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A SEMIOTIC FRAMEWORK TO UNDERSTAND HOW SIGNS IN A COLLECTIVE DESIGN TASK CONVEY INFORMATION

A pilot study of design in an open crowd context

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Abstract. A leading factor in reshaping boundaries between participatory design and co-creation is the power of crowd-sourcing; however crowdsourced design often produces less innovative results than smaller expert design teams. In design, representation plays a fundamental role whilst in crowdsourced design the collective interaction with representations is restricted. We propose more effective design in collective intelligence lies in the crowd's ability to generate meaningful contributions via the content of shared representations. In order to investigate this, the current paper examines how meanings are generated through the use of visual representations. We introduce a semiotic framework to understand the mechanisms of how signs convey contextual information in a collective design task, and illustrate the framework by applying it in an analysis of the signs used by the crowd engaging in an openly shared design task.

Keywords. Collective design, semiotics, representation.

1. Introduction

Rapid technological developments in web based communication allow us to share rich forms of media on a daily basis. As a result we are now coming face to face with a new form of visually aware Collective Intelligence (CI) (Parsa 2004). To take advantage of this 'visual' awareness, businesses are applying 'crowdsourcing' as a commercial model in order to extract collective 'design' intelligence from the crowd. CI in Design, or Collective Design (CD) seeks to explore new forms of web based mass participation in design,

of which crowdsourcing remains a leading reference point in a CD discussion. Design crowdsourcing strategies operate under similar frameworks to other areas such as science (Innocentive) or funding (Pozible; Indiegogo). However, crowdsourced design is not overtly benefiting from the advantages of crowd wisdom, particularly in comparison to ventures such as the human protein puzzle FoldiT or the scientific solutions generated through Innocentive. In a CD context, literature on communication and motivation are gradually accumulating, however there is a significant lack of knowledge about the role of representational media and it use.

The interaction with representations is central in design activity; it allows not only the exploration of ideas but enables - through the shared use of discipline specific conventions – a commonly understood method of communication between design experts. A crowd however, does not share the same visual conventions for design, and thus do not have the 'language' experts use to communicate with each other; therefore crowd members will need to find alternative methods of expressing design information. In the absence of both linguistic and visual conventions; a crowd are thought to rely on meaning embedded in various images to communicate design information. An important first step in understanding this process is to investigate what representations non-experts use in a CD context so that we might better understand how representations are used to convey meaning by a crowd in an openly shared web context.

This paper will focus on three areas: collective design (section 2), representation (section 2.1), and visual semiotics (section 2.2), before providing an illustrative application of the framework based on current literature in the field (section 3). Using examples from a pilot study we conducted, an analysis is presented in section 4, followed by a discussion in section 4.1 and our conclusion and future directions in section 4.2.

2. Collective design

There is a growing interest in the role that a crowd and various online tools might play in design. In order to better understand CD, researchers are increasingly turning to crowdsourcing. In many cases crowdsourcing provides the necessary collective diversity - through diverse problem solving heuristics – to solve complex problems which specialist teams with significant skills and experience struggle with. However, crowdsourcing design has proven to be much less fruitful in terms of collective diversity trumping specialist design ability.

Crowdsourced design functions on an approximation of the design process whereby participants are shepherded through simulated design phases.

Crowdsourcing strategies do not provide shared spaces for participants; as such these design phases require participants to contribute individually, at various stages of the process, from work undertaken in isolation. This model successfully engages the crowd in producing a large volume of design solutions but many of these designs are disregarded. Those that are selected are of still no comparison to the results produced by expert design teams. Such models for design crowdsourcing essentially reduce the crowd's collective wisdom to a collected wisdom (Maher 2010).

In order to understand CD Maher et al (2010) present a conceptual framework of three key areas: Communication - methods of information exchange in CD; Motivation - principle reasons for participation and Representation - digital visualisation for analysis, and synthesis in CD. Using this framework and by leveraging crowdsourcing Maher (2010), Paulini (2011) and Merrick et al. (2011) have all made significant contributions to our understanding of CD. However, no studies have examined representation in CD tasks and this area remains largely unexplored in the literature, despite the fact that it has long been understood that the key to successful design outcomes is the ability of designers to interact and communicate using representations. In a study by Park, et al (2012) Crowd Vs. Crowd was used to demonstrate that sharing the design representations in a competitive motivational context was beneficial and provided more competent design outcomes; however this was still firmly framed within a moderated context thereby limiting any findings with respect to how meaning was conveyed.

2.1. REPRESENTATION

Representationally speaking, sketches are considered central to design activity. However, non-sketch based imagery is also recognised for its ability to facilitate the exploration of new ideas. Referred to as 'precedents', the manipulation and re-application of external imagery is a well-known design paradigm (Oxman 1994, Maher et al 1996). Precedents are the symbolic representations that are stored, recalled, manipulated and used to recommend solutions that are close to the working context of the problem under analysis (Maher et al 2000). During this process designers choose the most appropriate visual medium at hand. Using visual imagery, design practitioners communicate meaning through the use of a hybrid set of symbolic conventions (Ashwin 1984); conventions of that are learnt either through discipline specific degrees or gained over time through practical experience. Design's relationship to the visual, however, is not confined to specific disciplines or conventions and is even evident in 'common' language (Boradkar 2001). As an example, the word 'design' is often interchangeable with the concept of

style. As Boradkar (2001) notes design can refer to spatial arrangements and composition. He adds "design in the popular press often tends to emphasize the visual, stylistic, and sensual qualities of products". In considering Boradkar's (2001) illustration of the shared common design language and Cross's (2006) assertion that design ability is collective, an interesting juxtaposition of ideas can be combined.

By its own definition the crowd is diverse. While the average member of a crowd is not expected to be as experienced as expert designers, or to possess a shared understanding of specific design language conventions the internet's crowd members nonetheless belong to a cultural phenomenon where much communication is undertaken via the self-generation of visual content.

We propose that this content might provide the right representational digital alternative to Goldschmidt's (2004) physically immersive conditions for creative and innovative thinking. That is, we believe that in the absence of shared conventions of design communication, it is the meaning embedded in shared representational imagery that is most likely to play a significant role in expressing aims and cues which lead to better design outcomes. Using semiotics to examine sign based meaning behind representational imagery is an effective starting point for dissecting and exploring the imagery used in CD design processes.

2.2. SEMIOTICS

Semiotic theory is a framework in which three types of imagery can be categorized, depending to how they allow for comprehension. These categories include icons, indexes, and symbols. Icon, Index and Symbol provide a coordinated way of talking about how meaning is expressed via the relationship between Object, Representamen, and Interpretant (Chapman, 2004). Icons represent the 'signified' through the use of similarity and work by imitating the visual features of the object that it is representing. Indexes convey a relationship between the 'signifier' and the signified. Symbols operate, not by using visual or conceptual connections to the signified, but through a socially established convention (i.e., something that has to be learned before the meaning of the symbol can be understood) (Pierce, 1982; Mahin et al, 2001; Chapman, 2004; Chandler, 2005). To explain the way signs are engendered and processed to make them meaningful, Pierce (1982) developed the concepts of firstness, secondness, and thirdness, which refers to how sign categories are made up through the process of semiosis (Table 1). In essence, Firstness refers to quality, Secondness to effect, and Thirdness to product and the process of its becoming. For example, in design, firstness might refer to a two-dimensional rectangular plan, sketch or precedent. Secondness

would refer to that plan, sketch or precedent's interactive interrelations to other representations that are also available. Thirdness refers to the viewer 'putting them all together' into an imaginary image and using further representations to communicate and express this idea. All three concepts occur in simultaneity in semiotics, however, in design, these semiotic instances not only occur simultaneously but also form a chain of semiotic meaning which continue to operate on the design process.

Table 1. Summary of Pierces classification of signs.

Category			**Sign Type**	**Icon**	**Index**	**Symbol**
Firstness	*Is*	Quality	semiotic mode	similarity	causal or natural convention	convention
Secondness	*Is*	Effect	practical examples	Photo, Painting, Diagram,	Footprint, Smoke for fire,	Word, insignia, morse code
Thirdness	*Is*	process becoming	How to make and take them	feeling Sensation	Perception, Inference,	Learning/ doing by instruction

In design as well as semiotics the main objective of generating representational 'signs' is to encode information about the physical object which is being designed. This allows other designers or participants to decode the information and turn the represented idea into an abstracted reality (Ashwin 1984). To this end, the 'signs' used in the design process signify information that conveys meaning in regards to the object that is the focus of the design process.

Semiotics provides a rational system for the analysis of visual communication and provides a methodology for the evaluation of visual contents. Design and Semiotics share several procedures which are directly related to the function of design representations; they both rely on descriptive content, to be functional and generative – often in simultaneous combination. Descriptive representations often take the form of precedents or sketches to be recalled for comparative analysis (similar to the signified). Functional representations are based on defining structural characteristics (similar to the Signifier). Lastly they can be Generative - where a knowledge base is constructed to generate new ideas, test, improve, and finalize in design (similar to the result of the Interpretant). The signs that convey contextual meaning in design can be categorized differently according to how they function in order to convey meaning or act as a cue in initiating further investigation.

By combining the different concepts introduced above, our semiotic framework can help describe the underlying mechanisms of how signs used in collective design scenarios convey contextual information. To show the power of this derived semiotic framework, the next section discusses the use of signs in pilot study using the framework's categories.

3. Illustrative application of the framework

To provide evidence for the analytical power of our framework, we adapted Hartmann and Vossebeld (2013) model for analysing semiotics in construction process visualisations (Table 2). Our data was collected from a pilot study of five non-expert participants that where recruited via our Collective Design Facebook page. Participants were asked to undertake a design task using the web based presentation tool Prezi. No expert discipline specific conventions of communication were expected or provided.

Table 2. A semiotic framework for analyzing visual images in collective design activity.

Design	**Content**		
Semiotics	**ICON**	**INDEX**	**SYMBOL**
1st ness-Convey meaning by	Similarity	Relation	Recall/convention
2nd ness-Functions via:	Representation	Communicative	Expressive
3rd ness-Generates further investigation from being	Theoretical	Aesthetic	Denotative

Like Hartmann and Vossebeld (2013), observational involvement was used to familiarise the researchers with the signs participants generated and the meaning they attributed to these signs, allowing us to meaningfully categorise the signs used in the visualisations. Design activity was analysed by reviewing the visualizations and extracting all the signs used to convey contextual information. Using this list of identified images, we then used the semiotic framework to categorize the signs into icons, indexes, or symbols. Table 3 provides a summary of the different characteristics of the semiotic sign types derived from the participants.

4. Representing design information

The web based presentation tool Prezi was used as our Collective Design Environment (CDE) to deliver the design task because of its ability to capture generated data in a permanent visual recording for each activity produced by the participants. The brief was to design a local holiday beach house. Because of the potential for confusion and disorganisation, the only formal requirement was for participants to work in a design circle and not to

delete each other's work. Within this circle they had complete autonomy and all their design work was visible to other participants. There were no identified or pre-established agreements regarding conventions for communication, nor did the participants know each other.

Figure 1, provides an illustrative sample of the thirty images used and demonstrates, by category, the type of iconic, symbolic and indexical qualities employed to convey contextual design meaning in our collective design task.

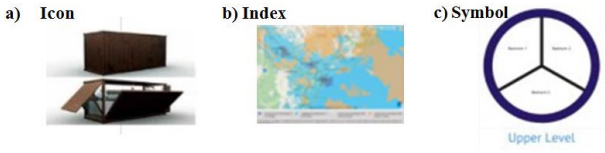


Figure 1. The categorised signs from our pilot study.

- **Iconic images:** Seventeen iconic images where used to provide a direct meaning in a number of contexts, they were used as precedents signifying the characteristics of similar buildings to the design task. The precedent imagery also included existing 'tin' shacks which are landmarks in the area and served as an important point of reference for understanding the overall design context. The use of iconic representations in our CDE also served as a permanent visual record for these recalled objects, or precedents. This precedent based sign type became conventionalised throughout the pilot, without prior agreement, and was a sign system universally used throughout our pilot study. Similarly, some iconic images where indexically used to signify meaning that combined design and construction ideas. These combinations contained indexical references to materials and spatial qualities.
- **Indexical images:** Ten directly indexical images where used primarily geographical in nature. This indexical visual information provided via maps taken by screenshot of Google maps. Indexical sketches were also provided and where indicative of thought processes and reflexive activity. These visualisations are mobile phone snapshots taken of sketchbooks. The sketch images where meant to indicate design information such as spatial arrangements, general and construction ideas. Indexical information also consisted of signs concerned with individual components such as solar panels and generators; these where used in reference to elements required in the brief and can be simultaneously characterized as iconic, symbolic and indexical.
- **Symbolic images:** Symbolic imagery was provided through three images, a rudimentary plan, section and elevation. The images where constructed through the use of a computer program such as paint. The use of symbolic imagery such as plans sections and elevations is a convention found in expert

practices, and in our study similarly denoted physical properties such as shape and spatial arrangement.

Table 3 provides a categorisation of the above described signs. The table uses the framework to summarise how thirty images where used to convey meaning in our collective design task.

Table 3. Semiotic categorization of the signs used to signify design related information.

Sign Type	Conveys Meaning by:	Functions via:	Generates via:
Icon	Recall	Representation	Denotative
Icon	Convention	Representation	Theoretical
Index	Relation	Representation	Denotative
Icon	Similarity	Representation	Theoretical
Symbol	Similarity	Representation	Denotative
Index	Convention	Representation	Theoretical
Icon	Similarity	Expressive	Aesthetic
Icon	Convention	Representation	Denotative

4.1. DISCUSSION

An initial analysis using the introduced framework might help to meaningfully discuss, if not even begin to understand the rationale behind the respective choice by participants in their selection of visual.

We investigated firstly what type of semiotic tool our participants used to convey meaning. The preliminary review revealed selections in line with Hartmann and Vossebeld's (2013) assessment of icons and mixed skill groups, and, as expected, there was much less reliance on symbolic conventions typically associated with expert design. By relying less on symbolic conventions the participants needed to find meaningful ways of communicating their contribution. The internet, as expected, provided a rich resource of iconic images for participants to use. A broad range of visual images where used including isolated objects (e.g., solar panels) as well as images of complete buildings. These images were then encoded as signs with recall, convention or similarity based information intended to act as precedents.

Furthermore, there were opportunities for investigation generated in the decoding of the denotative and theoretical content of the images. For example, two different semiotic interpretations (meanings) were observed to occur in the crowd with a sign shift between denotative and theoretical meaning for an icon – solar panel. On separate occasions, and without direct collaboration, a participant introduced the iconic image of a solar panel to signify and denote the need to consider power in the design task. Working by copy-

ing the same image and without communication between participants, another participant utilised the same image but in a theoretical context to suggest the solar panel 'could' act as a shade device. The re-contextualisation, through interpretation of the sign from denotative to theoretical icon, enabled an idea that might not have otherwise occurred without being prompted in the first instance by the presence of that particular sign image.

In a representation rich discipline such as design, it is the shared visual conventions that function toward managing ambiguity in the overall design/engineering process. Hartmann and Vossebeld (2013) suggest that less or no reliance on shared conventions might lead to dis-ambiguaties in how different participants interpret the signs in a visualization task. However, as shown in our pilot study, this interpretive dis-ambiguity may be beneficial in collective design, due to the potential for a near infinite volume of interpretations that can be iteratively re-interpreted in the generation of ideas prompted by representational visualizations.

The findings from this research presented preliminary evidence that a semiotic framework can be applied to describe how non-expert participants use signs to communicate design aims in an open web based collective design task. Our framework highlighted that there is potentially little to distinguish between experts and a crowd with respect to using precedents. The framework also revealed the importance of encoding and decoding the signs in relation to idea generation. By semiotically categorizing the sign types in collective design, this framework provides an opportunity to explore the potential for coding the sign based data. Coding will allow designers and researchers to quantitatively explore the relationship between representational functions, their meanings, and interpretations, to permit exploration of ideas generated through rules of collective and representationally interactive production, rather than the modelled process context we currently see used in crowdsourcing.

4.2. CONCLUSION AND FUTURE DIRECTIONS

This pilot study examined design activity in a shared web context and focused on the communicative meaning of imagery using a semiotic framework. A limitation of the presented study was the reliance on a small group of participants for collective data; however, the findings from this research provided proof of concept for the use of semiotics as an evaluation tool in collective design. Future work will apply the framework to larger, more realistic crowd situations and an expert group for comparative data. There is also a need to refine the framework categories and to combine a linguistic semiotic analysis with a visual analysis. The semiotic framework and its concepts

provided an effective analysis tool and aided insights into how design meanings are coded, communicated and decoded through the use of signs. Furthermore, these signs have the potential, through interpretations, to contribute to the generation of new ideas in the collective design context.

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