# Ends-Means

*Exploring the implications of digital technology on traditional notions of value in design.*

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**Abstract**

As design practices struggle to evaluate their roles within an industry dependent on the production and distribution of digital information, it is important to critically reflect on what constitutes value in contemporary design. Traditional sources of value were provided by individuals and design teams as hand-drawn, paper-based deliverables. The promotion of digital technology to define, store, and integrate the parameters and rules of a design process suggests that this may no longer be the case. The value proposition of contemporary digital design systems is to reduce the amount of time designers spend on repetitive tasks by providing the means through which to abstract and integrate various sources of design information and define logical rules for the management of that information. If we agree that this is the correct course of development, then it is imperative that the parties involved understand how these systems are structured in order to effectively and efficiently manipulate the data they contain. The difficulty in achieving these ends is not technical, but perceptual. A series of experiments in the expression of geometric forms through natural language algorithms were conducted to explore this argument.

## 1. Introduction

The need to reestablish standards of value is implicit in the negotiations among design and construction practitioners regarding the impact of digital design technology on their traditional roles and responsibilities. Traditionally the designer[1] was the originator, main repository, and manager of design information. The designer carried out the necessary processes of interpreting design ideas and translating those ideas a graphic design documentation. I will refer to the various transformations of information during this translation process as the 'conceptual states' of information. The various conceptual states and methodologies employed during these translation processes represented a primary source of value in the design process. A designer's professional value was based upon his/her knowledge of contractual and professional roles and responsibilities and his/her ability to incorporate this knowledge during the creation of design documents in accordance with a set of graphic standards[2]. The flow of information effectively went from the head to page via the hand, one drawing at a time. Prior to the widespread use of CAD systems the instrumentation used in the production of design documentation held relatively little commercial value. Once the use of CAD systems became viable in professional practice, the perception of the value of instrumentation changed, and value propositions in the design industry became more techno-centric. CAD systems have since replaced traditional hand-drawings as the standard format for the production of design information and documentation. However, the potential added-value of these systems promoted by developers and practitioners alike has changed very little[3].

The most recent development of CAD systems is organized around a conceptual framework that is meant to provide a comprehensive digital simulation of the physical and functional elements of the built environment. Arguably any digital representation which makes reference to these criteria is generically referred to as a Building Information Model (BIM). Such systems are meant to function as digital repositories into which geometric, financial, scheduling, analysis, and other types of project-relevant information can be fed, manipulated, and regurgitated. These systems are also meant to act as managers of these digital repositories. The flow of information is now meant to go from head to BIM, and from BIM to everything, acting as what Dennis Shelden referred to as a, “catalytic force…for directly repurposing information through various stages of project definition and execution…”[4] The general goal is to integrate the various sets of information produced by project teams and reduce the amount of time spent reproducing those sets information at each moment of exchange between team members or at each phase of a design project. Many of the impediments to this goal are assumed to stem from the incompatibility of data formats created by the various proprietary CAD systems used by the designers, consultants, fabricators, and contractors that comprise project teams.

A series of informal, empirical experiments in the communication of design information were conducted to explore the intermediary processes that effect the translation of information between conceptual states. I propose that an understanding of why a particular method of translation was selected is an important next step in reassessing the value of design. Following in section two, I describe the basis of the experiment and how it was carried out. In section three I present the results of the experiments. I conclude in section four with speculations on the results, and opportunities for future work.

## 2. Experiment

To explore how people involved in a design process understood design information, I created an exercise aimed at testing the efficacy of communicating geometric information as a procedural logic in the form of a natural language algorithm. The experiment is composed of two parts and involves two separate groups of participants. Each group only participates in one part of the experiment. Each individual in the first group is given a hard-copy document containing a three-dimensional geometric figure along with several orthographic projections of that figure (see Figure 1). The individuals in the first group are instructed to create a written procedure in natural language (an algorithm) from which the given figure can be derived. These procedures are then distributed to the second group who have not seen the initial shape. Assuming an equal number of participants in both groups, each participant in the second group is given a procedure created by someone in the first group. Each participant in the second group is asked to derive a shape based on the procedure he/she is given, following the procedure explicitly. Participants in the second group are asked to note any assumptions they feel they must make in order to complete the derivation as a result of what they perceive to be insufficient information. Participants in the first group are instructed that they may assume CAD software may be used in the derivation of their procedure, but that the use of such software by the second group is not required.

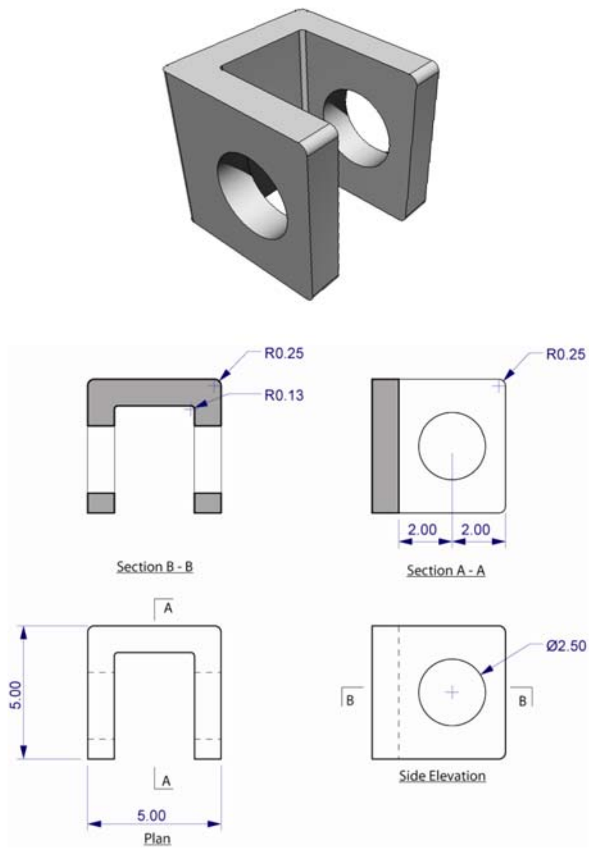


*Figure 1: Geometric used in experiments.*

The experiment was initially conducted in March 2008 with a group composed of graduate students in the Architecture Department at MIT, information technology (IT) staff in the Architecture Department at MIT, and a few practicing architects from various firms in the U.S. A second experiment was conducted in November 2008 with professionals at Front Inc., a design consulting firm in NYC specializing in façade systems. The participants in the second experiment included architects, engineers, and IT professionals within the firm. A third round of the experiment was conducted in March 2009 with graduate and undergraduate students in the Architecture Department at Cornell University. The methodology of conducting these experiments was organic and informal. No claim is made that rigorous, scientific conclusions can or should be drawn from the results. However, the results are provocative enough to provide sufficient grounds for speculation and further investigation.

### 3. Results

The initial experiment at MIT involved six participants in the first group and nine participants in the second group. Not all of the procedures from the first group have matching derivations due to a lack of participation by members of the second group. The six completed procedures ranged in length from 125 words to 1047 words, with an average of 366.5 words and a standard deviation of 339 words. Discounting the minimum and maximum the average was 257 words with a standard deviation of 46. Five of the nine derivations were completed by graduate students and four by practicing architects. The derivations completed by graduate students were all done using 3d CAD software, specifically AutoCAD and Rhinoceros. Of those completed by professionals, two were drawn by hand, and one was a 2d AutoCAD drawing of a 3d projection, and one was a 3d AutoCAD model. Based on a visual inspection, three of the student derivations were somewhat similar in appearance to the original geometry, and two were dissimilar. All four of the professionals' derivations were very similar to the original geometry (see Figure 2).

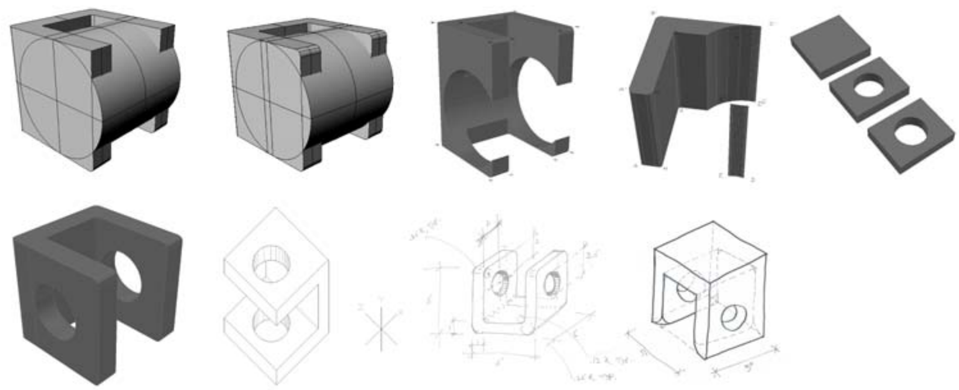

*Figure 2: Derivations from MIT experiments (Top row: derivations by students; Bottom row: derivations by practicing professionals).*

The experiment conducted at Front, Inc. resulted in seven procedures and seven derivations. However, as with the previous experiment, since all those solicited for the experiment did not return derivations, not all procedures were carried out. The completed procedures ranged in length from 137 words to 452 words. The average length was 237 words with a standard deviation of 114 words. Discounting the minimum and maximum length procedures the average was 214 words with a standard deviation of 70 words. Seven of the derivations were completed with CAD software, six in 3d and one in 2d. The software used included AutoCAD, Rhinoceros, SolidWorks, and CATIA. Based on a visual inspection, five of the derivations were very similar to the original geometry, one was similar, and one was somewhat similar (see Figure 3).

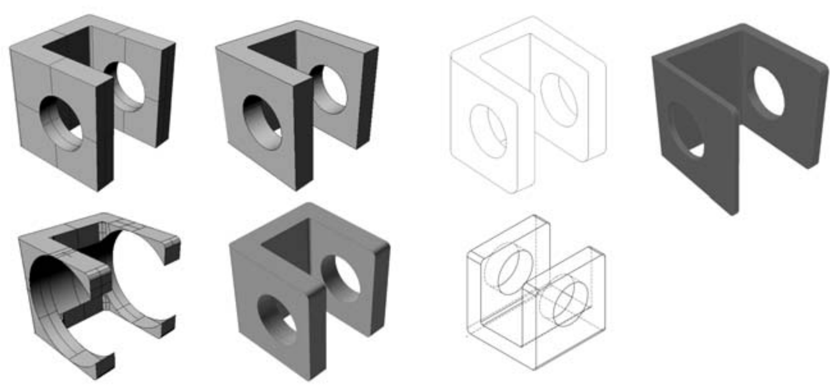

*Figure 3: Derivations from experiment at Front, Inc.*

The experiment at Cornell was conducted slightly differently from those previous. Because the experiment was conducted as part of an assignment for a design theory seminar, it was necessary to have all students participate in both parts of the experiment. To accommodate this a second shape was created for use in the experiment (see Figure 4). The students were divided into two groups; one with six members, the other with five. Each group was given a different shape from which to write a set of procedures. The groups then swapped procedures and carried out the derivations. Again, because the groups were unequal, not all the procedures from the six member group were derived, and one procedure from the five member group was derived twice. The length of the procedures ranged from 203 words to 1454 words. The average length was 480 words with a standard deviation of 365 words. Discounting the longest and shortest procedures, the average length was 403 words with a standard deviation of 177 words. Nine of the derivations were drawn by hand and two were completed with Rhinoceros CAD software. Based on a visual inspection four derivations were very similar to the original shape, two were similar, one was somewhat similar, and four were dissimilar.

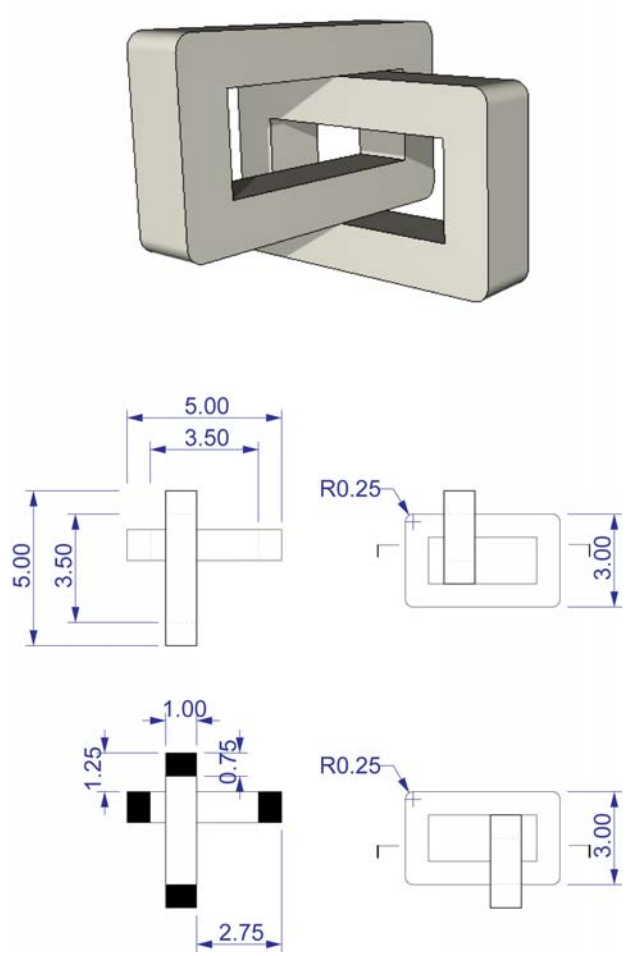


*Figure 4: Alternate geometry used at Cornell University.*

## 4. Conclusion and Future Work

Traditionally the successful materialization of design concepts did not necessitate or rely on a direct link between the processes of designing and the processes of making. However, success did rely on establishing an effective means of communicating between these two processes. The process of design and the process of construction were related by a third process of translation. The intent of these experiments was to explore this process of translation. As suggested by the results, the process of translation in design is fraught with assumptions, interpretations, and ambiguity.

The first part of this experiment required participants to deconstruct the geometry into constituent elements. These elements were not predetermined and therefore reveal how each participant *deconstructed* the shape into a set of constituent *parts* based on the goal of *communicating* the assembly of these elements into a comprehensive *whole* through a set of written instructions. The results of this phase of the experiment suggest that for a given geometric shape there are indefinitely many descriptions. In addition, without a more specific context for the work, other than the general communication of geometric information, it is difficult to assess the value of the various descriptions. The context of the work is imperative to understanding the appropriateness, or relative usefulness of one description versus another. This suggests that attempting to evaluate specific methodologies outside of the context in which they were implemented can prove misleading.

The second part of the experiment required a separate group of participants to *interpret* those instructions and *construct* a geometric shape through a series of discrete steps, without knowing what it was they were generating, or whether or not the resultant shape was correct. The results of this phase suggest that any form of communication which requires interpretation is necessarily fraught with ambiguity. Similar arguments have been proposed by Reddy[5] and Goodman[6]. Further, that lacking any means of validation via some feedback mechanism, it is impossible to determine the acceptability of the results. These exercises highlight the dynamic relationship between process (the creation of a procedural specification) and product (the derivation) in the communication of design information. In general, the majority of the derivations were graphically similar. Each specification however was unique. I believe this explicit juxtaposition of a similar product from a set of dissimilar processes is the most interesting and important result of these exercises.

CAD systems have since replaced traditional hand-drawings as the standard format for the production of design information and documentation. The traditional flow of information from the head of the designer to the page via the hand has been re-routed through the keyboard and mouse. Where the value of design instrumentation once represented relatively little commercial value, CAD systems and the data constructs they promise to deliver have become a market necessity for contemporary design firms. However, the potential added-value of these systems promoted by developers and practitioners alike has changed very little[7]. It is the conceit of the design industry to believe that technology can create value on its own. As the results of these experiments suggest, the means of achieving certain ends is not simply technical, but perceptual. Design intent is made evident by understanding not only how a particular goal reached, but why one particular path out of many was chosen to get there. It is the incorporation of this information as a key aspect of design documentation which I believe presents an important next step in reassessing the value of design.

[1] It is important to acknowledge that design work is often the result of a group of designers working together within a design team. The term ‘designer’ will be used throughout this paper to refer to both a single individual and teams of individuals.

[2] see Ramsey, Charles George, and John Ray Hoke Jr. *Architectural Graphic Standards, Tenth Edition*. 10th ed. Wiley, 2000.

[3] In 1975, Vladimir Bazjanac noted one of the widely held beliefs about the advent of CAD systems was that, “Computer applications will ‘free’ the designer from distracting and unproductive activities and allow him to devote more time to design.” Bazjanac V. “The Promises and Disappointments of Computer-Aided Design”, in *Reflections on Computer Aids to Design and Architecture,* Negroponte N. (ed.) New York:Petrocelli, 1975, p.18. Thirty-two years later in 2007 a textbook on Revit Architecture, a newly released BIM software, the authors, who were also involved with the development of the software, stated, “…the intent of BIM is to let the software take responsibility for redundant interactions and calculations, providing you, the designer, with more time to design…” Krygiel E., Demchak G., Dzambazova T. *Introducing Revit Architecture 2008*, Sybex, 2007, p.7

[4] see Shelden D. “Tectonics, Economics, and the Reconfiguration of Practice: The Case for Process Change by Digital Means”, in *Architectural Design*, vol. 76, issue 4, 2006, p.83

[5] Reddy, M. “The conduit metaphor: A case of frame conflict in our language about language.” in *Metaphor and Thought*. 2nd Edition, Ortony, A. (ed.), Cambridge University Press, 1993.

[6] Goodman, N. *Languages of Art*. 2nd ed. Hackett Publishing Company, 1976.

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