Scye: Material Form Technique

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The project, titled *Scye*, was produced by ISSSStudio as a commission for the 2015 Tallinn Architecture Biennale's main exhibition "Body Building." Curated by Estonian architects Siim Tuksam and Sille Pihlak, the exhibition brought together the work of ten international practices: Atelier Bruno Juricic (Croatia), Tom Wiscombe Architecture (USA), Kokkugia (Australia), Marjan Colletti (Austria), Julia Koerner (Austria/USA), Carlo Ratti Associati (Italy), nformations (Austria), City Form Lab (Estonia/Singapore), Achim Menges/ICD+UTKE (Germany) and ISSSStudio (USA). According to the curators, "Body Building" takes a look at hybrid forms of construction that combine cutting-edge technology with self-driven variability of material systems, thus exploring the balancing acts between the computational and the physical as well as between the unruly and the unpredictable.[1] Upon the curators' invitation to partake in the exhibition, it became clear that what brings this diverse group of practitioners together is the extensive use of physical objects—prototypes, models, mockups, full-scale fabrications—as integral to all of our digitally driven design methods. Curatorially the exhibition was to reflect this commonality by focusing on such objects, presenting to the broader public a range of possibilities for material output in architecture via digital technology. For ISSSStudio, this was an opportunity to further develop our design work with biodegradable plastics, a stream of research that we have been pursuing in various forms since 2011. Rather than treating the commission as simply an exhibition of artifacts related to other building-scale projects, the aim was to treat it as a project in its own right.

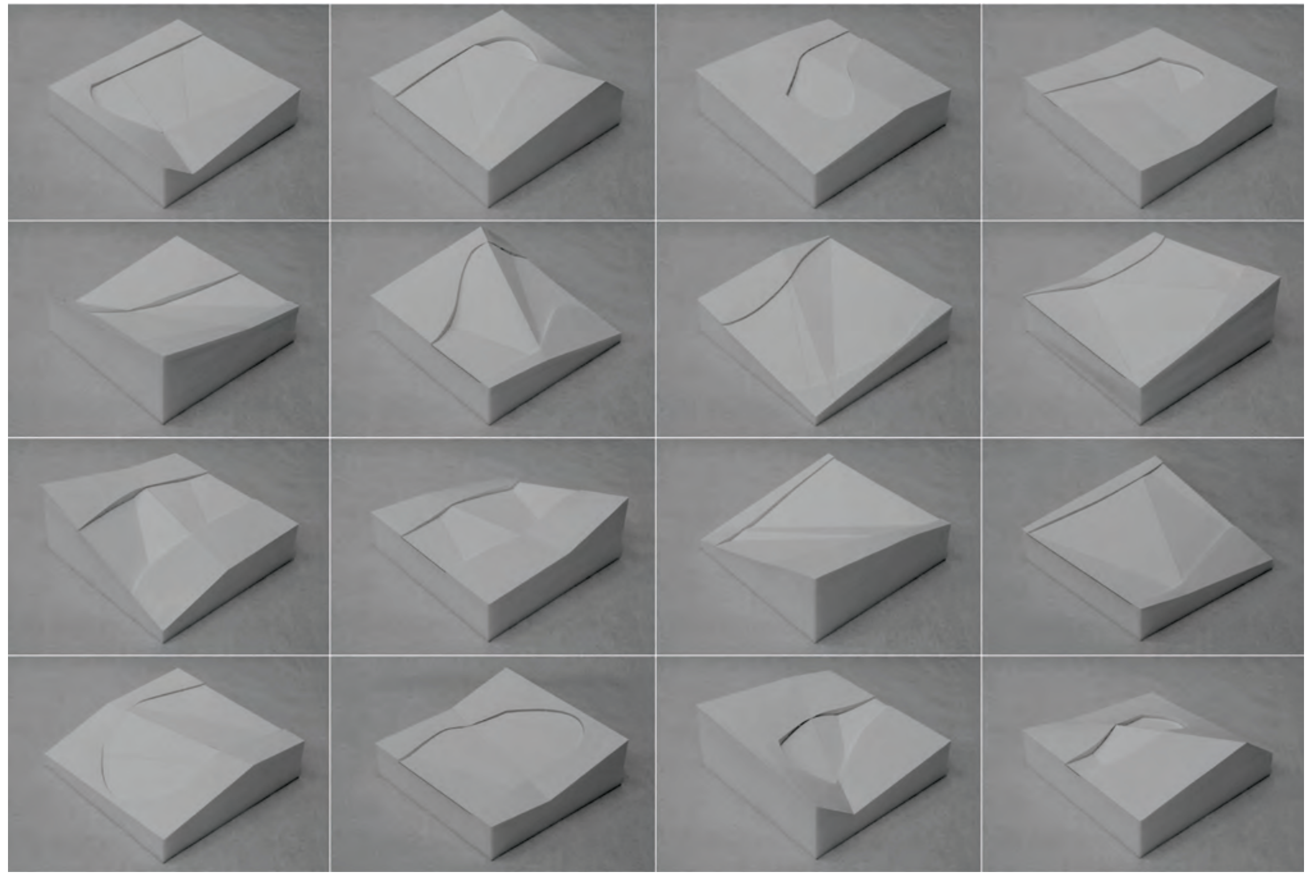
From the outset, we took into account a number of objective considerations that constrained the project and framed those as a reality to which we could respond to through our design. We knew that the project had to travel long-distance on a limited budget, which directly informed its size and weight relative to shipping conventions. We also knew that the installation at the exhibition was temporary, prompting us to engage with the question of the project's lifespan beyond the one-month display at the Estonian Museum of Architecture. These specific conditions—transportation, volume, weight, duration, lifecycle—shaped our design intentions in tandem with the curatorial direction and its relationship to ISSSStudio's larger body of work. Through a fabrication-driven process, the project's intentions coalesced into a design inquiry

Figure 1: Igor Siddiqui/ ISSSStudio, Scye, 2015. View of installation at the Museum of Estonian Architecture during the Tallinn Architecture Biennale.

about the interdependence of material, form, and technique. The outcome is an installation the size of a large architectural model, one that is less representational than it is relational in nature. In that sense it is constrained by size, rather than scale. The project is a three-part system consisting of a three-dimensionally tessellating base, a pair of translucent sleeves, and a series of freestanding objects (fig. 1). Each part considers its own set of specific material conditions investigated through its capacity to yield architectural form under the influence of production techniques. They are parametrically synthesized into a single system, constructing in effect an ecology of objects. As such, *Scye* can formally grow, evolve, and mutate over time through three specific operations: multiplication, extension and densification. The various materials that make up the overall system differentiate the parts in terms of how they may potentially circulate beyond the spatial and temporal footprint of the project. This brings us to the question that frequently preoccupies us in our work:

Where does material go?

The consideration of where material goes is twofold: it addresses the actualization of built form through material distribution, while also alluding to material lifecycles shaped by patterns of use, reuse, and disposal. As advancements in digital technologies continue to expand architects' ability to link design, fabrication, and assembly into new workflows, materials too have acquired a broader range of roles. With technologies like additive manufacturing, materials conform to the rule of data in ways that are evermore fluid, precise, and nonstandard. Meanwhile, increasing capabilities to digitally record, simulate, and reproduce materials' dynamic behavior are yielding new models of organization for architecture across multiple scales. The digitization of the design process has liberated architectural form from standardization, ushering the demand for material customization to the forefront of design innovation. Materials as such enter design not as fixed entities, but rather as pliable variables. Existing materials are remade to reveal latent character; new ones are made from scratch. In other words, materiality is not given but is rather designed, further expanding architecture's engagement with material resources and their circulation. The question of where material goes—but also where it is coming from—links a singular architectural project to the broader ecologies within which it operates. For us, the techniques for distributing materials relative to formal, structural, and



atmospheric demands of a single project have the potential to be expanded to encompass movement across larger territories and wider timeframes.

PART I: BASE

The base is a solid architectural volume with a footprint of 40 sf and thickness that varies from 1 to 10 inches. In plan, it is tiled in a 4-by-4 grid, creating a topography that is sectionally varied but continuous. Each tile, a three-dimensional block of recycled polyethylene, is a one-off and the tessellating pattern does not repeat (fig. 2). However, the tiles are organized into book-matching pairs; each pair nests to make a fully packed orthogonal volume which in turn maximizes the available space determined by the logistics of bringing the project overseas. As such, the base neatly packs into four 20-inch x 20-inch x 20-inch volumes, reflecting the largest permitting dimensions for checked-in luggage on commercial flights (fig. 3). While maximizing the volume, the aim was to minimize weight. For this purpose, we used light but relatively rigid polyethylene foam which commonly serves as packaging material. The digital script that allows for the volumes to nest when the parts sit on top of one another but book-match and tessellate when side-by-side produces a double-curved top surface constrained by a diagonal ridge on each tile. Because the volumes were designed not only to produce the base, but also to contain the other parts of the installation, additional geometries had to be carved into each block. Along the top surface of the base, a series of secondary, ruled surfaces is recessed into the blocks to contain folded out bioplastic sheets that make up the second part of the overall system, while eight of the blocks also contain pockets to hold the 3D-printed objects that constitute the third part (these pockets are cut into the underside of the base and are not visible when the project is on display). The blocks were fabricated using a 3-axis router, though a CNC-foam cutter would yield even more materially efficient results. The fabrication technique produces a satisfactory finished surface, but because we were limited to laminated material rather than solid blocks the top surface benefitted from another finished layer. We applied pliable white silicone sheeting to the double-curved areas; the developable parts of the surface were finished using rigid cotton board, laser-perforated at each interior seam for precision. All laminations between different materials were made using removable adhesive, so the layers could be separated for recycling. While this particular combination of the script with these material and fabrication techniques effectively yielded

Figure 2: Igor Siddiqui/ ISSSStudio, Scye, 2015. The series of nesting, book-matching, and tessellating blocks that together form the base of the installation.

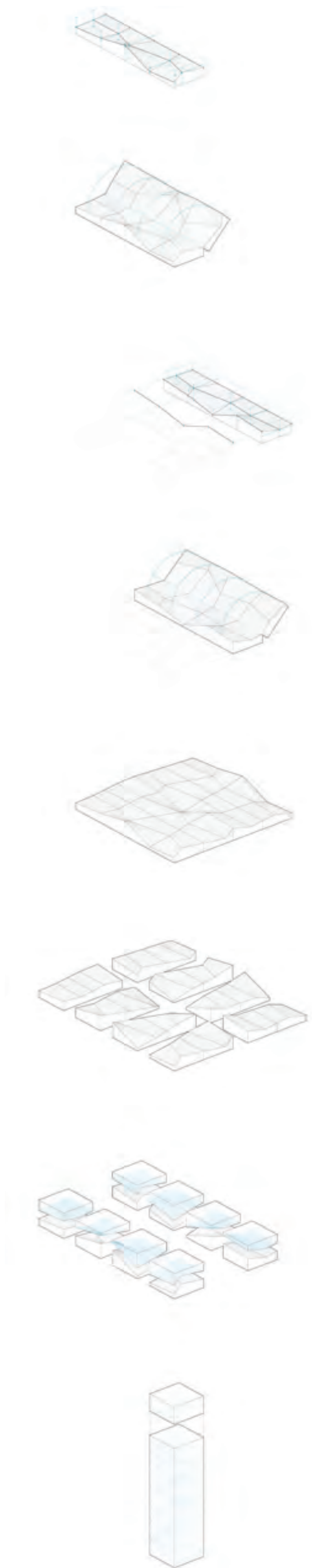


Figure 3: Igor Siddiqui/ ISSSStudio, Scye, 2015. A diagram of packing procedures.

a ground condition, the process could easily be tailored for the design of a vertical system, such as customized masonry.

PART II: SLEEVES

Book-matching as a strategy also informs the arrangement of the 16 translucent bioplastic surfaces into two parallel architectural volumes that we refer to as sleeves. Organized along one of the center axes of the base, the sleeves are symmetrical in plan but not in section, a result of their relationship to the geometry of the ground (fig. 4). They are subdivided into overlapping surfaces, the seams of which align with those of the blocks beneath. In section the surfaces were generated as catenary curves with equal lengths; the range of profile geometries in controlled by the distances between their end points on the ground, from the center axis and out. The geometry was scripted to respond to the changing geometries of base and tested through different iterations. Because the surfaces were cast and shipped flat, the lofted catenary profiles had to be designed as developable, the process enabled by the D.LOFT plugin for Grasshopper. The outlines of the flat components were mapped back onto the surfaces of the base to create recessed pockets for storage, while the creases introduced in the blocks in order to make those surfaces developable were mapped back onto the translucent sheets. These vectors influence the propagation of the surface pattern developed for the project—the closer to the vector the denser the pattern. The patterns serves as a device for distributing the material throughout the casting process, resulting in both structural and atmospheric effects. As in several of our previous projects, these surfaces were fabricated from entirely custom-made biodegradable plastic cast in bas-relief formwork. We use a combination of animal and vegetable-based polymers to make thermoplastic, allowing us to control material properties that include rigidity, thickness, transparency, and biodegradability (fig. 5). While the plastic is designed to be entirely compostable, it is chemically stable, anti-microbial and, when used in combination with other biopolymers, water-resistant. Through the design of the material itself we are able to increasingly calibrate and control not only its architectural properties, but also its lifespan beyond the project itself. Because the fabrication process is based on casting, we are currently investigating multiple ways in which formwork can be engaged as an asset to the overall ecology of a project rather than as redundant and wasteful.

PART III: OBJECT SERIES

The series of eight objects situated at the sides of the base parallel to the bioplastic sleeves leverage the volumetric constraints of the project with the potential of the surface pattern as structural. Each object is constrained by the geometry of an envelope shaped by three distinct conditions: 1) the amount of volume available for its nesting within the base block beneath; 2) the size of the 3D-printing bed; and 3) the geometry of the topographic surface that it sits on. Within this volume, each object is an investigation into the morphology of sleeves produced not through pliable sheets, but rather through rigid tubes (fig. 6). The shift from surface to volume utilizes the pattern not as an entity inscribed topically, but rather as a generator for the architectural thickness itself. As with the two other parts of the system, the articulation of seams is specific to the interrelated conditions of material, form, and technique. How the material is distributed to yield each micro-structure is specific to the logic of layering inherent to the fused deposition modeling (FDM) method of 3D-printing, allowing for a structural mesh based on the interaction of strands in the pattern. Although designed as full-scale objects, the series alludes to its potential realization as building much like the way more conventional scaled models in architecture typically do (fig. 7). For us, considering them as scaleless

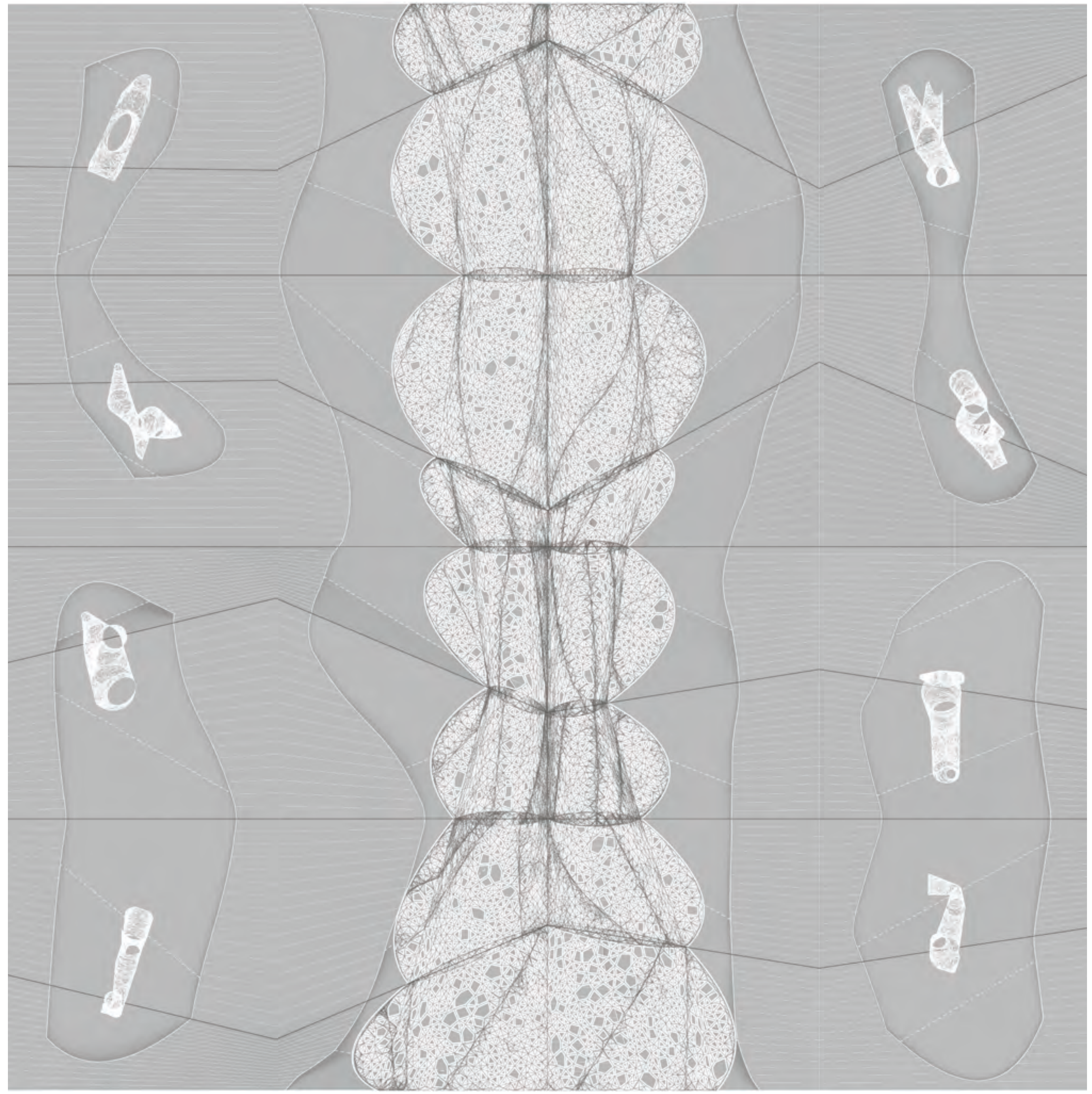


Figure 4: Igor Siddiqui/ ISSSStudio, Scye, 2015. Plan.

Figure 5: Igor Siddiqui / ISSSStudio, Scye, 2015. Detail view of bioplastic sleeves.

Figure 6: Igor Siddiqui / ISSSStudio, Scye, 2015. Detail view of 3D-printed objects.

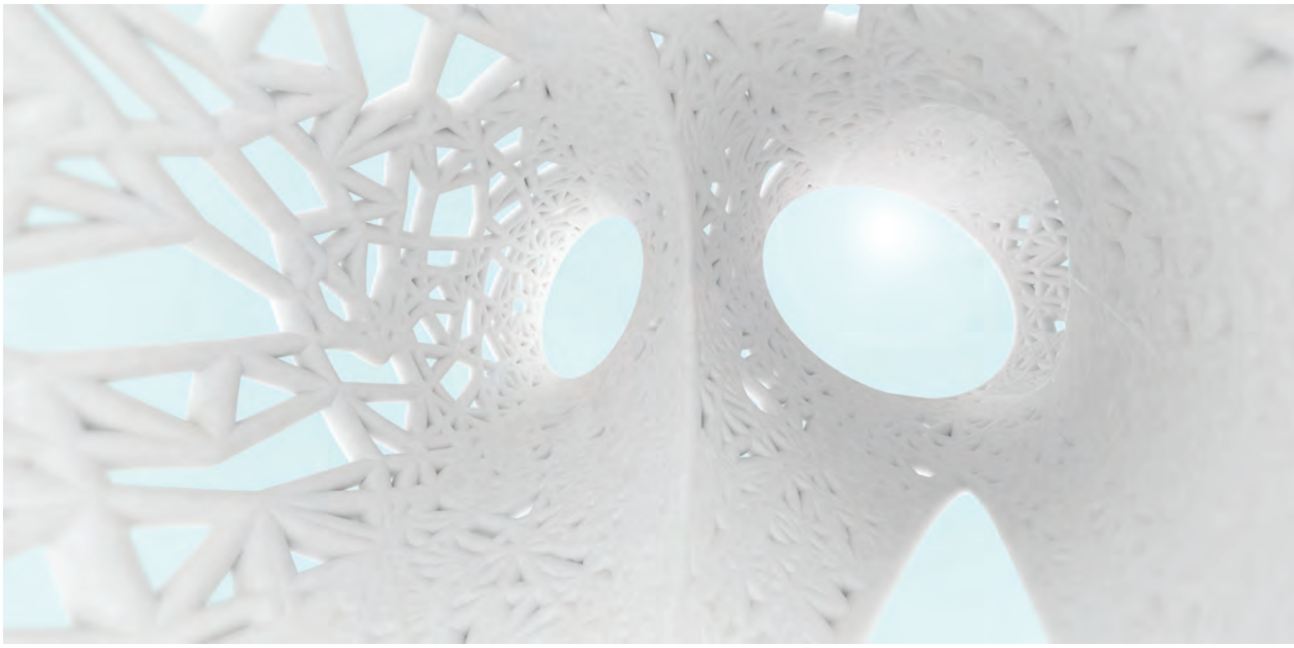


Figure 7: Igor Siddiqui/ ISSSStudio, Scye, 2015. Rendering of object interior.

but scalable allows us to speculate upon how such morphologies may be further developed through our future endeavors. While the other two parts of the systems are designed to be recycled and composted, the object series was designed as a collectible edition.

CONCLUSION

About the name: the project is titled after a term specific to the craft of tailoring, resonating thematically with the exhibition title, "Body Building." A scye is the seam that connects the top edge of a sleeve to the rest of the garment. As closed curves that circumscribe the area between the shoulder and the underarm, scyes—or armholes—are both joints and apertures. This condition resonates in architecture as it negotiates flatness with volume and dynamic movement with material. Both garments and buildings are membranes that surround us, yet to make a sleeve in architecture may not be the same as making a sleeve for the body. As far as tailoring is concerned, body is to clothing what ground is to architecture. The conjoined translucent sleeve in the *Scye* installation is defined by a series of parametrically differentiated sectional profiles tailored not to the vertical body, but rather to the horizontal ground plane. Like a scye's position relative to the body's hinge between the arm and the torso, these profiles coincide with the location of topographic shifts in the ground, articulated as expansion joints that register the movement underneath. In architecture materials appear static, whereas in practice they are always moved around and moving. As architects, we choreograph where materials go: perhaps more than ever we are now capable of shaping their trajectories in ways that are innovative, impactful, and otherwise significant.

ENDNOTE

* For further reference, see the exhibition catalog: Sille Pihlak and Siim Tuksam, eds., *Keha Ehitus/Body Building* (Tallinn: Estonian Centre of Architecture, 2015).

PROJECT CREDITS

Igor Siddiqui (Principal); Mitchell Peterson (Project Designer); Alex Wu and Heather Sutherland (Project Assistants).