Toward a Redefinition of the Vertical: The Skyscraper in the Age of Algorithmic Reproduction

"Most of what we are doing is a question of changing the style of things."
– Ludwig Wittgenstein[1]

"We build and erect extensions of ourselves."
– Marshall McLuhan[2]

Pasquale De Paola
Louisiana Tech University

INTRODUCTION

The urban and systemic role of high-rise buildings has come a long way since Burnham and Root's sixteen-story Monadnock Block in Chicago.[3] While typologically repetitive because of programmatic, technological and economical contingencies, skyscrapers have become progressively and inherently entangled with the city's economic patterning, while displaying a material embodiment of social and individual conditions often governed by a strong capitalistic agenda. Within this framework the increasing ambition for verticality has transformed this building type into a living spectacle as well as the ultimate repository of modernization and its dominant modes of production. Historically speaking, high-rise buildings have been frequently associated with corporate and real estate self-absorption, which has consequently created a culture that seeks standardization and redundancy as a rather simplistic point of arrival.[4] Yet, the redundancy of most systems of architectural production—especially those that promote repetitive seriality and disengage with local ecosystems—now require new modes of interdisciplinary research that engage in speculative and innovative modes of design production.

In *The Tall Building Artistically Reconsidered: the Search for a Skyscraper Style*, Ada Louise Huxtable recognizes a progression of four different ideological phases that are still current and applicable: functional, eclectic, modern and postmodern.[5] Skyscrapers are, to use Huxtable's words, the "servant of engineering," yet they also seem to communicate aesthetical affection through the articulation of their building skins, which essentially represent the mechanism that connects the architectural artifact to a specific cultural framework.[6] The high-rise's role as a legitimizer of capitalistic and political ambitions is rather obvious, especially if we look at contemporary high-rise buildings such as One WTC, Frank Gehry's 8 Spruce Street, the Petronas Towers, and the Burj Khalifa in Dubai.In fact, those buildings were primarily designed to maximize their financial profitability while superficially addressing approaches that provided certain levels of sophistications and systemic integration of ecology, structure, program, and form.[7] Those buildings were not conceptualized as a response to site-driven issues, but they were designed to legitimize the ambition of a clientele that was seeking sensation and affect through iconographic branding, reducing architecture to a mere marketing tool. As we still associate high-rise production to the implementation of processes that involves repetitiveness, serialization, and standardization, which fundamentally create rather prescriptive design modalities, how do we generate a more innovative approach that redefines the high-rise's new role within our progressively complex urban ecosystem?

The methodology that I investigate in this paper seeks a more systemic and integrated approach to architectural design via computation, as this can provide a better understanding of material characteristics and the organization of matter and form. Interestingly enough, extensive research on new emerging materials, renewable energy, and ecological issues have created a design culture that focus on provisional modes of architectural production that offer unconventional approaches in order to avoid a nostalgic return to traditional solutions.[8] Historically, if we look at the architectural production that defines the establishment of modernism, we can recognize a proactive modality in which the functionality, especially that of a high-rise building, is strictly related to its structural modularity. Nevertheless, its repetitive nature and programmatic homogeneity have led us to a sterile monumentality that seems to privilege static iconography rather than the heterogeneity typical of dynamic assemblages characterized by programmatic contaminations.[9] Again, how can we generate a new design methodology that through programmatic, urban, environmental and technological aspects create more site-responsive and operative high-rise buildings? This paper in essence challenges the limits of architectural production regarding skyscrapers, rethinking its anthropological and capitalistic-driven role through an examination of computational and parametric methodologies. To further validate this approach, my paper ultimately analyzes students work completed in two design studios taught in 2010 and 2013, which proposed a more systemic design practice discarding the idea of high-rises as static obelisks. Fundamentally, this pedagogy was implanted to ideologically redefine and transform the high-rise from a functional and capitalistic apparatus to a novel indexical machine defined by programmatic and operative hybridity.[10]

TOWARD A COMPUTATIONAL ONTOLOGY: SOFTWARE TAKES COMMAND

> "The message of any medium or technology is the change of scale or pace or pattern that is introduced into human affairs." – Marshal McLuhan[11]

Marshal McLuhan stated that technology, understood as a primary medium, could lead us to the abolition of dichotomies such as culture and knowledge.[12] Automation, as a process characterized by an indivisible "electronic logic," is information, and, as such, it requires different modes of production more contingent to its technological simultaneity. It is again evident how the "new electronic age" forecasted by McLuhan has ended up generating a new framework characterized by machinic assemblages in constant state of transformation that designate new morphogenetic and autonomous structures.[13] Within this framework, digital technologies have created a new meta-model characterized by various forms of software developments that have also shifted the attention from the typical, normally defined by ideas of representation, to the atypical which is now characterized by codification and flows.[14]

New approaches of advanced simulation in design have certainly redefined form-finding processes.[15] Indeed, the latest developments in computational design and digital technologies have dramatically increased architecture's repertoire of forms. Yet, the redundancy of most systems of architectural production—especially those that promote repetitive seriality and disengage with local ecosystems—require new modes of interdisciplinary research that engage in speculative and innovative modes of design production. This paper particularly investigates the typological and topological export of high-rise architecture while looking at the systemic influence of computational strategies and their impact on the development of a new speciation of the tall building. Evidently, software developments have created a new breed of designs that have to be approached and understood by looking at a worldview characterized by an object-oriented methodology. Therefore, to truly understand the underlying specificity of the object digitally generated, as well as most of the work produced in my design studios, we need to understand the generative modalities of those machinic processes of data gathering, patterning, and identification that ultimately define what Matthew Fuller calls "the digitality of the object."[16]

Indeed, I aim to analyze the unwritten relationship between computational tools and the traditional understanding of high-rise buildings in terms of performance driven qualities. I point out that through certain computational strategies and the development of precise generative algorithms that optimize variance, we can now establish a new design method less contingent on repetitiveness and more responsive to urban and ecological issues. The high-rise building, as a symbolic representation of standardized and serial design praxis is no longer adequate. Additionally, while is partially true that the basic demands on the creation of a successful urban environment have not substantially changed, the contemporary high-rise has to deal with new questions relative to performance, flexibility, and ecology, while providing fresh solutions that expand our disciplinary frontiers. Within this context, we ought to propose a new framework that aims toward the definition of an architectural practice more open to the interaction between humans, technologies, and natural ecosystems.

This pervasive development has not only created new formal outcomes, but it has also produced new material processes that are deeply rooted into the morphogenesis of self-organizational and environmentally responsive models. Thus, the synergy existing between emerging materials, modes of renewable energy, and ecological design have generated a new ontology of architectural production in which the science of materials is finally revaluating the traditionalistic notion of architectural signification via the establishment of new methods of digital morphogenesis and associative cellular arrangement. However, those patterns are not considered another aesthetic formalization of nature, instead they are seen as a more accurate study of those models based on the recognition of methodological reciprocity between elements of program, structure and form.

So, in order to generate a new high-rise breed, how do we produce a design ontology that goes beyond the typical aesthetical features traditionally associated to the parametricist agenda formulated by Patrik Schumacher?[17] The ideological worldview implemented to support my argument explores ideas of artificial emergence and contingency, which provide a more distinctive mathematico-logical derivation with its own ethical implications. Within this framework, the work of Alain Badiou proposes the existence of a mathematical ontology, which formally and conceptually supports the existence of an object-oriented philosophy. This is a stance of metaphysical realism that opted against the dominant forms of post-Kantian philosophy.[18] Speculative realist thinkers have a shared resistance to philosophies of human finitude inspired by the tradition of Immanuel Kant Objectification, taking precedence over subjectification, is a main point of Quentin Meillassoux, Levi Bryant, and Graham Harman.[19]

In particularly, Meillassoux claims to be able to resuscitate the “great outdoors” of pre-Critical Cartesian philosophy, one that would both forgo the correlationist impulses of the Kantian tradition as well as the necessity of an all-knowing God. Within this framework, reality is understood as an “entity without thought,” and can exist without thought, thus rendering the latter ontologically unnecessary.[20] Additionally, Meillassoux implies the distinction between primary and secondary qualities, which can be characterized as the difference between relational properties and non-relational properties. Primary qualities are the ones that can be mathematized so that 'what is mathematically conceivable is absolutely possible.' Mathematized qualities of things are independent of us, therefore Meillassoux's states that objects will still have those qualities even when all humans are dead.[21] With this in mind, it is important to understand that the computational layers used in architecture also regulate users to think through particular computational categories, creating an autonomous language of architectural production. So, how does this new ontology change the way we design high-rise buildings?

SKYSCRAPERS FOR THE XXI CENTURY: EVOLO AS PEDAGOGY

While considering the theoretical and philosophical implications stated above, my paper examines the work produced in two design studios taught in 2010 and 2013, both of which challenged the traditional framework and guidelines associated to the design of high-rise buildings. This radical scenario was provided by a design competition organized by eVolo, a progressive magazine lead by a group of designers that had created a forum promoting and debating about speculative developments in skyscraper design in the XXI century. In its specifics, the competition examines the future of urban skyscrapers in the current parametric age of production. Established in 2006, the Skyscraper Competition, as explained by Carlo Aiello, “recognizes exceptional ideas that redefine skyscraper design through the implementation of novel technologies, materials, programs, aesthetics, and spatial organizations along with studies on globalization, flexibility, adaptability, and the digital revolution. It is a forum that examines the relationship between the skyscraper and the natural world, the skyscraper and the community, and the skyscraper and the city.”[22]

Within this framework, students were forced to consider multiple issues regarding “advances in technology, the exploration of sustainable systems, and the establishment of new urban and architectural methods to solve economic, social, and cultural problems of the contemporary city including the scarcity of natural resources and infrastructure and the exponential increase of inhabitants, pollution, economic division, and unplanned urban sprawl.” The competition essentially investigates novel approaches that manipulate public and private space while creating dynamic and adaptive vertical communities. Another pedagogical move included the development and the exploration and adaptation of new habitats and territories based on a dynamic equilibrium between man and nature, or like Aiello calls it “a new kind of responsive and adaptive design capable of intelligent growth through the self-regulation of its own systems.”[23]

Conceptually speaking, computational design strategies provide a framework of complexity that links form, program and structure. The vast majority of those algorithmic models normally look at the organizational complexity of bio-analogue systems, whose form adaptation appears to be in constant feedback with the intrinsic nature of its organic structure. The importance of this method has to be found in its capacity to create scenarios characterized by diversity and flexibility. Computation also involves processing information algorithmically while creating a set of procedures regulated by precise mathematico-logical rules that generates operations necessary to solve given problems. An algorithm, as a sequence of explicit and finite instructions, is defined by particular scripts, and can be manipulated, customized, and adapted. It is a strategy codified to solve a specific problem.[24]

PEDAGOGICAL SUBSETS: TOWARD A REDEFINITION OF THE VERTICAL

Accordingly, the design studios were structured to create a pedagogical framework consistent with the eVolo guidelines, which provided a model more oriented towards the value of novel strategies in high-rise design, with an emphasis on form, tectonics, and structural morphology. In this specific case, the students explored the use of parametric and algorithmic design tools in order to engage in research and development of fabrication strategies and material processes, and search for innovation in building components and their assemblies. There were no particular restrictions in regards to site, program or size as the objective was to provide maximum freedom to the participants to engage the project without constraints in the most creative way. Consequently, students speculated on the future of vertical constructions by looking at different strategies that operatively challenge the way we understand high-rise buildings and their relationship with the natural and built environment; this was done by developing and designing skyscrapers that take a more active stance and attack the specific problems contingent to the sites.[25] Thus, buildings were designed to respond to environmental and social issues rather than to accommodate a certain market drive or real estate agenda.

In order to deny their aesthetic role, parametric approaches were also applied to address the use of alternative computational methodologies in challenging established architectural regimes of signs. The traditional architectural signification of high-rise buildings has limited those inherent possibilities for progressive approaches; indeed, a parametrically driven studio seemed to offer a design methodology more open to complexity, transformations, and new types of scalar exchanges that allow us to read the extents of the designed artifact topologically and systemically rather than typologically and aesthetically. Additionally, computational systems applied to architecture tend to provide, theoretically, a better long-term survival in constantly changing urban environments. A biostructure, for example, seems to develop its own adaptive behavior, and this can be entirely controlled through the production of scripts and open algorithms. This process is also entirely spontaneous as it responds to occupation and expression rather than being operated at human will.[26]

In Disaster Relief Tower (Figure 1), Michael Markham and Lestavion Beverly analyzed how vertical typologies can be used as an assistance center when cities are hit or threatened by natural disasters that they are unequipped to handle. The lack of readiness, in this particular case, boiled down to three main problems: congested evacuation routes, slow response to the needs of individuals, and a lack of autonomous shelters that provide necessary resources, which offer temporary relief until help arrives. In 2005, Hurricane Katrina revealed these three problems in New Orleans. In addition, the city's bowl shape made flooding a major problem and hurricanes a major threat. Flooding caused the city to be shut down until the water could be removed before residents and businesses moved back in. The lack of necessary response and the continued threat of flooding caused New Orleans' population to drop and it has yet to reach pre-Katrina levels. The answers to these problems were discovered within certain natural assemblies. In fact, nature seems to offer the most efficient structures and theses structures are adept at handling multiple stimuli. To take advantage of these structures, the students researched biomimicry, studying structures and systems in nature and replicating them in the built environment, which lead us to the dragonfly wing. The dragonfly wing, as a patternization of a systemic framework, offers lightweight, flexible structure and a dynamic pattern, which responds to changes in forces.

Through in depth computational analysis, those two students were able to decode the logic behind the dragonfly wing's pattern logic, which was then applied in Grasshopper at both the macro and micro scale, allowing them to generate an urban plan as well as the tower's structure using the same methodology. As a response to the chance of reoccurring disaster, the generated structure served as a disaster relief tower. As a bastion against natural disasters, the NOLA disaster relief tower was also thought as one of a network of towers placed in New Orleans. Each tower would serve as a transportation hub for trolley lines, bus routes and a station for a monorail system that runs near every major hospital in the city. When not in a state of crisis, the towers hold civic functions as well as high-density residential and commercial zones. One tower would also serve as a headquarters for FEMA in the region, while the base of the towers facilitated the local farmers market. During crisis situations, people would reach the towers via monorail. With flooding being the major threat in New Orleans the elevated rail allows people to be moved between towers and hospitals during flooding. A series of vertical gardens was also designed to help alleviate food needs until support arrives.

In Re-Claim (Figure 2), Kory Stanley and Surge Troost investigated comparative issues of costal erosion. Erosion is the process by which soil and rock are removed from the Earth's surface by exogenetic processes such as wind or water flow, and then transported and deposited in other locations. In order to address this situation, the students designed a self-sustaining tower that re-claimed the earth's coast by discharging huge quantities of sand in shallow locations or ashore, thus reconsolidating the once depleted coastline. Ideated as a massive sailboat, the Re-Claim high-rise uses microcontroller technology in order analyze the reading of specific hydro-geological indexes relative to the process of costal erosion and move when the data shows promising readings. The tower is also used a primary shelter, and marine labs that investigate erosion processes. Interestingly enough, this high-rise was designed using a computer integrated design process that took into account the dynamic nature of the coastline under erosion as well as views, and the optimal distribution of program and circulation.

This process involved the extensive use of Grasshopper, and it was finalized through the application of Galapagos, which is an evolutionary solver. With this building, the idea of fitness was generated by the relationship between the average value of storm surges and the value of costal erosion collected over the last 10 years. This methodology was applied to construct a system of data/patterns, which through the recognition of specific processes of natural occupation relative to areas subjected to drastic climatic agents would convey meaning through the mathematical and logical resemblance of site-specific conditions. This did not create an expected or predetermined form, but it generated an optimized model via the evolutionary solver.

In the Iron Lung (Figure 3), Eric Stafford and Scott Hunter examined the insertion of an atypical high-rise structure within the Beijing metropolitan area. The

ENDNOTES

1. Ludwig Wittgenstein, from Lectures and Conversations on Aesthetics, Psychology, and Religious Belief, (Berkeley, CA: University of California Press, 2007), 28.: AA Publication, 2013), 14.

2. Marshall McLuhan's Wake (DVD), directed by Kevin McMahon, (2007), 4.

3 Kenneth Frampton. Modern Architecture: A Critical History (Fourth Edition), (London: Thames & Hudson, 2007), 55.

4. Carol Willis, Form Follows Finance, (Princeton, NJ: Princeton Architectural Press, 1995), 148.

5. Ada Louise Huxtable, The Tall Building Artistically Reconsidered: the Search for a Skyscraper Style, (Berkeley, CA: University of California Press, 2007), 35.

6. Farshid Moussavi and Michael Kubo, The Function of Ornament, (Barcelona: Actar, 2006), 4.

7. See Kurt Hunker, "The Tall Office Building Artistically Considered," in eVolo 4, ed. By Carlo Aiello, (2012), 28-30.

8. See Brett Steele, "Ironies, Impracticalities, and Ecologies," in Environmental Tectonics: Forming Climatic Changes, Edited by Steven Hardy, (London: Architectural Association Publications, 2008), 9; also see Helen Castle, "Editorial," in AD: Material Computation, Vol. 216, (May, 2012), 5.

9. See Neri Oxman, "A lofty Index: The Skyscraper in the Age of the Digital Revolution," in Skyscrapers for the XXI Century, Ed. By Carlo Aiello, (New York: eVolo Architecture, 2008), 6-7.

10. Oxman, 7

11. See Lev Manovich, Software Takes Command, (New York: Bloomsbury, 2013), 33.

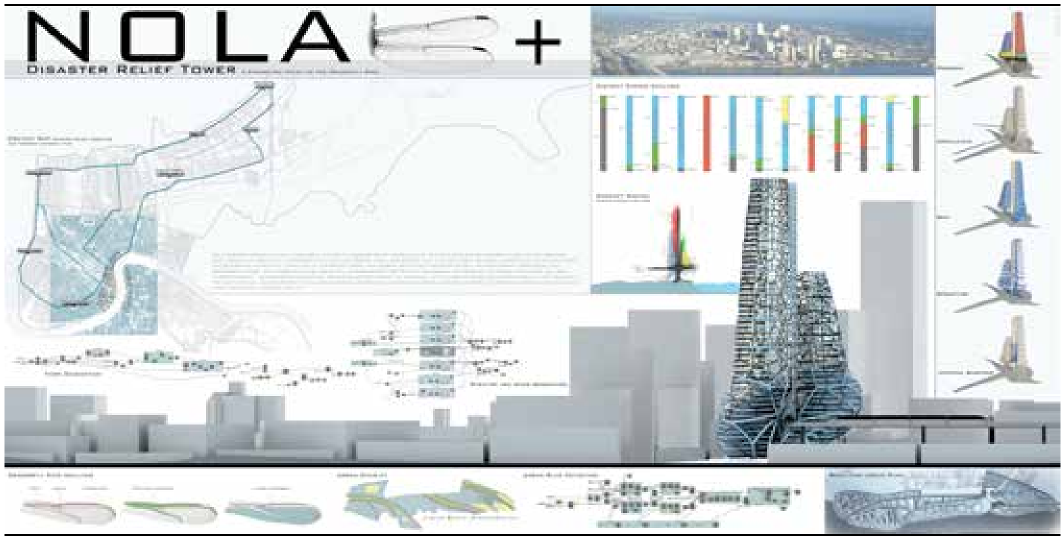

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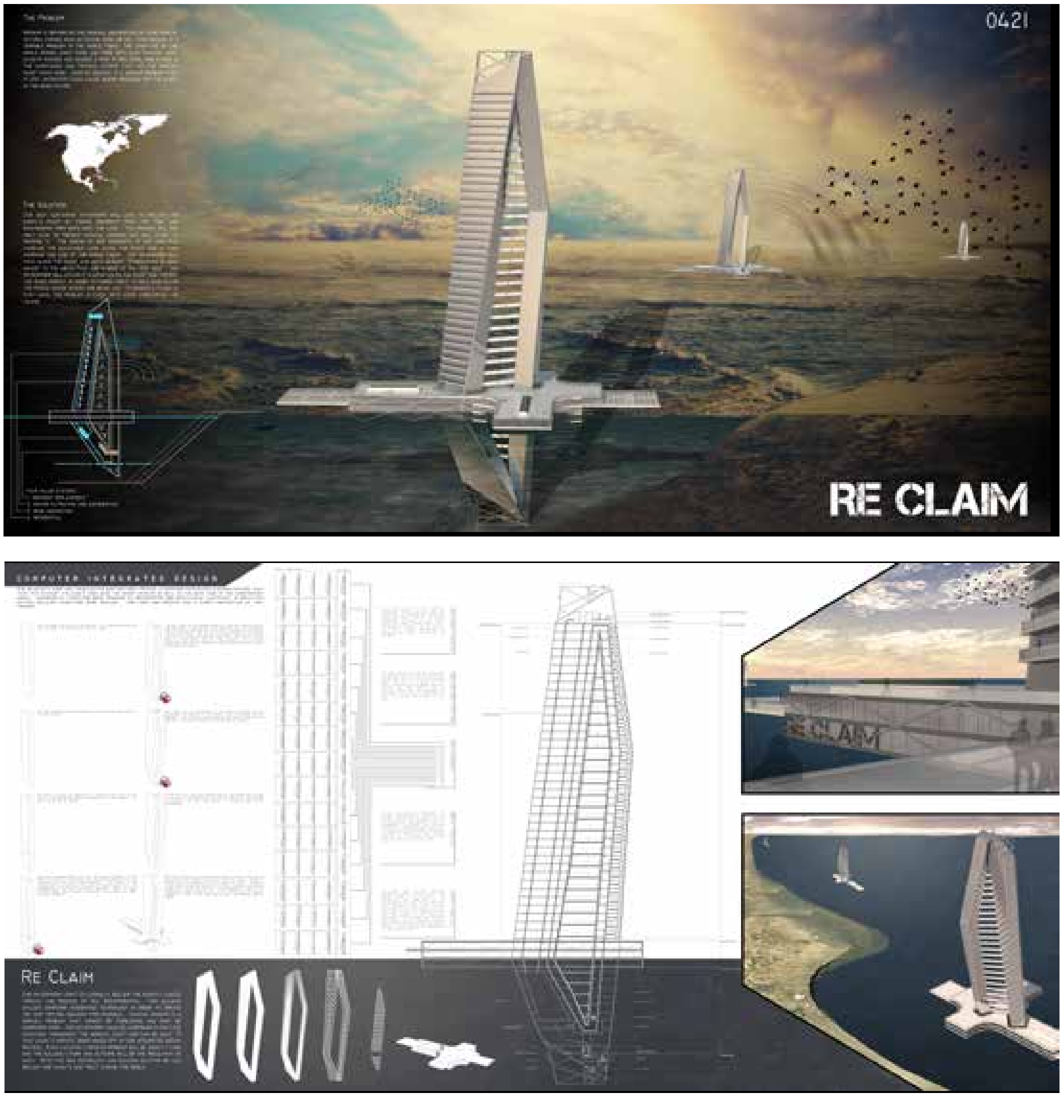
Figure 1: Disaster Relief Tower by Lestavion Beverly and Michael Markham.

investigation looked at both the macro and mesoscopic scale in order to explore issues of adaptation and remediation while producing a design solution capable of intelligent growth through self-regulation. More specifically, this group analyzed the impact of advancements in technological production and how they have affected both the urban and ecological systems related to this particular metro region. Normally, in the city of Beijing, pollution and smog on a small scale is a relative norm. However, in the early months of 2013 air quality levels were recorded at 40 times higher than what is considered healthy by the World Health Organization. Combined with frequent sands, emissions from the city's 5 million plus vehicles, multiple factories, and manufacturing centers, the resulting higher levels of pollutant agents can very likely cause the city and its population to disappear.

The concept developed in the form of a semi high-rise building is called the Iron Lung, which is essentially a giant air filter nested into specific districts in Beijing. Using multiple technologies and systems based on the integration of a faced system developed by elegant embellishment LTD, the prosolve37e™, this project can capture, clean, and redistribute the air in Beijing on a massive scale. This was accomplished through a network of underground, inhabitable super structures that will act as an air intake, filtration device, and ultimately a diffuser of the clean air. These structures are located in densely populated areas of Beijing, with their air intakes stretched miles away to the lesser populated outskirts of the city. The process began with the intake of polluted air, which was then pumped through the arms of the structure through electrostatic precipitators.

Electrostatic precipitators work by removing particles from the air using a force of an induced electrostatic charge. These electrostatic precipitators are powered using electricity harnessed deep within the structure using geothermal energy production. The cleaned air will then be pumped through the center of the structure and out into an above ground super structure that envelopes the surrounding area and diffuses the air over a large area. The section of the machine above ground serves two purposes; it provides an air "bubble" over Beijing and its population as it additionally acts as a dissipater for the newly purified air. This canopy is made up of smaller segments carrying the air from the main, underground air producers to the rest of the metropolis (Figure 4). It is comprised of a diagrid mega-structure, which supports the above ground system while allowing maximum flexibility and morphability around existing buildings, landmarks, highways, and green spaces.

12. Marshall McLuhan, Understanding Media: The Extensions of Man, Edited by Terrence Gordon, (Berkeley, CA: Ginko Press, 2011), 459.
13. Marshall McLuhan, 460.
14. See Matteo Pasquinelli, Animal Spirits: A Bestiary of the Commons, (Rotterdam, NL: NAi Publisher, 2009), 54.
15. See Michael Weinstock, and Nikolaos Stathopoulos, "Advanced Simulation in Design," in AD: Techniques and Technologies in Morphogenetic Design, Vol. 76, No. 2, (May, 2006), 55.
16. Matthew Fuller, "Digital Objects," in Media Mutandis: a NODE. London Reader, (London: node, 2006), 40.
17. See Patrik Schumacher, "Parametricism: A New Global Style for Architecture and Urban Design," in AD: Digital Cities, Vol. 79, No. 4, (July/August, 2009), 16.20.
18. See Graham Harman, Toward Speculative Realism: Essays and Lectures, (Washington, DC: Zero Books, 2010), 93.
19. Levi Bryant, The Speculative Turn: Continental Realism and Materialism, (Victoria, Australia: re.press, 2011), 127.
20. See Quentin Meillassoux, *After Finitude*, (London: Continuum, 2008), 108. Also see Graham Harman, *The Quadruple Object*, (Washington, USA: Zero Books, 2010), 15.
21. Roland Snooks, "Behavioral Formation and Material Assemblages," in Fresh Punches, (Lexington, KY: Suckerpunchdaily.com, 2013), 83-86..
22. The competition guidelines are available at http://www.evolo.us/category/competition/
23. See eVolo competition guidelines.
24. Achim Menges and Sean Ahlquist, Computational Design Thinking, (West Sussex, UK: John Wiley & Sons, 2011), 11.



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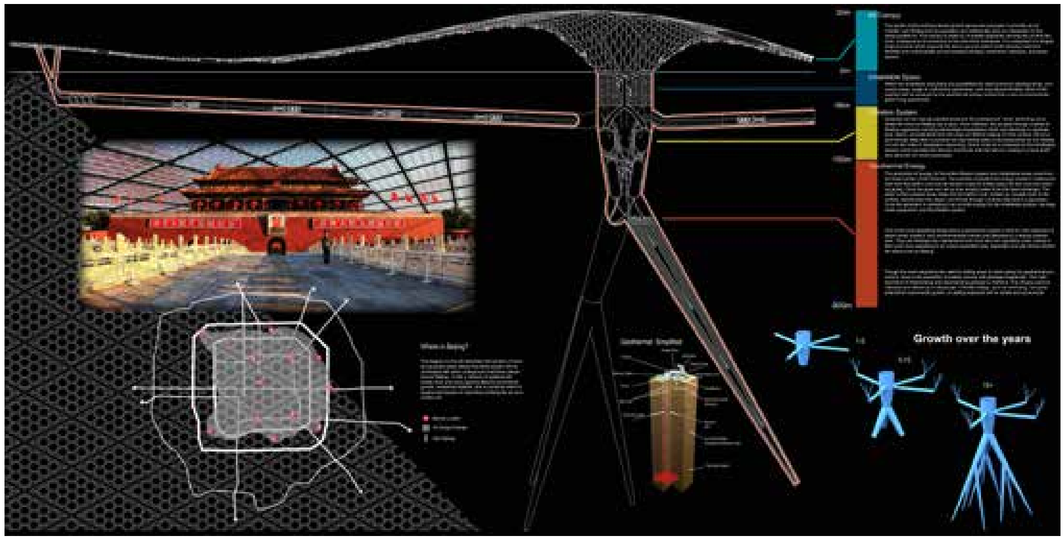
CONCLUSIONS

> "New economic uncertainties, transdisciplinary urban design agendas, divergent reactions to resources depletion, and affordable access to computing power have provided new ways to theorize and practice architecture with a fresh set of assumptions while discarding basic preconceptions about urban form and high-rise developments." – Mark Burry[27]

Extensive research on new emerging materials, renewable energy, and ecological design issues have indeed created a new design culture that exploits provisional modes of architectural production to avoid a return to the traditional.[28] The skyscrapers produced in my studios show the implementation of systems based on programmatic hybridity, vernacular tectonics, and site-specific problematics. Interestingly enough, the concept of the vernacular was less of a limitation in terms of its material and typological understanding, and more of an ecological denotation that linked the architectural object to particular environmental and social issues. By avoiding preconceived solutions, this studio proposed a methodology where architectural form had become the intelligible result of processes of morphogenetic optimization via algorithmic interfaces, generating more interest toward new topological exchanges. Ultimately, this process of variation produced new species of

Figure 2: Re-Claim by Surge Troost and Kory Stanley.

25. Carlo Aiello, "Editorial," in eVolo Skyscrapers of the Future, issues no.2 (2010), 14-15.
26. Francoise Roche, " I have heard about…," in AD: Digital Cities, Vol. 74, no. 4 (July/August, 2009), 42.
27. Mark Burry, "Foreword," in Masterplanning the Adaptive City: Computational Urbanism in the Twenty-First Century, (London: Routledge, 2013), xi.
28. See Brett Steele, "Ironies, Impracticalities, and Ecologies," in Environmental Tectonics: Forming Climatic Changes, Edited by



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high-rise buildings inherently described by those networked connections that seems to privilege flows and intersections while connecting the global to the local.[29]

Thus, high-rise buildings were not understood as iconographic or monumental urban placeholders; instead, they became part of a complex networked system that provided operative qualities at both the urban and the ecological scale.[30] As a "McLuhanesque" representation of the age we live in, high-rise buildings have to address both typological and topological issues; this can be facilitated by expanding the traditional notion of high-rise and rewire it accordingly to a computationally driven methodology. From corporate aesthetics to algorithmic contingencies, digital objects are now defined by their operative and systemic qualities inherently related to the computational tool, so that the high-rise is not just a byproduct of a market-driven determinism or an element of urban catalyst that might attract further developments; instead,it is an urban device that responds to the city and its multiplicity of growing artificial sub-ecosystem characterized by contingencies and instabilities. Clearly, while fundamentally provocative and conceivably sci-fi, most of the solutions produced in my modules showed what the future of high-rise design could be—a future less preoccupied with questions of corporatism or even real estate iconography, but more involved with the contingent production of systemic skyscrapers that finally respond to both architectural and ecological stimuli.

Figure 3: Section of the Iron Lungh by Eric Stafford and Scott Hunter.

Figure 4: The Iron Lungh by Eric Stafford and Scott Hunter | Urban Interface.

Steven Hardy, (London: Architectural Association Publications, 2008), 9; also see Helen Castle, "Editorial," in AD: Material Computation, Vol. 216, (May, 2012), 8.

29. Maria Pieto, "Manhattan Fever," in eVolo Skyscrapers of the Future, issues no.2 (2010), 95.

30. Javier Quintana, " Making the Future Real," in eVolo Skyscrapers of the Future, issues no.2 (2010), 36.