Relinquishing a bit of control: questions about the computer's role in geodesign

David Tulloch
Associate Professor
Rutgers University
dtulloch@crssa.rutgers.edu

What does drawing mean to the designer?

Writing in a *New York Times* guest column, architect Michael Graves (2012) stated that "Drawings are not just end products: they are part of the thought process of architectural design. Drawings express the interaction of our minds, eyes and hands." That interaction between the minds and hands is an expression of a commonly held belief in design that the act of drawing is a unique creative central to the process of design.

Since some of the earliest applications of computers in architecture and landscape architecture, designers have fretted over ceding creative control to machines. This creative role for the designer is treated as sacred, independent of the outcomes. Frequently cited as a concern is the loss of sensuous lines drawn expressively with a soft pencil or even, as landscape architect Laurie Olin offers, with a stick (Olin, 2013). Others suggest that the act of drawing activates cognition through the active linkages that Graves described. The act of drawing a design is also linked with the identity of the profession. Acknowledging that linkage, Scheer (2014:6) writes, "The craft of drawing has traditionally been the hallmark of the architect. Involving as it does the mind, the eye, and the hand, it builds understanding of the object on several levels." When Scheer calls drawing a hallmark, he is recognizing a traditional notion that the act of design is often intimately linked with drawing.

Despite both sentimental value and serious arguments for better creative outcomes, technologies like CAD, digital graphics packages, and digital 3-d information and modeling programs have necessitated themselves in the practice of many design professions. Their emergence is fundamental to the conversations driving geodesign and their use creates new opportunities for innovation in geodesign. And these innovations are resulting in new design approaches and techniques that raise fundamental questions about the essential nature of the designer.

Some of the most dramatic examples of technological impact in design are those where the designer cedes a significant degree of control of the design process – decision-making or form-generation – to the computer applications. In architecture, a substantial effort was invested in the development of techniques and software to support computer-mediated design in the form of parametric design. These are applications in which the computer is given a series of parameters or rules which it applies to generate a physical form. While it was explored for theoretical purposes and the creation of large quantities of alternatives, it was popularized by its integration into highly visible practices like those of Frank Gehry and Herzog & de Meuron.

The creative act in geodesign

In 1968, an architecture student at Harvard, Eric Teicholz, worked with landscape architecture professor Carl Steinitz to develop GRASP which used a systems-based approach to position buildings within a designated site (Ahlquist and Manges 2011). Notably, this package considered multiple conditions, including solar orientation, while generating an optimized solution. For geodesign, which is often concerned with complex site conditions, the consideration of multiple criteria is a substantial element. It was no coincidence that Teicholz's work was being conducted in the same environment where SYMAP was permitting users to overlay information about multiple conditions. For the field of geodesign, computer-mediated design is not simply a way to generate artistic alternatives or efficient solutions, it has the potential to link information about the landscape or design context with design outcomes producing site-sensitive solutions.

Across decades, planners and landscape architects have struggled with the need to integrate data or information about dozens of social and physical factors to guide their decisions. A 1967 study (Belknap and Furtado) endeavored to compare 3 remarkably different approaches for dealing with this potential information overload. In 1969, Ian McHarg (a featured designer in that 1967 study) published his wildly popular *Design with Nature* (1971) which helped popularize overlay techniques as a means for integrating interdisciplinary inputs. But the overlay techniques were documented to have much deeper roots in the traditions of planning and design dating back decades earlier (Steinitz, Parker and Jordan 1976).

One reason that overlays were so important to advance information-laden regional approaches is that they simultaneously presented to the designer a synthesis of more factors to consider in a design than the human brain is capable of processing at one time. Historically, the basis of this limitation has been linked with Miller's Law (Miller 1957). Miller showed that because of limitations in our short term memory, the average human can only hold 7 ± 2 objects or ideas in their working memory at a time. Treating the data layers frequently used design analyses, Miller's "magical number" of 7 describes a human limitation that demonstrates the finite amount of information a skilled landscape architect might be able to apply in one decision without overlays or computer aided analyses. Within the context of geodesign, Miller's Law stands as a barrier that computers permit designers to effectively ignore.

To be fair, it takes more than computers to turn this enormous amount of information into usable guidance for decisions or generation of forms in the landscape. One of the important theories that has been used to support design work in this area is multiple criteria decision modelling (MCDM) or multi-criteria analysis (MCA) (Saaty 1990; Voogd 1983; Nijkamp, Rietveld, Voogd 1990). The most common application of MCDM in geodesign is for suitability analysis, which involves the combination of data about different factors to create a composite index measuring the relative suitability of different sites for a specific use.

Analysis as design

On the surface, suitability analysis may not appear to be a form of computer-mediated design. However, it is essentially a rules-based process that makes informed decisions (albeit, only as informed as the data). Granted, some examples do not appear to be particularly spatial. An often used textbook example to introduce the topic is in Steiner's *The Living Landscape* (2008). It compares only six parcels of land (which fits Miller's Law), but GIS is commonly used for suitability analysis that compares thousands of vector parcels or hundreds of thousands of raster pixels. Sometimes the result is a singular choice of the best individual site but often the result is a data surface of reflecting a wide range of values modelling suitability. For the designer, the analysis surface can be either a general guide

interpreted loosely or it can be the source of forms for the final design. But it does represent an important step towards clear computer-mediated design across a landscape.

For a clearer example of landscape forms generated by analysis, consider the design of a hiking trail using least-cost path (LCP) analysis to identify appropriate routes across the landscape. Aside from a beginning and end point, least-cost path analysis requires the user to provide a surface that represent a relative cost for each pixel. For a hiker, higher costs may be dangerously steep terrain and unsightly stretches near development, while lower costs might represent areas with particular good views or existing trails that could be reused.

Some readers will ask whether a process that is strictly analytical is a design process. Where in this process, they might ask, is there a creative decision? At what point in the process has the designer inserted themselves – their experiences, their knowledge, perhaps even their personality – into influencing the design outcomes? In this example, the designer's creative contribution comes largely in the process of framing the question and establishing the priorities within the process. A simple decision to include or exclude north facing slopes, which can ice over and limit hiking at marginal times, might change the proposed shape of the trail dramatically. More subtly, including a layer representing north facing slopes that weights that cost slightly more or less than the cost of hiking close to existing development could lead to an interesting compromise.

Another opportunity for creativity on the part of the designer is treating the analysis as an iterative process. After crafting an algorithm that represents many of the designer's intentions, the designer will need to carefully review the least-cost path to see if the algorithm has achieved a satisfactory outcome. After careful inspection of the proposed trail (perhaps even groundtruthing it), a skilled geodesigner might correct a flaw in the data or artfully adjust the weights of several criteria to see if a trail design can result that satisfies his/her expectations. Adeptly manipulating the process, even with dozens of iterations, is noticeably similar to the traditional use of many sheets of trace paper to develop a form or space that is both functional and beautiful.

Another approach that positions the creative decisions differently is the use of multiple LCP solutions as a series of alternatives from which to choose or learn. During the data development and algorithmic design process, the designer may have found one criterion that to be particularly troublesome. The criterion could be assigned a low, intermediate and high weight for three different LCP analyses. With three different paths generated, the designer can do more than simply choose a best solution. The three paths can be considered together as a set. If the change in weighting produces three paths that are relatively similar, the design decision is quite different than if it produces two similar paths and one quite different.

Taking this idea one step further, two or three of the criteria could be treated as parameters with variable weighting. Running the LCP analysis with five different weights for three different parameters would produce a series of 125 path solutions. Taken together, the collective results could inform the designer and improve the final intervention in ways that a single solution would not. In this scenario the designer can compare these many paths and look both for similarities as well as unusual exceptions. For the successful geodesigner, the traditional skill of reading the landscape is complimented with the newer skill interpreting the analyses patterns.

With the examples used here it would be fair to ask whether we are confusing analysis with design. Parametric designs and rule-based designs may still be substantially different than a

creatively generated design, sketched in pencil and detailed in ink. But if they satisfy the stated design problem, are they designs?

Computer-mediated design in geodesign

With these examples in mind, it seems clear that a meaningful subset of what is generally discussed today as geodesign include some variation of computer-mediated design. Many of the examples available today fall into categories that are algorithmic or rules-based approaches, which are essentially optimization solutions to a constrained problem. Whoever decides those constraints or parameters will also be shaping the outcomes of the optimization or computer-mediated design solution. Will the creative shaping of the constraints or the creation of a unique algorithmic approach to those constraints become recognized as an act of design that is a regular part of the landscape architectural process? Stepping back a bit more, is the creative act really the shaping of what we describe as the design process?

Watching Frank Lloyd Wright sketch out ideas for a house was described by one of his apprentices as if he were “shaking houses out of his sleeve.” The ability to fluidly draw his mental 3-d idea as an elegant sketch on paper was central to the image of Wright’s innate architectural talents. Is it conceivable that exceptional geodesigners will be known for their deftness with algorithms and the ability to manipulate them to produce elegant solutions for spaces, experiences and structures?

While all of the design professions are being forced to confront their conceptions about the roles of computers in design, the spatial complexity and defensible decision processes needed for many geodesign projects makes this critical reconsideration of the computer all the more important for this emerging field. The questions it raises are many, but at its heart it leaves us asking: Can/will we learn to think differently about digital design? If not, what does it mean for the role of the computer as a design tool in geodesign’s future? If geodesign is a creative field, what are the creative acts in geodesign?

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