Collective Intelligence and Design Thinking

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Abstract

Collective intelligence (or CI) has recently emerged as a potential magnifier of design thinking. A surge of internet based social computing applications have achieved surprising results from people thinking collectively, without the aid or restrictions of formal organisation, supervision, or even payment in the conventional sense. Some of the best known applications, such as Threadless and Top Coder, involve limited forms of design activity. However, applying collective intelligence to more complex forms of designing appears likely to require greater understanding of both collective intelligence and design thinking. This paper considers three questions whose resolution may lead to a more general understanding of design thinking through the lens of collective intelligence, how existing CI applications contribute to design thinking, requirements for Collective intelligence for designing (or CID), and how to organise a CI environment to support design processes. The authors conclude that existing CI applications are already developing innovative design thinking activities, that there is an abundance of hitherto undiscovered ways of applying human intelligence to designing and that CI applications are largely self organising.

1. Introduction

Collective intelligence (or CI) is an emergent phenomenon that has long existed and evolved in human cultures. It can emerge spontaneously, or be induced, and develop in many forms and settings. In recent years CI, facilitated by internet technology, has emerged as a powerful, economical, human resource and a potentially effective magnifier of design cognition.

In this paper, we use the term CI to refer to the phenomena associated with internet-based applications that allow anyone to contribute, in the spirit of the ideas described in “Here Comes Everybody” (Shirky, 2009). Some of the best known internet based CI applications, (often referred to as crowdsourcing) including Wikipedia, Threadless and Top Coder, involve hundreds of thousands of participants interacting, collaborating, or competing with one another. The large numbers are indicators of popularity, success and processing scale, however numbers alone do not explain why or how these applications grew and now function so successfully. Many grew rapidly from modest beginnings. Significant bandwagon effects, evident now, came later. Success originates from the quality of and personal gain from the interaction, collaboration, or competition that humans experience with one another and with the user environment, made possible by the application design.

New CI applications with fundamentally different approaches, literally new paradigms, are emerging continually. Therefore, the potential contribution of CI to designing and how to achieve it most effectively is difficult to know at present.

In an earlier paper (Maher, Paulini, and Murty, 2010), the authors examined three dimensions of a conceptual space for computer-supported collective design. 1) Representation: Technologies that provide shared digital representations of the design artifact, 2) Communication: Technologies to support communication and collaboration and 3) Motivation: Principles, incentives and structures that motivate selected designers and others to participate in collective design. Following an analysis of six CI applications the study found that successful CI attracts and facilitates participation from individuals who are intrinsically motivated to participate, for personal reasons that go beyond financial reward, not simply because they have been preselected or instructed. An associated finding was that the wider the spectrum of motivational factors supported by the system, the more likely the application is to succeed and produce useful outputs.

This paper takes a step forward to consider issues and questions related to design thinking including; how existing CI applications contribute to design thinking, requirements for CID, and how to organise a CI environment to support design processes.

2. How existing CI applications contribute to design thinking

Few systems based on collective intelligence exist within the design domain, however, group intelligence has been utilised successfully for some activities associated with designing, most notably, at the ideation and evaluation stages.

Threadless is a web application that utilises crowdsourcing to design their products. Users are encouraged to contribute T-shirt designs, which are voted for by the community. The best designs are selected for manufacture. Although no explicit collaboration occurs on the designs, the results of the voting feeds back into the choices designers make to maximise their chances of being selected. Additionally, there is a thriving community with an engaged public discourse on the designs, so collaboration may occur even though it is not explicitly supported in the system structure.

Threadless relies on the community at three key places in the design cycle. At the conceptualisation phase, designs are generated by the community for free. At the evaluation phase, the community votes for their favourite designs, providing the company with free market analysis. Lastly, the community acts as a client and a market, ultimately purchasing the product.

Two activities commonly associated with designing are lateral thinking and problem-solving. A game was played over the Internet by Gary Kasparov the (now former) reigning world chess champion, and Team World, a diverse group comprising; five consulting chess champions, chess clubs distributed internationally, any person with an internet connection wishing to participate, and strong chess analysis software. Design strategies were invoked during gameplay to conceptualise solutions and problem-solve. The chess game, with its clearly defined rules provided a highly structured environment where participants needed to weigh various complex scenarios, to put forward the strongest move. The wide inclusion of contributors allowed for a unique and novel move to be played against Kasparov. The collaboration and internal competition of the community, coupled with a mechanism allowing the aggregation of their ideas meant each move could be the most suited response. Unfortunately, a breakdown in communication resulted in an uninformed move being played, ultimately leading to Kasparov's victory. Kasparov later said it had been the most significant game in the history of chess "The sheer number of ideas, the complexity, and the contribution it has made to chess make it the most important game ever played." This was all possible through the collective efforts of a diverse community.

Webcanvas is an online wall on which people doodle. It has tremendous zooming capabilities, allowing small spaces to be enlarged and filled. There is no definite purpose to the wall - it is merely an ongoing, nonspecific collaborative artwork, and a testament to the extent to which an open community can produce a work that is sympathetic and responsive to the individual efforts of members. In a design scenario, tools like Webcanvas can be incorporated into group sketching, leading to insight into the design problem and the discovery of solutions. Thinking about how to best integrate new tools and technologies into the design process can lead to changes in the way a task is approached and the kinds of discoveries that may be made.

Top Coder is perhaps the best existing example of how a highly successful website, utilising group intelligence and crowdsourcing, can be used across many aspects of a complex design process. Top Coder is a platform supporting software design and development. Its primary aim is to provide coding solutions to software design problems, which it presents to its community as design challenges. Individuals can compete for prize money or post a project for others to complete. Support is provided in the forum pages, which also acts as a platform for socialising and benefiting from group intelligence. Members can collaborate on a submission, and the finished product is often the successful integration of many smaller parts. The application incorporates a variety of incentives to ensure individuals are motivated to participate, whatever their level of knowledge or experience. Coding is a useful design task for group intelligence, as it has clear inputs and outputs, a well-defined process in the middle, and results are quantifiable. However a more recent venture, Top Coder

Studio, extends the Top Coder business model to logo design, web design, print design, and idea generation.

3. Requirements for CID

CI is possible because of the ease of use of internet technologies and the large numbers of people who are willing to spend their spare time on the internet. The requirements for CID cannot be considered as merely another kind of CI. In order to support designing, CID should build on the requirements for computer support for individual designers and collaborative or team design. In Maher, Paulini, and Murty (2010), the authors develop a conceptual space for understanding CI that has three sets of requirements: communication, representation, and motivation. They characterize successful CI applications in terms of how internet technologies satisfy these requirements as a guide for developing successful CID applications. Two additional requirements, guidance and self organisation are introduced here.

3.1 Communication

In general, it is highly advantageous for CID applications to be communication-rich and diverse. Whether co-located or geographically dispersed, effective communication, including shared representations across multiple platforms, play a key role in developing concepts and providing design commentary. Communication requirements in CID should include the consideration of the following:

Mode: synchronous, eg. voice chat, asynchronous, eg. email.

Type: direct, eg. between one person and one or more people, or indirect, eg. change shared representation.

Content: what is being communicated, eg. design idea, comment on process.

Structure: properties of the communications network connections and distribution.

3.2 Representation

Compared to individual or collaborative scenarios, CID applications are more likely to require multiple shared representations to achieve a shared understanding among a large diverse population. The range of representation media includes voice, text, sketches, 2D models, 3D models, immersive virtual environments. Representation functions include visualization, support for analysis or synthesis.

3.3 Motivation

Collective intelligence applications are started and fueled by motivated people. For the many who become, or who are already motivated, it is important to both reinforce and to not demotivate. Key motivating objectives are, to attract, welcome, intrigue, challenge, encourage and reward participation. Understanding and facilitating the range of motivations through the technologies and organizing principles that attract people to participate, is essential to the successful implementation of any collective design application and its continuing viability. It is likely and advantageous that many CI participants are influenced by intrinsic motivations such as ideology, challenge, or fun, as intrinsic motivation is highly regarded for its durability. However the extrinsic motivators such as recognition, social opportunities, career and material rewards are also associated with many CI applications. A likely general rule is that for the most advanced, or most designerly applications, the more motivators the better.

3.4 Guidance

Guidance is both a motivator and a practical necessity. Two key points are that: 1) A variety of guidance modes are required, eg. inform, orient, respond, elicit; and 2) User interfaces need to match different levels of familiarity and use patterns.

3.5 Self organisation

Self-organization is more important than managing people at such a large scale. Understanding how to enable self organization includes two considerations: individual and collective agency for low level tasks and negotiated collective agency for high level wholistic decisions. Opportunities to incorporate user sourced organisation may be increased if higher levels of intrinsic motivation can be achieved.

4. Organising a CID Environment to support design processes

Studies of designers have identified that conceptual design settings, or situations which require design intervention, have common properties. They are characterised by ill-defined or wicked problems that are not soluble simply by collecting and synthesing information. Instead designing requires interpretation, or pre-structuring, of situations and it proceeds by a parallel or iterative, counter-play, of conjecture and a variety of other acts, or processes that precede and follow, in which solutions and problems tend to emerge and develop together. Often what is vital only becomes evident when designing takes place Cross (1999). This dynamic has been variously interpreted by different theorists as argumentation (Rittel 1972), a negotiation (Lawson 1997), and a reflective conversation (Schön 1983). Darke (1979) observed that the conjectures of expert designers were derived from particular ideas, interpretations, or pre-structures, she referred to as primary generators. For this discussion, designing is portrayed as a conjectural process in which: 1) Conjectures emerge from generators, exploration and/or discoveries, 2) Conjectures influence generators, exploration and discovery, as shown in Figure 1.

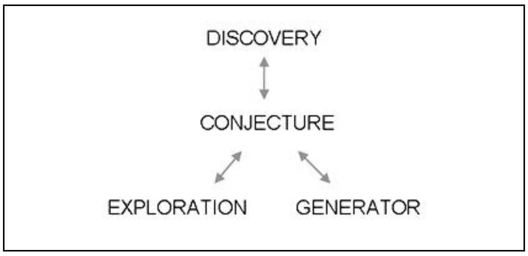

Figure 1. Design Conjecture model (Murty 2009)

4.1 Conjecture

A conjecture in everyday terms is an educated guess or, more precisely, an outcome of abductive reasoning. In the design context, this means putting forward a possible solution or hypothetical approach which can be checked or tested against the design requirements. A conjecture may be a modest step, a bold leap, or anything in between. One designer of a medium density housing project, for example, may conjecture that visiting the site to get a sense of the feel of the location before commencing to design is likely to achieve a better outcome, while another may be confident that an earlier design can be reproduced on the site with a few tweaks, here and there.

Conjectures typically emerge as tentative questions or propositions. A CID system needs to provide an interactive environment which motivates its user population to provide and select relevant inputs, in accordance with appropriate fitness criteria. The testing methods and criteria may be the outcome of a similar conjectural process, conducted earlier or in parallel, with the capacity to "learn" from experience. We can see in Threadless that designs are submitted as propositions, where each designer submits their own design. In Top Coder, the software is decomposed into parts and conjecture as propositions are put forward at any node in the decomposition. These different approaches to supporting conjecture in CID rely on support for a shared representation of the design and the motivation to contribute.

4.2 Generator

A generator can be viewed as a particular class of conjecture which conceptualises a stage or aspect of a design or its situation, providing a basis for further conjectures. Darke (1979) proposes a key effect of a powerful or "primary generator" is to reduce the range of possible solutions, thereby simplifying the problem. The designer of a medium density housing project, may choose a tower, row houses or walk-up apartments as the primary generator. Further understanding of the design can be gained from testing the generator, by deriving and testing further conjectures from it. The row house solution may be tested by generating two alternative site arrangements, building along the site contours or stepping across them.

This sounds complicated, but sketch investigations of this nature are an everyday event during individual or group design sessions. Sessions may involve sketching and verbal descriptions of alternative shapes. As generators are conjectures too, distinguished only by perceived greater design significance than other conjectures, a CID system needs to support a broad range of representation types and alternatives. In addition, if we want to support interaction among the people proposing generators and conjectures, the CID system has an increased need for many kinds of communication technologies as outlined in section 3.1.

4.3 Exploration

Exploring, in the context of designing means investigating or searching into parts, or all, of requirements or solutions. Design exploration typically involves a combination of physical and cognitive activities, such as modeling, analysing, experiencing, reflecting and discussing. Given the situated nature of designing one act may lead to and inform another, in almost any order.

An individual designer actively engaged in this process, either working solo, or as a collaborator, perceiving the transactions of designing directly, may experience a succession of different events without undue difficulty; no less normal than driving in traffic perhaps. Frequently, collaborations involve people in different roles, such as leader, note taker, assistant. If done well, this structuring reduces the cognitive load, as well as the workload per individual and provides a level of coherence and predictability, enabling individuals to concentrate on what they do best and thereby achieve more.

CID needs to accommodate multiple levels of parallel explorations. There may be thousands of participants exploring simultaneously, individually, in collaboration, or as part of a crowd source. In addition the parallelism is multidimensional. There is duplication and there will be different start and end times and conditions, different subjects and different findings. For this process to result in something more than babble simple but effective structuring is required.

Some very large scale undertakings, such as Wikipedia and the Open Source Initiative have achieved remarkable successes in coordinating large numbers of parallel participants. These two organisations are very different in what they produce; one an online encyclopedia and the other a wide range of computer software. What they have in common includes:

- a coherent task which can be subdivided,
- a strong central control group to give structure to new initiatives,
- explicitly expressed rule based organisation,

- welcoming culture,
- readily available training information,
- permission to initiate tasks,
- few or no directions towards or away from particular tasks,
- directions on how to do things are confined to the operation of the application, not the subject, and
- structured peer critical review procedures.

The review process begins when inputs are received and continues after they are accepted, to promote and facilitate continuing improvement. A broad observation one can make at this point is that these endeavors do not micro-manage, that is left to the participants and the natural selection process of never ending peer review.

4.4 Discovery

A discovery is typically an unexpected and novel experience. It may, for example, occur in the form of a new awareness, understanding, recognition or an idea. Individuals make discoveries in many unexpected places and ways, whether working alone or with others; and they make different kinds of discoveries.

The significance of different kinds of discoveries, here, is not so much their features, but rather their effects in a design setting. Unlike Wikipedia, consisting of thousands of different items, or Open Source, made up of program modules, design thinking can require a wholistic sensibility in addition to attention to detail. The effects of some discoveries may be relatively trivial, but a more revelatory experience, may go right to the core of a design. In a CID application, involving many parallel processes, this possibility indicates that a form of part-to-whole attention facility may be required.

5. Conclusions

Three aspects of CID have been considered in this paper:

- How existing CI applications contribute to design thinking
- What is required for CID
- What are the implications for a CID environment to support conjectural design processes.

The existing applications are revealing in different ways. Threadless began as a simple graphic design application, but from it there has emerged a thriving community engaged in public discourse, without explicit application support. Kasparov v Team World was not explicitly a design application but it involved many thousands of people in complex strategic thinking and aggregation of ideas and voluntary collaborations leading to at least one new powerful move. Top Coder provides solutions to software design problems, but its commercial success has led to the application recently entering other design areas unrelated to computer software. These few examples are sufficient to demonstrate an important point, that the emerging collective intelligence is not limited by the scope envisaged when the application was created.

Successful CI requires an active motivated participant population. Additional requirements for CID were identified as follows. Applications need to be communication rich in order to facilitate the interchange of information and development of concepts. Multiple, shared representations are required to achieve shared understanding, and facilitate designing. The importance of motivation was stressed and a range of motivation objectives were identified. The importance of intrinsic motivation was further highlighted. So too was the observation that, for the most advanced, or most designerly applications, the more motivators the system supports the more likely it is to become successful. Guidance and the enabling of self organisation were also described.

How a CID environment needs to be organised to support conjectural design processes, including conjecture, generator, exploration and discovery was also considered. A CID system need not generate questions or answers. Instead, it needs to provide an interactive connective environment which motivates its user population and facilitates and manages multiple simultaneous collective design processes.

At this point one might ask: can CID really lead to new design thinking strategies or activities? We would venture a confident "yes" to new design activities. It is doing that already. The presence of CI on the Internet is also an example of itself, in the sense of being a carrier of collective intelligence about collective intelligence. The great diversity of the growing stream of new CI applications demonstrates very clearly that there is an abundance of hitherto undiscovered ways of applying human intelligence and high levels of enthusiasm to contribute, among many people worldwide. Are there new design thinking strategies possible in CID? This remains to be seen as we study the phenomena of CID.

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