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Grafting Interiority: Generative Methodologies Between the Natural and the Synthetic

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Abstract

Design is approaching a crucial period where the exchange between interior and exterior systems needs to be rethought and addressed from the standpoint of resilience and innovative environmental responses. The era of the detached interior bubble that is climate controlled and therein severed from natural systems is no longer justified or feasible. Interior spaces must respond to environmental conditions and proactively engage natural systems. The paper examines grafting methodology as an interior spatial formula that aims to generate complex sectional strategies for new programmatic typologies. It showcases work from a third-year interior architecture studio where students utilised natural landscapes as the premise to develop generative computational models that informed their design interventions.

While placing interior interventions between natural and synthetic processes, interior grafts outline a design tactic that challenges the disjunction between internal settings and external parameters. The potential to draw relevance from external parameters and integrate the derivative systems into the interior volume carries many implications for interior architecture and urban dynamics. This approach demarks a radical repositioning of the interior volume as a continuation of the exterior scape, proliferating a fluid and active interiority.

Keywords: interiority, grafts, fluidity, natural, synthetic

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Introduction

In its most basic sensibilities, interior space implies an enclosure, a calculated separation from the natural and the human-made elements. This severance between exterior and interior is established only to be revoked in various allowances through occupancy spaces. Conventionally, managing the exchange between exterior and interior has been dependent on generic architectural components such as floors, openings, and walls, with some consideration to materials and finishes. Within these parameters, the interior volume remains segmented from the exterior while offering a juxtaposed uniform flatness to the topographic variances of the landscapes it occupies.

Interior grafts (Figure 1) represent a design framework that challenges this disjunction between exterior and interior topographies while offering landscape extension as opposed to its severance as an operable design method. Here, the extension is not only in the conventional sense of aligning views, but also in exploring interior spaces' tangible topographic possibilities. Activated through sectional explorations and understood as a grafting process, the resulting interior topographies challenge the flatness of surfaces to which interior spaces have commonly resorted. This is not to say that the focus entirely rests on generating formal 'cave-like' settings or that the notion of topography translates directly into its synthetic counterpart or counterfeit, to be more precise. Instead, this is an endeavour to foster a fluid exchange between exterior and interior territories. It invites an active extension of the contextual parameters of setting and place into the interior spatial volume (Figure 2) instead of cutting them off or limiting the exchange to visual connection.

Grafting Interior and Exterior

In horticulture, grafting depicts the act of integrating one plant into another, forming a union where the two partners continue to grow together (Encyclopaedia Britannica, n.d.). Similarly, in architecture, the concept can be employed toward joining an interior spatial system to an existing volume/context, thus, grafting the interior system into the existing setting to arrive at a unique and dynamic formation. The grafting process establishes a design tactic that challenges the disconnection between internal and external parameters, establishing a continuum where a symbiosis exists between the interior graft and its site. This understanding of architectural intervention was highlighted in Catalonia's proposal for the 2014 Venice Biennale of Architecture titled Grafting Architecture. Through showcasing several adaptive reuse and restoration projects, the exhibit shed light on grafting as a design modality where new forms are grafted into existing contexts,

resulting in hybridised constructs more vigorous than either of the originals on their own (Torrents i Alegre et al., 2014).

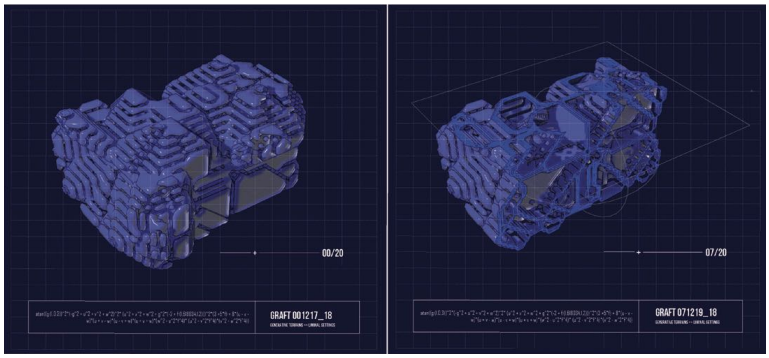

Figure 1
Example of an interior graft: A porous spatial system receptive to external conditions (Image by author)

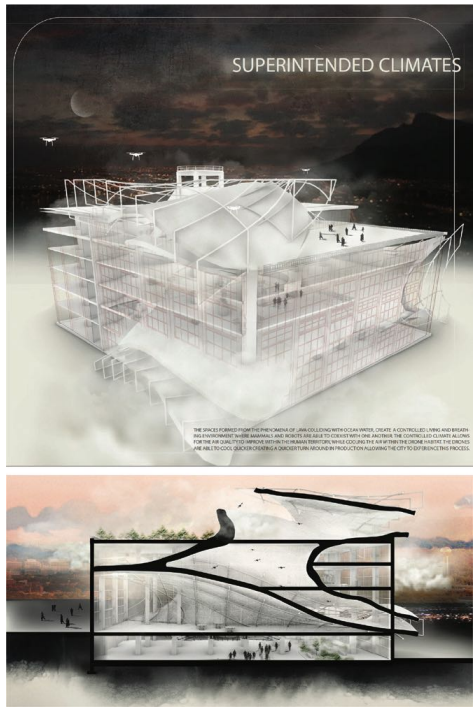

Figure 2
Student work by Julie Lucas. Interior intervention integrating external setting within the internal volume (Image by author)

Influential designers and theorists such as Verner Panton, Claude Parent, and Paul Virilio employed the notion of interior architecture as an act of intervention that bonds with the existing settings and issues in new contextual parameters. While understanding the inherent potential of interior systems and their impact on the base structure, Verner Panton embedded complex interior topographies into often static settings. This can be seen in his work for the Spiegel

House, Hamburg. The fluid and vibrant interior forms grafted into the rigid concrete structure of the Spiegel building resulted in a dynamic contextual interplay. Panton's work has challenged the ways occupants see and interact with the interior as his spatial topographies activate not only the floor plane but the entirety of the interior volume (Burroughs, 2018). Claude Parent and Paul Virilio advanced a similar approach. Their Oblique Function Theory advocated for dynamic wall-less spatial systems composed solely by slanted planes. All spatial features and furnishings were incorporated within this interior landscape in an inclusive formal logic that fully engaged the occupants and activated their movements (Johnston, 1996).

Fluid Interiority and Contextual Dynamism

With its intricate systems and various social implications, the city offers prime testing grounds for the possibilities inherent in the topographic extensions of its context into the interior volume and vice versa. Movements such as the Situationists encouraged the city dweller to establish extensions to the urban context. Occupying the urban setting through what they labelled "psychogeographical drifting" (Picon, 2015, p. 128) allows, in essence, the flow of the occupants' interior selves into the city. While such approaches gained some traction in urban design, interior spaces have remained segregated from their sites and contexts, both figuratively and literally. The disconnection between urban thinking and interiority was the point of departure for this research. The studio aimed to establish a fluid exchange between urban and internal conditions. Pursuing such fluidity is not new. Technology in terms of computational tools and fabrication methods has enabled a relative fluidity in architecture formally. Nonetheless, its interior translations remain limited.

The integral factor in designing an interior fluidity is positioning interiority within the context of a flowing urbanity and understanding its situational bearing and social impact. In describing his approach towards a flowing urbanity, Claude Parent (in Alexa, 2016) states his occupation with not only fluid architecture but also an overall environmental dynamism where the flows of people are continual. He states:

> My drawings are not only about fluidity in architecture; they are also about migration—a future civilization of migration based on permanent traveling all over the world, people circulating on massive roads that transform into cities and buildings where people can come and go. … I believe that we should no longer build walled cities, closed upon themselves by their own territorial boundaries, protected

> by insurmountable defenses. Let's unfurl onto the Earth passages that billow like continuous ribbons (Grau & Zahm, 2013, paras. 42–43)

Building on such theories that propagate formal fluidity and contextual dynamism was the basis for developing parametric interior spatial devices in the studio. The devices are derived from and respond to environmental attributes while hosting micro settings within their folds and crevices. These formations (Figure 3) were understood as spatial elements to be grafted into the urban setting.

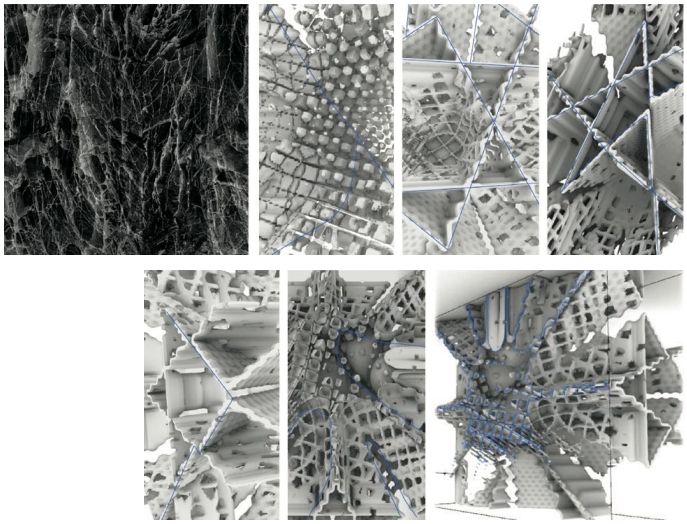

Figure 3
Student work by Megan Lange. Derivative formal studies of an interior system based on the analysis of fault lines (Image by author)

The interior graft is not a final product; on the contrary, it merely seeds territories that operate in open systems. "An open system is defined as a system in exchange of matter with its environment, presenting import and export, building-up and breaking-down of its material components" (Bertalanffy, 1973, p. 141). This conceptual formula caters to a unique contextual vitality extending external parameters (ecological and sociological) into the interior volume, allowing both to grow in a non-linear manner. To better understand the application and relevance of this interior design method, the process was tested through multiple iterations in the context of the studio utilising generative computational tools. Such alchemy enabled the integration of research and experimentation. It allowed for the formal and theoretical implications of grafting interior spatial systems to be tested as both an operative spatial formula and a conceptual theorem. The developed method illustrates the complex relationships interiority engenders on architecture's various levels of engagement and exchange.

Interventions Between the Natural and the Synthetic

Grafting is a complex process that depends on precise splicing and implanting to succeed. Within the interior, the method takes on similar qualities. The potential of drawing relevance conceptually and formally from external parameters and then integrating them into the interior volume carries many implications. Chief among them is a radical repositioning of the interior volume as a continuation of the exterior scape instead of vacuity. The spatial graft is then allowed to grow within the interior; together, the transplanted form and the base space propagate new spatial topographies. This process calls for an essential shift (Figure 4) from the standard interior treatments and claddings that have often played heavily in the assessment of interior architecture. An interior, as such, accepts adaptation, not mere changeability of its parts. It boasts traces of use, thus establishing site-specific registries. Such an approach suggests that the architecture of the interior is never autonomous, rather dependent on the milieus it occupies. Furthermore, fluid reciprocity between exterior context and the interior setting is requisite to maintain a productive dialogue and pertinence between the two entities.

Figure 4
Student work by Megan Lange. The resultant design intervention based on grafting studies in Figure 3 (Image by author)

This coevolution of sorts needs both entities to subsist and thrive. While such an analogy draws from natural processes, it is not altogether natural. It is positioned at the intersection of the natural and the synthetic. In the article, Ecology beyond Nature, Pasquero and Poletto (2014) refer to such operations as biocybernetics or biohacking. They explain design biohacking saying:

> It is not about us humans copying [natural systems] to design a new breed of manmade technologies but rather us humans understanding the dynamic mechanisms underpinning such problem-solving machines of "nature" to hack them, to connect directly to them to establish immediate relationships between observed natural systems

> and observing manmade ones, or vice versa. (Pasquero & Poletto, 2014, p. 35)

Understanding the complexities of these interrelated processes requires a reassessment of how we gauge our environments in terms of cycles of dormancy and growth. A requisite reassessment accepts atrophy as an essential phase to the city's advancement while understanding that recovery depends on how we address the turnaround of the city's interior pockets. In this process, adaptive reuse is an indispensable ally, yet reuse often suggests a lacklustre response to interiority and open-ended site resolution. In contrast, interior grafts make a case for the adaptive redesign and rethinking of systems, both physical and abstract. The rethinking takes place amid consideration of the continuously emerging virtual and physical networks and their distinct coalesced ecologies.

The impact of virtuality on cities everywhere is well documented as it has been a fast-evolving reality for decades. In his book, *Smart Cities: A Spatialised Intelligence,* Antoine Picon (2015) situates this hybridisation at the centre of dynamic environments where individuals are inseparable from their surroundings largely due to increased connectivity and cybernetics. He further notes the extent to which this evolution is anchored in the contemporary human narrative (Picon, 2015). How do interior spaces respond to those hybrid realities where virtual and physical parameters overlap?

Toward a New Ethology of Spatial Occupancy

The studio set out to address interiority in the context of hybridised dynamic environments. It endeavoured to redefine the very aspects of spatial design, forsaking the typical conventions of compartmentalising space in favour of the design of mediating topographies. These topographies' reactive and responsive attributes to environmental parameters and user needs were the primary studio agenda. Informing this process was a rigorous examination and adaptation of systematic methods in nature. Looking closely at the composition of organic systems and their adaptive functions, students examined the behaviour and principles of natural systems (Figure 5). They employed their studies towards the formation of interior spaces. The objective was to provide a research-based analysis of such natural phenomena and devise methods to translate them into novel design strategies. This process became the catalyst for developing a synthetic construct consisting of topographic variances that cater to various spatial conditions. The synthetic topography defined the parameters for hybrid human ethology that is fully integrated with technology, responding formally and systematically to new realities of our daily

practices. We are moving towards a fourth industrial revolution characterised by a "fusion of technologies that is blurring the lines between the physical, digital, and biological spheres" (Schwab, 2016). As designers, we must take the primary authorship in deploying the framework for a hybrid built environment that works for collective well-being while harnessing the potential of this new world.

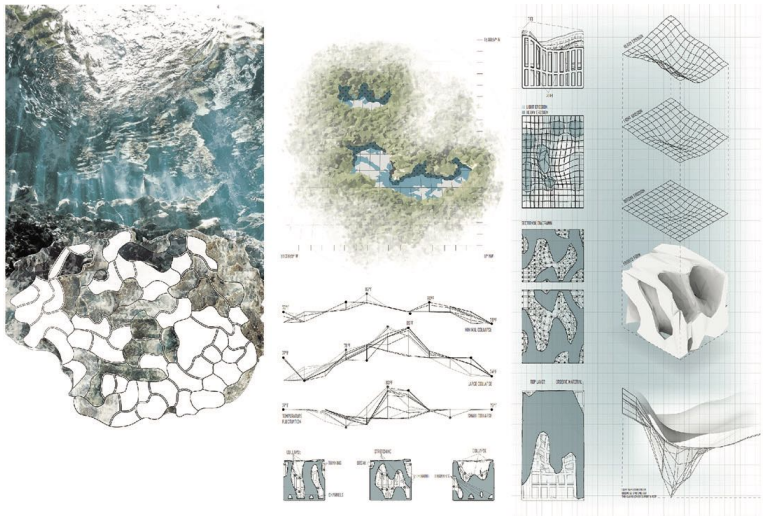

Figure 5
Student work by Danielle Lanier. A series of studies examining cenotes and their formal and ecological attributes, from which a formal system was derived. These conceptual grafts became the basis for the design intervention in Figure 6 (Image by author)

Interiority's aptitude for rebreeding space is perhaps among its primary agencies. There has never been a time when exercising such an agency is more integral. Within the purview of these parameters listed above, the studio sought to define new trajectories for augmented settings. Working with new programmatic typologies that address human/machine integration, the studio furbished existing structures with new adaptive interior systems. The cohabitation of mechanical/robotic constructs and humans in space challenges the architectural construct, as it does many aspects of life. In addressing these new programmatic realities, the aspiration was not merely to allocate volumes to each entity but to establish a new design paradigm where the spatial and functional exchanges are fluid (Figure 6). In order to achieve this fluidity, it was essential to devise a rich sectional language that allows for a more proficient conceptual and tangible exchange between the natural and synthetic to take place. Consequently, the studio had to engage in a creative process that looked outside the traditional boundaries of design and pursued new opportunities in material experimentation and novel tectonics. The studio project was carried out in three phases outlined and discussed in the forthcoming sections.

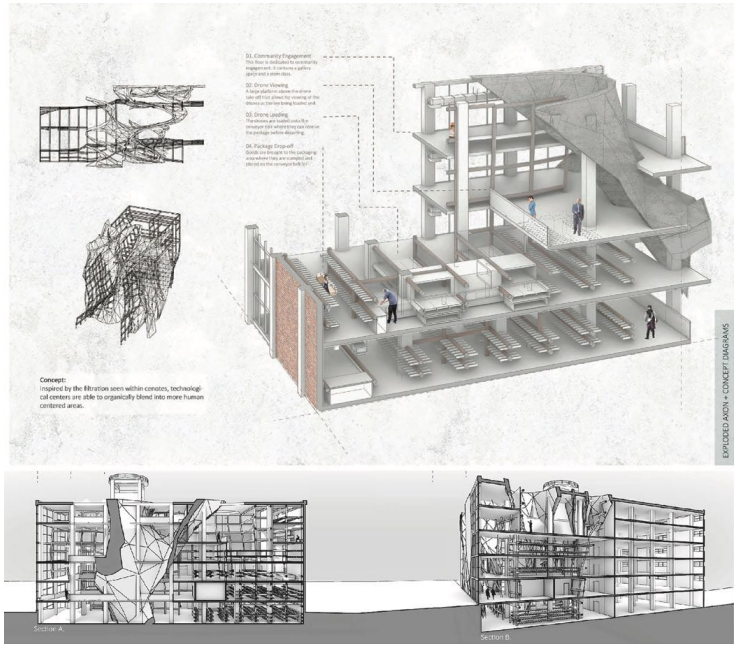

Figure 6
Student work by Danielle Lanier. The resultant design intervention is based on grafting studies in Figure 5. The transplanted interior grafts allow for fluid exchanges between the interior program and exterior context (Image by author)

Topographic variances in nature

Nature offers an array of diverse landscapes and various ecologies; some remain untouched wilderness while others are landforms with contemporary footprints. The biodiversity of these environments reveals a rich platform for research into natural artefacts. The studio's ambition was to rethink existing design methodologies and exploit the potential of cutting-edge technology to formulate an interior spatial strategy driven from a design research perspective towards the natural phenomenon. Thus, the first phase of the studio project investigated natural phenomena such as dunes, rock strata, rock bridges, canyons, and gorges, among other natural formations shown in Figure 7. Employing the principles and logic of natural systems, students designed an iterative material and formal palette that corresponded to a research-based understanding of how such formations occur in nature and find their translation in the design of the synthetic. The studies examined a range of topographic variances and their resultant ecologies. They further studied atmospheric conditions of these sites, such as light and sound permeability and temperature changes. This starting point allowed the students to step outside design processes they are familiar with when it comes to interior architecture and look at precedents that are not commonly associated with interior spaces. It was germane that this process gauged a natural starting point and merged it with highly technical mapping and modelling exercises. This amalgamation disputes the assumption that technology and

nature are two opposing forces and builds on employing natural models as instigators to advance a dynamic technology and design agenda (Brownell & Swackhamer, 2015).

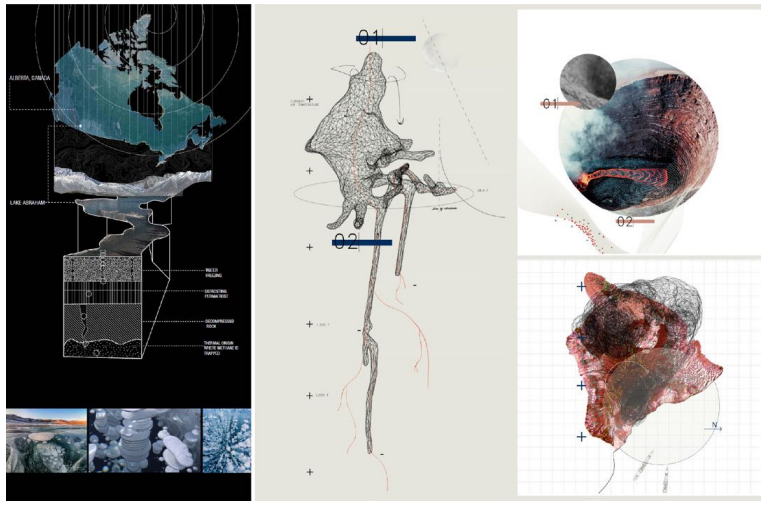

Figure 7
Student work by Julie Lucas and Lauren Podraza. Examples of natural systems studies. These studies serve as a premise for developing spatial strategies derived from natural models and employed in interior architecture interventions (Image by author)

Interior topographies as operative spatial strategies

In the second phase of the project, the resulting graphic traces and generative reproductions of the natural formation underwent an abstraction that distilled them down to complex spatial and topographic diagrams. The morphology of topographically complex landscapes, their underlying principles, and processes was investigated within a computational context. While working towards the development of algorithmically generated topologies, several technologies were utilised to produce the premise of interior sectional diagrams. These diagrams were understood as inverted landscapes, formulating the operative grafting for the main project. They reflected adaptive synthetic topographies yielding innovative spatial possibilities and occupancy patterns. To build an understanding of interiority as a graft, students implemented these topographies within the constraints of a structural grid that juxtaposes the organic parameters of the derived formations shown in Figure 8. The initial studies afforded the students a rich palette of formal strategies and textural variations, offering different permeability levels. The two-phase process's main objective was to arrive at grafted topographic strategies that employ bio-digital design workflows ready to be transplanted in the context of an existing building. It was essential to utilise this process to activate a stance towards architecture and nature, engendering a broader spectrum of considerations and applications of natural models.

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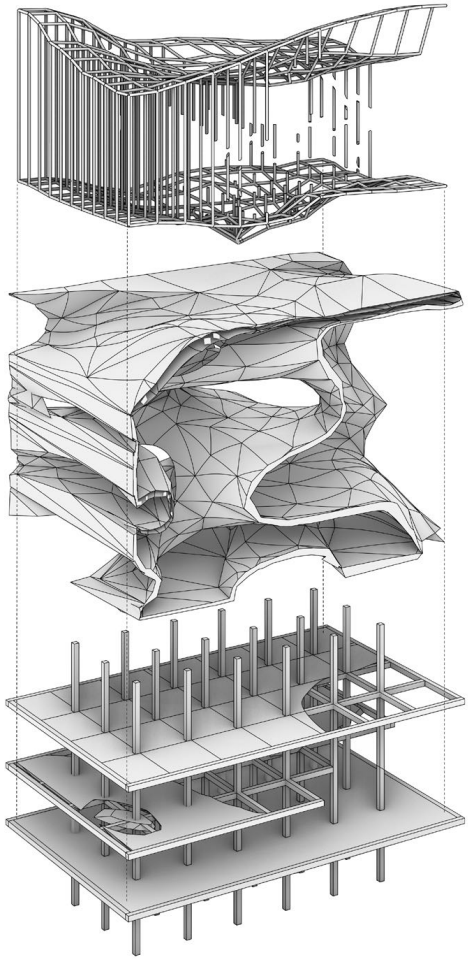

Figure 8
Student work by Danielle Lanier. Exploded axon of initial testing of the graft (from Figure 6) within the existing structural grid (Image by author)

In his introduction to the book *Alive: Advancements in Adaptive Architecture,* Manuel Kretzer (2015) addresses the compound role nature plays with regard to architecture and position the interplay between the two, nature and architecture, at the centre of design thinking. He writes:

> Among the most crucial aspects, architects have to consider when designing spatially is the relationship between architecture and nature, built form and living system, anthropogenic construction and organic evolution. This applies equally to strategies of environmental responsibility, geological or meteorological impacts, anticipatory human behavior, transit occupation, or cultural, social, and demographic variety. (Kretzer & Hovestadt, 2015, p. 16)

While an understanding of nature in this manner allows for its employment at various levels in the design process, its implications go further. This new assessment facilitates an active integration between architectural thinking and expands the definition of natural settings. It challenges the absolute dichotomy often set between the built and natural and ushers a paradigm shift that does not revoke the sustainability of one in favour of the other. With this understanding, grafting interiors enables a new syntax in design pedagogy and practice to emerge, one that embraces technological intervention as part of our natural evolution as a species. This thinking is specific to not only how we design but also how we use our space and interact with others in hybrid settings where the virtual and the physical synergistically operate.

Toward a multimodal spatiality

In discussing the development of cities, Heather Barker (2016) denotes a parallel development of visceral and material urbanism. She writes:

> The city is a complex, adaptive, intelligent system designed to facilitate human behavior and sustain the human organism. Humans, augmented through technology, now simultaneously exist in physical space as well as within a dense space of human-made features that are immaterial. This condition has changed humans from life-forms that use tools to life-forms that have grafted tools to their organism becoming tools themselves. (Barker, 2016, p. 892)

This evolution changes familiar architectural typologies and design approach, as it does any aspects of our human living. While architecture has often relied on the physical proportions of the human body to establish its tolerances, this central figure and its implications as we have come to know them are no longer applicable. New spatial modalities emerge corresponding to new breeds of occupants while navigating the continual shifting parameters of user and place. Within the incipient realities of our modern-day augmented environments in Figure 9, the studio set out to define a grafted interiority in Figure 10 that caters to this integration. Students used the interior topographies from the preceding phases to design an Amazon Prime Air fulfilment centre located in an existing storage building in shown in Figures 9 and 11. The building is in an active industrial district of the city. It consists of a concrete grid structure that is proportionally compatible with the structural grid the students employed in their conceptual grafting studies. This compatibility enables continuous transitions for the abstract formal investigations into the design development.

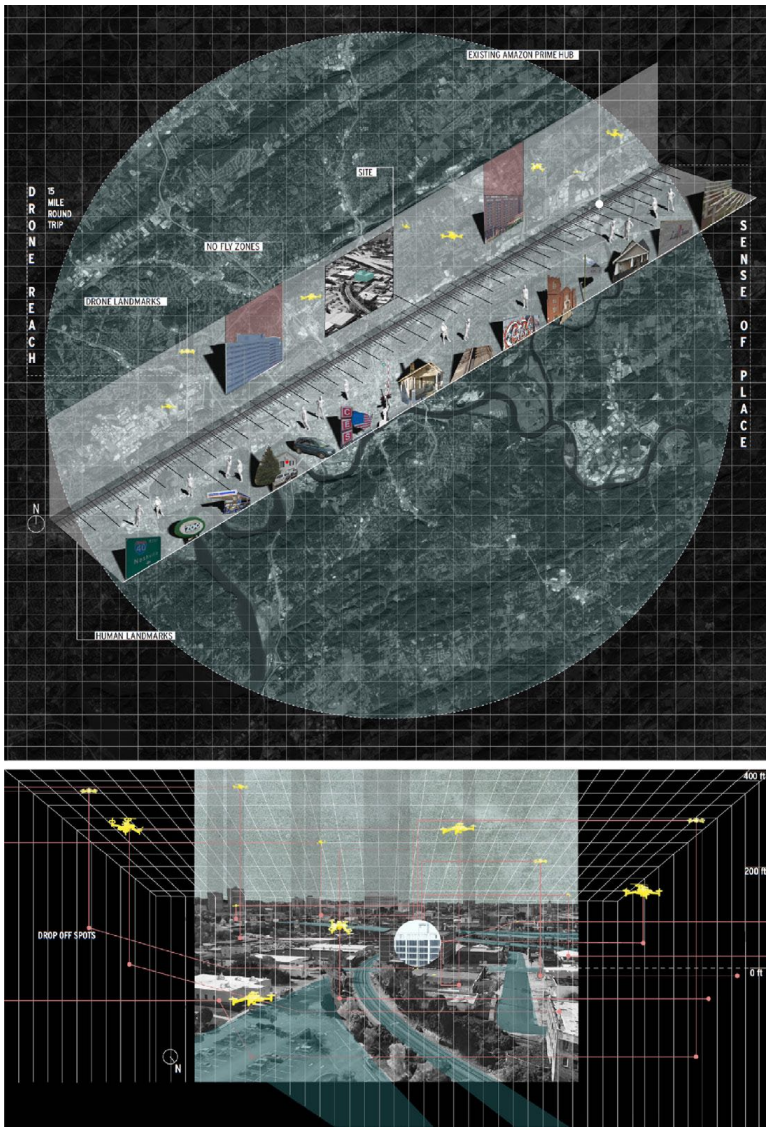

Figure 9
Student work by Isabel Huisman. Site analysis gauging the contextual parameters from human and drone vantages (Image by author)

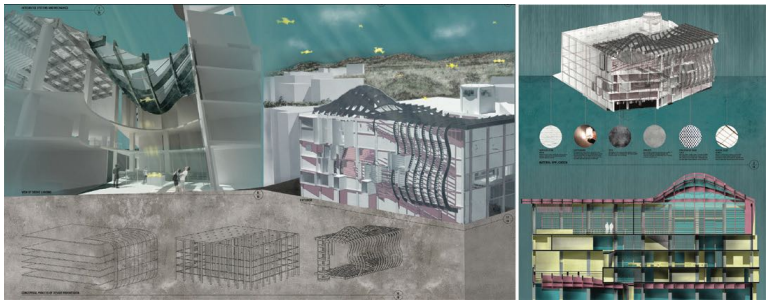

Figure 10
Student work by Isabel Huisman. The resultant design caters to a contextual porosity and engages the site from Figure 9 (Image by author)

The Prime Air facility employs drones to deliver packages and incorporates a complex automated infrastructure to transfer goods. Hence, the complexity of the design problem lies in creating inhabitable spaces for a hybrid species of sorts, the human and the machined, while establishing an integral interior topography that links the programmatic interior spaces to the city's context. This prompt allows the external site properties to shape interior strategies and vice versa. Interior space has often been understood and advanced in alignment with human occupancy, prioritising parameters for external separation and comfort. In that sense, interiority has usually maintained a closed, discrete internal system. This isolation is challenged through the programme of the project and the process of the design. Here, interiority must respond to the changing demands of our environments. It must actively partake in a future narrative where ecologies of place, space, buildings, human, and non-human entities, become intrinsically interwoven and indispensable to our advancement.

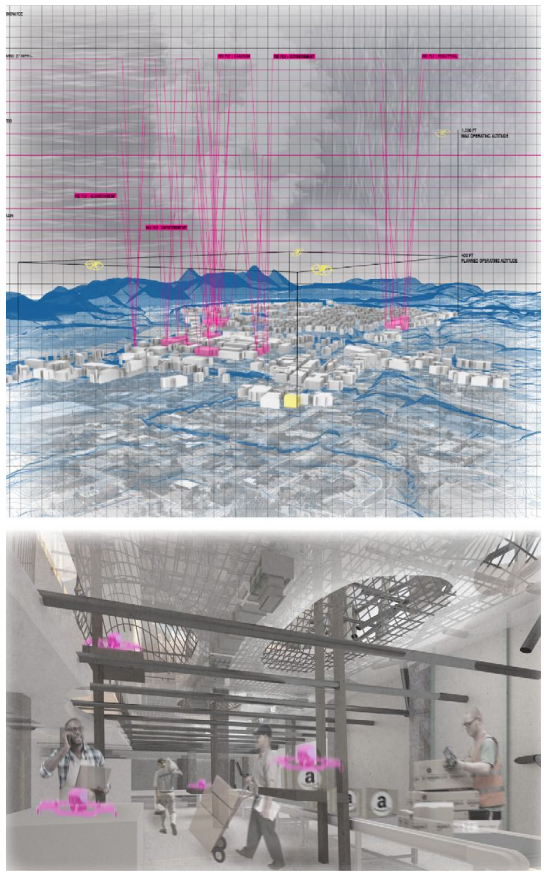

Figure 11
Student work by Lauren Podraza. Site analysis and interior perspective illustrating the resulting exchanges between the internal functions of programme and exterior site (Image by author)

To devise interventions proliferating a robust interior agenda in urban contexts, students generated extensive site surveys from human and drone stances. The site surveys, coupled with the conceptual studies and supported by robust computational platforms and prototyping, allowed for innovative interventions within the existing building and site. The projects engaged interiority as both concept and condition. They effectively presented schemes contingent on immediate and distant contexts. The resultant interior architecture concepts initiated and reinforced an exterior/interior overlap and further advanced this relation by employing adaptive and responsive internal strategies in Figure 12. It postulated innovative spatial applications of the systematic functions and design sensibilities afforded by models in nature, proving these methods beneficial to increasing the efficiency and aesthetics of interior spaces.

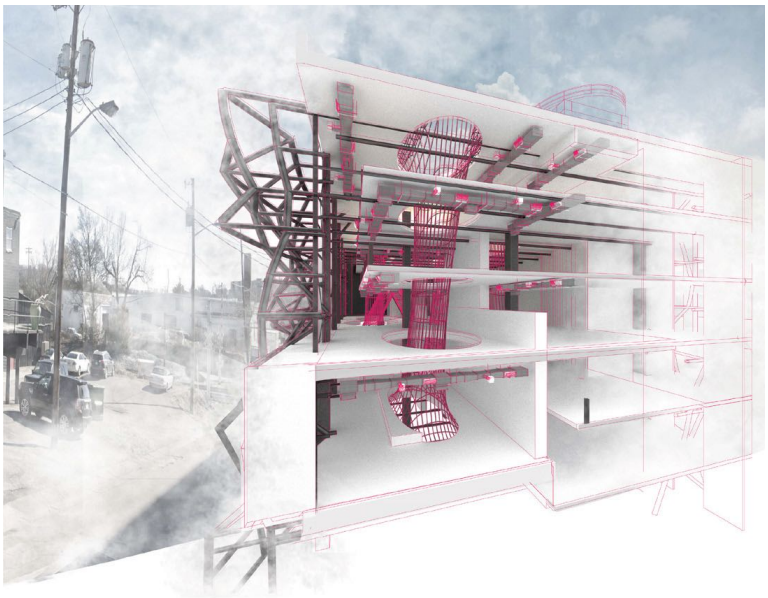

Figure 12
Student work by Lauren Podraza. Section perspective of the project from Figure 9 (Image by author)

We are entering an era where the multimodality of architecture is developing parallel to that of daily life. Space is no longer under the sole authorship of the human figure, literarily and metaphorically speaking. These conditions stem from technology's role in being the designer's counterpart and from the entanglements of biotic entities with artificial intelligence. As human and non-human figures forge dependencies and overlaps, to speak of actively evolving hybridised breeds is warranted. In *Animal Machines: The Architecture of the Body*, Iman Ansari addressed the changing idea of the body in the context of today's realities, saying:

> To speak of 'the body' today is not to describe an organic substrate, a psychological being, a historical object, or simply a living animal. It is instead to speak of the processes and conditions through which consciousness, vitalism, or 'life' assimilates into its cultural and technical milieu and takes a material form: it is to speak of embodiment." (Ansari, n.d.)

This transformation is paramount not only in everyday practices but also in their formal and spatial outputs. Moreover, the evolution of the architectural discourse has been aligned with design's subjects and its tooling, both developing in tandem with technological advancements. The current design modalities must cater to an operational multiplicity warranted by the advent of layered contexts and evolving occupancies.

Conclusion

From conceptual to pragmatic applications, natural processes offer a rich repertoire that can be adapted into living design strategies. Philip Beesley indicates that architecture's living attributes stem from coupling synthetic and biological systems utilising technologies in computation and synthetic biology. He postulates that such integration will result in a revolutionary living architecture that will transform human relationships with the built environment (Beesley, 2016). Gauging interior architecture from the standpoint of grafting provided the interior architecture studio featured in this essay the platform to propose a living interiority in line with Beesley's conclusions and projections. The process and resultant proposals fostered fluid reciprocity between inside and outside, maintaining a productive dialogue and pertinence between the two. Moreover, it derived operable spatial topologies that involved integral sectional thinking propagating interiority on conceptual and practical levels. Students employed the grafting methodology as an interior spatial formula activating the entirety of the interior volume while addressing new programmatic typologies.

The grafting process outlined a design tactic that challenged the disjunction between internal settings and external parameters. The potential to draw relevance conceptually from external parameters and integrate the derivative systems into the interior volume carries many implications, not only for interior architecture but also for urban settings. Utilising generative computational tools allowed the students to forsake the typical conventions of compartmentalising space in favour of the design of mediating topographies that are reactive and responsive to environmental parameters and users' needs. As designers and occupants of space, we must challenge

the prevalent autonomy of the interior volume, asserting through design the realities of our contemporary augmented environments. Now more than ever, it is imperative to formulate new methods and systems that devise hybrid contextual settings where interior spaces operate in tandem with the exterior environment. Methods, as such, allow for sustainable integration between internal and external parameters and cater to their fluid integration.

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References

Alexa, A. (2016, March 1). *Claude Parent's vision for a tilted world*. Core77. https://www.core77.com/posts/47856/Claude-Parents-Vision-for-a-Tilted-World

Ansari, I. (n. d.). Animal machines: The architecture of the body. *Places*. https://placesjournal.org/reading-list/animal-machines-the-architecture-of-the-body/

Barker, H. R. (2016). Adaptive environmental interfaces: Biomimetic morphologies and tactical urbanism. *Procedia - Social and Behavioral Sciences*, *216*, 888–898. https://doi.org/10.1016/j.sbspro.2015.12.085

Beesley, P. (2016). Can architecture embody living systems? Emerging 'living' technologies and synthetic biology. *Architectural Research Quarterly, 20*(2), 92–93. https://doi.org/10.1017/S1359135516000439

Bertalanffy, L. (1973). *General system theory: Foundations, development, applications*. George Braziller.

Brownell, B. E., & Swackhamer, M. (2015). *Hypernatural: Architecture's new relationship with nature*. Princeton Architectural Press.

Burroughs, M. (2018, September 10). *How Verner Panton changed the way the world sees furniture design*. AnOther. https://www.anothermag.com/design-living/11113/how-verner-panton-changed-the-way-the-world-sees-furniture-design

Encyclopaedia Britannica. (n.d.). *Graft*. Encyclopaedia Britannica. https://www.britannica.com/topic/graft

Johnston, P. (1996). *The function of the oblique: The architecture of Claude Parent and Paul Virilio, 1963–1969*. AA Publications.

Kretzer, M. (2014). Introduction. In M. Kretzer & L. Hovestadt (Eds.), *Alive: Advancements in adaptive architecture* (pp. 16–23). Birkhäuser.

Grau, D., & Zahm, O. (2013). Claude Parent: Architecture for the future. *Purple, 20*. https://purple.fr/magazine/fw-2013-issue-20/claude-parent/

Pasquero, C., & Poletto, M. (2014). Ecology beyond nature. In M. Kretzer & L. Hovestadt (Eds.), *Alive: Advancements in adaptive architecture* (pp. 34–38). Birkhäuser.

Picon, A. (2015). *Smart cities: A spatialised intelligence.* John Wiley & Sons.

Schwab, K. (2016, January 14) *The fourth industrial revolution: What it means, how to respond*. Weforum. www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

Torrents i Alegre, J., Bescos, G., & Ribas i Boldu, J. (2014). *Grafting architecture: Catalonia at Venice*. Institut Ramon Llull. https://www.llull.cat/monografics/venezia2014/english/index.cfm