# REPRESENTATIONS OF DESIGN OUTPUTS IN CROSS-FUNCTIONAL TEAMS

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## ABSTRACT

We aim to discuss how designers' design concepts through outputs (design artefacts) produced during the New Product Development (NPD) process such as sketches and models might be impacting upon cross-functional NPD team members. We will use a case study of a recent international student project to explore this issue. In conclusion, we propose that design students, the emerging design professionals of the future, should be made aware of how their design ideas are communicated to and interpreted by others during NPD and the implications this has upon the development team members.

*Keywords: Design brief, design representations, case study, design education*

## 1    INTRODUCTION

The complex nature of developing high volume products now involves an increasing number of specialists, who must synthesize their expertise and work together in cross-functional teams. [1-3]. The strength of a cross-functional team is the specialist knowledge 'held' by the members and made available to other disciplinary development team members. However, this can also create difficulties, for example, when knowledge becomes specialised and embedded it becomes tacit and difficult to share and communicate across functional boundaries. Specialist contributions such as technical drawings done by an engineer or a designer's sketch can be difficult to communicate across functional boundaries to other members of the development team [4].

These difficulties associated with communication that may potentially inhibit those working with designers in cross-functional teams, have long been acknowledge and discussed with differences in relation to: object worlds [5] cognitive processes [6] and fundamental differences in education [7] as key factors. Researchers agree that these differences mean individuals from different disciplines, often find it difficult to achieve a mutual or shared understanding of both the design task or design problem and specific design content such as the direction and approach [7-9]. Some researchers have suggested that these differences can in fact be positive for creativity and that the variety and differences in thinking within a cross-functional team can potentially have a positive impact upon the outcome of ideas and the team's ability to innovate [10]. When examining the breadth of literature in the design management and communication field, many contrast this view with more pragmatic explanations that describe how even basic communication and understanding of language and one another's approaches can often be lacking in many practicing cross-functional teams. Many attribute the chaotic and high pressured industrial environment as the reason for difficulty in achieving this understanding across the cross-functional development teams [11, 12].

## 2    DESIGNERS' OUTPUTS

Designers increasingly play diverse roles within the NPD process. It has been suggested that one of the most common role is to help the wider development team and clients visualise ideas through representations such as sketches and prototypes [7]. Visual representations have been attributed to increasing the wider team's participation [9], to promote a common understanding [8] and are thought to act as a communication channel through which different types of information, such as tacit design knowledge and experiential knowledge can be shared [13]. Despite the more intrinsic value and benefits of representations such as sketches (as outlined above), investigations have uncovered instances where such outputs may compromise the ability of a team to work together. For example; the inherent ambiguity of a fuzzy design sketch may present opportunities for creative thought and discussion, but can also lead to differing interpretations by the project team [4, 5, 7]. When trying to

address this ambiguity, research has shown that higher fidelity representations may remove this ambiguity at the expense of creativity and room for experimentation [14]. With this considered, excessive clarity may help eliminate the confusion and fuzziness, but can often influence a team in a detrimental way, i.e. limiting their ability to think broadly and creatively [10]. For example, once sketches and prototypes are shown in meetings at an early stage of the design process, an 'irreversibility' that may orient the team towards future choices, may creep into the process [15]. This may result in the development team becoming fixed on a certain idea and unable to see alternatives that may develop at a later stage as the project evolves. Designers too can become fixated on concepts they create or see elsewhere. Designers may form attachments to these particular ideas and which may have a detrimental effect of the innovation potential of a project [6, 16].

The effectiveness of sketches as a method to communicate knowledge and promote mutual understanding has been questioned [17]. Misinterpretations of the design content due to a lack of effective communication, combined with a lack of knowledge towards each other's functions [4] means each member of a cross-functional team assigns a different level of salience to the same aspects of a shared representation [18] which relates to their own experience and personal agendas [17]. These key differences lead to a number of  fragmented  views of the same product and make building a similar or shared understand across disciplinary boundaries very challenging [8, 19]. Ultimately the main challenges facing a cross-functional team is to balance their views and differing interpretations and come together to collectively bring products through a production and market launch stages[5, 20].

The Summary below is an extract of a research that investigated what is known about design representations adapted from Pei [19] and Kleinsmann, [8].

- Representations make it easier to convey information difficult to express in words.
- Used as a persuasive tool to sell the idea to management.
- Used to record thoughts.
- Used to stimulate dialogue and facilitate the input of others.
- Used as a communication medium for design ideas to be expressed.
- Relives the cognitive load from the designer.
- Enabler both a focus on details and a view of the product as a whole.
- Does not require a huge commitment in terms of cost.
- Representations can increase team participation.
- Makes it easier for complex designs to be visualised.
- To visually assess whether current ideas meet project objectives.
- Enhance awareness of visual details such as size, shape, texture and colour.
- Allows the developer to test aspects such as size, proportion and colour.
- Shows various viewpoints for a better understanding of shape and connections.

The above points are important to consider in the context of how designers' outputs might affect how cross-functional NPD members interpret these outputs.

## 2.1  Learning Lessons for the Future:

The difficulties and challenges faced by a cross-functional development teams as discussed above will continue to challenge designers to improve as communicators and take strides towards developing representations of design ideas that facilitate an increase of the team participation and to improve the buy-in of clients to new ideas [7]. There are also lessons to learn from research that has been done in the design communication field that can be invaluable to both designers in the development of their practice and wider members of a cross-functional team as they strive to work more effectively with designers. For example, a recent study has shown that designers use representations as a visual memory aid to ease the pressure on the cognitive memory but to also allow designers to rationalise and evaluate design solutions as they go [21]. Representations presented by other functions of a cross-functional team, often represent more refined and considered level of detail when compare with design representations that are often 'work-in-progress' and thinking on the page [15]. During problem solving for example, engineers within a cross-function team may prefer to work out the details, whereas designers take a more holistic approach and present things relating to an overall context [5]. Designer representations of design potential solutions can however be useful in starting conversation in order to drive collaboration between a design and manufacturing engineer, but when such

representations are shared with a representative from a production or marketing background who is unfamiliar with its use, the representations can unintentionally confuse and alienate the that individual from in this case the production function, which will resulting in poor agreements and downstream delays [4].

It is clear that representations used in the wrong way can cause a series of delays and create confusion among a cross-functional team. With this in mind, research has looked closely at how designers may be able to improve their practice and thus become a more effective cross-functional team member. Research uncovered interesting aspects relating to how the designer reflects and rationalises how and why representations are constructed. During in-depth research by Pei [19], some unexpected processes that designers go through were discovered. For example, designers have often incorporated miss-leading details by representing their design ideas in a 'better light' through the use of a more spectacular colour, or specify higher quality materials in order to 'sell' their concepts to both clients and the wider team. This creates problems later in the process whereby a concept has to be down-graded or presented in a lower spec in order to meet cost or manufacturing requirements. Frequently designers may be pressured into saving time and want to create rough foam prototype to convey a basic principle or idea to the wider team. These kinds of representations of design concepts are often referred to as 'soft' models, such as a scale model, or even a full-scale model that uses different material or colours. These models may often be full of inaccuracies and ambiguous but are created to demonstrate a principle that satisfies the time and cost pressures that may be incurred if full sized or like for like models were produced [8, 19]. These ambiguities will typically lead to an understanding from others that does not represent the reality and/or likeness of the final product, which can lead either a poor buy-in of the idea or the creation of an understanding that is far removed from the creators intention [15].

## 3  CASE STUDY

To contextualise the debate and further the aims of this research, i.e. to raise the awareness among student towards how their representations may impact on others, an example from a recent undergraduate student project is discussed below. The example is taken from an international collaborative project involving teams of design students across the seven countries (see figure 1). The project titled the Gift was run through the Global Studio (http://theglobalstudio.eu) [22]. The Global Studio is a cross-institutional collaboration conducted between a university based in England, industry partners, and international universities. Its purpose is to equip students with an appreciation of cross-cultural and distance communication. In the Global Studio, all students are given access to an online site, which provides a common interface and space for staff, students, and industry partners to collaborate on assignments [23].

In this paper we focus on one the teams located within an English University. This team of students comprised of second year design Transportation and Industrial Design students on an undergraduate course located in an English University. As novice designers, the students involved in this project are still in the process of developing the key communication skills that allow them to interact and convey their thoughts and ideas successfully to others. It was interesting to note how regardless of the stage of the project, i.e. initial sketch and ideas phase or the final presentation stage, for some students, the ambiguity and fuzziness of sketches remained in their final outcomes. Illustration included below in Figure 2 on the left hand side provides an example of a sketch concept from a student's projects. Illustration on the right hand side in the same figure is an example of the final developed presentation of the concept with some extra contextual information. The final presentation retains the low-level of detail shown in figure 2 with only a colour to differentiate the two sketches. This may indeed be an example of a fixation with the chosen concept, but also demonstrated how ability to communicate clear and specific details, produces limited development of the concept.
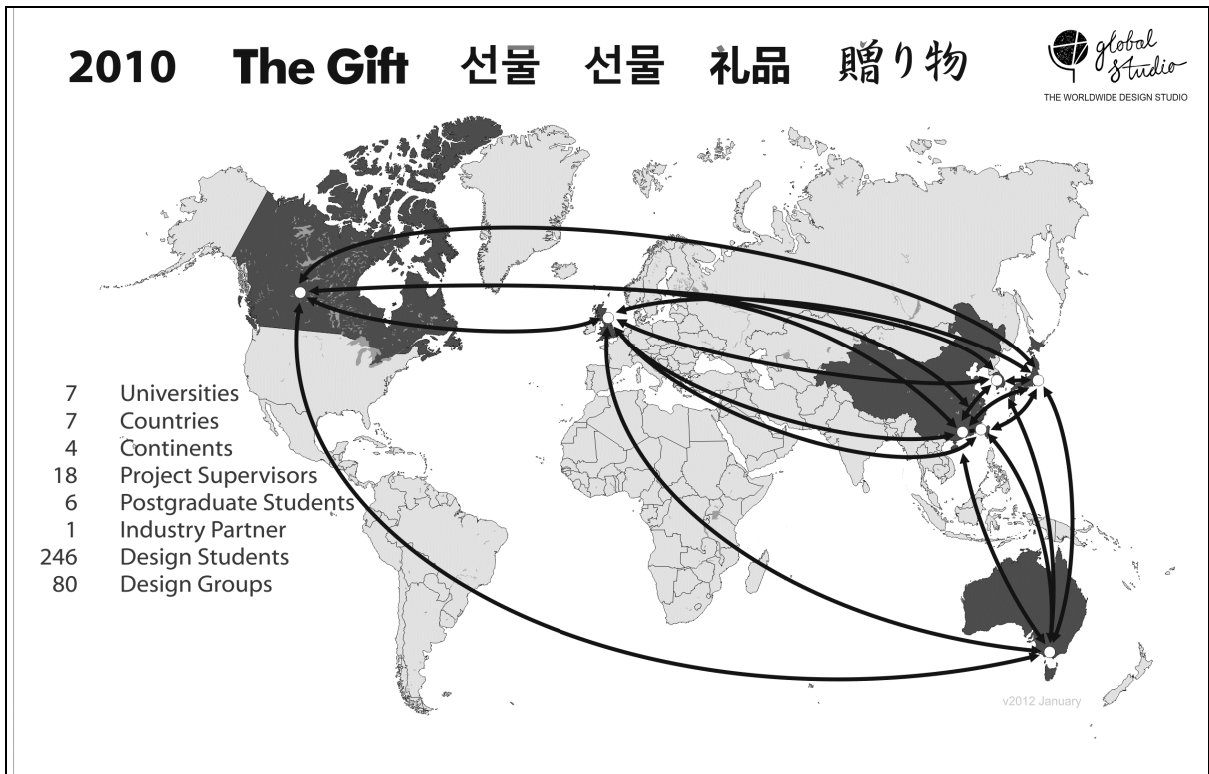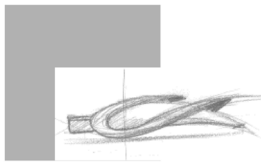
*Figure 1. The Global Studio: The Gift– project participant geographical locations*
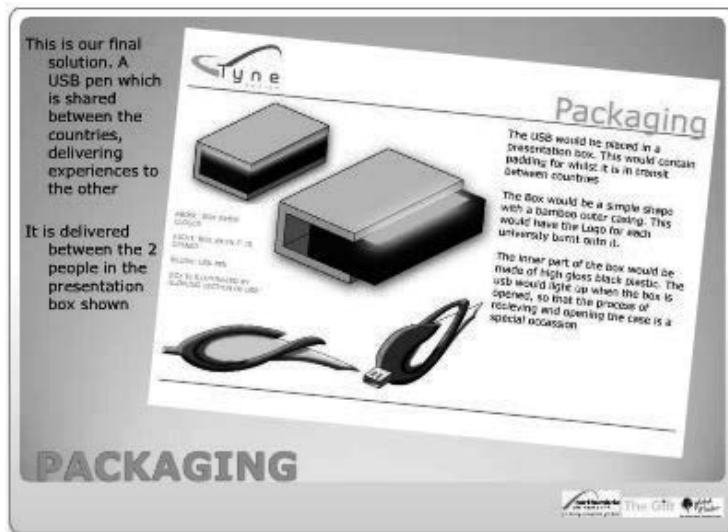


*Figure 2. Concept sketch for a USB gift (on the right) and*
*Final Presentation for a USB gift (on the left).*

Figure 3. below illustrates how a very low level of detail during the sketch development phase is also present in the final presentation. Those receiving the presentation commented how the detail was difficult to make out and how the early sketches actually seemed to give away more about the idea.
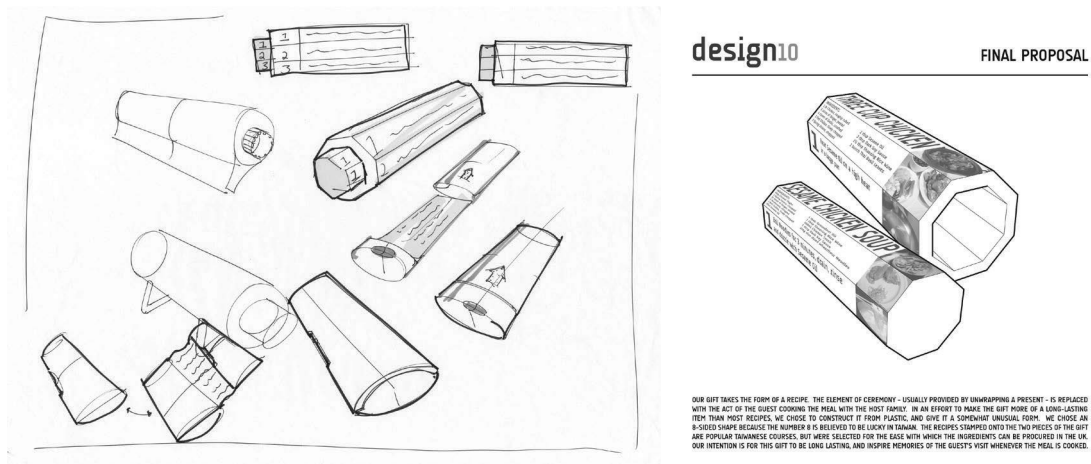
*Figure 3. Early Sketches of recipe wheel (left hand side) and*
*Final Developed concept of recipe wheel (right hand side).*

Perhaps this was linked to the level of skill and/or simply the level of engagement with the subject matter. Despite this, for other students the level of detail and ability to communication and illustrate clear details continued to develop throughout the project. It is also interesting to highlight how students who demonstrated higher levels of detail in their representations and those with a lower fidelity approach, both still relied heavily on verbal and gestural descriptions to back up, validate and add levels of detail that were not visible from the representations themselves. Often these extra details were unlocked during discussion and questions from their peers and the academic staff during interim and final critique stages. It appeared that students often used this process to of feedback and critique to help develop their own understanding of their concepts and how they fit within the wider problem or project context.

As with many student projects, students typically share design representations with academic staff, their peers and also even a collaborative client. Unlike industry, most of those reviewing the work come from a design background and will have a particular view grounded in a design perspective. Regardless of the absence of interaction and sharing of representations with distinctly different functions as within industry,  their remains some fundamental aspects that still exist such as the differences in object worlds and the differences in experience and backgrounds within the group that were still very much in the early stages of developing their understanding and skills.

When asked to comment on how they felt their representations were understood by others, many students were seemingly unaware of the challenges faced by the tutors and other team members, when giving comments on specific sketches shared by individual students. It appeared that students assumed an automatic 'sharedness' of understanding within the design fraternity, i.e. the context of the school and student group. Such assumptions that because someone is a designer they will automatically be able to engage and understand what sketches mean, highlighted the fact that some of these students had yet to develop or more rounded and more worldly perspective towards what their representations mean out of the context of a design studio.

## 4   RECOMMENDATIONS

After reviewing literature and reflecting on a number of examples of student projects, a number of points to consider have become evident. With the aim of raising an awareness and anticipation among student as to how their representations impact on others, would potentially help their transition from comfort of an academic studio into the fast paced industrial environment. The key recommendations that this study would make would be to raising design students awareness of the challenges faced in industry during the project interaction and exchanges that increasingly take place remotely via email and other electronic means. The lack of face-to-face interaction that is enjoyed in a university design studio project creates new challenges that the student must learn to overcome when moving into the professional context. Communicating ideas and concepts to those whom you have never met or spoken to, let alone enjoyed a familiar relationship with, is vastly different from a peer group and academic staff team that share a similar agenda and perspective. Interacting remotely eliminates many of the

verbal cues and the individual's ability to gesture and explain in detail to a colleague in another department and/or country. Promoting this deeper awareness of how project information that is seemingly obvious to someone from a design background, can be misinterpreted by others, would hopefully help student consider to learn how to appropriate design outputs fit for all audiences, not just those with design skills and an understanding towards how sketches are constituted. Any measures design professionals of the further can take to reduce the ambiguity and eliminate confusion that can delay the development process, would be a value asset to any aspiring designer who by entering the professional world will also enter into a long running relationship with those from others functions.

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