The Post-Humanist Skyscraper

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What happens, architecturally and socially, when buildings are almost exclusively occupied and organized by non-human actors, actors such as computers and robots, as well as animals, plants, and rocks? While such spaces have a long history, current technological and social developments are producing them at an ever-quickening pace. Using these building types as a reference point, this paper examines the architecture of non-humans via the speculative production of an as-yet-to-emerge example: the vertical distribution center. This new variation on the skyscraper will be historicized and theorized before we present versions of it developed in an architectural studio taught by the authors. We will conclude with some speculations regarding the future of this research project and about the importance of non-human architecture in general.

FROM INFRASTRUCTURE TO ARCHITECTURE AND BACK

For over a century the "social conditions" and technologies identified by Louis Sullivan as creating the demand for the tall office building – i.e. the "need to do business," the elevator, the steel frame, rapid urban transit systems, rising urban land values and burgeoning populations- remained relatively unchanged. What changed was the status and function of architecture.[1]

Knowledge about infrastructure, military and utilitarian buildings, which since antiquity had been a part of the core of architectural expertise, was gradually transferred to disciplines outside of architecture canon. These in turn intervened in the design and construction process with a fundamentally different set of concerns. Between the 15th and the 19th century architecture became increasingly focused on the design of representational buildings and spaces, separating itself from engineering, which took over the design of infrastructural and utilitarian typologies.

Sullivan accepted such changes "as fact" and deemed them beyond the scope of the architect's responsibility. As an emblematic (if not late) illustration of this point he attempted to humanize one of these new facts, the skyscraper, by considering it "artistically." Similarly, more conventional Beaux-Arts architects were wrapping power plants, water works, bridges et al. in historical styles.

This ethos, however, did not last long. By the mid- twentieth century power stations, refineries, water treatment plant, etc. were no longer hidden behind architectural imagery, instead they were left naked and banished to the edge of the cities.

Contermporary infrastructure's intelligent, automated networks further accelerate the rates of exchange between energy, information, people and places, becoming ever more integral with everyday life. And yet, despite the recognition of the cyborg and post-humanist subjectivities that these new technologies have produced, the physical manifestations of our energy dependent and algorithmically determined present remain isolated and invisible. How can it be, should it be, that as we become ever more entangled with our inventions, we are further isolated from them? In short, if our bodies can be part human and part machine why can't our buildings and cities also shed some of the humanist baggage that restricts their functional, organizational and expressive possibilities?

The practice of placing infrastructural entities in liminal locations continues with the non-human architecture of contemporary logistics. While critics often lament the indifferent buildings and scarred landscapes these transportation, information and energy systems produce, there has been little study of their physical qualities. We ask: How can we engage these architectural objects via the formal categories of space, shape, organization and surface? What are the rules that control their dimensional and material properties? How much space do they need to perform their expected duties? What do they have in common that might allow us to recognize groups and subgroups? How different are they from human-scaled structures? In other words, what are their typological features?

We seek this information with no intent of aestheticizing or humanizing contemporary infrastructure. Its strangeness, its scale, its otherness need not be domesticated. That would only repeat past strategies of obfuscation and would negate their disruptive potential. Nor must they remain on the outskirts. The question is what will happen if these creatures are urbanized, what kind of architectural possibilities will they enable, and what kind of urbanity will they bring forth? We expect that the examination and establishment of the specific rules that govern these objects will provide us with the information required to export and integrate their logics and forms with other functional and cultural contexts.

VERTICAL FULFILLMENT: A SIDEWAYS TYPE

Some things haven't changed much since Sullivan's day. Large buildings are still needed to conduct business. However, many of these large buildings now require few humans and many machines to manage and distribute the goods within them. Similarly, urban land is still in short supply and ever more expensive. Ever taller, narrower buildings are required to make the land pay. This makes the presence of long, low, buildings in the city - like the current generation of fulfillment centers - infeasible.

Both the form and location of these increasingly automated fulfillment centers are understood as being economically expedient. However, this arrangement is less efficient from a temporal and resource perspective and anemic from an architectural one. Many of the end users of the goods in these warehouses are concentrated in dense urban areas. What would be the advantage of having them located closer to, if not within the city center, and, what architectural consequences would it have? In short, what would a tall warehouse building, considered typologically, be?

We are using the term *type* to refer to (existing) objects according to their similarities (either formal or functional). Elsewhere we will use *model* –not in the 19th century sense of an example to be emulated but instead as an abstract set of rules and relations that have no fixed connection to any specific formal output. If the category of type is a comparative notion used to recognize differences between objects, the idea of model here refers to a generative description of a formal organization that accounts for its internal, rather than external, differences. In this way the concept is similar to economic and climate models, and is equally dependent on computational systems to create them. The idea of model thus serves as a speculative and productive technique while type refers to a descriptive system.[2]

Architectural typologies come in two varieties: the formal and the functional. Modern architecture rejected the former and accepted the latter as the generative basis of architectural organization and composition. Symmetrical, axial organizations were questioned, and often replaced with ad hoc arrangements found in factories, grain elevators and electrical dynamos.[3]

But must the formal and functional logics remain discrete? What happens when they are confronted with one another? What mutations would occur when a formal type is forced to adjust to the logic imposed on it by a functional type? How do functional types evolve in response to imposed formal organizations?

With regard to fulfillment centers, this would force one to remove a function from its seemingly natural formal habitat (i.e. horizontal and suburban) and put it into a seemingly strange environment (vertical and urban). Conducted in the laboratory-like setting of the studio, this misplacement could spawn new models for design and new formal types.

DIAGRAMS, NOT BUILDINGS

In researching both the history and technology of fulfillment centers, we found out that we were not the first to think about a tall version of them. Amazon was granted a patent for *multi-level distribution towers* in January of 2017. The patent reveals six variations on the theme, each supplied with conventional truck deliveries on the ground floor but which use drones (or UAVs) to deliver outgoing packages.[4]

The drawings are intentionally vague and have no dimensional specificity. Without using the specific size of things - including pallets, robots, drones, automated storage and retrieval systems, etc. - there is no sense of the scale in the drawings and no indication of quantitative relations that could productively constrain the prototypes in one way or another, especially in the plans and sections.

While not physically realistic, these schemes are presented, as most patents are, as solutions to a specific problem. If Amazon's diagrams are a somewhat naïve attempt to respond to an emerging urban and business opportunity, what would be an architecturally specific way to address the problem?

LABORATORY OF TYPOLOGICAL MUTATIONS

To tackle that question in a controlled setting we ran a design studio at the School of Architecture and Urban Studies at Universidad Torcuato Di Tella entitled The Post-humanist Skyscraper. The studio is the first instance of a series that will explore the possibilities of the high-rise typology in its encounter with the set of bio-technical functions mentioned above.

The studio brief proposed to formalize the research process through a detailed analysis of existing skyscrapers and automated warehousing systems. The sequence was:

1. Analyze case-study skyscrapers, recognizing and measuring their structural, circulatory and envelope systems and their interrelations.
2. Construct a parametric model of the skyscraper that transforms the theoretical model into generative rules and geometric constraints.
3. Seek possibilities for augmenting performance by playing with the parametric model of the skyscraper, and see how its systems and capacities are transformed.
4. Formulate conjectures about how the model might need to re-configure itself to function beyond those limits.
5. Collect information about contemporary fulfillment centers and the various technical systems that are used therein, and distill their functional parameters
6. Colonize the skyscraper structures with the studied automated storage and retrieval systems applying an engineering logic, i.e., maximizing storage and operation efficiency.
7. Present the project emphasizing the architectural novelties that it introduces into the typological palette of the skyscraper.

PROPOSITIONS

A. Porous chimney model: deviating from Rafael Viñoly's 432 Park Avenue rules of repetition.

This project takes Viñoly's 432 Park Avenue building in New York City as a model for how a very slender structure for luxury residences might be turned into a non-human environment. One of the Viñoly building's most evident features is that it makes an effort to absorb the variations required by the structure as the building gets taller into the thickness of its external tube. Seen from outside the building looks like a homogeneous structure. But this homogeneity disguises the fact that as the building grows the thickness of its outer shell decreases in response to diminishing wind and gravity loads. Conversely, the augmented thickness of the external tube is such that at street level the columns end up looking more like a series of buttresses surrounding the core rather than a continuous folded plane.

In the adapted model created in the studio this difference in thickness is exaggerated by squeezing the structural section to the thinnest possible peripheral shell at the top of the building, while stretching it to form a continuous field of structural elements at ground level. The result is the generation of an internal void in the shape of an inverted pyramid that runs the entire height of the building, which becomes a chimney for the UAVs carrying goods to their destinations. Inward drone circulation takes place from the sides of the buildings, which function as a porous membrane to allow machines, rather than light and air, in.

However, if Viñoly's tube-in-tube structure is designed with anthropometric parameters in mind (the generative element is a 3x3 meter window that *maps* the smallest possible room behind it), the redesigned project removes all traces of human scale from the building. Its generative component is a hollow girder with a 3 ft x 3ft cross section that allows items to be stored inside it. These dimensions are meant to accommodate a fully automated storage system that requires minimal human operation and which serves as the main transport system to move goods within the structure. The robotic picking machines move both vertically and horizontally, using the top surface of the girders to circulate horizontally and the channels generated on the perimeter of the structure to climb up and down.

With no walls or floors required, the structure and the storage system become one and the same system. While this is efficient it does expose the design to a lack of adaptability to alternative technologies and uses. Further, while the original design took advantage of the density of its expensive urban site and achieved the paradoxical effect of iconicity through regularity, the new version is fully optimized functionality and its iconicity is achieved via the adaptation of its structural model to non-human scales and technologies.

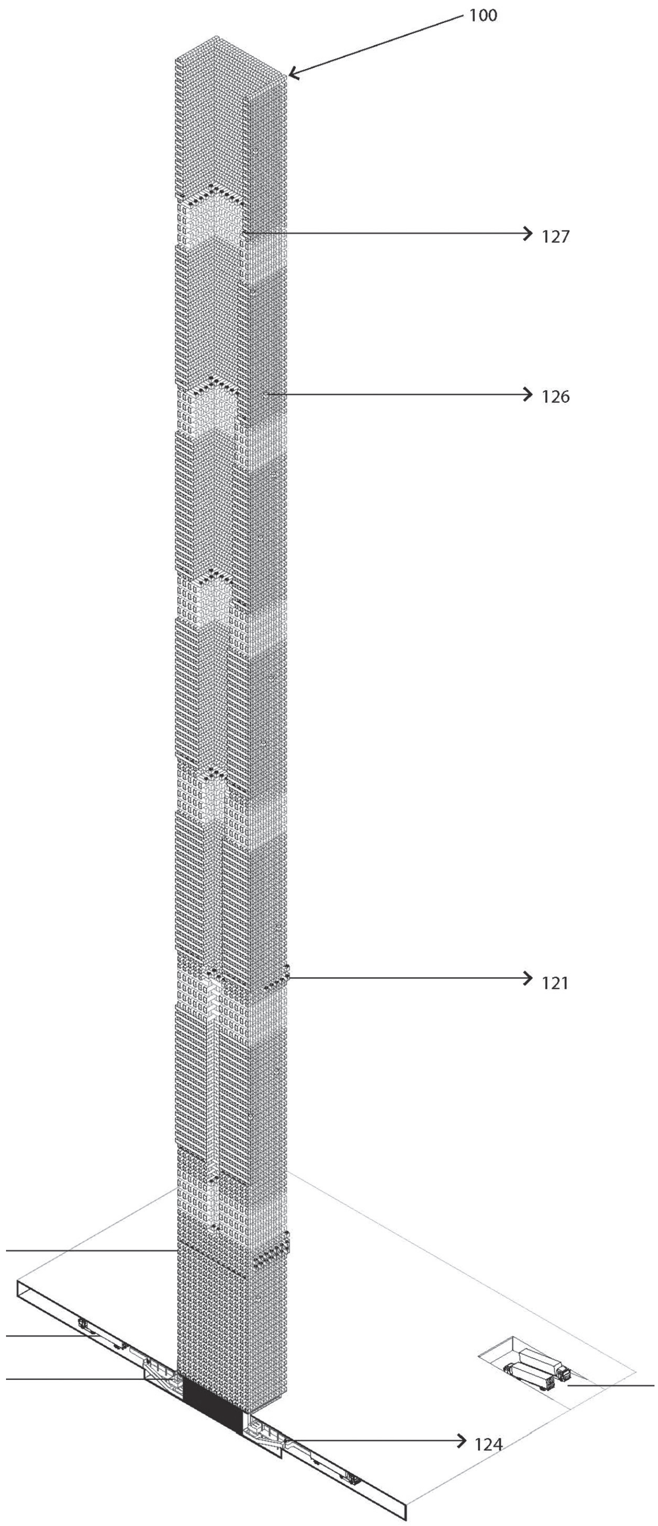

Figure 1. Porous chimney building. Deviation from Rafael Viñoly's 432 Park Avenue building's rules of repetition. Sectional axonometry. Project by Julieta Abrodos, Francisco Alcalá, Eugenia Massa, Simón Montagnoli. Copyright: Archivo EAEU/UTDT.

B. Converging atria model: tampering with Foster and Partners' Commerzbank building's rules of continuity.

An interesting aspect of Norman Foster's project in Frankfurt is how it simultaneously constructs a smooth, continuous skin that blends together structural and non-structural elements, while generating a network of interconnected voids (courtyards, atria, skygardens) that give it porosity, openness, and a rich internal connectivity. Considered from the perspective of human use, these voids perform their duties by providing natural ventilation, visual connectivity and orientation, and allowing what would otherwise be dull interior corridors and land-locked offices to maintain contact with the exterior. Yet, the complex spatial topology created by the network of voids is also well suited for a building type in which various forms of movement and access are required throughout the structure.

The new non-human model is initiated by creating geometric constraints that allow the description and manipulation of the building's envelope without interrupting its continuity. It then explores strategies to occupy the floor-plate with standardized systems of racks. With the exception of the position of the vertical shafts, which are fixed to preserve the functional logical of conventional elevators, the geometry of the floor plates is allowed to grow as if it was being inflated to accommodate increased storage space demanded by the automated storage and retrieval system. To make that deformation possible, the profile of the floor-plate is constructed by a series of circular curves joined together at nodal points. The arcs are held together by constraints on the position of their centers, and the continuity of tangents at some of the nodal points. Gaps and overlaps are limiting conditions for the deformation. With these constraints in place the project locates the original Foster floor-plate at mid-height of the structure and then morphs the floor-plate downward to a maximized profile and upward to a minimized profile.

The original triangular atrium that separates the three wings of the Foster building is coordinated with the new geometry of the envelope so that when a given threshold is crossed in the expansion of the envelope, new atria are generated. As the atria expand and diverge from the center, a network of voids through the building is created which is now used to move UAV's and goods. These operations transform the repeated V-shaped plans for human use into a whole catalogue of plan types ranging from deep to shallow, which increase the capacity for internal and external connectivity by means of a more complex spatial topology. They also accommodate a diversified palette of storage patterns and technologies, and potentially for other non-human and human programs as well.

C. Hybrid hotel model: deviating from Shreve, Lamb & Harmon's Empire State Building's rules of transportation.

The Empire State Building (ESB) was described by Rem Koolhaas in *Delirious New York* as a series of 30 feet deep "rings" of inhabitable space that "grow" to the maximum depth allowed by daylight regulations around an invisible pyramid of vertical circulation shafts. However, as the number of elevators accumulates toward the ground floor,

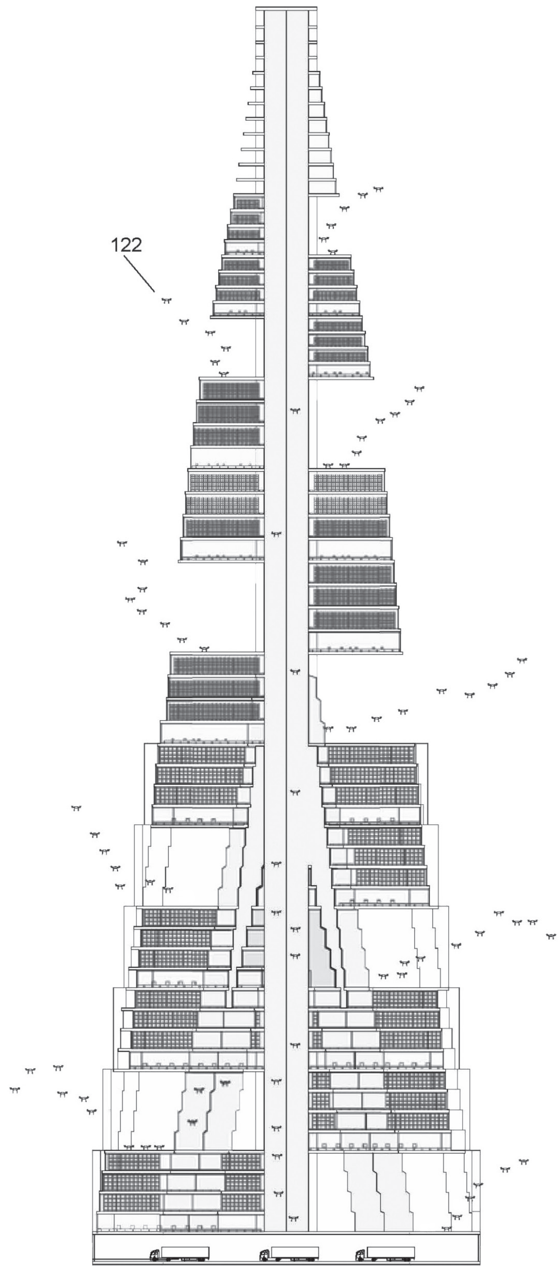

Figure 2. Converging atria building. Tampering with Foster and Partners' Commerzbank building's rules of continuity. Section. Project by Florencia Feldsberg, Carola Garione, Gonzalo Novoa, Maximilian Plank. Copyright: Archivo EAEU/UTDT.

and various levels are united functionally by local elevator routes, students discovered that the formal "fit" between the circulation and envelope systems begins to hide functional redundancies that have the potential to disrupt the formal continuity of the building and its pyramidal shape.

The subsequent mutations of the neo-ESB critique this typological condition by exploiting the redundant circulatory capacities of the building which are allowed to express themselves formally. The project can be summarized as the outcome of two main operations. First, the excess transport capacity of the elevator groups is measured and used to scale up the floor plates until their size (in a maximum occupation scenario) exhausts the available elevator capacity. This has an immediate impact on the shape of the building, which is transformed into a series of stacked boxes, revealing the discontinuous nature of the transportation system. The second operation picks up the original design parameters of the ESB and re-establishes the peripheral area of the floor plate as a space adequate for human occupation in the terms described by Koolhaas. Beyond this peripheral, well-lit zone, the remaining spaces within each box are vertically unified to allow for their occupation by automated storage systems.

Finally, the lower level of each box is established as an exchange floor where humans and objects are forced to meet when changing from local to express travel options.

D. Expansive bundle-tower model: hacking SOM's Sears Tower rules of vertical proliferation.

A fourth project used the Sears Tower in Chicago as a reference model and introduced two important mutations into the type. The first one proliferates the number of floor plans as one moves down from the top, rather than reducing them from the bottom up. SOM's nine square grid –the compositional basis of the building- is thus no longer particularly relevant, but merely a "state" in its vertical development. This could allow the model to transition from a pencil-type high-rise, to a predominantly horizontal organization.

Second, whereas the principle of SOM's project is based on the idea of the structural collaboration among a bundle of tubes, their functional autonomy is compromised by the grouping of the elevator shafts at the center of the plan. Instead, the project maximizes the autonomy of the tubes by placing an elevator shaft – or really robotic dumbwaiters for goods - at the center of each tube, which is again determined by the type and size of package it accommodates.

This transformation of the type allows the building´s floor plans to be functionally integrated through a network of transversal circulation paths but, it also makes it possible for each of the tubes to grow vertically according to its own needs and rules of internal consistency. Thus, the distance between floor slabs can vary, allowing different types and sizes of automated storage and retrieval systems to be installed. Likewise, this autonomy allows the tubes to reduce the size of their envelope through setbacks without being disconnected. This creates opportunities for landing and take-off platforms for UAV's on the top levels of each tube, which combined with the setbacks in turn exaggerate the building's iconic shape.

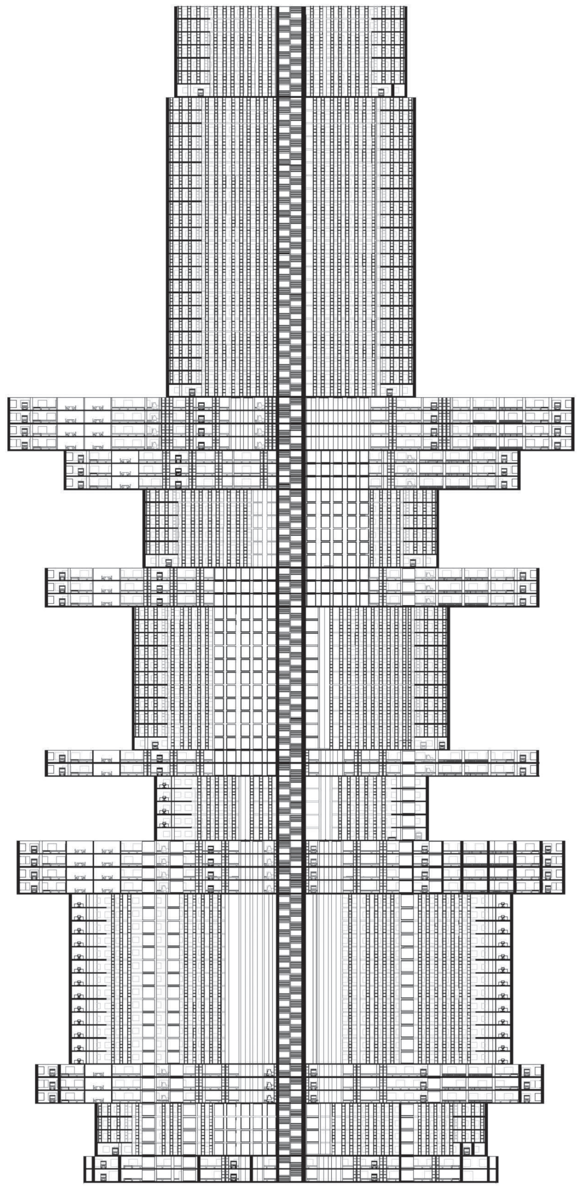

Figure 3. Hybrid hotel building. Exploiting Shreve, Lamb & Harmon's Empire State Building's rules of transportation. Section. Project by Micaela Altenburg, Maximilano Groshaus, Frida Varegg Svensen, Sol Zamalloa. Copyright: Archivo EAEU/UTDT.

DISCOVERIES

Like the Amazon patents, our case-study-based strategy meant that each buildings were assumed to be an isolated object. The next steps in the research process could involve further testing of these models through simulations that provide

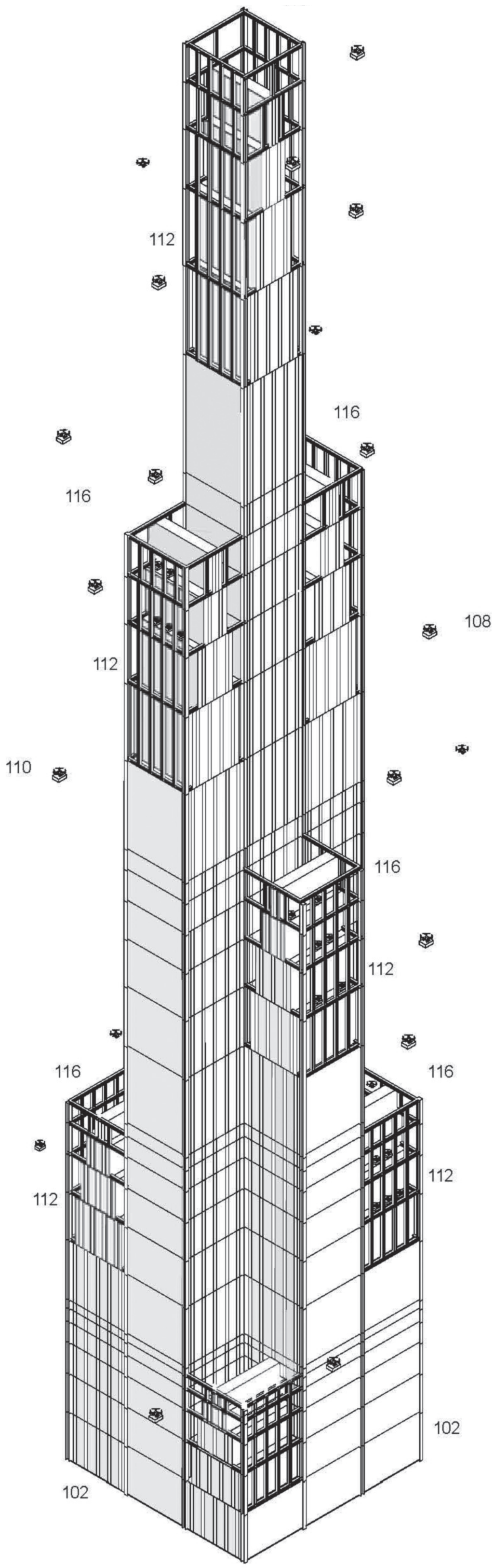

Figure 4. Expansive bundle-tower building: hacking SOM's Sears Tower rules of vertical proliferation. Axonometry. Project by Guillaume Bernard, Santiago Cornejo, Abril Pintabona, Manuela Toto. Copyright: Archivo EAEU/UTDT.

feedback about their functional and urban performance. This would imply refining their internal relations, and locating and adapting them to specific sites in order to study their potential response to external constraints –whether that be in terms of geometric, dimensional, or programmatic transformations. A number of issues would need to be checked in order to streamline the relations between input, storage and output in each model. Simulations could expose patterns of interactions between machines and people, or among different types of machines. These patterns would be manipulated in order to exacerbate the effects sought by the projects.

However, if the goal is to a hypothesis about the merging of functional and formal types, and, to find the rules of non-human architecture in general, then a broader approach must be taken. Our inclination is to delay as much as possible the imposition of criteria of evaluation derived from the historical background of the discipline, knowing, as we do, that such exercise would imply an inevitable return to humanistic principles of organization and appearance. That does not mean abandoning architecture or architectural typologies. The history of non-human buildings is quite robust and only partially told. Buildings for goods (storehouses, grain elevators), buildings for plants (greenhouses), buildings for animals (barns, slaughterhouses), buildings for energy (power stations) and buildings for information (server farms) are all types to be examined. In other words, the close and detailed development of multiple types is necessary in order to avoid making any pragmatically premature suggestions for how to integrate these new types into the contemporary city.

Still, a number of lines of inquiry have already emerged from looking at these examples. While the results need refinement and testing, through the analysis of both the existing structures and the automated warehouse systems, the studio did produce a number of unique organizational models for vertical fulfillment centers. Our experiments have opened the possibility to think in terms of two scenarios: one of extreme mechanization and one of hybridity. The first one involves the radical removal of all traces of human scale and activity, and the liberation of the expressive and performative potential of the technological devices that are currently constrained by humanistic concerns. These projects exemplify a fully developed typological evolution and are represented in the Park Avenue and Sears Tower project showed here. The second one –the hybrid project- promotes the encounter between objects, people and machines found in the transformed Empire State Building and the Commerzbank. From an evolutionary point of view, they can be conceptualized as transitional types in that they could prepare the field for more radical experimentations.

Why the need for such experiments? At a time when social crises seem to emerge daily, why take on typologies that are seemingly anti-social? For one, while these buildings are not built to house human bodies, they are built to fulfill social

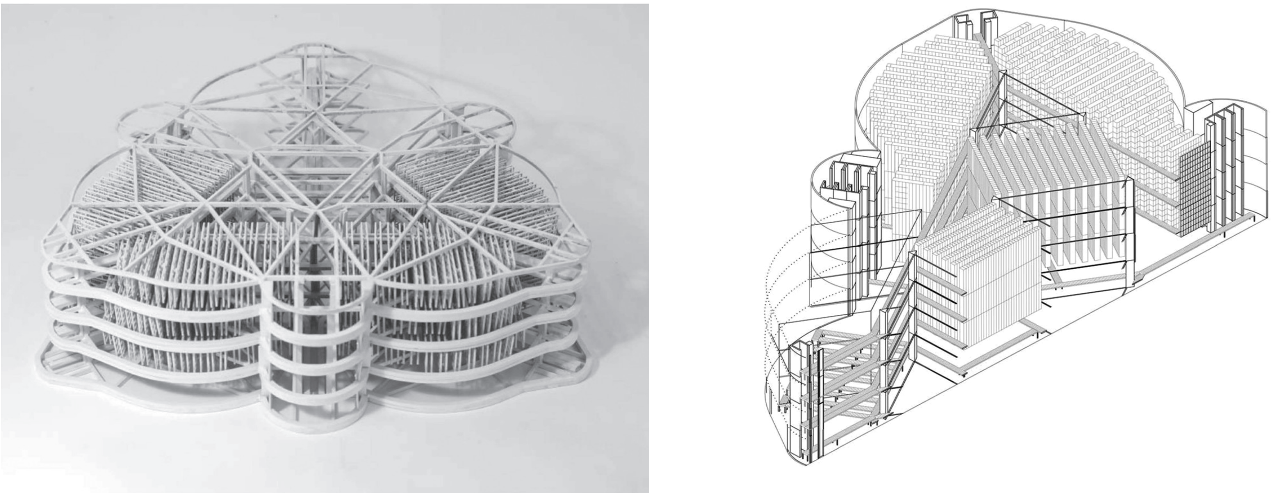

Figure 5. Converging atria building. Tampering with Foster and Partners' Commerzbank building's rules of continuity. Model and sectional axonometric. Project by Florencia Feldsberg, Carola Garione, Gonzalo Novoa, Maximilian Plank. Copyright: Archivo EAEU/UTDT.

needs. It is the increasing dependence on non-human thought and labor (from agriculture to warfare) to satisfy these needs that makes the study of non-human architecture immediately relevant. The projects created in the studio do not let go of all human-related constraints, but their emphasis on the non-human can function to generate opportunities for social and individual experiences that intensify and enrich the emerging bio-technical ecology of the upcoming metropolis.

Finally, understanding and designing the interfaces and the interactions between humans and the technologies we use to adapt ourselves to our physical and social environment is a perpetual need, a task architecture has mediated for a long time. Its disciplinary tendency to integrate diverse requirements means that it can provide a holistic approach to the design of buildings that includes addressing social, ecological and aesthetic issues, as well as purely pragmatic ones. As such it does not just accommodate new social techniques and types, it can also imagine new and alternative ones.

ENDNOTES

1. Louis Sullivan, "The Tall Office Building Artistically Considered," *Lippincot's Magazine* (March 1896): 403-409.
2. The literature dealing with the notion of type is extensive. Quatremère de Quincy's distinction between "type" and "model" can be found in "Type," trans. A. Vidler, *Oppositions* 8 (1977): 147-150, originally published in *Dictionnaire Historique d'Architecture*, Tome Second (1832): 629-630.
3. Alan Colquhoun, "Typology and Design Method," *Perspecta* 12 (1969):71-74.
4. Amazon Technologies, "Multi-level Fulfillment Center," US Patent #2017/0175413, filed December 18, 2015, issued June 22, 2017.