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EMERGENT DESIGN METHODOLOGIES AND IMPLICATIONS

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ABSTRACT
Emergent design is a crowdsourcing toolset for designers doing ethnographic user research on large-scale, multi-user, multi-continent design challenges. In contrast to traditional user research studies that include small numbers of in-depth ethnographies, emergent design aims to access the same quality of rich insights by acquiring small pieces of qualitative information from millions of people around the world, synthesizing responses, and deriving design inspiration from emergent properties of the collective. This paper presents the concept of emergence as it relates to design, the new class of design problem that inspired the development of this toolset, and its major components, methodologies, and an initial pilot project.

Keywords: emergent design, storytelling, empathy, ethnography, methodology, crowdsourcing

1 INTRODUCTION
The scope of design problems is evolving. Designers are used to being called on to create artifacts, experiences, interfaces, and more recently to use design for corporate strategy and management. However, as issues of global importance such as sustainability, economic reform, and renewable energy occupy more of the public mind space, designers are being summoned to apply their knowledge and techniques to this new class of problem. These are complex, grand design challenges that are multi-continent, multi-cultural, long time-frame problems. In order to address these problems, it makes sense that designers will need to adapt their traditional process and methodologies.

In a localized design problem, early-phase user research and ethnography studies are often done in depth with a small number of users. With globe-wide design problems, users number in the millions, and the expense of visiting and studying even a sampling of them is prohibitive. This new class of problem necessitates a new design toolset.

This research surrounds a new type of user research and ethnography for engineering design. Based on the principles of emergence, I have begun to develop a toolset for designers to collect, processes, and interpret rich, qualitative user information from millions of people around the world, quickly and cheaply.

This research is in its early phases. At present, I have developed emergent design methodologies and am currently running a pilot study, explained in this paper. This is an active, ongoing project and what I present here are my initial motivations, techniques, and future directions for broader discussion.

2 APPLYING EMERGENCE TO USER RESEARCH
Emergence is well defined in some fields, such as artificial life or biosciences, but addressed less-often in relationship to design, or the towards the formulation of specific design directions based on a large number of observations.

In the field of artificial life, Ronald et. al. (99) follows the definition of Arkin (98) where, “emergent behavior implies a holistic capability where the sum is considerably greater than its parts,” however they propose a test of emergence to qualify the label [1,2]. In the artificial life realm, emergence is

also seen as related to flocking behavior in birds (Reynolds, 1987) and cooperative behavior in the prisoner's dilemma situation (Axelrod, 1984), among many others [3,4].

In the biosciences, emergence occurs when the whole is greater than, or even unpredicted from, the sum of its parts, such as in honeybee hives and ant colonies. Wheeler (28) called ant colonies superorganisms because the complex dynamics of the colony cannot be predicted from any individual ant [5]. As a collective, the superorganism that is a honeybee hive has a memory of three months, but an individual bee can remember for only six days, and lives for only 90 days (Kelly, 94). Superorganisms are functioning entities that emerge from a mass of individual organisms and have the ability to communicate with one another [6].

As related to design, Gero (96) classifies emergence as the process of making implicit properties of a system explicit [7]. Saunders and Gero (2000) posit that both the design processes, as well as produced outcome of the design work, need to be evaluated in order to determine the presence of emergence [8].

2.1 Adapting emergence for design process

I propose an exploration of emergence as it applies to engineering design based on the definition of emergence used in the artificial life and biological fields. Ronald et. al. (99)'s emergence test proposes three conditions for emergence:

1. *Design:* The studied system is constructed, and describes basic rules or relationships between parts.
2. *Observation:* An observer of the system is aware of the system design, but is able to describe global phenomena over time.
3. *Surprise:* Cognitive dissonance, or non-obvious differences, occurs between the design and observation parts of the system [1].

This study attempts a modified application of these rules for a user-driven design process:

0. *Assume:* This toolset is intended for problems that are multi-party, multi-scale, geographically spread out, complex, and where the stakes are high for the welfare of the system or stakeholder. Each user response becomes a unit of study, and the interaction of these responses can show unexpected or emergent behavior in the form of combined user qualities and understanding.
1. *Decide:* Choose the issue to be studied. Choose the physical and temporal scope. Understand the boundaries of your scope and the type of user you are attempting to engage. Choose a media channel, query mechanism, and interaction design with which to address your users.
2. *Acquire:* Engage your users via your media channel, and collect responses. Each user is responding to the same query.
3. *Process:* Sort and organize data looking for insights, surprises, and any unexpected results that might lead to a new design direction.

Because emergent behavior arises from the interaction of many similar components, the best place in the design process to explore emergence is in its early phase, when designers are attempting to form a design direction from a number of user observations.

Each user becomes a component in the system, and the designer attempts to derive a point of view based on insights from his or her observations. At this point, designers are understanding users, and actively observing behaviors. This is in contrast to traditional, user-driven design process, where the in-depth, quality observations of a few users is preferred to rapid survey-type polling of a large number of users. Emergent design requires mass numbers of people to be part of the early phase design process, yet attempts to gather and process rich, qualitative information from these people.

3 ACCESSING THE MASSES

Currently, mass numbers of people have channels to take part in the latter phases of design process when digital products are being created, such as wikis or open source software. Additionally, some physical products allow input from large numbers of users at different phases via online commentary

or forums. However, in all cases, the masses are not utilized currently in early phase design process. Enabling people to take part, knowing how to best use their input, and then processing that input is another way to think about the emergent design process.

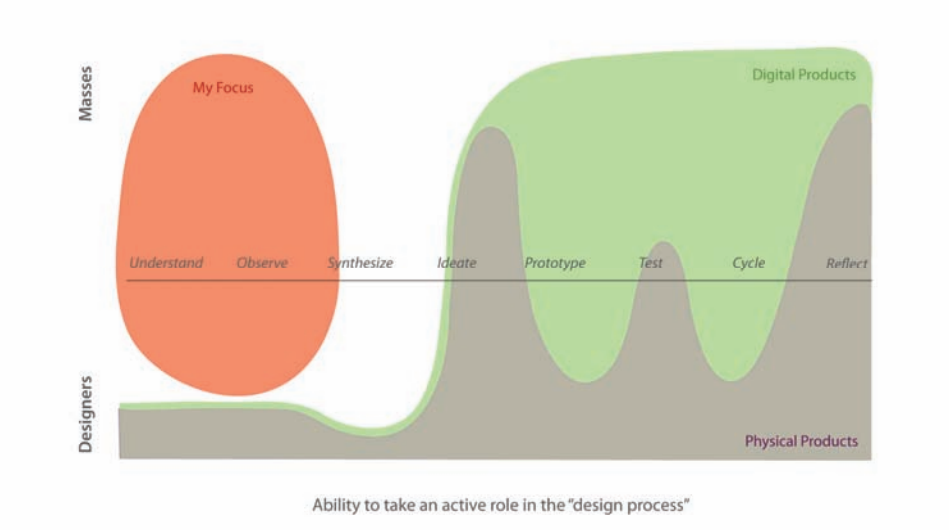


Figure 1. The ability for mass numbers of people to take an active role in the design process varies with type of product and place in the design cycle. Emergent design focuses on using perspectives from the masses in early phase design ethnography.

4 PILOT STUDY

The following shows the emergent design process in an ongoing pilot study. Each phase is outlined and preliminary results are shown.

0. *Assume:* The chosen problem for the pilot study is the global water crisis. Providing access to clean water is listed as one of the National Academy of Engineering Grand Challenges for Engineering, but the global water crisis is not concisely defined [9]. It includes issues related to water access, acquisition, and purification. Many people of varying professions work on this problem at a range of scales, geographies, and points of view. The problem is grand in scale and fuzzy in context and boundary.

1. *Decide:*

Scope

Without specifying the geography or sub-domain, I attempted to understand how people all around the world relate to water, and how it fits in their lives. My physical scope was unbounded, and my temporal scope was the present.

Media Channel

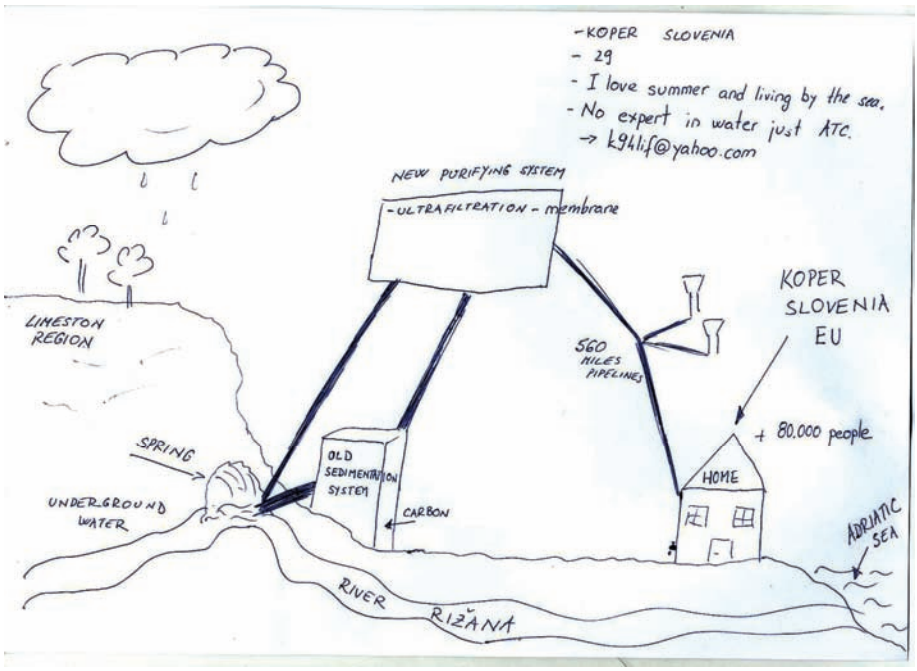
My chosen media channel was Amazon Mechanical Turk, an online tool for crowdsourcing repeated tasks, and each participant was compensated with 25 cents [10]. I understood that using a digital, internet tool for my acquisition of responses limited my users to those that are computer literate.

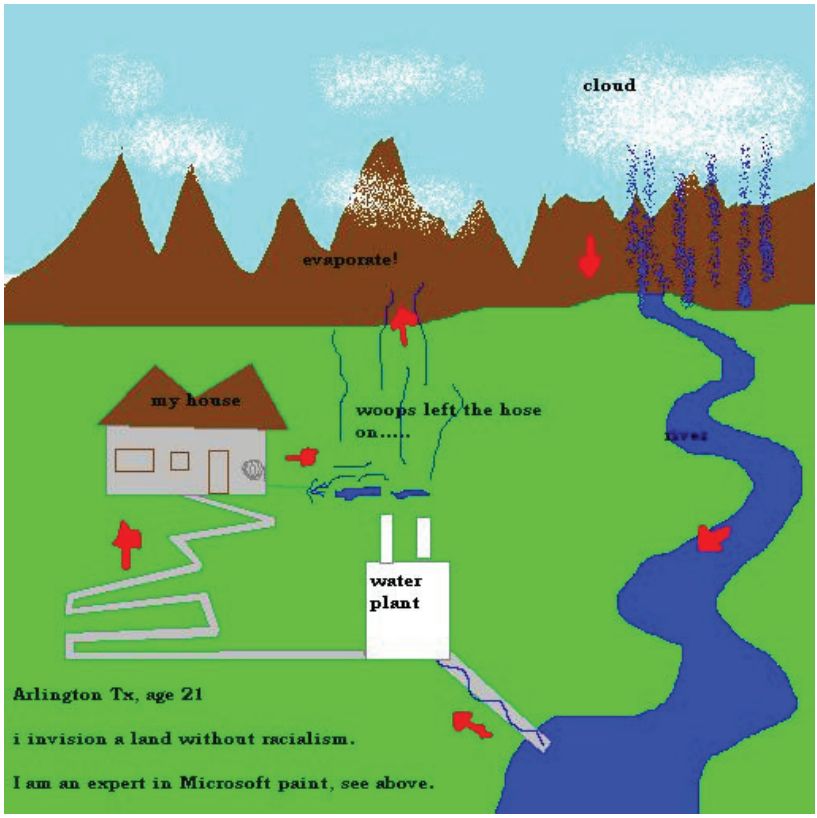
Query Mechanism

The query mechanism I used was the hand-drawn map. Each participant received the same design brief: "Draw a map of the path that water takes from when it falls out of the sky to when it flows out of your faucet." The reason for this brief is because people know their own lives quite well. When asked to map situations, processes, and spaces relevant to their day to day activities, many will be able to detail not only what they know, but also how they place it, and how it makes them feel. Because ethnographic research strives for the stories, this technique highlights the scale that people

think around and understand within. Additionally, the query asked each user to give his or her location, age, one sentence that described them, and in what vein did they consider themselves an expert.

2. *Acquire:* A Mechanical Turk request was sent out and two hundred users selected, completed, and returned the task within a four-day span. Example results are shown below:





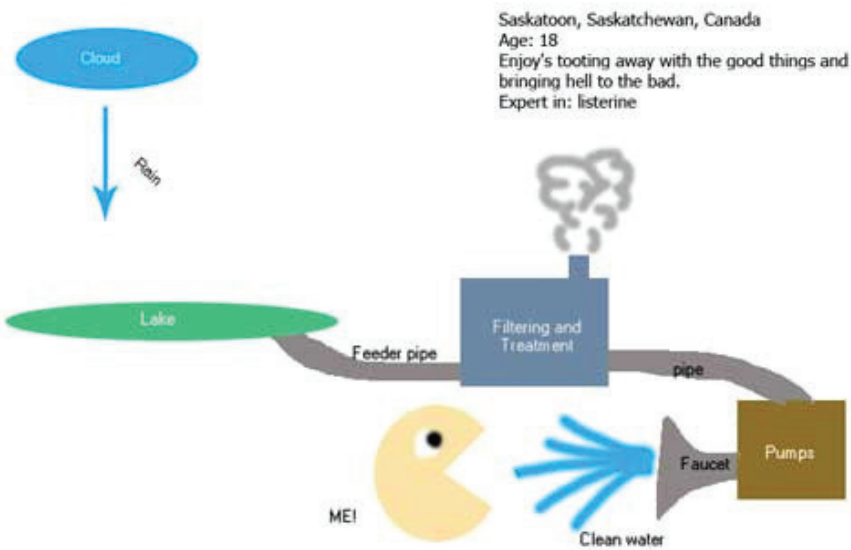


Figure 2. Example results of hand-drawn map query. Users were asked to draw the path that water took from the sky to their faucet.

3. *Process:* At this point in time, synthesis, sorting, and organization of this data is ongoing but promising. With specific, simple, coding rules the maps are being processed according to the number of nodes, connections between nodes, and emotions displayed either visually or with text. From this, a larger picture of the understanding and personal experience of each person can be portrayed, and overlaying all of the responses together gives a larger picture of the collective perspective on this query. Determining the presence of emergence will require understanding the linkages in understanding between individual participants, and the collective dynamics that arise.

   Currently, I am experimenting with various frameworks for systematically organizing the mapping methodology and resultant responses. This Dubberly and Evenson framework, adapted for the acquisition of hand-drawn map perspectives is shown below [11]. Next steps in this area include completion of data processing and indication of design directions.

Figure 3. Framework for accessing, acquiring, and processing of maps. Each map becomes a perspective, and in turn these perspectives are combined and analyzed for emergent properties that may drive design directions.

4 SUMMARY AND NEXT STEPS

By accessing mass numbers of people and imploring hand-drawn mapping techniques described in this paper, I begin to explore emergence as it applies to early phase (understanding, observation) design process. In this system, each user is a basic component, and each of these components responds to the same query in the same format (hand-drawn map). The resulting maps are then aggregated into a global system, and any emergent phenomena are used to drive design decisions.

Emergent design methodologies and the projects that use them are works in progress. I have developed and am currently pilot testing the techniques, and am iterating on sorting and organizing the collected responses. Initial collected responses indicate that rich information can be assembled quickly and efficiently from mass numbers of people around the world. These responses are loaded with texture that can be synthesized using a variety of mapping techniques for use by designers on grand world challenges. This is a new toolset for a new class of engineering design problem.

Emergent design has the potential to be a preserver of the stories and perspectives of millions. It can develop into an iterative visual language where information is connected by perception. Next steps include further development of the toolset, continued pilot testing, and implemented proof of concept for analysis.

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