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MULTIDISCIPLINARY TEAM COMMUNICATION THROUGH VISUAL REPRESENTATIONS

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ABSTRACT
Communication between design team members is critical to ensure a project's success particularly during the early stages of the design process. Effective design teams rely on the collective knowledge of their members who increasingly include participants from diverse disciplinary domains. Thus communication, including integration of specialized knowledge and negotiation of differences among domain specialists, has emerged as a fundamental component of the design process [1]. An important aspect of communication is the role that visual communication practices, visual representations, and visual thinking play in the success of a design team. While much attention has been given to the use of external representations as aids in the internal problem solving process, and the visualization tools available to assist in the creation of those visual representations (sketching, diagramming, 3D modelling, mind mapping, storyboarding etc.), little has been studied regarding their communication role within multidisciplinary teams.
This paper presents three different applications of visualization tools—visualization tools for conceptual development, for collaboration, and for presentation—that emerged during the study of eighteen multidisciplinary design situations. The successful use of visualization tools and their products (visual representations) supported knowledge exploration, integration, and collaboration by transferring information across discipline boundaries. While all of the visual representations were used for communication purposes, team members were not evenly skilled at *generating* visual representations and at *communicating* through the use of visual representations. These differences were discipline–based and were critical in defining team interaction and team leadership. Implications for design methods, tools and education are discussed.

Keywords: Communication, design process, multidisciplinary teams, visual representations

1 INTRODUCTION

Because global competition demands rapid, successful collaboration within teams that comprise multiple cultures as well as multiple disciplines, the need to develop tools and methods that enable clear, effective communication among team members has become imperative. "The best teams invest a tremendous amount of time and efforts exploring, shaping, and agreeing on a purpose that belongs to them both collectively and individually" [2]. But every team member brings different disciplinary methods of research, tools for making decisions, and techniques for communicating results that make team collaboration difficult [3]. These differences can create high levels of frustration and scepticism within teams, especially when cultural differences are

present. On the other hand, the inevitable conflicts among these differing mindsets have the potential for generating truly innovative contributions. The challenge is to foster collaboration among all the parties involved while creating seamless, effective communication.

Typically, team members communicate verbally but also through the use of visual and physical representations.

> External representations fulfil various functions during the design process: they can serve as aids for analysis, solution generation, evaluation, and communication and as external storage…Self-made sketches, for example, support the limited human memory capacity and mental processing for a detailed problem…Since the design process is strongly influenced by feedback and dialogue, the communicative function of sketches is also of great importance in the daily design practice… [4]

This paper, then, is a qualitative study looking at the communication flow and the visualization tools utilized during eighteen different design situations or scenarios. We defined visualization tools as the mechanisms that generate external representations of products, ideas or processes, such as: drawings, sketches, models, storyboards, diagrams, sticky notes, mind maps, etc. It is structured by first giving an overview of the method that was followed during the interviews; and secondly, by describing the mechanisms of how the visual representations were generated and used during the early stages of the design process. The generation of the visual representations or the use of visualization tools will be termed *making* and the use of the actual visual representations as communication vehicles will be termed *telling*. The conclusions of the interviews were diagrammed in order to identify patterns or commonalities in the types and uses of visualization tools and representations as well as the flow of communication between team members. The paper concludes that visualization tools can aid in the communication process, but that there is a need for training team members in *making* and *telling* in order to improve collaboration.

2 CASE STUDY

2.1 Participants and interviews

Informal interviews were conducted with eighteen professionals: general managers, marketing managers and creative directors with backgrounds in industrial design, interior design, graphic design, mechanical engineering and industrial engineering. These individuals represented the consumer product industry, the service industry, and governmental agencies. They were asked to describe the communication flow among stakeholders through the beginning stages of a design project that involved groups comprised of designers, business professionals and/or engineers. Participants were asked to explain the communication process from the very first moment they learned about the design problem, usually through a client, until the moment when the design team was ready to provide the first solutions or recommendations to the client for decision-making. The interview was crafted with open-ended questions along with participatory research methods—generative techniques used to create context awareness by eliciting visual responses from the participants [5]. To aid their description, participants were given a large piece of paper, markers and pre-labelled sticky notes to map out the process. The sticky note labels included words or concepts such as: information, brainstorm, research, define the problem, define opportunities, generate ideas, constraints, hypothesis, and a blank for their own words. There were different colour-coded stacks of the same pre-labelled notes for them to differentiate team member's domain by colour. Also, a list of possible visualization tools and applications

used during the process was given (figure 1). All interviewees were asked to visually represent the communication flow of a given design situation or scenario.

Figure 1 List of possible visualization tools given to interviewees

2.2 Findings and discussion

A first tally of all the different applications of visualization tools as well as the types of visual representations employed during the scenarios described by the interviewees revealed that professionals from different backgrounds utilized visualization tools in very different ways, as shown in figure 2.

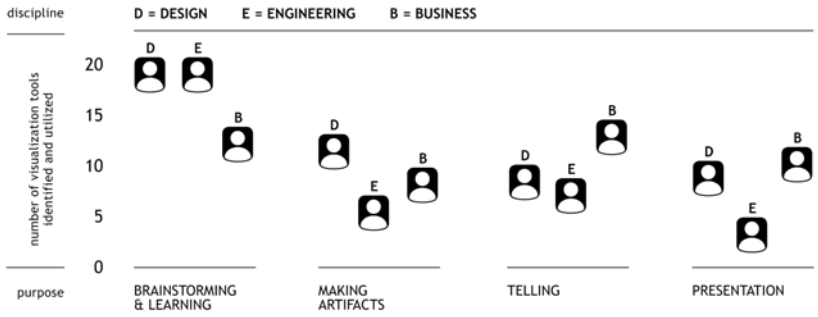

Figure 2 Number of visualization tools identified and utilized by discipline and purpose

While all participants were involved in utilizing visualization tools and generating visual representations, there were differences in how many visual representations were used for communication between members and at what point during the process they were used. Designers and engineers were heavily involved in *making* visual representations as aids for analysis and idea generation (individually and collectively), while business people preferred to utilize the representations generated by the team for dialogue and feedback.

In order to recognize additional patterns and identify participants' interactions regarding the use of visualization tools as communication aids, each scenario was analysed using two different approaches: first by listening to the narratives and second by diagramming the communication flow, depicting who used what tool for what type of communication application or activity (based on the interviewees' own diagrams developed during the interviews).

Figure 3 depicts a consensus of the most successful design situations, where communication among all members was supported by the use of visualization tools during different communication activities or applications. From this positive scenario we were able to identify three related applications of visualization tools used to facilitate communication across disciplines: visualization tools for conceptual development, visualization tools for collaboration, and visualization tools for dialogue and presentation.

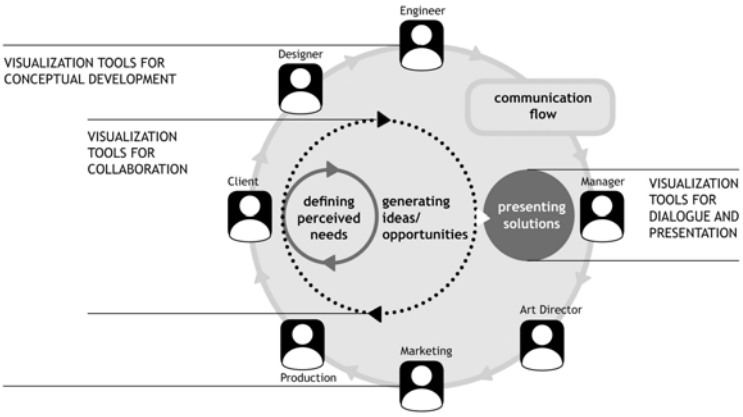

Figure 3 Diagram of a successful model of communication flow in multidisciplinary teams

In addition to the three different applications, participants described the interactions and flow between the different team members. Regardless of their discipline or domain knowledge, the interviewees agreed that all team members participated during the three activities.

However, when analysing the interviewees' own diagrams developed during the interviews, different conclusions emerged. The narratives describing the most positive interaction differ from the diagrams describing the actual communication flow.

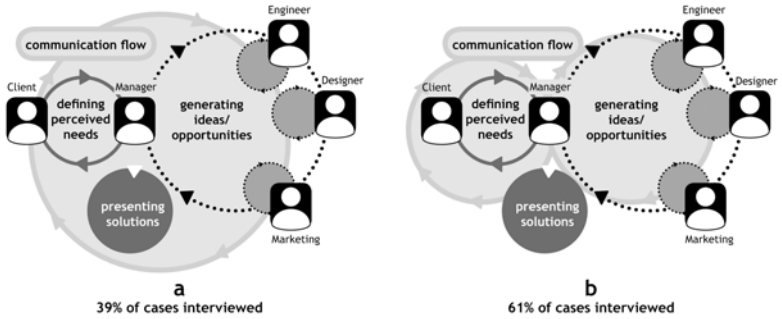

Figure 4 Diagrams of the actual communication flow within multidisciplinary teams

The diagrams in figure 4 represent the actual models of communication flow through the early stages of the design process. The two models that emerged reflect a different degree of communication flow between the team members and the client. In 39% of the scenarios described, the client participated in the information exchange (figure 4a). In 61% of the scenarios, all of the information was filtered through the project manager (figure 4b).

In all of the scenarios described, the process started with an expressed need from a client (individual or team) who searched for recommendations/solutions to a design problem. The initial flow of information occurred between the client and the representative(s) of the design firm, usually the design manager or project manager. During preliminary meetings the client and the design manager defined the perceived needs or design problem. Then, the design firm initiated its own process of generating

ideas and/or design opportunities in a more or less collaborative/inclusive way in order to present recommendations or possible solutions to the client.
One important characteristic in both models was the role of the design managers who were central to the communication flow between key players in the process. They filtered the information from the client, decided which solutions were presented to the client, and selected the team players and the disciplines involved in the project. Consequently, the experience and skill level of design managers was critical in ensuring clear, effective communication among team members.
Regarding the actual visualization tools utilized during the different scenarios, figure 5 presents a summary of the narratives as well as the diagrams generated during the interviews. By looking at which tools were used by whom, when and for what purpose we were able to define the use of the visualization tools into two basic categories: visualization tools that were used to generate visual representations (*making)* and visualization tools used to generate discussion and feedback (*telling)*. Even though the actual tools may have been the same (sketches, drawings, mindmaps, etc) the communication process they supported was different depending on who the "user" was. For example, designers and engineers *made* sketches and models. They used them to support the idea generation process. The visual representations generated for this process-assisted team members in communicating with themselves, and with each other. Business managers, on the other hand, utilized the products of the previous process to support their verbal communication exchange and generate discussion, feedback and additional dialogue. Figure 5 illustrates the list of visualization tools used throughout the early stages of design process and indicates which tools were primarily used for *making* or for *telling*.

Figure 5 Visualization tools used at the beginning stages of the design process within multidisciplinary teams.

3 CONCLUSIONS AND FUTURE WORK

This study brings to light discipline-based communication strengths and weaknesses and differentiates visual tools and strategies used by different disciplines in order to effectively communicate within multidisciplinary settings. It also suggests the need for better training in the use of visualization tools and visual representations by all disciplines. Some professionals can benefit from learning how to use visualization tools to generate representations. This can be a powerful tool when the team member is interested in participating in the generation of ideas. Others can benefit from learning how to better communicate by using visual representations as communication vehicles to generate feedback, discussions and to sell ideas to the client. Most importantly, by understanding how the different disciplines use visual representations and at what stages in the process, project managers can ensure that information between all the team members reaches across discipline boundaries, and all perspectives are taken into consideration.

In terms of its relevance to design education, by identifying visualization tools that can assist in levelling discipline-based visual strengths and weaknesses, new opportunities for teaching arise. These findings open an entirely new set of questions that we hope to investigate further in the future with the objective of developing a new set of interdisciplinary courses for design–related fields.

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