Crowdsourcing Design Exploration Using Generative Design Models

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ABSTRACT

With today's computational support, the act of designing is augmented by generative algorithms to quickly produce thousands of design solutions. These systems help designers explore a large design space more efficiently than ever before. The commonly used applications of generative systems are parametric systems, where a three-dimensional geometry is designed based on a set of parameters. The examples of parametric systems include Grasshopper (a plugin for Rhino), GenerativeComponents by Bentley® and Revit by Autodesk. This research explores the potential of using crowdsourcing to generate design alternatives from a parametric design model based on an initial set of design requirements developed by a designer. In this position paper, I propose the involvement of a crowd during the conceptual design phase of the design process, when the problem space is loosely defined, and the range of possible design solutions is large. This paper explores several ways to leverage crowdsourcing during the conceptual design phase of a design project, however, the effectiveness of each proposed technique needs to be verified by a user study.

KEYWORDS

Design Space exploration; large design spaces; generative design; crowdsourcing; co-creation.

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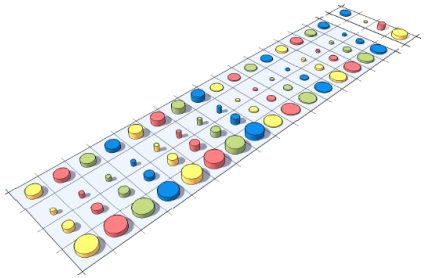

Figure 1. A parametric cylinder with four possible heights, radii and colour values can create 64 alternative solutions (image courtesy of Sheikholeslami 2009) [26]

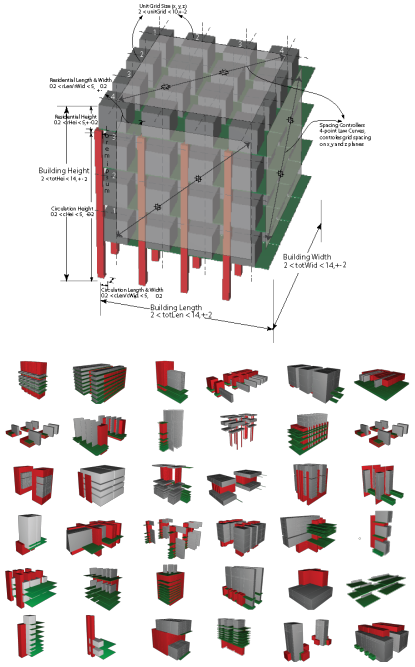

Figure 2. (Top) An example of a complex base parametric model; (Bottom) A sample of design alternatives computationally generated from the base model.

1 INTRODUCTION

The design literature indisputably finds that designers explore design alternatives during their design process [2][5][6][8][9][17]. Creativity support tool design principles [24][25] emphasize a need to encourage users to explore a given design space and try out many different alternatives for creative problem solving. The advent of generative systems has impacted the overall design practice with the introduction of parameters, which means there exists a new potential alternative with each parametric change, see example in Figure 1 and Figure 2 [28]. But the challenge remains, for not only how to produce design alternatives using these new tools, but also how to interact with and manage these alternatives explored through generative mechanisms.

Another important tenet of creativity-support-tools literature [24][25] is to provide support for collaboration within the tools. Recently, many researchers have investigated a variety of techniques for crowd-based ideation [3][4][10][12][19][20]. And as a result a number of large-scale ideation platforms have emerged with spaces where people brainstorm ideas to help solve open-ended creative problems, such as openIDEO [16], Local Motors, Amazon Mechanical Turk (MTurk) are few to name. The common notion among these platforms is to produce a large number of ideas from which a set of quality ideas can be distilled.

My previous research focuses on developing representations and tools to support the act of exploration using parametric design models on large screen displays [20]. For this research, however, I intend to study how *crowdsourcing* can seamlessly be integrated in the process of design exploration to produce thousands of design alternatives using generative design models. Many previous studies have explored the effectiveness of crowdsourcing during the ideation phase of an open-ended design problem where most of the times focus has been on a solution, rather than multiple solutions [10][15][19][20]. To my knowledge, none of these studies explore the usefulness of involving crowd to explore hundreds of thousands of *alternative design models*. This research addresses a specific niche in the design process, that is *the generation of design alternatives*. There are multiple highly related larger research goals for the proposed program;

1. To investigate how a large-scale human effort can be integrated with the computer-aided approaches to take advantages of both computational generative capabilities and human decision-making powers.
2. To explore if crowdsourcing can help designers explore a larger design space more effectively (less effort) and efficiently (less time).
3. What are the possible interface solutions and tool features of a crowd-powered computer aided generative design tool?

2 METHODOLOGY

Crowdsourcing is a model in which a distributed network of individual agents responds to an open call for collaboration [4][11]. Though successful in few ideation studies, there are still multiple limitations associated with this model; 1) the expertise and skill level vary between the crowd members. 2) based on the domain specific knowledge, the quality of individual ideas can be very low, 3) It is likely that many ideas will be repeated due to a lack of coordination among crowd members. 4) It takes time and effort to select best ideas or discern patterns from a larger pool of ideas. [1]

Keeping these limitations in mind, I propose the following ways to integrate crowdsourcing with alternative generation of parametric models.

2.1 Rate Designs

The simplest of the previously explored forms of crowd-based collaboration in a creative design process is to ask a population of untrained workers to rate/critique a set of computationally generated design alternatives on a number of subjective criteria, such as creativity, novelty, clarity, usefulness etc. see [14][22][23] and [15].

2.2 Compare Designs

Another way to integrate a large workforce irrespective of their expertise and skill level is to ask them to compare every two designs within a set and select a design based on a pre-defined set of criteria. This way, a list of popular design alternatives is generated alongside their most commonly associated design criteria. Later, the designer can use this information to guide their final selection and exploration in next design phases.

2.3 Organize/Arrange Design Space

With a more experienced crowd, I propose to introduce the crowd to thousands of pre-generated design alternatives and ask them to organize the design space such that it informs the next design phase. Crowd members would have to meet certain criteria, for example, perhaps they must have participated previously in related Human Intelligence Tasks (HIT).

2.4 Generate Design Alternatives

The most interesting way would be to invite a trained workforce to generate design alternatives using a set of design parameters embedded in the base parametric geometry. This would involve integrating the Computer-Aided-Design (CAD) tool with a collaboration friendly interface such

that it could support recruiting a workforce and enabling synchronized exploration of design alternatives.

2.5 In person Collaboration with Real-Time Crowd

An interesting venue to explore the potential for the creative task of exploring a large design space would be an interface like CrowdBoard [1] – where a team of professional designers collaborate with an online crowd in real-time. Such a system could be used to validate the effectiveness of synchronous interaction in a different design domain, where design challenges are different and design media involve generative design tools.

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