Piles of Bits: Notes on the Virtual Grounds of Post-digital Practice

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The relationship between building and ground is one of the most significant dynamics within the discipline of architecture. During the twentieth century, for instance, numerous critics interpreted the building/ground joint as a symbolic representation of the discipline's conceptual posture towards modernity's shifting technological, socio-cultural, and geopolitical conditions. This paper examines architectural conceptions of ground amidst another transformative moment: namely, the arrival of a "post-digital" or "second digital" era. Whereas designers of the so-called "first digital turn" emphasized the formal possibilities facilitated by virtual space's liberation from gravity and physics, there is an emerging generation of designers who are using digital tools in a completely different manner. Rather than formal virtuosity, these designers of the post-digital generation focus on the integration of physics, along with the properties of matter, into the virtual realm. Among the experimental approaches that fall within this larger conceptual project is the simulation of gravity, a technique that often results with the piling up of digital bits. By examining the recent proliferation of simulated piles, this paper highlights the ways in which shifting applications of digital tools are reshaping disciplinary conceptions of ground.

GRAVITY'S PULL

On Earth, the downward acceleration of gravity is approximated at 9.8 meters per second squared. Of course, this acceleration value does not account for air resistance and it applies only when an object falls within a certain proximity of the Earth's surface. Moreover, colloquial characterizations of gravity's "downward" pull can be misleading since the actual phenomenon is better understood as an attraction between masses that exist independent of human conceptions of up or down. In other words, the behavior of gravity–both its speed and its directionality–is relative and contingent, rather than universal and absolute. Nonetheless, even those who are well versed in Newtonian physics and Einstein's General Theory of Relativity might still be tempted to imagine that a pop-fly hit towards left field is falling on a downward trajectory towards an endless, horizontal plane. Perhaps, as some have suggested, this tendency to restructure perceived phenomena along

horizontal and vertical axes is a function of human evolutionary development, partially due to our own upright posture. Regardless of its origins or inaccuracies, this habit of describing the ground as an infinite horizontal plane in perpendicular relation to the forces of gravity can be found throughout the history of architecture. In an oft-repeated anecdote from Le Corbusier's travels along the French coastline, for instance, the architect happens upon an upright menhir forming "a right angle with the horizon."[1] Drawing an implicit connection back to architecture, Le Corbusier proclaims: "The vertical gives the meaning of the horizontal. One is alive because of the other. Such are the powers of synthesis."[2] However, if one accepts this premise that architecture can only achieve its full potency when put in relation to the horizon, then what can be said for those who now design in digital modeling environments where gravity and ground are ostensibly absent?

By default, geometries created in digital modeling software like Maya and Rhinoceros 3D float weightlessly in virtual space. The only suggestion of a ground plane in these digital modeling environments is a faint grid that rotates with the camera as a user clicks and drags the cursor within the perspective viewport. Early adopters of digital tools within the discipline of architecture celebrated and exploited this newfound liberation from the traditional constraints of gravity and ground. Throughout the 1990s and early 2000s, designers of the so-called "first digital turn" tested out new formal typologies that folded, twisted, and hovered in complete defiance of the laws of physics.[3] Yet, as the novelty of these early digital experiments wanes, a cohort of digital-native architects is advancing a different mode of computational experimentation aimed at integrating the physical properties of matter and space into the virtual realm. Rather than a return to traditional typologies, however, these simulations of real-world behaviors signal an emerging disciplinary interest in informality and chance, which often manifests through the curation of loose accumulations and haphazard piles. Curiously, because of their reliance on the (simulated) laws of physics, these pile-like accumulations reinstate gravity and ground as primary actors in the production of architecture. Thus, unpacking the technical, theoretical, and historical contexts of these simulated piles and their virtual horizons offers key insights into the intellectual culture of post-digital practice.[4]

Figure 1. Pile simulation workshop from a graduate seminar, entitled "Groundforms," taught by Zachary Tate Porter at the University of Nebraska-Lincoln, Fall 2020. Student: William Cox.

SHIFTING GROUNDS

Ground is one of those terms within architectural discourse that seems so familiar that we rarely see a need to offer a definition at all. Yet, the more one tries to characterize ground in specific language, the more slippery the term becomes. Much of this ambiguity and confusion stems from the fact that historians and theorists have characterized the ground in radically different–sometimes even oppositional–ways within architectural discourse. In the mid-nineteenth century, Gottfried Semper used the metaphor of a *mound* to portray the ground as an essential foundation (both literally and conceptually) for architects to build upon.[5] Yet, undermining the stability of Semper's mound is the notion that the very conditions of modernity–its technological, philosophical, and geopolitical developments–precluded any conception of a stable foundation for architecture. Modern-period architects responded to these conditions by inventing new formal typologies, which facilitated a diverse range of approaches relative to the ground. While some leveraged innovations in steel and reinforced concrete to physically disengage their buildings from the earth, others deconstructed the architectural object in an effort to extend their interior spaces into the surrounding landscape. Architects of the postwar era explored even more radical approaches to ground, ranging from speculations on nomadic buildings to the complete dissolution of architecture into "field conditions." The point here is not to dwell upon any one particular conception of ground, but instead, to acknowledge the ways in which a multiplicity of terminologies, practices, and ideologies related to the ground have coexisted and overlapped throughout modern history.

Despite this slipperiness (or perhaps because of it!), the relationship between building and ground remains one of the most significant dynamics within the discipline of architecture. Within the past decade, an increasing number of critics, historians, and designers have turned their attention to the ground, producing extensive catalogues of grounding strategies (see Ilka and Andreas Ruby, *Groundscapes: The Rediscovery of Ground in Contemporary Architecture* and Toma Berlanda, *Architectural Topographies: A Graphic Lexicon of How Buildings Touch the Ground*), historical reappraisals of modern architecture's relationship to ground (see David Leatherbarrow, *Uncommon Ground: Architecture, Technology, Topography* and Marc Treib, *Landscapes of Modern Architecture*), and introspective manifestos on ground for contemporary practice (see Dominique Perrault, *Groundscapes: Other Topographies* and Productora, *Being the Mountain*). Perhaps the most significant developments within recent discourse on ground, however, are the various calls for a hybridization of buildings, landscapes, and cities. Loosely grouped under the movements of Landscape Urbanism and Landform Building, proponents of such a disciplinary hybridization contend that the blurring of boundaries between architecture, landscape, and infrastructure would reinvigorate urban experience with smooth flows and networked connections. Completed projects, such as FOA's Yokohama Port Terminal in the Kanagawa region of Japan, illustrate the profound formal implications of this disciplinary hybridization. Here, ground undulates and folds, becoming benches, walls, and even ceiling planes.

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In many ways, these realized landscape-building projects can be understood as an extension of the early digital experiments with continuous surfaces that proliferated during the late 1990s and early 2000s. At the time, the new spatial possibilities facilitated by digital modeling engines were met with enthusiasm and paired, however clumsily, with various theoretical frameworks. Deleuze's analysis of "the fold," for instance, offered a convenient alibi for architects who were probably already inclined to create continuous surfaces folding in virtual space.[6] For the 2001 Eyebeam Competition, multiple submissions—especially those produced by Diller + Scofidio and Atelier Leeser— featured continuous surfaces folding in section to produce complex spatial organizations.[7] Other projects embracing this typology of the continuous surface include FOA's 2003 BBC Music Box proposal and Zaha Hadid's Heydar Aliyev Center, which completed construction in 2013.Yet, despite the fact that many of these continuous surface projects were ultimately built, they, nonetheless, remain linked to the virtual spaces in which they were conceived. In other words, great effort (not to mention cost) was expended to make the volumetric folds in these projects appear as they might in a digital modeling environment where gravity and materiality are suspended. By contrast, a number of emerging practices have begun to explore formal vocabularies that explicitly engage with the unpredictable nature of physical materials, even accepting their inevitable tendencies to slump, curl, or bunch up on certain occasions. Such an approach is intriguing because it voluntarily relinquishes the precision, predictability, and control that digital tools offer.

One of the more curious developments within recent applications of digital modeling in the field of architecture is the simulation of physical forces like gravity. While software packages like Maya and 3D Studio Max have had the capacity to simulate the physical properties of matter and space for more than two decades, architects have only recently incorporated this functionality into their workflows. Significantly for the purposes of this essay, the gravity simulations produced by experimental design practices like MOS, d.ESK, and First Office, among others, amplify the presence of ground within the digital modeling environment. Rather than operating merely as a static backdrop, ground is given agency in these simulation experiments to actively participate in the production of architectural form. Such agency emerges when geometries subjected to the simulated force of gravity come into contact with a horizontal collision plane. In contrast to the early digital emphasis on formal virtuosity and parametric smoothness, this tendency to pile things up reflects an emerging aesthetic sensibility that celebrates nonchalant informality, even to the point of absurd awkwardness. By examining the recent proliferation of piles—both within and beyond the computer screen—this essay aims to highlight the ways in which shifting applications of digital tools are reshaping disciplinary conceptions of ground.

ALL PILED UP

Whereas Semper's invocation of the mound in his *Four Elements of Architecture* conjures a sense of stability and foundation, the pile does the exact opposite. After all, piles are fragile, temporary constructions.[8] This being the case, one would not expect architects to embrace the pile as a salient formal typology. Yet, a number of emerging practices, such as formlessfinder and T+E+A+M, have nonetheless turned to the pile as a central reference point for their work.[9] With their 2013 Design Miami Pavilion, for instance, formlessfinder constructed a massive pile of white sand beneath a cantilevered roof. While the choice of material in this case was a nod to the ubiquity of white sand in Miami, one might wonder what larger conceptual agenda undergirds their proclivity for piling. As evidenced by the very name of their firm, the principals of formlessfinder, Julian Rose and Garret Ricciardi, seek to align themselves with George Bataille's theoretical writings on *l'informe* (formless).[10] A manifesto-like statement posted on their website makes this positioning explicit, referencing Bataille's critique of architecture as a symbol of power and, in response, proposing an architecture absent of form altogether. They write:

> Form has always tended to operate as a mechanism of control in architecture…Form suppresses material, and tends to either idealize architectural materials or dematerialize architecture altogether. In response, we propose a fundamental shift from material – that which is sublimated or invested with symbolic power – to matter – that which simply is…We embrace the raw, the unprocessed, the unstable, the ephemeral, and the degradable.[11]

For formlessfinder, the pile represents the antithesis to traditional conceptions of architectural form. Rather than static and stable, the pile is "raw," "ephemeral," and "degradable."

A similar embrace of the pile as an alternative to traditional formal typologies can be found in the work of T+E+A+M, an experimental practice operating out of Ann Arbor. In T+E+A+M's case, piling is associated with the cataloguing of rubble and debris, which they, ultimately, transform into new composite materials. Their Detroit Reassembly Plant, for instance, proposes to selectively demolish portions of the vacant Packard Plant and then use the resulting debris as aggregate for a series of cast forms throughout the site. The model photographs and rendered drawings produced for the project celebrate the unmediated adjacency of delicate architectural insertions and piles of formless rubble. Piles also feature prominently in T+E+A+M's Ghostbox model, produced for the 2016 Chicago Architecture Biennale. Here, the pile is a reference to James Wines, whose Best Products Showroom in Houston, Texas features a front façade crumbling beneath its own weight and forming a pile of bricks on top of the store's entrance. T+E+A+M takes this approach even further,
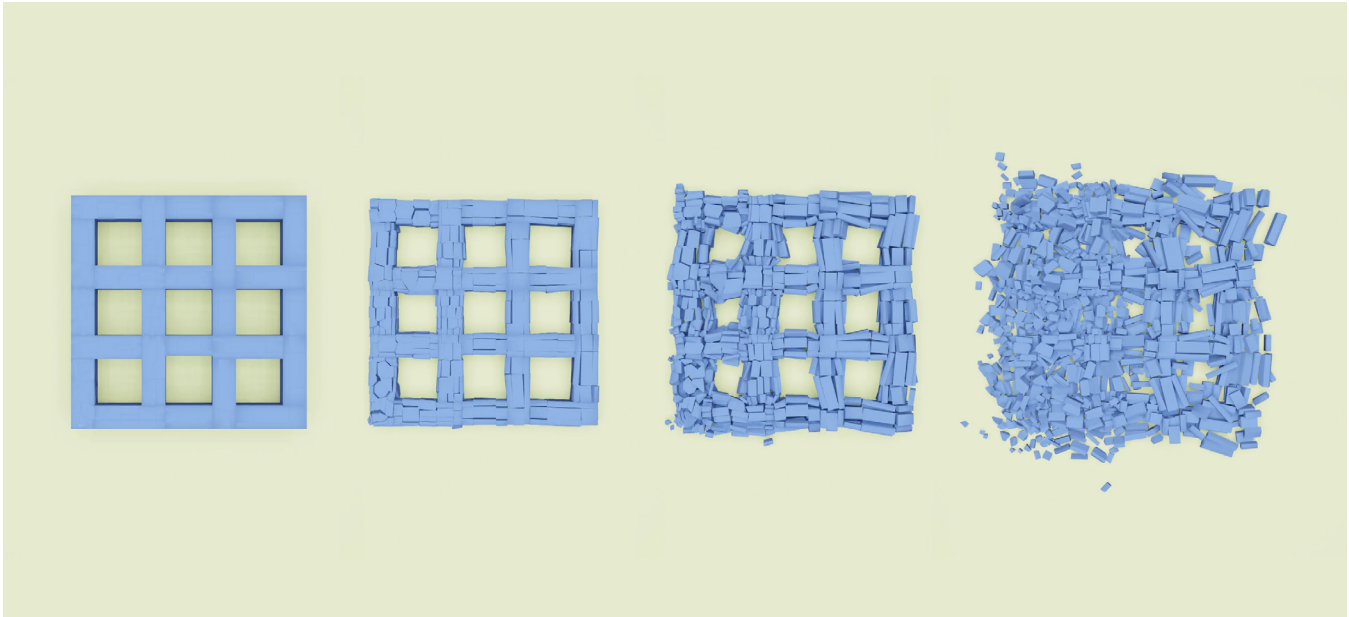
Figure 2. *How to Smash a Nine Square.* Courtesy of the author.

allowing this process of ruination to move from the exterior into the contained volume the big box's structural grid. In their description of the project, T+E+A+M emphasizes the concept of "reassembly" in which "building components are taken apart, moved around, piled up, and mixed with new construction to create alternative uses."[12] Echoing formlessfinder's appeal to matter over materiality, T+E+A+M notes that "this approach views a building's materiality as matter-of-fact, while stripping away the assumptions commonly associated with disused properties."[13]

As a matter of precision, it is useful to distinguish the pile from other related typologies of vertical accumulation. The pile is materially determined, its form dictated by the force of gravity, as well as the angle of repose for the specific material used to compose the pile. This way of producing a vertical accumulation is distinct from other strategies that require more curatorial discretion, such as stacking. For instance, the sculptural work of Michael Johansson, as well as the architectural speculations of Andrew Kovacs and Jennifer Bonner, rely on the vertical aggregation of discrete elements. In the work of Kovacs and Bonner, the individual layers or elements in the stack are often quite different from one other, leading to a heterogeneous form that emphasizes the legibility of parts within the overall whole. Whether one calls these forms stacks or assemblages, or in Jennifer Bonner's case, "sandwiches," they playfully disrupt our expectations about the uniformity of buildings. More specifically, the key difference between these stacked compositions and traditional approaches to architectural design is that the parts come before any knowledge of the whole. Yet, while these stacks have some of the haphazard qualities of piles, they still require the designer to carefully

consider the joints between elements. By contrast, the pile removes this direct form of authorship. The designer of a pile can select its material and location; but other than that, the designer must get out of the way and let gravity do the rest. Thus, the pile relies upon two key concepts that have historically been suppressed within architecture's pursuit of ideal form: namely, materiality—or matter, to be more precise—and temporality. Yet, while this contemporary appetite for piles of debris and matter is curious enough, an even more surprising development is the recurring presence of piles within virtual space.

In recent years, a growing number of contemporary design practices have created their own software applications that do little more than pile stuff up into digital heaps. Examples of this trend include MOS's Softwares *No. 4 SAND* and *No. 15 SAND2*, First Office's *Blocks of blabla* developed with Theo Triantafyllidis, and Office CA's *Male.vich* web app. Meanwhile, other designers have used the physics simulators embedded in modeling programs like 3DS Max to animate the pile's dual characteristics of materiality and temporality. While the use of digital tools to generate disorderly piles verges on the absurd, one might wonder if there is actually a critical agenda undergirding this odd inclination. In an essay published in *Log* 46, Viola Ago offers an interpretation of architecture's recent obsession with what she terms "compositional physics," characterizing these recent simulation experiments as a natural evolution of the "diagrams of force" that prevailed within first wave digital architecture.[14] In other ways, however, the pseudo-absurd (mis)use of software to generate piles represents a rejection of the idea that that digital tools are primarily instruments for optimization. In this sense, the
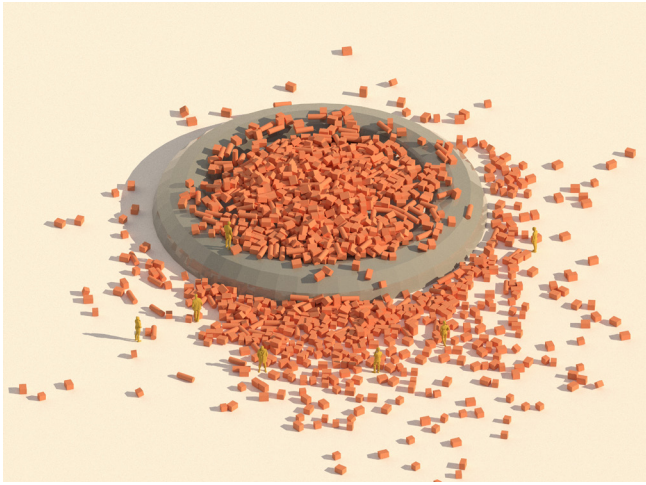
Figure 3. Groundforms, Pile Workshop. Student: Ashley Glesinger.

Figure 4. Groundforms, Pile Workshop. Student: Quinn McFadden.

Figure 5. Groundforms, Pile Workshop. Student: Pegah Rahmani.

decidedly nonchalant posture of the simulated piles that proliferate within contemporary practice is not just different than the aesthetics of emergence that prevailed during the first digital turn. Rather, these piles represent a reaction against the principles of smoothness and continuity, which were ultimately folded into theorizations of parametricism. Yet, unlike the fractures and collisions that preceded the digital turn, these piles are also not deconstructions of anything. They are simply inventories of matter–pixels, in this case–piled up on a backlit computer screen according to default orientations within software. In this sense, these simulations of gravity and materiality fit within the larger ambitions of contemporary designers who reject digital novelty as an end in itself, and instead, playfully exploit translations back and forth across the physical and virtual realms.

Despite their apparent correspondence to real-world forces, however, Galo Canizares has argued that these simulations are not objective experiments intended to accurately mimic the conditions of reality, at least not in a technical sense.[15] Gravity, for instance, can even be intensified beyond its normal 9.81ms pull. According to Canizares, "the medium of simulation—despite its association with science and engineering—might have more to offer the design disciplines if it is understood as a narrative or even literary tool instead of an objective, truth-finding quest."[16] For architects who use these simulations to create piles, the narratives they tell suggest a shift from established disciplinary conceptions of form to a new sensibility–one that resists the traditional reliance on part-to-whole hierarchies and "ideal forms." At the same time, this emerging sensibility also departs from both the violent collisions of Deconstructivist architecture and the unified complexity of parametricism. Instead, these simulated piles celebrate the casual, the relaxed, the nonchalant, the haphazard, and even the lazy. Moreover, the simulated pile accounts for both the existence of gravity and a defined ground plane in ways that early digital work did not consider. To have a pile, there must be a force pulling individual elements in a downward direction and there must be a surface where those elements accumulate on top of one another. Thus, the pile offers an alternative to the binary positions of Semper's foundational ground and the ungroundedness of early digital experimentation. Rather than ignoring architecture's horizontal other, the pile reifies the indeterminacy of ground, forcing us to confront our romantic nostalgia for stability, foundation, and truth.

CONCLUSION
Beyond its literal reference to topography or terrain, ground represents a rich discourse within the discipline of architecture that encompasses a range of theoretical frameworks and ideological positions. Thus, examining the shifting manifestations of ground within virtual space is not merely a matter of technical procedure, but instead, an opportunity to reflect on the reciprocity between digital

tools and architectural discourse, more broadly. Putting aside the question of their aesthetic merit, the piles proliferating within contemporary practice remind us that ground is no longer a given within architectural design. In other words, ground is constructed rather found; and this is just as true on a physical construction site as it is in the virtual space of a digital model. Yet, as contemporary workflows increasingly come to rely on digital tools, it is critical that architects resist the tendency to see software as a neutral conduit for creative expression and, instead, regard these digital platforms as active participants in the process of design. As Mario Carpo has stated, digital technologies "are no longer the tools for making; they are primarily tools for thinking."[17] In this sense, the simulation of physical forces like gravity within virtual space is not only a means for generating formless piles, but also an intellectual meditation on the role of ground within architectural design. Given the inherent political nature of ground, these various manifestations of the pile might even suggest emerging postures towards the uncertainty of our contemporary moment.

ENDNOTES

1. Le Corbusier, *Precisions: On the Present State of Architecture and City Planning*, Cambridge: MIT Press, 1991, p. 75.

2. Ibid.

3. This concept of a "first digital turn" has been referenced by a number of theorists and critics, especially Mario Carpo, whose 2017 book, *The Second Digital Turn*, describes the evolution of digital technologies from tools for making to tools for thinking.

4. "Post-digital" remains one of the most disputed and misunderstood qualifiers within current architectural discourse. As Adam Fure has pointed out, it should not be interpreted as technophobia or romanticism for pre-digital practice (see Adam Fure, "What does it really mean to be "post-digital" in architecture and beyond?" *The Architect's Newspaper* (May 22, 2018) https://archpaper.com/2018/05/postdigital-forthe-record/). Instead, the understanding advanced here is that "post-digital" reflects a growing consensus that digital virtuosity can no longer be considered an end in of itself. Thus, many architects of the so-called post-digital generation are concerned with translations between virtual and physical worlds. Sometimes this translation involves the integration of physical properties of matter—i.e. laws of gravity—into digital modeling environments. At other times, this translation works in the opposite direction, integrating digital techniques into physical construction, as seen in the façade of MVRDV's Glass Farm project, which appears to have been edited with a Photoshop brush (This is the example that Fure highlights in his response to Mario Carpo's attack on "post-digital quitters."). Such context is important to discussions of ground, because it is precisely this rejection of digital virtuosity as an end (rather than a means) that has allowed an emerging generation of architects to depart from the continuous surface project of the early 2000s, which constituted ground as virtual, immaterial, and unconstrained by the laws of physics.

5. See Gottfried Semper, *The Four Elements of Architecture*, translated by Harry Francis Mallgrave and Wolfgang Herrmann, Cambridge: Cambridge University Press, 1989.

6. See *Folding in Architecture*, edited by Greg Lynn, New York: Wiley-Academy Press, 2004.

7. Diller + Scofidio + Renfro returned to language of the folded slab in their Columbia University Medical Center, which completed construction in 2016.

8. Given their potential to evoke a sense of instability and loss, it is not surprising that piles became recurring forms for many artists of the postwar era. Among the most powerful examples is Felix Gonzalez-Torres and his series of untitled sculptures that pile wrapped candies in the corners of museum galleries. The number of candies in Gonzalez-Torres' sculptures is determined by weight—more specifically, the ideal weight of a named person who has died as a result of AIDS. Inviting museum visitors to pick up, unwrap, and eat the candy, Gonzalez-Torres constructs a performative experience in which the viewer literally consumes the subject matter. Several decades earlier, in 1970, Robert Smithson explored notions of entropy and material instability in his site-specific work, *Partially Buried Woodshed*, on the campus of Kent State University. Piling twenty truckloads of dirt onto an existing woodshed until the central beam cracked, Smithson then requested that no intervention be made to save the structure from its inevitable collapse.

9. In the summer of 1996, the Center de Pompidou hosted an exhibition entitled, "The Formless: Instructions for Use." The show's curators, Rosalind Krauss and Yve-Alain Bois, organized the exhibition around Georges Bataille's concept of the "the "formless," which, as Krauss and Bois point out in the catalogue, is not "a stable motif to which we can refer, a symbolizable theme, [or] a given quality." Instead, the curators argue that Bataille's concept of "the formless has only an operational existence: it is a performative, like obscene words, the violence of which derives less from semantics than from the very act of their delivery. The formless is an operation." (Yve-Alain Bois and Rosalind Krauss, *Formless: A User's Guide*, New York: Zone Books, 1997, p. 18) While Bataille's theorization of the formless precludes any kind of stable typology, one cannot help but notice that many of the artists included in Krauss and Bois' exhibition tend to pile things up. The pile is evident, for instance, in Armen's accumulations, Claus Oldenburg's *Green Beans* (1964), and Robert Morris' untitled felt piece (1967-68), just to name a few.

10. Samuel Medina was one of the first critics to comment on this emerging interest in piles. His 2017 article for Metropolis is evocatively titled, "The Architectural 'Blob' is Dead, Long Live the 'Pile.'" Further evidence of the pile's hold within experimental corners of the discipline can be found in *This X That's* interview with Andrew Holder, co-founder of the Los Angeles Design Group. As Holder explains, "I like small and medium piles. Stacks of construction material are good...Piles of trash in South End on garbage day are also good."

11. formlessfinder, "Statement," http://www.formlessfinder.com/statement (accessed November 1, 2020).

12. T+E+A+M, "Ghost Box," http://tpluseplusaplusm.us/ghostbox.html (accessed November 1, 2020).

13. Ibid.

14. Viola Ago, "Compositional Physics and Other Diagrams of Force," *Log* 46 (2019), p. 34.

15. Galo Canizares, "Default World Design," *POOL*, Issue 5: "Simulation" (UCLA), 2019.

16. Ibid.

17. Mario Carpo, "The Alternative Science of Computation," *e-flux Architecture* (June 2017) accessed May 17, 2020. http://www.e-flux.com/architecture/artificial-labor/142274/the-alternativescience-of-computation/

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