

# Plato's Columns: Platonic Geometries vs. Vague Gestures in Robotic Construction

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### ABSTRACT

*Platonem ferunt didicisse Pythagorea omnia.*  
—Cicero

This paper examines the inherent possibilities for architectural production in automated deposition modeling techniques, primarily explored through the use of industrial robots in combination with plastic deposition heads. These robots, in combination with various polymers, toolpaths and colorations, served as a design ecology for the exploration of emergent behaviors in robotic construction. The relationship between geometry (Euclidian, topological, fractal), mechanical properties of material (plasticity, elasticity, viscosity, resilience), optical properties (color, absorbance, transmittance, scattering), and the gestural qualities of robotic toolpaths constitute the palette adopted for the presented project. The project combines the rigor of a platonic body (fig. 2) with the emergent properties of vague gestures. The introduction of moments of uncertainty in the process produces glitches that are embraced as an

opportunity to find novel aesthetic conditions. The profound entanglement with the post-digital realm is discussed as the discursive plane of thinking applied to the project.

### INTRODUCTION: AN EXCURSION INTO POST-DIGITAL THINKING

When discussing the emergent properties of automated processes, it is essential to touch on the topic of post-human and post-digital conditions. Post-human does not entail a condition after the dominance of the human species or without humans, but rather emphasizes an alternative perspective on design that shifts the focus away from an anthropocentric position of observation and control. Post-human design practices decentralize the role of human judgement and embrace the notion that creative agencies can be conferred to nonhuman entities such as objects, tools, materials, other species (organic or machinic), and environmental forces. Externalized knowledge begins to take identity and instrumentality, and participates in the process of generating novel design ecologies and alternative design agencies for architecture at large (Velikov et al. 2016).

Figure 1: Hirsute Column, interior view.

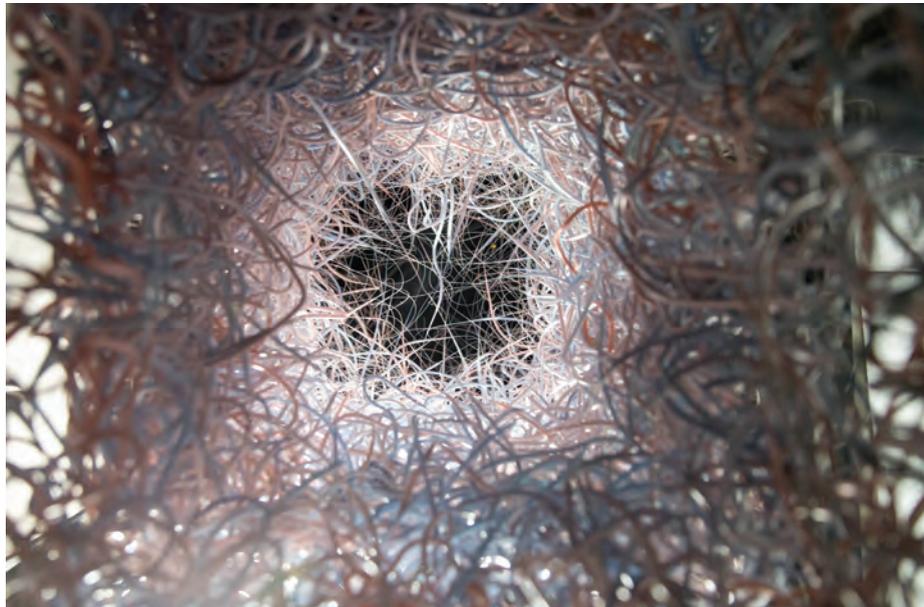
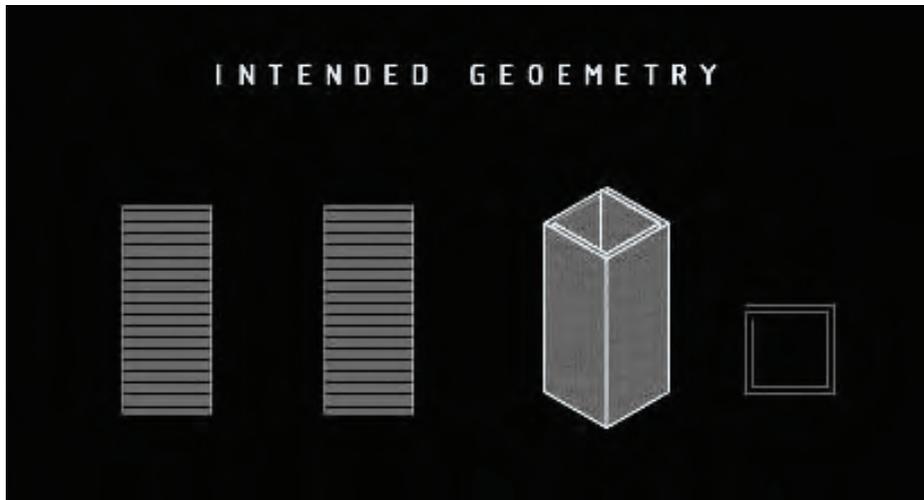


Figure 2: Extruded square as initial definition.



The term "post-digital" emerged in digital arts discourse around the year 2000 and was coined by the musician Kim Cascone, specifically in regards to using glitches in digital technology as a source of inspiration. Cascone, an electronic music composer by trade, used the term for the first time in his article "The Aesthetics of Failure: 'Post-digital' Tendencies in Contemporary Computer Music." In this article, Cascone observes that as digital technologies have become part of the mainstream world and are deeply entangled in everything from commerce to "Hollywood cranking out digital fluff by the gigabyte" (Cascone 2000), the initial fascination with digital tools per se has evaporated. This has created a space for novel developments that do not utilize technological terms to describe the work, but rather interrogate the errors and mishaps (fig. 3) in the

process as potential sources of inspiration (del Campo and Manning 2014).

In this light, the term inherently approaches the explosive evolution of digital technologies in the arts and how it mutates the relationship to the human condition. It explores the notion in creative disciplines where computational tools have become standard practice, and the emergence of novel insights do not rely on the tool as a mode of explanation. This is a tendency that can also be observed in the architectural discipline, where the notion of explaining a project (of any kind) by highlighting the applied toolset is observed with an increased amount of suspicion—a suspicion that, in the best case, produces novel lenses of observation for architectural problems. On closer examination of the paradigm of consensus, there is a selection to be made: Either there is intrinsic

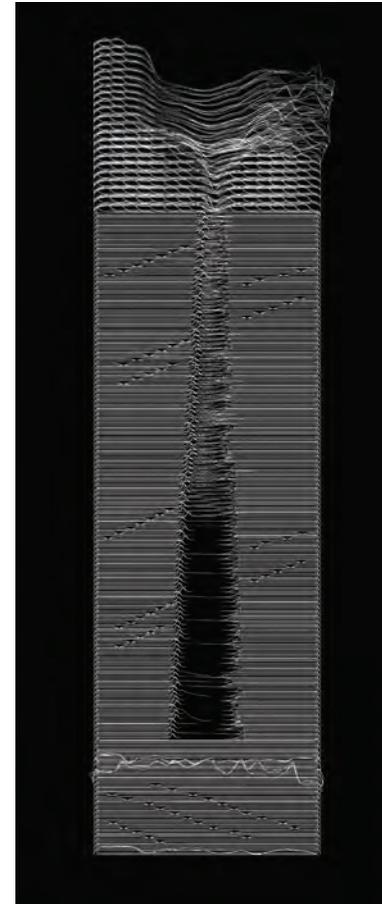


Figure 3: Mapping of the deposition result post facto.

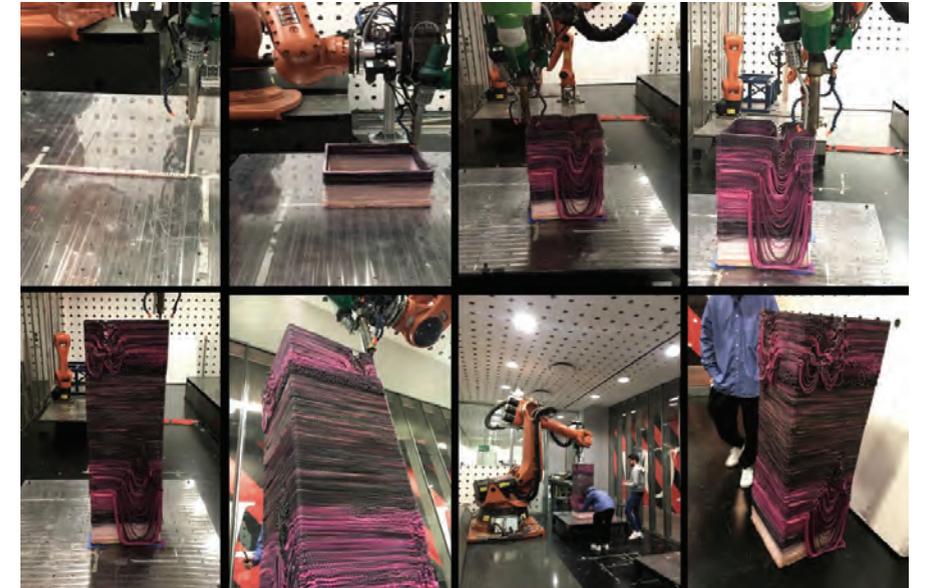


Figure 4: Image sequence displaying the fabrication process.

meaning in a post-digital society, or it is swallowed into a contextualized paradigm of consensus that includes art and architecture as a totality. It is probably best summarized in Roy Ascott's (2003) averment that the discernment separating the digital from the post-digital is part of the economy of reality. In this sense, it does not represent a disruptive moment of cultural change, but rather demonstrates a continuous slow transition from one state to the other, or in Heideggerian terms, from Ereignis to Sein (Heidegger 2003).

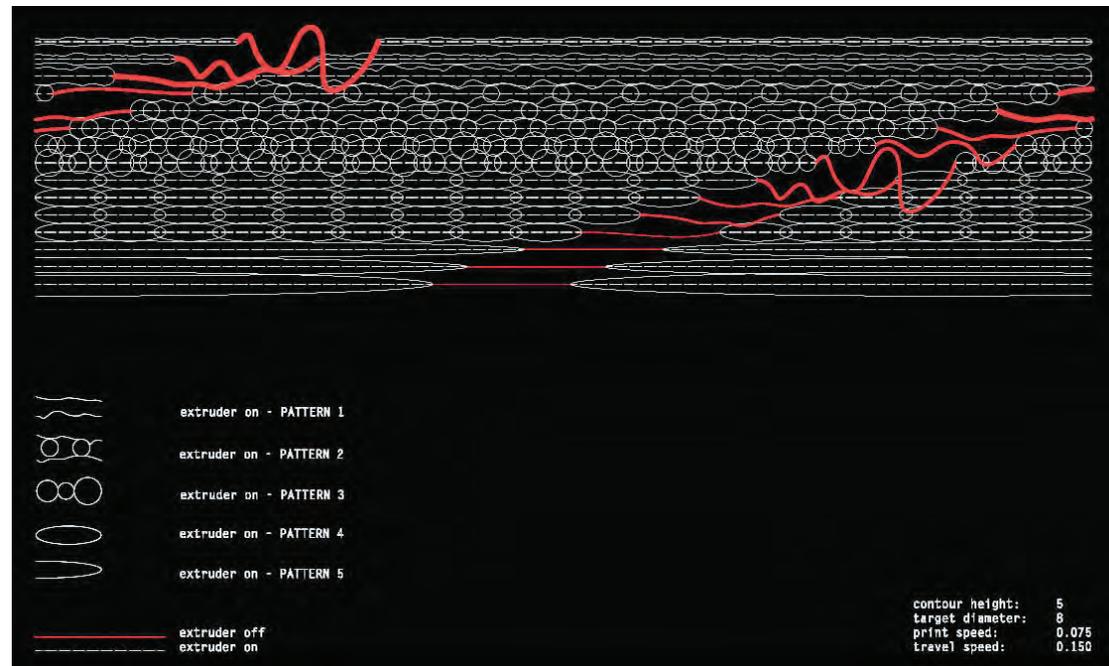
In terms of architectural discourse, the ballistic trajectories of conversation can be put in perspective by Mario Carpo's (2012) book *The Digital Turn in Architecture*, which serves as an excellent marker to define the time frame of the digital and post-digital lineages in architecture. Carpo's book defines the period of the digital turn as occurring from 1992 to 2012. The time after 2012 marks a shift in the architectural conversation with the emergence of alternative theoretical constructions, such as object-oriented ontologies, speculative realism, and an elevated interest in aspects of phenomenology. These tendencies most certainly frame a paradigmatic shift in architectural discourse from the computational, seamless, and continuous narratives of Deleuzian thinking to a

critical interrogation of the toolsets developed in the process. As to the definition of the term "paradigm," Giorgio Agamben (2002) might be helpful here with his description of a paradigm as something that we think with, rather than a condition, thing, or object that we think about. To this end, the post-digital can be described as a paradigm, comparable, for example, to post-humanism, which does not describe a universe after the digital, but rather characterizes the contemporary attempt to examine the consequences of the digital age. In other words, the emanations of the human enhancement achieved with computational tools—the ramifications of the globe-spanning prosthetics that are achieved by the application of software—all of which present themselves as exquisite specimens for speculative interrogation and theoretical inquiry.

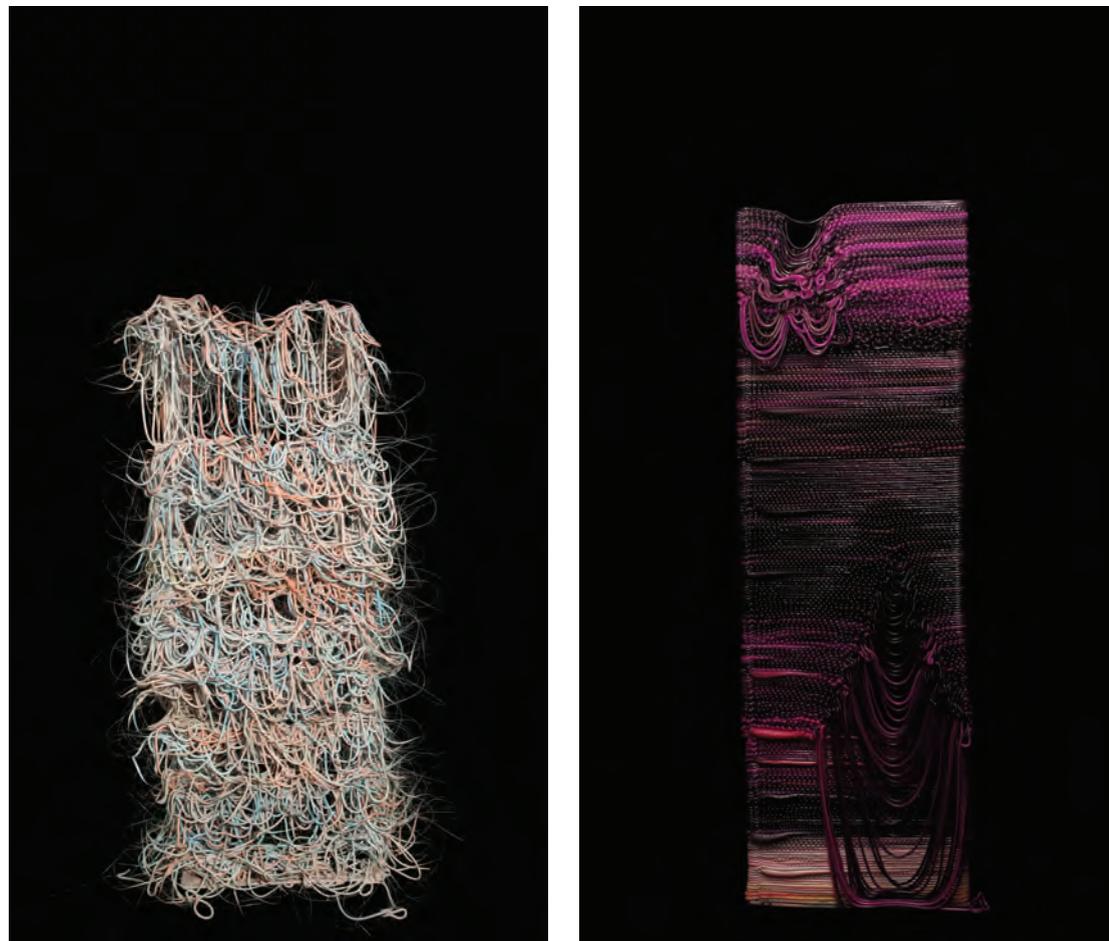
#### CELEBRATING THE GLITCH

In the project *Plato's Columns*, the notion of the glitch is celebrated within the framework of a rigid robotic setup. On one side, the G-code of the toolpath that fluctuates within the precise figuration of a rigorous geometry; on the other, the programmatic sequence of varying speeds, and the immediate response of material

Figure 5: Analysis of the deposition result post facto to refine the G-code.



Figures 6: Designing the G-code resulted in varying articulation qualities.



properties. The combination of the inherent precision of the robotic setup and the vague deposition created by the infusion of varying speeds, as well as fluctuations in the material's response to the laws of thermodynamics and gravitational forces, results in glitches in the morphogenetic process (figs. 4 and 5). The initial figuration in the form of an extruded square is intentionally chosen to demonstrate how a distinct and precise form can achieve intricacy through variations in the material's response, as well as by mixing colorations in the pellet chamber of the deposition head. One of the more telling moments at the very beginning of this research was when students suddenly stopped the deposition process every time an error started to emerge. It was difficult for them to grasp that this was precisely what the studio was looking for: not the prevailing tendency for the perfect replication of a computational model, but rather a dialogue between computational information and physical properties, which results in forms informed as much as by binary code as by environmental forces.

The moment students got the task to just keep going, interesting things started to happen. First and foremost, a self-healing quality of the deposition process emerged.

Errors that presented themselves as holes in the platonic figure started to incrementally close again. This behavior allowed for the introduction of an alternative method for creating apertures in platonic geometries. These were neither violently inserted into the body nor elegantly inserted in accordance with the underlying geometry in a topological fashion. Instead, they emerged through a procedural approach to material deposition akin to the emergence of holes in leaves of plants, which occur due to the lack of nutrients in specific areas. Students were then encouraged to develop strategies that involved designing deposition paths that implemented variation in the deposition speed. A regular deposition speed will always result in an identical deposition thickness for the utilized polymers. A variation in speed yields results that range from bulbous, pearly chains to ultrathin, fibrous sections of paths. In an analogy to painterly techniques, the interplay of both can be read as a crossbreed between impasto, thick and expressive strokes, and the finesse of delicate glaze painting. In contrast to the intuitive expressive gestures found in Jackson Pollock's oeuvre, this approach relies on the rigorous toolpath of an extruded square. These impressions are enhanced



through the bold use of color. The use of colored polymer pellets, mixed inside the container of the deposition head, created bold colorations that gradually transitioned from one color to another. The palette was intentionally chosen to resemble Baroque color schemes.

Probably one of the more interesting results was the Hirsute Column (fig. 6, first image). This column has a very interesting toolpath in that it is not of a continuous nature but starts and stops in a random crosshatch fashion, vaguely following the original platonic form. In a computational model, this random set of lines does not produce a result that can be perceived as a possible project. It only starts to make sense once the column starts to emerge in the fabrication process.

The setup consists of a robotic arm in combination with a plastic deposition head, as depicted in Figure 7. The material for the explorations is various synthetic granulates with color additives. The deposition head was outfitted with a pellet feeder that allows for the creation of continuous color changes, since it avoids discrete feeding of the deposition head, as with uniform filaments. The basic architectural archetype of the column served as a testing ground for the combination of a rigorous geometric body with the gestural qualities of sensible robotic toolpaths. The basic prismatic shape of an extruded square (fig. 2) forms the origin for all the conducted tests and was chosen to facilitate the comparison between the models. The range of results, from tight rhythmic patterns to fluffy hirsute clouds, demonstrates the panorama of possible design options with this technique (fig. 6).

The common motif in all models is the application of alternating sequences as the forming method. This pulsation is achieved through a rhythmic variation of speed of deposition. These fluctuations in the deposition speed proved to be a successful method for achieving a variety of effects, from the introduction of apertures in the prismatic proto body by applying higher speeds to the introduction of curls and pearls on the surface by reducing the speed. In combination with the saturated coloration of the material, the process results in richly informed surfaces that make the process of modelling matter highly readable:

*In the age of Big Data and 3D printing, decoration is no longer an addition; ornament is no longer a supplemental expense; hence the very same terms of decoration and ornament, predicated as they are on the traditional Western notion of ornament as supplement and superfluity, do not apply, and perhaps we should simply discard these terms, together with the meanings they still convey. (Carpo 2012)*

One of the main issues raised by this research is the necessity of creating a novel method of architectural notation that does not rely on the manifestation of a unique, specified condition—as is the case with traditional recording methods of architecture, such as

plan and section—but rather utilizes a system that only defines a few key design specifics and leaves the rest to the emergent properties of the chosen fabrication methods and material qualities.

## CONCLUSION

In borrowing from the post-digital discourse in music, an alternative method of thinking about architectural production for our contemporary age also calls for alternative methods of describing the current work. To this end, the post-digital can be described as a paradigm, comparable, for example, to post-humanism, which does not describe a universe after the digital, but rather characterizes the contemporary attempt to examine the consequences of the digital age. In other words, the emanations of the human enhancement achieved with computational tools—the ramifications of the globe-spanning prosthetics that are achieved by the application of software—all of which present themselves as exquisite specimens for speculative interrogation and theoretical inquiry. The project Plato's Columns combines the rigor of a body with the emergent properties of vague gestures. The introduction of moments of uncertainty in the process produces glitches that are embraced as an opportunity to find novel aesthetic conditions.

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## IMAGE CREDITS

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Figure 7: The robotic setup, consisting of a six-axis industrial robot and an extrusion head.