Understanding collective design communication in open innovation communities[1]

Mercedes Paulini[2], Paul Murty and Mary Lou Maher

The University of Sydney, Sydney, Australia

We characterise collective design as an emerging area of research in the field of online collective intelligence and introduce mechanisms by which communities can be integrated into the innovation process. The community's role in open innovation is reflected in their style of communication, which shapes contributions to the design process. Communication is studied across three successful social platforms that encourage an open community to participate in the design process. We describe these communities in relation to the communication dimension of a conceptual space for collective design, extending analysis to visual representations of the design process and a protocol study of communication content. The article concludes with our findings that the collective design community benefits from working within a structured design process where specific roles are ascribed for formulation, synthesis and evaluation.

1. Introduction

The topic of collective design has been gaining increasing attention in the design community as a growing number of online platforms support new ways of addressing complex problems by allowing motivated individuals to contribute. We use the word 'design' in a discipline independent way, as presented for example by proponents of "Design Thinking" (Brown, 2009): a way of incorporating design thinking into a business model that focuses on user centric, creative problem-solving. Design thinking also refers to the study of design cognition in order to better understand design processes employed by individuals and groups, for example, the studies reported in Cross , Christiaans, and Dorst (1996). As we continue to move toward increasing the use of social networking and online participation in design, we need to better understand the dynamics of online communities and their potential role in a more social process of design.

Jane McGonigal, a social games theorist, highlights in her 2010 TED talk "Gaming can make a better world", that online gaming communities are a massive potential resource possessing the culture and motivation to tackle some of the biggest issues facing the world today: such as poverty, hunger and climate change. Jeff Howe (2009) suggests others besides gamers can contribute to worthwhile causes, for example, knowledge workers who come home from the office to engage with online projects in their "off-cycles". Open innovation extends an invitation to all, no matter their background, to contribute. When individuals from a diversity of backgrounds become involved in online innovation, their collective focus can be used to address complex problems that benefit from multiple perspectives. This phenomenon, arising from the collaboration and competition of many, connected individuals, is known as *collective intelligence*.

Collective design is based on collective intelligence and involves an open, online community (or crowd) contributing to the design process. Architects and urban planners were involving communities in design for years prior to the mid 1970s when participatory design first became a research area (Kensing and Blomburg 1998). Since then, participatory design has become a

---

recognised mode of professional design practice, enabling the inclusion of stakeholders possessing a wide range of knowledge and skills - who are not necessarily designers. In a further enabling move, Druin (2002, 2009) developed a methodology to include children in the process of designing new child-centered technologies. Collective design communities allow the inclusive nature of participatory design to be extended to almost unlimited levels. The online collective design systems we study here attract a wide user base, beyond targeted stakeholders, to allow any motivated individual to contribute to the design process.

The way individual contributions are included in the design process can be characterized by the amount of collaboration among the members of the collective. Not all collective intelligence platforms encourage collaboration: for example, Innocentive.com broadcasts a challenge publicly and encourages people to submit solutions independently. Figure 1 shows a continuum ranging from Collected Design, where each member contributes a solution, to Collective Design where members collaborate to produce a solution that is a synthesis of many contributions. In this paper we will primarily focus on collective design, but draw on some examples of collected design, or collected intelligence, for comparison.
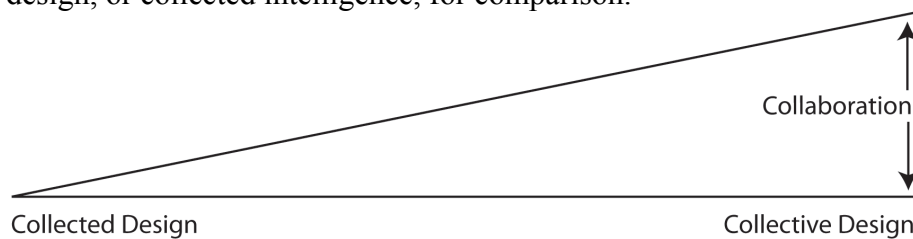

Figure 1. The Presence of Collaboration: collected design to collective design (adapted from Maher, Paulini and Murty 2010)

Collective design distinguishes itself from *collaborative design* by including contributions from any motivated individuals rather than only from a pre-selected team of individuals. This is possible due to advancements in social technology and the increasing interest in social networking. Maher et al (2010) present a conceptual space, shown in Figure 2, to model how technology has supported and enabled the transition from individual design, to team design, to collective design along three dimensions: representation, communication, and motivation. The representation dimension captures the ways in which computing technology has facilitated increasingly complex design solutions by providing digital models for analysis, visualization, and simulation. The communication dimension is crucial to understanding collaborative design and more recently for enabling collective design. The motivation dimension characterizes a shift in emphasis from collaborative to collective design in which the technology platform provides incentive structures that motivate people to participate in design processes. This paper focuses on developing a better understanding of how communication is supported and structured in collective design.

The central concept behind collective design is that knowledge relevant to a project can be dispersed among, and collected from, many physically distributed professionals and communities. There are many successful examples of online design sites leveraging the diversity within a community by crowdsourcing their design problems: asking members to independently develop solutions. We look beyond online platforms that aggregate results and focus on three collective design environments with a large degree of collaboration in the community and innovative practice. These three case studies provide the data for an analysis of communication in collective design. More specifically, in this paper, we: (i) outline the ways collective design environments integrate online communities into a collective design process, and (ii) explore how such communities contribute to solving real world design problems through a study of the communication content.
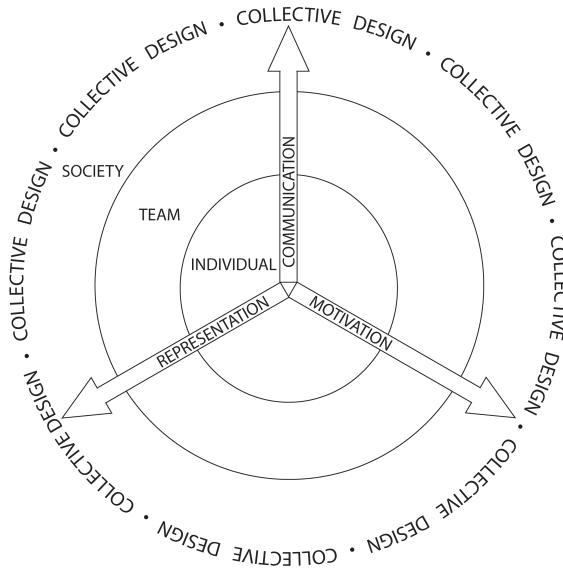
Figure 2. Conceptual space for collective design from Maher et al (2010).

2. Collective design platforms

Collective design is a developing practice and as such there is a limited number of online communities for social innovation. The three online, collective design platforms selected for analysis are Quirky.com, OpenIdeo.com and MyooCreate.com. These three were selected to highlight the similarities and differences in how the design process is structured and in the role the community assumes in the design process. The platforms provide a good source of data as the design process is transparent, well-documented and publicly available online. Data in design research is traditionally obtained from experiments where the design problem has been artificially created and the subjects are aware they are being studied. It is a limitation of these studies that subjects' behaviour may be affected by this knowledge. The communities on these sites have none of these concerns and the data is therefore indicative of true design communication.

Quirky is a platform for product design selected for its clear contribution to design practice and its established presence (95 projects in 95 weeks at the time of writing and demonstrated commercial viability). The OpenIdeo and MyooCreate platforms address global welfare issues to create positive change through community collaboration. They were selected for their different approaches to using design thinking for problems crossing design disciplines. At the time of writing, OpenIdeo had six completed challenges, MyooCreate had four. It is relevant to our analysis to note that MyooCreate appear to have suspended operations after running for a little over seven months. Their final challenge and blog post was on September 30th, 2010.

The Quirky platform maintains detailed statistics on chief 'influencers', individuals from the public who have a significant role in shaping the project. OpenIdeo provides similar statistics on each individual through a badge of honour (a Design Quotient). By following the username of influencers, it is possible to track their comments and contributions on the website. Public design communication over MyooCreate can also be followed through the screen names of individuals. A chronologically ordered forum for each stage of the design process catalogues design communication between members on all three platforms.

Quirky, OpenIdeo and MyooCreate employ design as a process that can be applied to a range of contexts to encourage innovative thinking. They involve both professionals and amateurs to varying degrees, favouring a hybrid approach where experts guide the design process and tap into the crowd's contributions for ideas and feedback.

Quirky gathers ideas from individuals and presents them to the crowd in what resembles an

ideas popularity contest. Each week, the idea with the most votes is selected for development. The crowd is sourced from people who choose to participate and make contributions, and these volunteers are involved in the design process at key stages: creating the original design brief, voting on which brief to progress, product research, industrial design, evaluation, product naming, tagline and logo design. Formal aspects of the design are carried out by a dedicated in-house professional design team which takes place offline, with the outcomes of each stage in product development made available online to the crowd. A legal team also evaluates projects, presumably for copyright infringement.

OpenIdeo places an emphasis on collaboration with financial sponsors who set the project brief, such as finding new ways to use technologies to improve maternal health in disadvantaged, rural communities. The platform draws on its crowd of contributors to provide background research, suggest ideas and applaud and evaluate proposed solutions. The top concepts as voted by the crowd are then evaluated by a panel of experts for business viability and technological feasibility before a winner is announced.

MyooCreate also sources their challenges and prizes from industry. The challenges are quite broad in what the crowd is expected to deliver. In one example, a photograph with a 200 word description is needed; in another, a 500 word essay on the future of social enterprise. Collaboration occurs within each submission, and there are parallel submissions to each challenge. For example, the Care to Air challenge crowdsources product design by asking participants to invent a sustainable air-drying solution for clothing. The panel of judges come from affiliated sponsors and invited guests from industry. Their only role in the design process is to select the winning solution.

The hybrid model these platforms employ uses communication tools to bring out the strengths of the in-house team of experts and the crowd in order to bring ideas to fruition in a viable way. In the following sections we focus on the role communication plays in understanding issues and developing solutions as online communities address real world design problems.

3. Integrating online communities in the design process

Open, online communities are characterised by the ebb and flow of member involvement. As with online forums, members can be moderators, fully active contributors, contribute only once or sporadically, or "lurk" - observing passively. Preece and Schneiderman (2009) describe the stages of participation in an online community with their Reader-to-Leader framework where individuals begin as readers of content, become contributors by adding small edits then larger ones as they become collaborators, until they might develop into leaders who promote participation, mentor novices and create and enforce the policies of the community. To achieve continuity and progress within a design community, leaders must take responsibility for developing user contributions according to design constraints such as time and budget. Online communities incorporate this leadership structure naturally by self-organising into roles which allows individuals to take responsibility for the project. Benkler and Nissenbaum (2006) identifies peer production as superior to traditional forms of production because it allows individuals to self-identify tasks to which they are suited; thus, some remain collaborators while others naturally progress to more involved roles. Other communities (often businesses with the finance to hire people) incorporate a dedicated team to monitor progress and keep the design within given constraints. In forming a hybrid system where both crowdsourcing and a dedicated team are used, good communication is essential. This can be achieved by updating shared representations so contributing members can know where they are located in the design cycle and how their contributions are being used.

One way to increase the usefulness of contributions is to provide members with a set of guidelines to apply to a task. If the experience and task is limited, an individual can, in a short space of time, be trained to a level where they are able to complete a limited task to a sufficiently

high standard. Community training has been demonstrated in the specialised domain of molecular biology. Foldit is an online protein-folding game built around a task usually carried out by biologists or biochemists. It introduces the principles of protein folding to individuals via a series of introductory puzzles, encouraging them to learn field-specific terminology and protein-folding rules. Skills such as spatial reasoning (Cooper et al. 2010) and decision making for solving 'wicked' problems are utilised in the exercise, demonstrating that an individual's creative thinking can benefit domains other than that in which they are formally qualified. This is relevant to collective design as it suggests that some of the skills and techniques of professional designers can be transferred to amateurs. Findings show that few of the top players in Foldit were biochemists, or even possessed a scientific background, yet they contributed valuable work to a specialized domain. The outputs of this game (optimally folded proteins) have implications in Alzheimer's disease, cancer and HIV/AIDS research, which supports McGonigal's reasoning that problems faced in the real world can be deployed in a gaming context to motivate online communities to find solutions. Giving communities the skills and knowledge to use design thinking in new contexts is a viable option for increasing the usefulness of their contributions.

In cases where extensive expertise is required and a crowd cannot be trained for practical reasons, the platform or challenge can target suitable people by broadcasting to those with expertise: either by specialising in a niche market (TopCoder.com focuses solely on software design), or by wording the problem description (challenge) in such a way that only those with the relevant knowledge can contribute. This is the case with Innocentive.com, where problems are so specialised that their descriptions alone will turn away those without the necessary background to solve them. This 'necessary background' does not directly translate to domain expertise: as solvers often come from related fields, bringing a novel perspective that enables them to solve the problem where domain experts have failed (Lakhani & Jeppesen 2007).

An important characteristic of open, online communities is the diversity of member's backgrounds, education and opinion. In this diversity lies an inherent ability for the crowd to generate unique perspectives. Some theorists (for example, Arias 2000; Benkler and Nissenbaum, 2006) argue that knowledge relevant to a problem is distributed among stakeholders and that by bringing together different and controversial points of view, new insights, ideas and artifacts can be made. Diversity is particularly useful in the ideation phase of design, where multiple potential solutions are evaluated against specific criteria. Shah, Smith, and Vargas-Hernandez (2003) show processes that generate more ideas are more likely to produce creative designs. Unique perspectives may re-frame the problem or produce an unexpected solution, thus enlarging the known solution space, which is more likely to lead to innovation.

The majority of the offerings provided by a diverse crowd can often be predictable and expected, but within the collective, some will be surprising in the way they successfully address the problem. Encouraging, identifying and developing useful contributions is the most important function of these systems. Methods of identification can be intrinsic to the system, i.e. individuals rate each other, or extrinsic where professionals or accredited individuals conduct evaluative measures.

3.1 Communicating the design process to the community

In this section, we outline the ways in which existing online, collective design platforms encourage and integrate communities into the design process to produce valuable user contributions by establishing a project along a timeline or as a design process. An awareness of the community's place in the design process can lead to a better understanding of how their communication reflects their contributions to the design. Two of the three collective design platforms analysed (Quirky and OpenIdeo) incorporate a structured design process to guide the community in design while the third (MyooCreate) uses a timeline to track progress in the

project. Specifying each stage of the design process helps guide the content of communication and provides a focus for decisions at each stage, providing a scaffold to drive the design forward.

Quirky provides a product timeline which includes specific parts of the design process that can expand to suit the unique needs of the project. An image from one of the projects in Quirky is shown in Figure 3. Some projects undergo several iterations of evaluation or industrial design, which is reflected in the graphic. The example in Figure 3 was taken from a product that had completed the design process and proceeded to the manufacturing stage. Strikethrough lines are placed across the text at the conclusion of each task. The text strikethroughs act as a visual indicator of the level of completion at which the project stands. Emphasis is placed on product evaluation, research, industrial design and branding. Product research involves questionnaire-type surveys to assess their market, rather than precedent analysis.

Figure 3. Quirky design process.

OpenIdeo present a 'bar graphic' that treats design as a linear process, shown in Figure 4. This may seem like an over-simplification, but it allows the platform to manage multiple streams of projects developing concurrently. The graphic contains visual elements that communicate important aspects of the design process. The bar originally starts as a light gray, with colours filling sections as they are completed. Sections are separated from each other by their colour, which is a visual theme that runs through the sub-pages of each project i.e. appearing in the hyperlink colour. This acts as a visual reinforcement of the content of communication within a section. The project commences with Inspiration - a form of precedent analysis where existing work is profiled for its relevance to the current challenge. Once this part of the design process is completed, a factor determined by a deadline, the timeline begins to highlight the next section. The content of the smaller text below the title changes depending on whether a section is active or looming. While active, it reflects the number of ideas submitted, but if the previous section in this linear arrangement has not been completed, it provides either a countdown to the number of days remaining (if immediately following the active section), or otherwise a static date.

Figure 4. OpenIdeo design process: at the start and completion of projects (shown by colour fill progression)

Besides written evaluation on submissions, OpenIdeo also include an applause feature, as shown in Figure 5. This feature uses an individual's Facebook or OpenIdeo account login details to show approval for a submission. This is a numeric representation of simple, binary collective opinion for people who feel strongly enough about the project to submit applause.
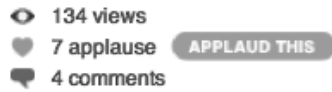

Figure 5. Communicate approval through applause in OpenIdeo.

MyooCreate differs from the other examples, as their graphic does not feature elements of the design process. MyooCreate communicates a timeline for each project, as shown in Figure 6. This indicates that the design process is not distributed to the community but is performed by individuals and the community is asked to comment on the design solutions to help enhance them.
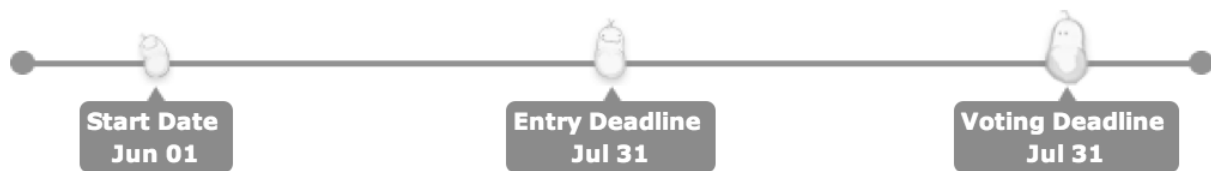

Figure 6. MyooCreate timeline

These graphics help in part to reveal the emphasis each platform places on the content of design communication and the role of the community, with Quirky and OpenIdeo guiding the individual along the design process and MyooCreate highlighting submission deadlines, leaving the design process to the individual.

Online, collective design communities borrow concepts such as *time lines* and *stages in the design process* from collaborative design, but they allow each member of the community to select how they wish to contribute. Participation can be as simple as clicking on a button to vote, or more elaborate, such as being involved in ongoing design discussion. Time lines and design process diagrams are useful visualisations of the stage the design is at. Members who are 'dropping in' or 'passing through' can immediately see what kind of contribution is appropriate for the stage of the design cycle and their form of contribution can be guided by this.

In this next section we discuss how design communities contribute based on their role in the design process.

3.2 Ascribing roles in the design process to the community

One of the main differences between individual designers and collaborative designers, whether in a team or in a community, is that members have roles and relationships relative to each other (Cross and Cross 1995). In some cases, individuals can adopt a role (Preece and Schneiderman 2009) and in others, such as these three collective design systems, particular roles within the design process are ascribed to the community in order to facilitate communication. Cross and Cross (1995) presented an analysis of the roles within team design communication and their social interactions including gathering and sharing information, developing concepts and conflict resolution. Here we examine their public interactions in relation to the roles they've been ascribed. The community's role in the design process depends on the nature of the problem and the ability of the system to identify relevant expertise. Although many scholars and design practitioners have written detailed analysis on the design process in specific disciplines, we use

the model of design developed in Maher (1990), which presents a high level model of the design process as having three phases rather than prescribing a design method. The three design phases are: formulation, synthesis and evaluation.

3.2.1. Design Formulation

Design formulation involves identifying the requirements and specifications of the design problem. This is sometimes referred to as the design brief or program, or more simply as the definition of the design problem.

Quirky involves the community in the earliest stage of design formulation, whereas OpenIdeo and MyooCreate collaborate with industry sponsors to provide design briefs in the form of challenges to the community. Each week within Quirky, several potential design projects are suggested by individuals in the community, and the community votes on which to select for further development. The community formulates the design brief through market-research style questionnaires, aimed at revealing the needs of the community, who also act as representatives and predictors of future consumer markets.

A part of formulation is the gathering of information relevant to the design task. The OpenIdeo design process initially begins with a period called 'inspiration', which requires the community to source concepts and products that can have an effect on the direction of design development. The search strategies are somewhat poorly understood (Cross and Cross 1995), but by finding elements of existing projects that can be related back to the challenge, an act of re-formulation takes place, where the challenge is re-framed in terms of the collected material.

The chat forums on each platform contain communication that suggests the community seeks to better understand the design brief by asking relevant questions. The questions are answered by other members of the community as well as the design team employed by each collective design company.

3.2.2. Design Synthesis

Design synthesis includes the identification of one or more design solutions consistent with the requirements defined during formulation and any additional requirements identified during synthesis.

Design synthesis in online communities can be conducted by an individual, where a solution is proposed and others in the community comment, or it can be conducted collaboratively, where many members may contribute to the generation of ideas and the synthesis of complex solutions. The products designed at Quirky represent cumulative decisions along the design process, and key influencers are recognised and publicized on the website. In OpenIdeo, synthesis is a process that occurs as a collective decision between voting members of the community and an expert panel, who take into consideration the community's views.

OpenIdeo's crowdsourced "inspirations" section in the design process is dedicated to identifying and sharing existing information and projects related to the design brief. This acts as a form of precedent analysis and is particularly suited to the diversity within the community to locate relevant material.

Ideation is a significant aspect of design synthesis and is encouraged on several crowdsourcing platforms: Quirky.com, MyooCreate.com, OpenIdeo.com, Threadless.com and TopCoder Studio, to name a few. Users submit ideas in the form of logos, sketches, textual descriptions and keywords. Idea-jams occur on the discussion forum, where the community engages in lively discussion about the product, coming up with a large list of design features. Quirky uses this model of crowdsourcing when seeking a brand name for the product or brand artwork.

3.2.3. Design Evaluation

Design evaluation involves interpreting a partially or completely specified design description for conformance with expected performances. This phase of the design process often includes engineering analysis.

Evaluation is a mechanism to ensure proposed solutions have integrity and crowd appeal. It can occur within the crowd through collected or collective means, or by a process separate from the crowd. Quirky encourages the crowd to discuss their personal views and evaluation of ideas during ideation. This provides feedback on the appeal of the design to the collective.

When the crowd is ascribed the role of evaluation for integrity and selection, the qualifications of the evaluator is important. TopCoder uses competitions and a history of 'wins' to rank their members and provide performance metrics of their coding skills in particular areas of software development, such as algorithm or conceptualisation. The best coders of TopCoder.com are given the executive ability to evaluate code submitted in competitions and select winners. Rather than give the crowd the role of evaluating and selecting a winning design, Innocentive.com and Quirky.com employ an expert panel to judge submissions; in Quirky's case, this is a dedicated professional design team who evaluate the design, market and viability of each submission[3]. Viability is also assessed by Quirky's lawyers, who bring specialised legal knowledge to the evaluation process. This expert evaluation occurs alongside the crowd's opinions and votes on the designs.

Howe (2009) identifies prediction markets benefiting from collective intelligence. Prediction can be a way of evaluating the potential of a solution. Quirky makes use of prediction markets in a limited way by opening pre-sales of the product to its community, using the purchases by its members as a predictor of future sales.

4. Analysis of collective design communication

One way to understand the design process of an online community is to study the communication among individuals. A protocol analysis of the designers' communication is one approach that has been used to understand the design process of a team of designers (for example, Maher et al 2006). Communication content can reveal how a collective understanding of a design problem is formed; how active and engaged a community is within the design process; how ideas are developed; and how they grow or decline in popularity. This section presents the results of a protocol analysis of communication data from three projects on the Quirky site as the basis for a quantitative and qualitative analysis of communication in collective design.

In Paulini et al (2011), we presented differences and similarities between collective design and traditional team or individual design processes through an analysis of design communication on Quirky. A protocol study was carried out on three public forums on Quirky.com. The three design projects studied were a waffle maker (265 segments of data), switchblade (426 segments of data) and iPad cover (88 segments of data). These three projects were selected because they had completed the design process and were either available for pre-sales or sales, are strongly rooted in product design, possess a common feature of supporting the community's textual communication via forums and have additional means of gathering opinion via surveys and rudimentary voting mechanisms.

4.1. Segmentation

The forum comments for each project appear as a continuous stream of chronologically ordered text, which was copied directly from the webpage to a spreadsheet, during which time segmentation was also performed. Segmentation occurred at three levels: the speaker level, the sentence structure level, and the code level. At the first level, the data was segmented whenever a new person added a comment. At the second level, each person's comments were segmented at

---

[3] http://aquirkyblog.com/2011/02/what-does-quirky-look-for/

sentence breaks. At the third level a sentence was segmented so that each segment could be assigned only one code.

4.2. Coding the dataset

The communication data selected for analysis was not part of the problem formulation process. We coded the data initially according to the part of the design process to which the discussion contributed: synthesis and evaluation. We used the codes *ideation* and *evaluation* because these words more clearly indicate whether the community member was contributing new ideas or contributing to an evaluation of existing ideas. We added other codes to capture the content of the communication that was part of the social process of designing rather than contributing directly to the solution description. Segments were coded into 5 categories: Ideation, Evaluation, Referencing, Qualifications and Social. *Referencing* describes segments which allude to existing products or concepts. These often take the form of hyperlinks to outside sides (such as the Swiss Army knife website in the Switchblade project) or mention of a brand name. *Qualifications* refer to instances where individuals qualify their judgments or design commentary by communicating their past experiences with the problem, product or situation. *Social* refers to communication where the content is not directly relevant to the project or design process.

4.3. Analysis

The results of coding the segments in the three projects and the mean across all three projects are shown in Table 1. The majority of contributions lay within three areas: ideation (I = 34.67%); social communication (S = 29%); and evaluation (E = 25.67%). Referencing (R) was 9.33%; and qualifications (Q) and uncoded data (U) were both 0.67%, Table 1.

Table 1. Quirky Data Top-Level Results

	Waffler %	Switch %	Cloak %	mean %
I	27	33	44	34.67
E	24	22	31	25.67
R	12	8	8	9.33
S	34	36	17	29.00
Q	1	1	0	0.67
U	2	0	0	0.67

Luther et al (2010) writes that one of Weber's eight principles of the open source process is to "talk a lot", with discussion venturing beyond the project to other topics. This was also observed here, where participants augmented their design contributions with social discourse not directly related to the design, but instrumental in persuading individuals of their view or for establishing credibility and rapport. Social comments consisted of: emoticons; abbreviations; jokes; friendly, comments to others that involved no design communication; and phrases such as "so....hmmmm" to give the text conversational properties. This indicated that some of the communication culture from mobile technologies: SMS language (Textese), typed chat programs, social networks and microblogging services were appropriated for the collective design context. Voicing agreement to other's ideas was high, indicating an emphasis on social support. Social communication formed 29% of total communication, a significant proportion which is on a par with ideation and evaluation. This suggests social commentary plays a large role in design discourse, enabling design commentary to be framed. It may also assist design communication by developing the identity of members who are otherwise socially anonymous and enabling relationships to form between members.

Previously, we have experience in coding team design communication (for example, Maher et al. 2006) that is recorded while the team is working together and at the same time. This

synchronous communication had many similarities to the asynchronous communication in collective design. For example, the highest number of segments were design process related, for example, ideation and evaluation. However, an analysis of the content of the Quirky forum communications brought to light some marked differences in communication in asynchronous and synchronous modes of design communication. What initially appeared to be a repetition of ideas on Quirky may actually be categorised as *new ideas* due to the failure of new members to read the discussion history. Since all members of a design team were present for the entire collaboration period, the repetition of an idea was easy to track. Further, in collective design projects members come and go and new members may not read all of the communication that occurred in the past. This reflects the inherent nature of the collective design crowd to "drop-in/drop-out".

We also observed that people supported their evaluations or insights with details of their (usually informal) qualifications. During a discussion about a redesign of the multi-tool pocket knife, one member cited their experiences with airport security to ensure the blades would not be confiscated. Others admitted to being lifelong users of brand name pocket knives or their experiences with using similar products to justify their design inputs. It is hypothesised that by listing their 'qualifications' they add weight to the content of their communication and the reason they feel they need to do this is because of the open and anonymous nature of the community. In design teams, individuals are usually acquainted and have a knowledge of their educational backgrounds which qualify them to put forward design decisions. In a collective design community, individuals' backgrounds are unknown to one another and they can support their contribution with examples of experience. Polanyi (cited in Fischer 2011) observed the importance of externalising tacit knowledge in distributed design projects. The total percentage of qualifications in design communication was lower than anticipated at 0.67%. In future, it is worth investigating whether this is because members are hesitant to qualify their perspectives, or because it is not necessary to do so in this particular design culture.

5. Summary

Collective Design, both as an online phenomenon and as a research area, is still in its infancy, but as community interest in participation continues to grow our understanding of this phenomenon will continue to develop. Mapping three collective design platforms from real world examples to a conceptual space for collective design is the first step to characterizing design communication. Taking real world examples of creative innovation from a non-laboratory setting ensures the study is not limited by external factors. This paper has examined the design process of three websites through the visual representations presented to the community. These visualizations act as guidelines that inform the type of contribution made. Mapping communication onto design processes, particularly by casting the community into roles within the design process, has led to a greater understanding of how communities engage in collective design by informing innovation through the formulation of design briefs; synthesis of potential solutions; and the evaluation of proposed solutions.

An analysis of the communication of communities during the design process has revealed that about one third of the focus is on developing ideas, one third on evaluating them, and one third is spent on social commentary. Stempfle and Badke-Schaub's (2002) observations that the solution space in team design can be kept to manageable level by alternating analysis (widening the solution space) and evaluation (narrowing the solution space) could be further explored in relation to collective design communities, as these results indicate ideation and evaluation are relatively proportional.

A protocol study of communication content in three collective design projects has revealed two key areas in the design process where communities are particularly good at contributing: ideation and evaluation. It has also shown that social commentary forms a significant part of

design communication. It is hypothesized that social content plays an important role in persuading others to agree with design statements and forming a sense of community.

The structure of the design process afforded by a collective design platform helps to compensate for any lack of professional expertise within the open community. The collective design community is self-forming rather than pre-selected as design teams. Unlike most design teams, collective design communities are self-organised to the extent that individuals choose their roles, the degree to which they contribute, and the duration of their involvement. It is essential that the collective design platform provides an organisational framework to support this format for design by providing adequate channels of communication.

By ascribing roles and working within a design structure, elements such as keeping within time and budget do not have to be a responsibility of participants, who are freed to concentrate their contributions towards a defined outcome. de Souza and Preece (2004) write that a useful place to use professionals is for keeping the project running to schedule, as communities are less conscious of schedules than work teams.

References

Arras, E., 2000, Transcending the individual human mind—Creating shared understanding through collaborative design, *ACM Transactions on Computer-Human Interaction* **7**(1), 84–113.

Stempfle, J and Badke-Schaub, P: 2002, Thinking in design teams – an analysis of team communication. *Design Studies* 23(5).

Barabási, A-L., 2003, *Linked: How Everything is Connected to Everything else and what it means for Business, Science and Everyday Life*, Plume: NY, p71.

Benkler, Y. and Nissenbaum H., 2006, Commons-based peer production and virtue, *Journal of Political Philosophy* (14)4, 394-419.

Brown, T., 2009, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, Harper Business.

Cooper, S., Khatib, F., Treuille, A., Barbero, J., Lee, J., Beenen, M., Leaver-Fay, A., Baker, D., Popovic, Z. and Foldit players, 2010, Predicting protein structures with a multiplayer online game, *Nature* 466, 756–760.

Cross, N., 1999, Design research: A disciplined conversation, *Design Issues* 15(2), 5-10.

Cross, N. and Cross A.C., 1995, Observations of team work and social processes in design, *Design Studies* 16(2), 143-170.

Cross, N., Christiaans, H. and Dorst, K. (eds.), 1996, Analysing Design Activity, John Wiley & Sons Ltd., Chichester.

De Souza, C. and Preece, J., 2004, A framework for analyzing and understanding online communities, *Interacting with Computers, The Interdisciplinary Journal of Human-Computer Interaction.* 16 (3), 579-610.

Druin, A., 2002, The role of children in the design of new technology, *Behaviour and Information Technology* 21(1),1-25.

Druin, A. (ed.), 2009, *Mobile Technology for Children: Designing for Interaction and Learning*. Boston: Morgan Kaufmann.

Fischer, G. and Shipman F.: 2011, Collaborative design rationale and social creativity in cultures of participation, Human Technology Journal: An Interdisciplinary Journal on Humans in ICT Environments (in press)

Gregory, S.A. (ed.), 1966, Design and the design method, in *The design method* Butterworths, London, (in Cross, N: Designerly ways of knowing).

Howe, J., 2009, *Crowdsourcing: Why the power of the crowd is driving the future of business*, Three Rivers Press, New York.

Kensing, F. and Blomberg, J., 1998, Participatory design: Issues and concerns,

Computer Supported Cooperative Work 7, 167–185.

Lakhani, K.R. and Jeppesen, L.B., 2007, Getting unusual suspects to solve R&D puzzles, *Harvard Business Review* 85(5).

Luther, K., Caine, L., Ziegler, K. and Bruckman A., 2010 Why it works (when it works): Success factors in online creative collaboration, Paper presented at the Group 2010 conference, Sanibel, FL, USA.

March, L.J. (ed.), 1976, The logic of design and the question of value, in *The architecture of Form* Cambridge University Press, UK (in Cross, N: Designerly ways of knowing).

Maher, M.L., 1990, Process models of design synthesis, *AI Magazine* 11(4), 49-58.

Maher, M.L., 2010a Evaluating creativity in humans, computers, and collectively intelligent systems, in *Proceedings of the DESIRE'10 Conference: Creativity and Innovation in Design*, Christensen, B.T., Boztepe, S., Kristensen, T. (eds), ACM International Conference Proceedings Series, 22–28.

Maher, M.L., 2010b, Design creativity research: From the individual to the crowd, in Taura, T., Nagai, N. (eds.) *Design Creativity*, Springer-Verlag London, pp. 41-46.

Maher, M.L., Bilda, Z. and Gül, L.F., 2006, Impact of collaborative virtual environments on design behaviour, in Gero, J.S. (ed), *Design Computing and Cognition'06*, Springer, Dordrecht, The Netherlands, pp 305-321.

Maher, M.L., Paulini, M. and Murty, P., 2010, Scaling up: From individual design to collaborative design to collective design, in Gero, J.S. (ed) *Design Computing and Cognition'10*, Springer, pp. 581-600.

McGonigal, J., 2010, Jane McGonigal: Gaming can make a better world. [Video file] retrieved from: http://www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world.html

Paulini, M., Maher, M.L. and Murty, P., 2011, The role of collective intelligence in design, *Computer Aided Architectural Design Futures* (to appear).

Preece, J. and Schneiderman, B., 2009, The Reader-to-Leader Framework: Motivating technology-mediated social participation, *AIS Transactions on Human-Computer Interaction* 1(1), 13-32, Available at: http://aisel.aisnet.org/thci/vol1/iss1/5

Shah, J.J., Smith, S.M., Vargas-Hernandez, N., 2003, Metrics for measuring ideation effectiveness, *Design Studies* 24: 111-134.