Design Agency, Robotic Design and Synthesis of Architectural Form

Registration Number

Abstract

This paper explores agency within the architectural design process. We propose that a robotic designer that utilizes artificial intelligence could convert architectural norms into appropriately designed forms, and (with some human intervention) simultaneously compare these to mores of cultural landscape, meaning, and theories of art and architecture. The sequence of architectural design tasks is explored with reference to the potential utility of a robotic architect. A design-morphing machine is proposed within a virtual augmented reality environment as a means of interactively investigating a mosaic of form possibilities. Robotic design provides a rich field of opportunities and options that blur current definitions of design agency.

1. Introduction: Form-finding through reflective decision-making

In this paper we explore the potential of robotic design in architecture, and specifically architectural design aided by artificial intelligence. To many architects this is unpalatable due to the proposition that robotic design is a direct assault on the widely held belief that design is an essentially mysterious artistic process (Jones, J. C. 1970). We however, identify a potential for robot architects to assist us through the experimental synthesis of a plethora of ideas and forms, and in so doing increase the quality of architectural outcomes.

There are many aspects to architectural design. Here we have focused discussion on form making a central aspect of the Architect’s craft. Can a robot design, and if so, by what process can we see this happening?

In terms of form-finding, architectural design involves a process of reflective decision-making that examines norms/codes which best allow the exigencies of a design brief to be developed into a set of particular forms (Jones, 1970). From the outset, the designer's understanding of the world in general, together with her knowledge of past architectural solutions, is brought to bear on the problem (Schon, 1984). In the first stage of design a mapping process occurs between dissimilar domains, made possible by abstract pre-structures, which allow the designer to move from the problem statement towards a general solution. In the second stage the designer maps between a general solution and a particular solution. Following a hypothetico-deductive process, the designer utilizes conjecture-and-test and trial-and-error procedures (Hillier and Leaman, 1974).
We suggest that a robot should be capable of generating appropriate form solutions from typological inputs; and with a significant artificial intelligence system, could be programmed with the requisite norms, for example, a hierarchy of local planning and design forms; vernacular libraries of planning; and a set of design rules derived for example from Vitruvius, Eckbo, Choay, and Alexander (Alexander, 1977; Choay, 1997; Eckbo, 1950; Vitruvius, trans. 1960). These normative rules and constraints must somehow be balanced by the primitive poetry of an ideal image of architecture – as Payne suggests “the world thought in the image of Vitruvian man”. The “…potential that resides in the architectural image, an anamorphic one in which the infrastructural support that imaginary and symbolic mechanisms lend to the ego’s construction of its “world-picture” … the imaginary object’s anamorphic potencies, … its capacity to give play to these potencies that architecture is thought … to enjoy a special proximity to the most primitive psychic motivations informing the work of art” (Payne, 2013). With the recent rise of AI computing power and robotic technologies at least some of these processes could be replicated within ‘the machine’, suggesting a future integration of design processes between robot and human.

2. Agency in a morphological design process

We envisage the robot architect’s machine reasoning as having the ability to create a vast number of form outcomes in real time. Output would be fluid with malleable ‘morphing’ forms controlled through an architectural mixing desk that increases or reduces weighting of elements/variables. Design agency within the process is analogous to that of a recording studio with the human architect being the ‘producer/engineer’, the robot as the ‘artist’ with contractor/interior designer as ‘DJ’s. The client may also be given greater agency if the design process is rendered more accessible than current approaches. Four kinds of process are described below:

A ‘community architecture’ process: In the production of civic buildings design agency could be wrested away from the architect using some kind of democratic process in which the community/users vote to set the ‘mix’.

A ‘modern’ process: Remarkably what we propose is not unlike existing design practice by which (apprentice) architects prepare constraint driven design options for the (the master) director who then clarifies the pattern, stamps their office style onto it and creates the final sublime ‘arrangement’. This is especially true in the case of ‘commodity’ buildings such as office buildings -‘conventional buildings’ that are a direct result of economic and practice decisions (Scott-Brown & Venturi, 1968).

A ‘post-modern’ process: In music, the arranger is greatly assisted by the fact that Jazz has a wealth of standards that can be manipulated into something recognizable yet fresh. A parallel can be located in architecture, by which a designer attempts to short cut the design process via reference to existing typological forms or patterns (Jorgensen, M.
1991), or to reuse a existing commodious product (Heath, 1984). As an example, the typological transformations by Ashton Raggatt McDougall that were developed using analogue transformative techniques in the 1990s, could in the future be developed utilizing robotic technologies that offer greater control over a larger array of design variables to produce more subtle, less obviously derivative, and potentially more satisfying outcomes (figures 1-3). Similarly, it is hard to imagine the extreme level of complexity that Eisenman might have brought to bear on the design problem if he had access to robotic morphing design technology at the time he produced houses I to X (Eisenman, P. 1987) (figure 4).

Figure 1. LHS: Mothers House, Venturi, 1964 ‘transformed’ into Howard Kronberg Medical Centre, Ashton Raggatt McDougall (ARM), 1993

Figure 2. Australian Institute of Aboriginal and Torres Strait Islander Studies , ARM , 2001

Figure 3. LHS: Storey Hall, 1995. (“The Green Brain”) Building 22 RMIT, 2011: ARM.
A deconstructive hyper-environmental design process: With the array of variables that could be blended and refined we predict the reemergence of total design with cultural critique (Wigley, 1998). Environmental and economic sustainability would also be core expectations applied within a robotic design process and its fully immersive critique. Rather than an eclectic pastiche or populist mediocrity, the objective would be architecture of highest quality such as the (experimental) work of Shigeru Ban (figure 5), or J. Meyer-H (figure 6).

3. The Robotic Architect

How are we to envisage a robotic architect and what role might they have in actual design situations? Archer describes a sequence of steps that are taken along the design process: Training; programming; data collection; analysis; synthesis; development; communication (Archer, 1964). Based on our own experience as practicing architects, one can elucidate a parallel, but slightly more pragmatic sequence of events. Consider a few of the basic tasks of a practicing (robotic) architect. These are listed in process order below:

1. Program and site survey: The client could describe the project program verbally to the robot - elements of the brief would need to be prioritized, and re-conveyed to the client. The subjectivity of the client and basic proximity theories of consciousness are assumed (Noe, 2009). The Robotic Architect would have some form of drone-based mobility. Its small ‘probes’, could quickly and effectively explore the environment, assessing a site in detail. It could GIS map and 3-D
model the site and surrounding context without human intervention.

2. Concept design - digital modeling and rendering: This would be an interactive process using a norm to form process as described above.

3. Presentation of the concept to the human architect (or client): We anticipate presentation within a virtual or augmented reality and interactive environment with in-built applications for design morphing. Here, a fully immersive environment in which the design team (or client) and are able to interrogate and morph the interior and exterior form. This sort of situation may allow for ‘tuning’ of the design with near instant re-configurations. Within the design dialogue between human and machine, there is opportunity for developing poetic and cultural critiques, and to find meaning in the patterns and elements of the design proposal. (XXXX, 1998).

4. Detailed design and documentation: With extensive programming of current city codes, building standards and regulations, we consider that the robotic design and ‘drafting’ (if required) of structural or construction systems would likely be of unparalleled quality. Professional indemnity insurers, registration boards, and city hall would likely insist on detailed design by robots to maintain cover, registration and obtain consent.

5. Construction (Design-Build) The Architect-Robot could connect itself to a ‘Construction-Bot’ in order to project-manage and construct the building itself. There are many possibilities - for example 3D printing technology like that used by the ‘man that printed houses’ (Webb & Wake-Walker, 2014).

Figure 6. Building a vision for 2030, J. Mayer-H Architects 2013

4. Conclusion

The possibility and inevitability of the Robotic Architect can be summed-up by Vanderbilt (paraphrased from an article on the robotic vehicle): "It can think [and design] faster than any mortal … [architect]. It can attend to more information, react more quickly to … [design problems], and keep track of more complicated … [design exigencies]. It never panics. It never gets angry. It never even blinks. In short, it is
better than a human in just about every way. (Vanderbilt, 2012)

Robotic Architecture will challenge traditional notions of design agency, and has the potential to create interesting design outcomes together with more satisfying and useful buildings. Anything is possible. “When I try to make the world the way I intend it to be, I succeed if the world comes to be the way I intend it to be … only if I make it be that way…” (Searle, 1984).

References
XXX 1998, The Cultural Landscape: Patterns and Elements: Meaning,
University Press.

Vanderbilt, T. 2012 "Let the Robot Drive", Wired, February 2012.

