

# Evolved Architectural Representation: From Orthographic Drawings to Corporal Mapping and Swarm Behaviour

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## Abstract

Traditionally architecture has employed a limited oeuvre of drawings and two-dimensional representations to communicate what a design is. Sketches have served as a means to share preliminary ideas. The development of a project then resorts to orthographic projections that include scaled versions of the plans, sections and elevations. Axonometric, isometric and perspective drawings are also commonly utilized. Computers were adopted by architects at the end of the twentieth century to aid in the creation of these drawings. The desktop computer is still predominantly used for computer aided drawing (computerization which is representational) and to improve efficiency. However, this posture undermines the use of computation (algorithmic processes that require the definition of variables and actions) which is laden with potential for much more powerful operations that may deduce fitness and effectiveness which help to achieve greater levels of performance. "Systematic, adaptive variation, continuous differentiation, and dynamic, parametric figuration concerns all design tasks from urbanism to the level of tectonic detail." (Schumacher, 2008) This shift towards computational design thinking is occurring and requires designers to shift the focus of design operations towards iterative processes. Furthermore, morphogenetic design processes, inspired by Goethe's work on natural morphology, mark a turn from the predetermined end-product of form towards formation. On one level biology has inspired designers towards an evolutionary paradigm that seeks emergence order from chaos. (Frazer 1995, Holland 2000) At another level, design inspired by nature and biomimetic practices have led to a questioning of the degree to which an architect can engage with living matter. This paper highlights some of this development in relation to science (biology) and visualization. The text is illustrated with the work of the author and his students.

## Keywords

Anthropocentric Design, Motion Capture, Computational Design Thinking, Morphogenesis, Architecture

## Introduction

A building is understood as the aggregation of inert matter to form shelter for human inhabitation. The practice of architecture can be described as a painstaking labor that articulates the formation of earth, dust, sticks, metal and glass. The odd reality is that the architectural design process is an estrangement from the tangible and physical materials themselves. "Architects do not make buildings; they make drawings of buildings." (Evans, 1989, p. 369) The use of scaled drawings and models has been the vehicle to mediate the *virtual* and the *actual*; to bridge thought and ideas with the physical construction. Traditionally orthographic projections have enabled the architect to communicate the geometrical properties of the form. Computer Aided Design software has continued to function within the paradigm established by Jean-Nicolas-Louis Durand in *Précis des leçons d'architecture données à l'École royale polytechnique* which was written over two hundred years ago. However, the matured use of computation is starting to demonstrate the potential to disrupt architectural practice in interesting ways. A fundamental shift is occurring that questions authorship and design as a linear process; computational design thinking coupled with greater access to computational processing power and sophisticated digital design, visualization and fabrication tools enables a complex interplay of human and non-human actors. (Ahlquist and Menges, 2011) This introduction takes a step back to the Renaissance to bring the issues of authorship and of nature to the surface: The scope of this paper is limited to a description of architectural design and an identification of some of the fissures that new (non-traditional) forms of visualization are affording the discipline.



Figure 1. This series of images includes (from left to right) the Vitruvian Man by Leonardo DaVinci(top left), the Modular by Le Corbusier(bottom left), photograph of my student in the motion capture facility (middle) and our version of the point cloud spherical envelope surrounding the body(right).

### An Evolving Sense of Disegno

The etymological seed (Latin) of the Italian *disegnare* signifies “designation” which alludes to an ownership of marks that embody thought and have meaning. Key figures of the Renaissance employed drafting, drawing and the geometry of the perspective as the means for the intellect to be transmitted. In Giorgio Vasari’s introduction to *Lives of the Artists* (2<sup>nd</sup> edition of *Vite*, 1568 translated by Quek, 2007, p.47), he posited “we recognize a certain notion of the mind, and this we refer to as *disegno*... that is not other than a visible expression and a revelation of our inner conception, or that which others have imagined and given form to in their idea.” This simple notion that design is substantiated through a visible form of expression persists. For the sake of the discussion of this excerpt, distinguishing between pencils, pens and paper of the analog world and screens, VR and/or AR of the digital realm is not necessary; each tool serves as an interface to make, designate and communicate. However, there is another notion worth examining further which is that of input.

In the writings of Vasari, Alberti, DaVinci and Dürer, there was a displacement of the notions of divine intervention. Where Greek mythology had described the role of daemons which were vessels sending messages from sky to earth, Vasari credits the Divine Architect of Time but negates any mediator. The sculpting of formless clay matter into man became the ideal example to employ as he described the pursuit of artists on their quest to achieve godliness. On one hand, Vasari places high value on the ability to give form to the formless. On the other, the human object gains traction as an ideal form itself; not only as a form to sculpt, but the

human body has served as the central source to measure all. For example, the imperial system uses the foot as its primary unit of measurement. The inch is derived from the width of the thumb, which is explicitly noted in languages such as Spanish that use “pulgár” for thumb and “pulgado” for inch. In architecture, the dimensions of the Vitruvian Man drawn by DaVinci serve as the geometric corporal model at the center of it all (metaphorically and literally). There are multiple limitations that exist with this type of anthropocentric framing and modulation. Within the field of architecture, several problems were addressed. The first of which is the lack of accountability for variations in size and shape of humans. The second issue aims to address movement. While DaVinci’s diagram suggests a range of movement, the image is static. We asked ourselves how this work could be recast in productive ways.

This led us to analyze a variety of other graphic standards used in furniture design and in architecture. Some, such as Neuferts, acknowledged a range of dimensions, yet not to a satisfactory level. Other diagrams accompany interior typologies, yet privilege moments. For example, in the kitchen the sink of a kitchen is shown in plan and section. The plan includes a human figure and illustrates that there is a radius of motion from a central point (feet) and the section shows where outstretched arms reach. As a guide, this may suffice. However, we sought to critically examine what other possibilities may exist. At this point we were granted access to SENA Tecnoparque’s Motion Capture Laboratory. We created large scale mock-ups to give a sense of scale and enlisted various students to engage in role play. Each participant acted out his/her day. The data gathered was imported into Motionbuilder and point clouds (Figure 1) were developed. Though not practical, this crude experiment clearly demonstrated a similar, yet wide variety of human movement to the same tasks. Another important finding was the gestures and movements at interstitial spaces of the acting. For example, the space needed to get out of bed, stretch and move towards closet. Our preliminary literature review had encountered data includes size of objects and guides for buffers between objects, yet this level of documentation that we undertook superseded the existing information available.

## Panels



Figure 2. This series of images includes the prototype subtraction model being inhabited.

Participants garnered a mouse and navigated around the “residue” of their actions. An important observation is that our findings were legible when viewing the point cloud in 3d space: One was able to infer what combination of activities had occurred. This is one example that confronts the traditional use of representational devices. As a final exercise, the human body was metaphorically and literally removed from the box. A subtraction procedure was realized to view the negative space of this movement in a 1:1 scaled model (Figure 2). Though the aim is not to propose this as a design strategy, one is able to see an abstraction of authorship.

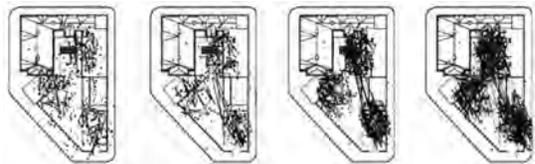


Figure 3. First attempt of author to use flocking simulation for pedestrian flows at a cultural institution – Moma’s site PS1.



Figure 4. This series of images shows how foot traffic was studied at an urban scale. These simulations impacted the design of the park as flow was used to help articulate ramps and terraces.

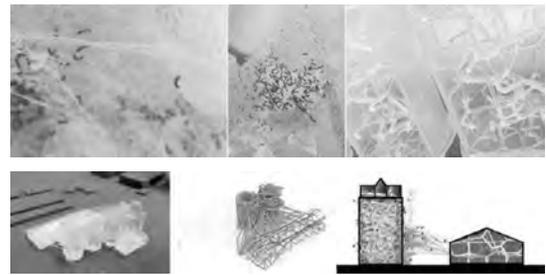
### Nature is the Baseline

The use of “Nature” in architecture has existed ever since there was a notion of built environment. Think

no further than Greek temples to see the creation of ornament and proportions that mimic nature. The storied evolution of the column includes anthropomorphic descriptions of Doric, Ionic and Corinthian typologies. The last of which is recognized for the fact that it is ornately adorned with the Acanthus leaf. Though the use of nature for representational and symbolic purposes continues, it is relatively recently that architects have begun to mine the biological realm for something more.

The baseline for excellence was found in Nature. “Disegno, father of our three arts of architecture, sculpture, and painting that proceed from the intellect derives from many things a universal judgment of form or idea of all things in nature, and is unique in its measurements.” (ibid)

I am convinced that anyone who will discreetly ponder this matter will agree with me, as I said above, that the origin of these arts was Nature herself, that the inspiration or model was the beautiful fabric of the world...



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### Author Biography

Aaron Brakke is an Assistant Professor of Architecture at the University of Illinois Urbana Champaign and a licensed architect in Colombia. He holds undergraduate degrees in environmental design and in architecture and a post-professional Master of Architecture from Ball State University. He participated in the Ecosa Institute's Regenerative Design Program at Arcosanti. He has worked with Joseph Giovannini and at Archi-tectonics (Winka Dubbeldam) in New York.

Brakke spent a decade in the city of Bogotá, Colombia where he founded Whiteknee and was a Professor of Architecture at the Universidad Piloto de Colombia. At this institution, he founded and directed the Center of Innovation which blends digital fabrication machinery with tools for Simulation and Visualization (VR and Augmented Reality). His primary research interest is situated in understanding how the evolution of technology has impacted the construction practices and the vernacular epistemology of indigenous communities located in the Andes mountain range.