compare the communicative frequency of both teams. On

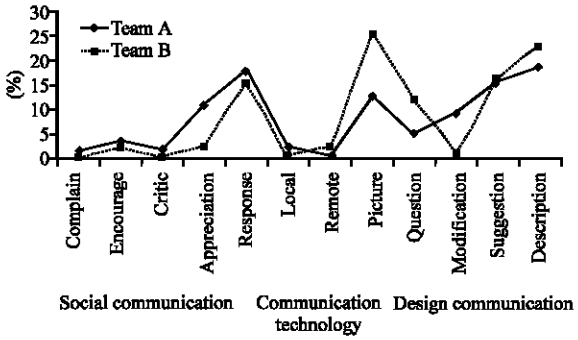

Fig. 6: The interactive frequency of both team

the social communication section, team A is more active than team B on the issue of appreciation. On the communication technology section, team A had more issues on local technology communicative problem while team B was on the remote ends. On the design communication section, team B had higher contribution on picture upload and design question issues. While team A had higher frequency on modification, suggestion and description issues, indicates dynamics on team A was more focus on the refining and modifying, while team B was more on picture uploading.

During the design process, all team members expressed their opinions and responded to the others. The supervisor chose not to give suggestions in order to force the teams to find their own solutions. After a few days on the sketch stage, the project manager suggested using vote to generate the best design. All designs under consideration were presented in one webpage and team members were asked to choose three. The designs of each team with the most votes were promoted to the final section. By design expert evaluation, 5 experts with more than 10 years design experience participated, on the issues of creativity and quality of the designs. It was found that Team A was considered to have better result than team B on the sketch and the 3D modeling design stages (Fig. 7), which is consistent with the communicative frequency analysis of the team commitments.

The working hours: Since the RCIDS sever can be login 24 h during a day. Despite the deadline of the design process, people may login anytime when feel comfortable with their schedule. As (Fig. 8) shows, date hours of 9-10 and 13-14 are the most popular hours. However, there is no interaction during the date hours of 5-6 in team A and 19-20 in both teams. It was also found that people in team A work harder during the hours of 9-14, while team B on hours 1-2.

Fig. 7: 3D modeling of both teams

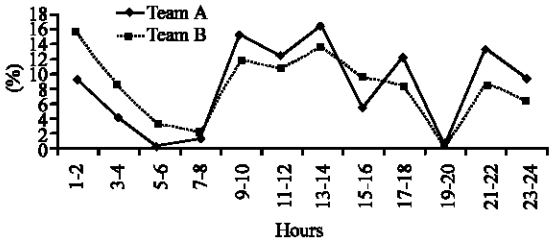

Fig. 8: The comparison of working hours on both team

DISCUSSION

Four main findings from this research were summarized as follows:

Motivation and commitment: Some team members were very active on certain design sections but were inactive on others. There are two main possible reasons. One potential cause is because of the designers' personal interests. Some designers may be more interested on design analysis, while the others focused more on sketch or 3D modeling. The other reason is because of the driving force of the design development. Team members become much more committed when their design ideas were accepted. Take team A for example, despite the contribution of team manager and leader, team member 4 and 5 become very active on the sketch and 3D modeling stages. The reason is because their design ideas were chosen and appointed to work on the 3D modeling.

Team management: As learnt from analysis, team manager and team leader committed more time and opinions than the others in average, by coaching and developing team members and managing product development. Yet, there were differences in the communicative dynamic patterns of both teams, team A has a much balanced communicative frequency from every member, while team B was dominated by the leader. Refers to the design outcome of both teams, it shall not be overlooked that the team with ideal all type networks dynamic tends to have better design outcome.

Because the manager in this study suggested the teams to apply voting for the final design decision, anonymous voting process may avoid the problems caused from the people interaction. Even though the design interaction were conveyed remotely, some participants reported feeling uneasy with voting and reacted favorably to people with whom they were familiar. Therefore, the result of the vote may be influenced by non-professional factors. From a managerial aspect, a well organized decision making procedures or anonymous voting system would avoid the variables from personal issues.

Communicative issues: On the social communication section, team A had more interaction on appreciation, modification, while team B more on picture and description. On the communication technology section, team A had more issues on local technology in the analysis stage thanks to adaptation of the system. On the design communication section, team A had higher frequency on modification, suggestion and description issues while team B had higher contribution on picture upload and design question issues. Team dynamics focuses on the issues of modification, suggestion and description turned out to have better design result than the team on other issues

Peak hours: The average peak hours of communication were between hours 9-14, while none of the communication on 19-20 h during the whole design process. The secondly popular hours were mid night and the third were the hours on 17-18 and 21-22. Thus, there were two main preferable time for RCIDS communication, one is between the hours from 9-18 and the other from hour 21 till next day on hours 3-4.

Deadline effect: Because day 6, 13 and 20 were deadlines for each design stage the communicative frequencies before or after them were higher than other dates in average.

CONCLUSION

The RCIDS with two separate teams were tested and observed successfully in this research. The system did provide a convenient communicative platform for the design teams. It meets the need for an open atmosphere and for breaking the personal limitations of scheduling and location. The positive virtues are available 24 h per day, seven days per week, thus making the remote teams more efficient and flexible in design processing. Teamwork is to enhance the effectiveness and creativity of the

design output. The team with ideal all type networks dynamic and greater interaction among team members turned out to have better design outcome. By assigning roles, specifying work and targeting design outcomes, designers should be able to solve a given problem, adapt their teamwork skills and behaviors and take the advantage of the RCIDS.

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