Adaptable Urban Models in the Age of Climatic Changes: ParametricNOLA

"The understanding of the connection between technology and the deepest aspects of biological necessity frequently stops at an acknowledgment of increased access to the direct material requirements of existence. It rarely acknowledges the more abstract but arguably more fundamental underlying drive to create structures of collective organization, a principle not reducible to the action or instincts of a single organism, but an emergent drive from which all compound 'gain' or optimization can be derived."

—Sanford Kwinter [1]

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INTRODUCTION: PARAMETRIC NOLA

It has become rather apparent that recent computational developments and the consequent implementation of parametric design strategies have altered our traditional understanding of architecture. Extensive research on new emerging materials, renewable energy, and ecological design issues have created a fascinating yet speculative design culture that has put major emphasis on those provisional modes of architectural production that offer rather unconventional approaches to avoid a rather nostalgic return to traditional schemes.[2]

Because of this extensive and persistent use of new digital tools, architectural and urban production has been looking into complex self-organizing systems that require a much higher level of conceptual and methodological hybridity. This rather morphogenetic process rejects the implementation of traditional planning design strategies such as functional zoning or socioeconomic growth management, while it promotes the application of complex algorithmic and non-linear approaches that address dynamic complexity typical of urban apparatuses. Indeed, the contemporary city appears to be very rhizomic in its internal and organizational structure where heterogeneous assemblages are connected via networked associations.[3] Within this framework, it is apparent that the design of urban settlements ought to originate from what Manuel DeLanda calls "*the emergence*

of novelty," or the capacity for the urban to morphogenetically adapt to the existing infrastructural and ecological background.[4] In order to understand this new generative praxis, we have to discard any preconceived understanding of traditional urban models that generally focus on goal-setting rather than strategy formation,[5] while we should focus more on the implementation of active models informed by what Patrik Schumacher calls "*the creative exploitation of parametric design systems in the course of articulating increasingly complex social processes and institutions*."[6] The ultimate goal is thus to create a symbiotic urban system that receives, records, and processes human feedback while generating morphogenetic solutions consistent with some of the dynamic and evolutionary qualities of the framework itself.

How can these new processes help us design more responsive and adaptable cities? While considering the current and rapidly increasing levels of urbanization, it is opportune to take into account that throughout the history of our discipline, architects have always tried to optimize strategies and processes of urban growth, to make cities more controllable and also more adaptable to socio-political and economic changes.[7] From Ledoux's ideal city of Chaux, to Howard's Garden City; from Leonidov's project for Magnitogorsk, to Le Corbusier's Ville Radieuse, utopian or not, cities have been planned and designed to control social, economic and political situations, deliberately avoiding any heterogeneous and morphogenetic conceptualization of urban form. More specifically, a study released by the International Federation of Surveyors in January 2010 showed that most of the currently existing 19 megacities share severe ecological, economic, and social problems relative to their lack of formal planning strategies that address specific regional, environmental, and climatic conditions.[8]

A QUESTION OF PEDAGOGY

Thus, in order to deviate from this orthodox methodology, my paper will analyze the work produced in ParametricNOLA, a computationally driven urban design studio taught during the fall quarter of 2011. While recognizing that the idea of parametricism, as formulated by Patrik Schumacher, indeed offers an aesthetically driven methodology based on formal exuberance,[9] the studio's main pedagogical premises were based on the idea that the design of urban settlements needs to look into new generative models characterized by heterogeneous feedback and morphogenetic adaptability to regional and climatic changes to generate new urban growth and more dynamic and adaptable city models.

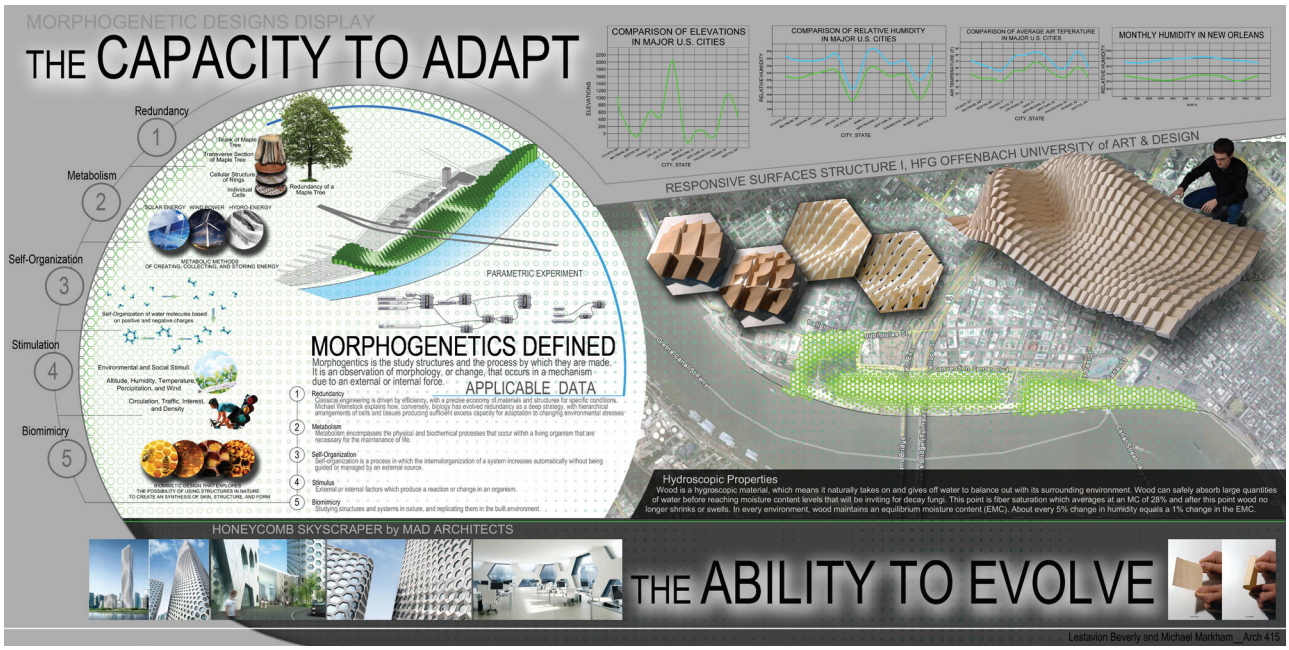
To investigate the significance and applicability of these new methodological and pedagogical premises, I looked into the possibility of integrating a basic computational praxis into a senior-level design studio that reconsidered and partially challenged its NAAB Student Performance Criteria, which seemed to recommend a very limiting and repetitive operational framework. The opportunity was materialized by a design competition sponsored by eVolo® Architecture, a progressive magazine led by a group of designers that had created a forum promoting and debating speculative

developments in architectural and urban design in the twenty-first century. In its specifics, the competition examined the future of urban skyscrapers in the current parametric age of production, and it has been ongoing since 2005. However, while designing a skyscraper remained the final scope of this design studio, the specificity and magnitude of particular climatic changes relative to the region of our studies, the New Orleans metropolitan area, essentially required us to re-think the entire urban palimpsest relative to the area of architectural operation, creating for us an opportunity to generate new models of urban growth. Furthermore, as the project investigated issues relative to costal developments and global climatic changes, it became rather evident that while certain costal urban settlements are constantly susceptible to catastrophic territorial changes brought on by extreme weather conditions, their relative ecosystems have showed very minor morphogenetic modifications, actually generating subsystems of species that formally, functionally, and structurally are completely respondent to those dramatic climatic conditions typical of the region of study.[10]

It also seems that parametric approaches address the use of alternative computational methodologies in challenging established architectural regimes of signs. In fact, while a traditional architectural signification has limited our inherent possibilities for progressive approaches, 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 architecture topologically rather than typologically. Additionally, computational systems applied to architecture tend to provide, theoretically, a better long-term survival in constantly changing urban environments and responsiveness to unpredictable climatic conditions.

One may ask, for instance, whether human beings can truly create something novel, or if humanity is simply realizing previously defined technological possibilities. Indeed, the question of the emergence of novelty is central not only when thinking about human-developed (physical and conceptual) machinery, but more generally, the machinery of living beings as developed through evolutionary processes. Can anything truly different emerge in the course of evolution or are evolutionary processes just the playing out of possible outcomes determined in advance?[11]

Parametric-associative platforms have the ability to facilitate and simulate evolution of design processes based on algorithmically organized urban components, producing new emergent solutions (emergence of novelty). Most of this theoretical framework is underlined by diagrammatic models that deterritorialize the meaning of architectural design, to allow for more flexible solutions. Moreover, the computational process can also localize and transfer properties and processes involving complex hierarchical systems into basic algorithmic modules that can be connected to specific emerging urban models. Hence, to fit its ideological premises, the studio pedagogy was articulated around four different phases: research, parsing/mining, representing, and interacting. As part of a collaborative studio agenda, the students had to pair up and work in groups. Initially, each research team had to propose a



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speculative reading of the site by investigating how complex urban systems respond to very specific climatic and environmental conditions. To do so, the students had to analyze certain ecological patterns generated by extreme climatic conditions, which they began to scrutinize and manipulate via the use and application of non-linear algorithmic models and adaptive scripts to produce more responsive urban interventions.

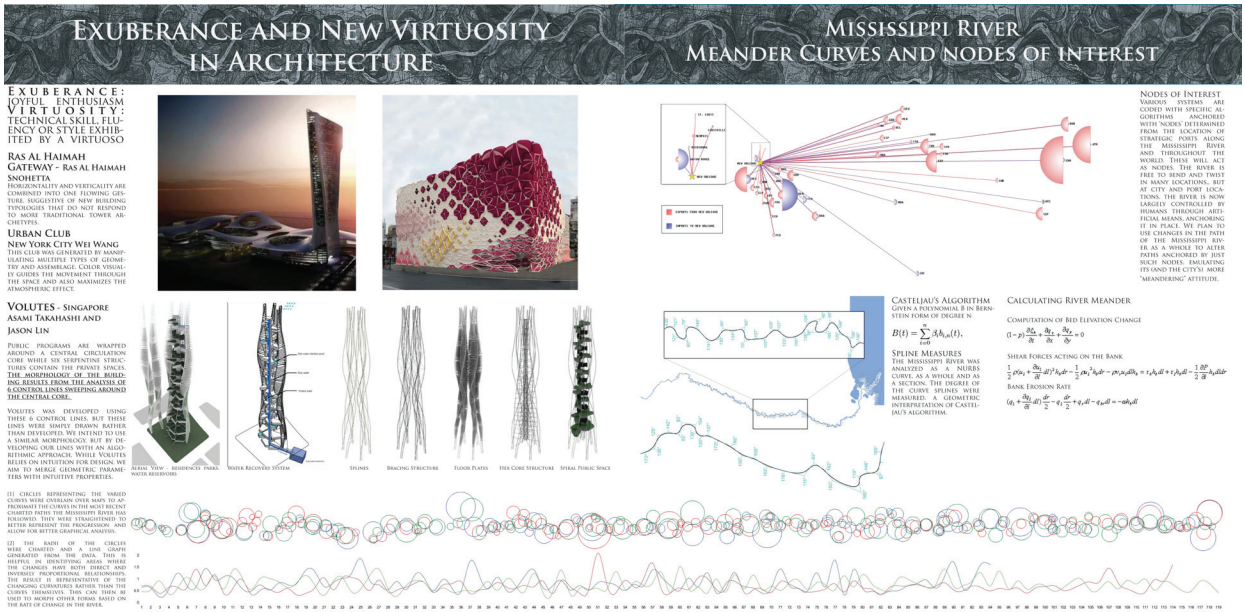
Through a process of data mining, urban feedback was collected and sequentially analyzed to generate tangible contextual data. The same information was then algorithmically parsed in Grasshopper®, and Ghx definitions were generated to redesign parts of the plan. Thus, a series of evolutionary projections of the site were articulated by proposing speculative scenarios that could become proposals for future urban growth through morphogenetic selection, accentuating the importance of field correlations existing between urban fabric, open public spaces as well as the infrastructural systems that connect them (Figure 1).[12]

EMERGENT FRAMEWORK

> We pursue the parametric design paradigm all the way, penetrating into all corners of the discipline. Systematic, adaptive variation, continuous differentiation (rather than mere variety), and dynamic, parametric figuration concerns all design tasks from urbanism to the level of tectonic detail, interior furnishings and the world of products.[13]

ParametricNOLA's major ideological framework is based on the understanding that cities grow and behave like biogenetic organisms, and thus need to be understood as such. In my personal and academic research, I have always been interested in the way cities respond to complex dynamic inputs (topological and ecological) that tend to create specific emergent models

Figure 1: Michael Markham and Lestavion Beverly | The Capacity to Adapt, The Ability to Evolve



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of urban growth. Within this framework, it is important to look at the concept of emergence, which throughout this paper is understood as the way complex systems and patterns arise out of a multiplicity of relatively simple interactions.[14] Emergent architectural and urban structures appear at many different levels of organization or as spontaneous order. Emergent self-organization also appears frequently in cities where no planning or zoning entity predetermines the layout of the city.[15] This approach required a major understanding of differentiated structures and complex morphogenetic theories as they inform the recognition of variations, yet if we can summarize the results of this process of codification, then we should be able to classify those elements of spontaneous order by specific genomic types.

However, rather than creating a static list of architectural or morphogenetic traits, 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 bio-ecological analogues (Figure 2).[16] Physical notations were essentially used to generate multiple urban diagrams that did not translate meaning, but instead, transposed it by displacing traditional conventions. Yet, before analyzing the urban hypothesis of my design studio, I believe that it is important to look at those processes that generate the rules of formation to understand how certain morphogenetic rules might arise.

Figure 2: Kris Kepner and Kristen Caulk | Mississippi River Meander Curves and Nodes of Interest

GENERATING THE RULES: NATURE AS COMPUTATION

To generate the primary architectural modalities of operation, our first assignment examined the notion of climatic agents, morphogenesis, and territory. While territory is intended as the place that inhabits and encourages architectural transformations and topological mutations, morphogenesis is understood as the underlying mechanism that explains the emergence and formation of specific structural systems defined by

particular forms and shapes.[17]

While looking at the territorial stratification of our region, we recognized that the Louisiana territory recasts architecture with a dynamic relationship to its ecosystem and its environment, which is strongly characterized by invasive climatic agents that have altered the definition and morphology of the territory itself. This approach is in line with recent preoccupation with nature and biology in architecture as outlined by several issues of AD (see Scarcity: Architecture in an Age of Depleting Resources Digital Cities, Typological Urbanism, and Versatility and Vicissitude: Performance in Morpho-Ecological Design). It is also clear that the contemporary obsessions with biological and biomimetic studies has been particularly emphasized by the increasing use of parametric tools and other scripting devices. This has also created a new methodological context dictated by a systemically driven praxis that we had to analyze by way of identifying biological, climatic, and ecological models typical of the Louisiana/Mississippi Gulf Coast region.

Thus, student-led research groups looked into contextual emergent and biological models typical of areas affected by extreme weather conditions such as hurricanes, tropical storms or depressions, which are characterized by precise pattern-recognition processes. Conceptually speaking, patterns enable prediction; pattern formations, which are often characterized by a sometimes-microscopic structure, follow a clear mathematical logic of arrangement, which may indeed represent the best probability for urban survival. Furthermore, form does not arise from complexity or chaos, but instead it arises from a very contingent system based on the most basic mathematical and physical laws that explain pattern-making processes.[18] Through the use of diagrams, sketches, and computational models, the students reconstructed the principles and rationale of pattern formations. Those principles were then summarized by a specific mathematical procedure that was eventually tested in Grasshopper®. The outcomes of this first research assignment dictated the nature of some of our final design approaches by way of unfolding and understanding the relevance of existing biological, ecological, and climatic patterns relevant to our site and its ecological, environmental, and topological characters. The research phase effectively created notational systems that would describe a work yet to be realized; essentially, a Deluzian diagram.

DETERRITORIALIZING THE PLAN

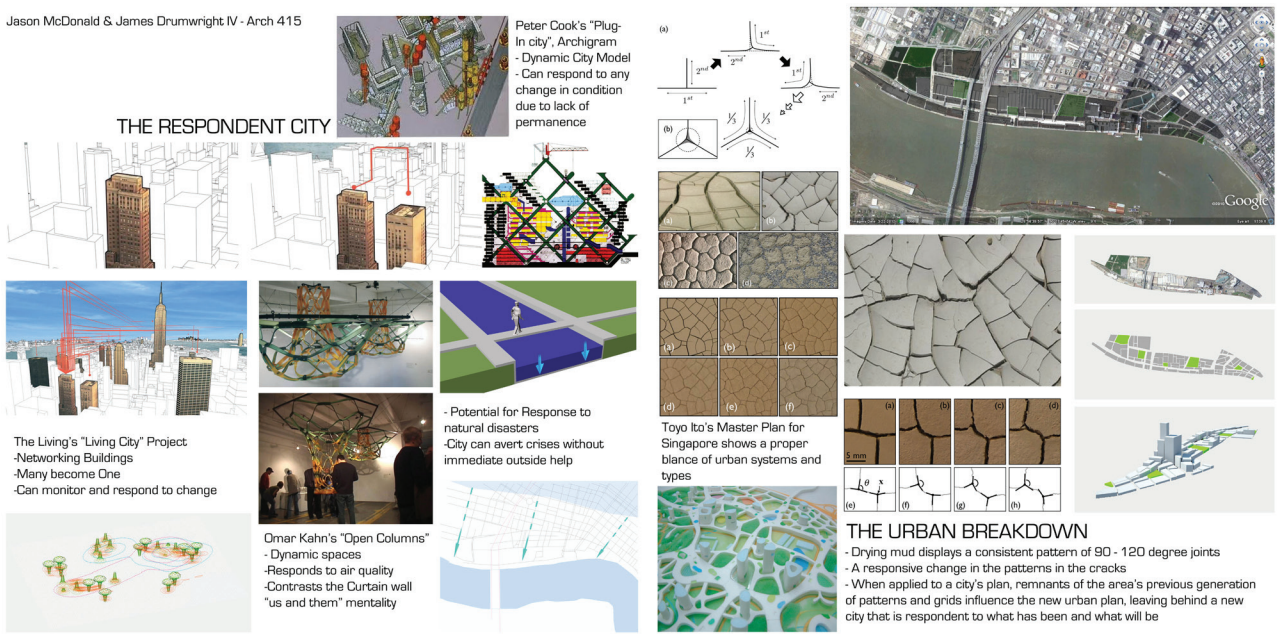
> How could movements of deterritorialization and processes of reterritorialization not be relative, always connected, caught up in one another? The orchid deterritorializes by forming an image, a tracing of a wasp; but the wasp reterritorializes on that image. The wasp is nevertheless deterritorialized, becoming a piece in the orchid's reproductive apparatus. But it reterritorializes the orchid by transporting its pollen. Wasp and orchid, as heterogeneous elements, form a rhizome. It could be said that the orchid imitates the wasp, reproducing its image in a signifying fashion (mimesis, mimicry, lure, etc.).[19]

In the second and third stage (parsing/mining and representing), student groups had to analyze a large urban site, which is located in New Orleans, adjacent to the Central Business District (a subdistrict of the French Quarter), the Iberville Development (north), the Lower Garden District (south), the Mississippi River (east), the Tulane/Gravier (west), and the Central City (south). Interestingly enough, a masterplan for our site already existed (see Crescent Masterplan led by architects George Hargreaves, Michael Maltzan, David Adjaye, and Allen Eskew of Studio EDR). The students looked at its major guidelines and proposals, and had to critically respond by forming new alternative solutions to a plan perhaps too much centered around traditional solutions that offered no contingent adaptability to some of the climatic and ecological concerns present in the area.

The site is also characterized by several landmarks such as the World Trade Center, the Audubon Aquarium of the Americas, The Ernest N. Morial Convention Center, and the Riverwalk Marketplace. Those components, as well as the regional, ecological, and environmental elements such as the Mississippi River and the proximity to the Gulf of Mexico, were all kept into consideration while parsing speculative proposals. Within this process, the students had to propose a series of tactical design approaches that challenged the traditional and regimental nature of the existing physical master plan, seeking valid alternatives to produce adaptable solutions (deterritorialization). To do so, they used computational systems capable of addressing multiple and constantly changing variables. This process accounted for a new relationship between programmatic zones and infrastructural systems, creating new scenarios perhaps more relevant to the site's internal structure (both architectural and ecological).

Taxonomic classification was one of the tactics implemented. Taxonomy is generally defined as a strategic classification, arranged in a hierarchical structure. Typically, this is organized by supertype-subtype relationships, also called generalization-specialization relationships, or less formally, parent-child relationships. In such an inheritance relationship, the subtype by definition has the same properties, behaviors, and constraints as the supertype plus one or more additional properties, behaviors, or constraints.[20] Students also looked into other interdisciplinary approaches to generate a more reasoned and articulated methodology. This procedural investigation essentially underlined those generative processes that show differences and changes over time.[21] Those variations were then analyzed in terms of morphogenetic changes, which become more evident through the study of the local urban fabric.

This system of conceptual and disciplinary deterritorialization through biogenetic and ecological analogues was particularly explored by looking at how complex systems adapt. Urban tessellation, hair dynamics as extension of existing urban and ecological flows, and water-driven resilience models were all analyzed to construct more speculative solutions. While classification provided the hierarchical layout of the possibilities available, computational devices based on generative algorithms allowed us to actually implement those modalities in the form of design definitions, which

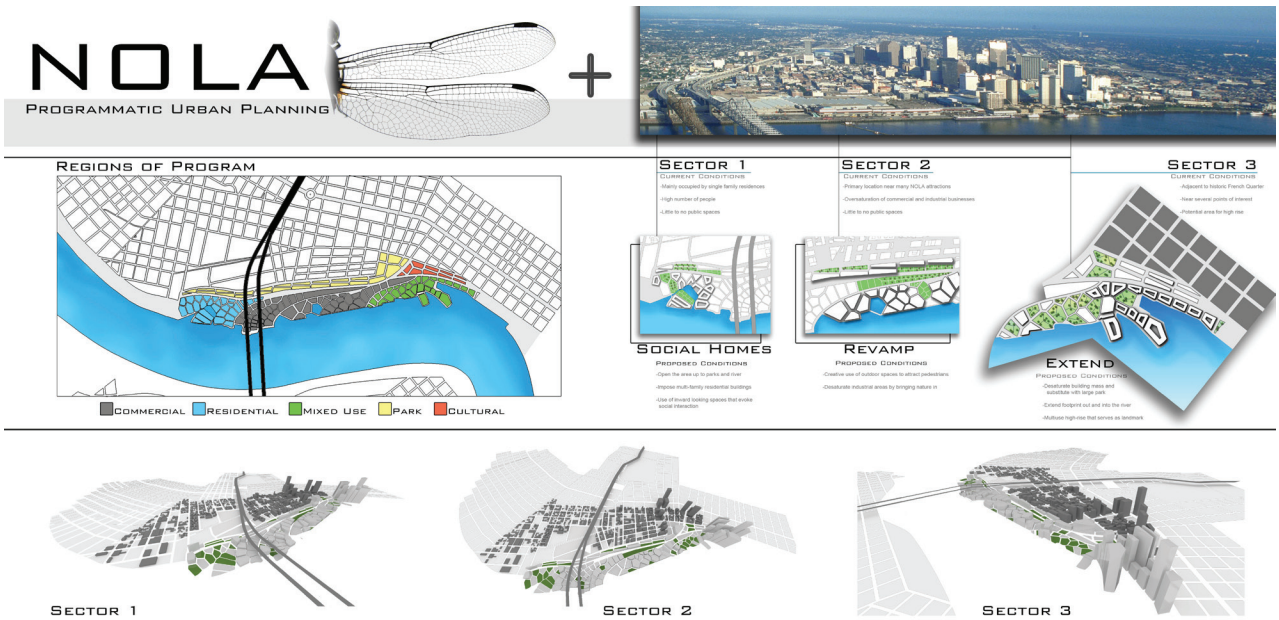


embodied biomimetic complexity proposing solutions more consistent to the climatic character of the region. As part of the didactic framework, the students ended up developing speculative urban solutions relative to an area within the New Orleans metropolitan region.

In the Respondent City, Jason McDonald and James Drumwright looked at the work of Peter Cook of Archigram and the Plug-in City as a way to understand how cities can develop or respond to any change in conditions due to the lack of permanence. Their study, thus, proposed a methodology that looked into the morphogenetic qualities of dried mud cracks, which happen to show respondent grid-like patterns that maintained precise morphological and porous qualities even after major flood. This proposition showed that particular issues of networked connections, when effected by specific climatic exposure, can be predicted through the implementation of a system that follows specific mathematical rules, and that can self-regulate and also regenerate in its organizing structure while providing some sort of ecological adaptability through algorithmic repetition. Within this outline, particular building types were schematically developed to reinforce the morphogenetic nature of the framework, creating settlements that would reflect the mathematical qualities of the plan, and that would be rapidly produced because of their implicit geometric qualities.[22]

In Dragonfly Urbanism, Michael Markham and Lestavion Beverly investigated the morphogenetic qualities of the Voronoi diagram and the dragonfly wing pattern by looking at the work of D'Arcy Thompson, who, in *On Growth and Form*, had already addressed the mathematical and geometric nature of growing cells, stating that form does not arise from the irrationality of chaotic systems, but it arises from the most basic mathematical and physical laws of material aggregation.[23] In fact, the Voronoi tessellation

Figure 3: Jason McDonald and James Drumwright | The Respondent City



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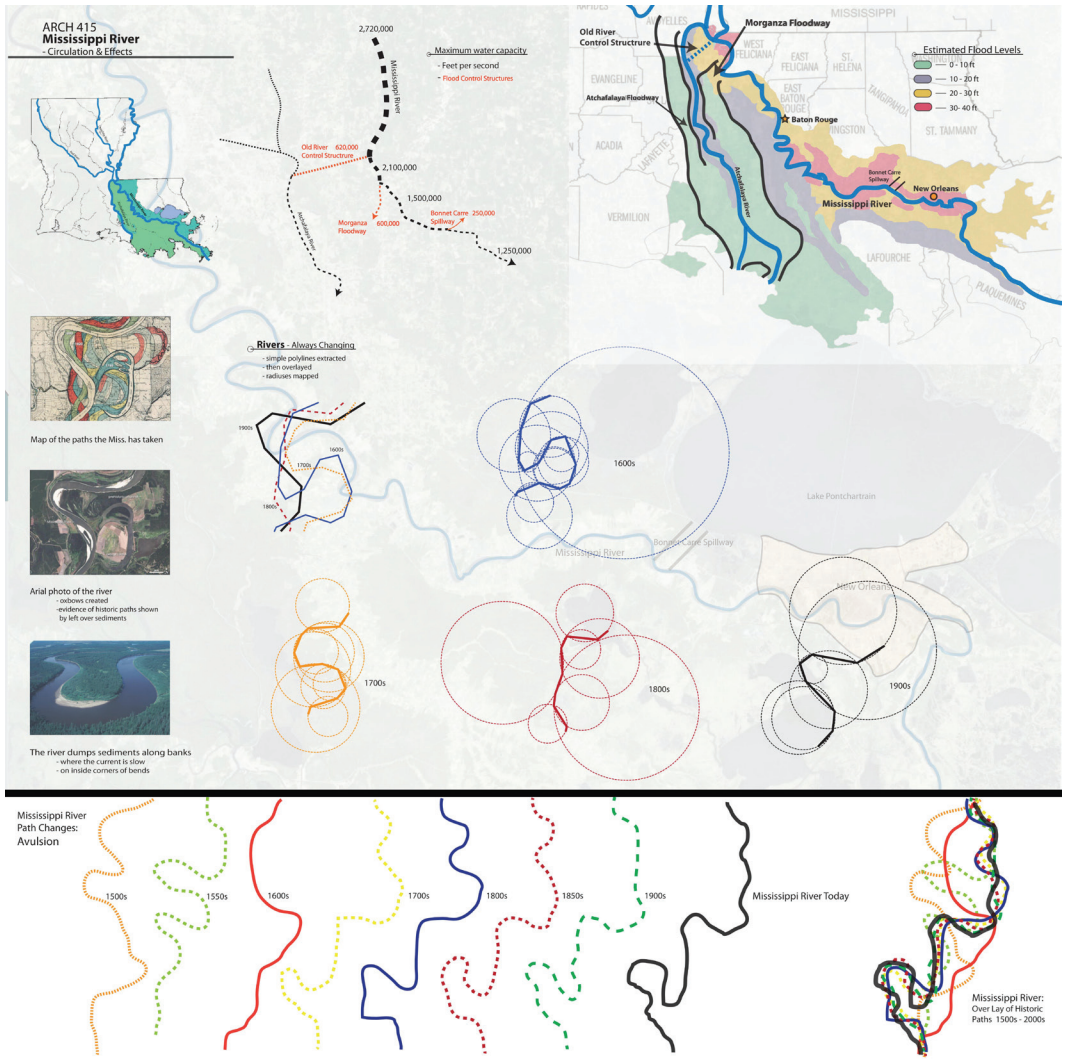
and the dragon fly wing both show a rather complex organizational system based on the interaction between primary and secondary systems, which are intrinsically and closely related. Interestingly enough, these systems can be reapplied at the urban scale to create a more integrated network of infrastructures and new urban fabric. Based on critical reading of the work of D'Arcy Thompson, the students observed that cells between two ribs could be quadrangular in shape mimicking the nature of the existing urban plan in New Orleans. Additionally, when two rows of cells appear to be inscribed by two ribs, their adjacency is determined by a 120 degree angle, while when the distance between ribs increases, the cells assume hexagonal shapes that share a coequal 120-degree angle.[24] The final results proposed an urban solution characterized by a spatial subdivision that allowed for morphological sophistication, hierarchical organization, resistance and consequent adaptability to regional climatic variations. In this case as well, certain morphological qualities can be expected. This certainly provided another adaptable framework that, because of its mathematically regulated logic of morphogenetic formation, could be rapidly produced.[25]

Other interesting solutions analyzed the provisional qualities of protocellular organizational patterns applied to existing urban environments, which appear to progressively and symbiotically fill existing urban voids generated by intense climatic agents while keeping their potential to be programmed to sense environmental changes. The morphogenetic study of the Mississippi River, to predict territorial variations relative to major floods through the study of the Casteljau's Algorithm as a methodological analogue, was analyzed to provide a suitable framework that would investigate and evaluate morphogenetic variations of specific urban flood zones over the last 200 years.

Figure 4: Michael Markham and Lestavion Beverly | Dragonfly Urbanism



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Interestingly enough, a few of the solutions produced by the students showed some thought-provoking qualities—mostly systemic and methodological—while other less successful proposals superficially negated the ecological framework, creating a simplistic repertoire of digi-bio-techno ornamental models.[26] However, considering the time limitations imposed by a quarter-based system, the students ended up identifying specific significant systems and methods of interpretation that addressed issues relative to rapid urban growth that did not necessarily privilege typical planning strategies. The work displayed, while expectedly too formal, also uncovered some of the positive qualities of certain speculative methodologies, which emphasized important territorial and behavioral qualities that included authenticity, hybridity, connectivity, porosity, and vulnerability.[27] Altogether, those behaviors ended up creating a speculative, and perhaps more consistent, urban approach, which, rather than proposing a static model based on procedural segregation, was based on the full integration of architecture and ecology, people and nature.

Figure 5: Zach Culpepper | Morphogenetic and Evolutionary Study of The Mississippi River

CONCLUSIONS

This paper has addressed the implementation of a parametrically driven urban studio as an alternative pedagogical examination of current issues related to the adaptability of a certain speculative proposition of rapid urban growth typical of ecosystems exposed to extreme climatic conditions. Most of the work produced in my urban module was organized to construct a clear methodological process based on the comprehensiveness of computational strategies as a way to avoid preconceived morphological solutions.

While looking at specific contextual conditions, it became rather clear how the necessity of rapid urban growth forced the local New Orleans Housing Authority to seek developments in areas that were not ecologically compatible with dense residential urban developments.[28] Indeed, this process of superficial urbanization contributed to some of the major complications triggered by specific climatic agents (Hurricane Katrina and Rita for example). Thus, the complexity and heterogeneity of urban apparatuses undeniably requires the transposition and use of different methodological approaches, which, rather than addressing static processes typical of traditional planning, investigated the implications and uses of new design tools through a research-based analysis characterized by speculative approaches and nonlinear computational design strategies that converge more on the importance of concepts such as rapid adaptability, and urban resilience applied to particular contextual ecologies.

Considering the intricacy of this methodological framework, we have the obligation to look at alternative models that offer more contingent approaches to rapid growth, but most importantly we need to avoid a return to those strategies that have failed to adapt to the increasing magnitude of particular regional climatic agents. While looking at the Mississippi and Gulf Coast Region, ParametricNOLA has shown that the implementation of computational design strategies applied at the urban scale can facilitate processes of differentiation and ecological integration through the establishment of a morphogenetic practice that uses biomimetic procedures typical of the region of analysis as a way to create more responsive models. While this proposition certainly offered a methodology perhaps too anchored to a narcissist form of parametricism, it also proposed some interesting procedural guidelines that were indeed more contingent with the extreme territorial conditions typical of particular ecosystems intensely exposed to progressive climatic changes.

As in any methodological praxis, the design rationale has to be articulated so that the final product is always informed by some sort of critical procedural feedback; the didactic agenda of ParametricNOLA has tried to construct a procedural framework based on the integration of research and design modules so that the end results can always be rewired and redesigned by reformulating its initial ideological premises. I believe that while computational and algorithmic processes have absolutely created a new aesthetic exuberance, they have also opened up the field of possibilities inherent to the progressive design of rapid urban settlements. Cities are

complex and articulated organisms located in specific territorial contingencies characterized by dynamic ecological and climatic variables. To design more respondent cities and to address issues of rapid urban growth, we need to discard old processes that favor territorial and ecological discrimination by way of homogeneity, while we ought to refocus on the use of computational strategies, which seem to propose a systemic approach more compatible with contextual urban ecologies. Ultimately, we can only phase out common design preconceptions through clear opportunistic and speculative visions. ◆

ENDNOTES

1. Johan Bettum. *"An Interview with Sanford Kwinter: Communication as Cosmology,"* Staedelschule Archive, (2003), 2-9.
2. See Brett Steele, "Ironies, Impracticalities, and Ecologies," in *Environmental Tectonics: Forming Climatic Changes*, Edited by Steven Hardy, (London: Architectural Association Publications, 2008), 8.
3. Gilles Deleuze, Felix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia*, Trans. By Brian Massumi (Minneapolis: University of Minnesota Press, 1987), 10.
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5. See Henri Lefebvre, "The Specificity of the City," in *Writing on Cities*, (Malden, MA: Blackwell Editing, 1996), 100.
6. 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.
7. Kenneth Frampton. *Modern Architecture: A Critical History (Fourth Edition)*, (London: Thames & Hudson, 2007), 12-15.
8. See *Rapid Urbanization and Megacities: The Need for Spatial Information Management*, a research study by FIG Commission 3, (Copenhagen, 2010), 7.
9. See Patrik Schumacher, *Parametricism as Style - Parametricist Manifesto*, Patrik Schumacher, (London, 2008). The Manifesto was presented and discussed at the Dark Side Club, 11th Architecture Biennale, (Venice 2008).
10. See Robert Twilley, *Coastal Wetlands & Global Climatic Change*. The report was prepared for the Pew Center on Global Climate Change in 2007.
11. Manuel DeLanda, "The Machinic Phylum," in *TechnoMorphica*, (1997). Also, see Brain Massumi, *A User Guide to Capitalism and Schizophrenia*, (Cambridge, MA: The MIT Press, 1992), 12-13.
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13. See Patrik Schumacher, *Parametricism as Style - Parametricist Manifesto*, Patrik Schumacher, (London, 2008). The Manifesto was presented and discussed at the Dark Side Club, 11th Architecture Biennale, (Venice 2008).
14. Michael Weinstock, *The Architecture of Emergence: The Evolution of Form in Nature and Civilization*, (London: John Wiley & Sons, 2010), 10.
15. Ibid, 12.
16. This process was thoroughly investigated by Frei Otto, who sought thought the study of biological analogues a possibility to understand territorial developments with particular references to human settlements. See Frei Otto, *Occupying and Connecting*, (London: Axel Menges Edition, 2009).
17. David Gissen, "Territory: Architecture Beyond Environment," in *AD: Territory*, Vol. 80, No. 3, (May/June, 2010), 8.
18. See Quentin Meillassoux, *After Finitude*, (London: Continuum, 2008), 5. Also see Graham Harman, *The Quadruple Object*, (Washington, USA: Zero Books, 2010), 15.