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Modular ConstructS

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The notion of modularity has been known to European architecture and construction since the classical period. It can be described as a system which allows economy and efficiency in the design and realization of architectural projects. Nevertheless, modularity is not a static term, but a constantly shifting notion, which readjusts its meaning in relation to contemporary manufacturing and production technology, taking its lead from significant technological innovations.

Today, in the midst of the digital and information revolutions, modularity seems to be undergoing a drastic realignment. CAD/CAM technologies have revolutionized the production of constructional elements, as design and form-defining mechanisms.

Figure 1: The Parthenon.

Conceptual Definition

Modularity was first brought to our attention by Vitruvius. By analyzing the "Doric order" present in the ancient Greek temples, he introduces the "module" (modulus)[1] as a minimum unit by which any other component of the temple may be measured. By applying the rule to the Parthenon (see Figure 1), he explores further the 4 : 6 : 9 module to the other dimensions of the building, which he defines by the size of the "triglyph" (= 875.9mm). Thus, each structural element of the temple has a precisely defined relation to other elements and the rest of the building as a whole.

By examining the Parthenon in terms of manufacturing, we can see that the temple shows many characteristics of contemporary building. It is constructed of standardised, modular pieces, which were manufactured to a high degree of precision under quasi-industrial conditions. Considering this, modularity as defined in the classical period becomes a determination technique for design, organization and efficiency in construction. The "rhythm" of the ratio 4:6:9 functions as a design tool and detailing principle at the same time. The module is not a physical element but a theoretical definition of a measurement, which operates as a form defining and problem-solving mechanism.

Identical Units

Modular constructions appear again in abundance as a consequence of colonial expansion and the industrial revolution. The lack of skilled craftsmen in the new world forced engineers to develop light, modular constructions that would allow standardised mass production on an industrial scale and facilitate the easy assembly of the components on site.

Thus, the first industrially produced construction system came into being: the balloon frame. Its name reflects its lightness and its "high-tech" construction, which was similar to the balloons, or the woven baskets. The "balloon frame"[2] could be described as a technique based on structural units, called "studs", which provide a stable frame to which interior and exterior wall coverings were attached and covered by a roof comprising horizontal joists or sloping rafters covered by various sheathing materials.

The wooden frames become identical modules, which are being repeatedly added, generating a regular three-dimensional grid. Their width and height determined the dimensions of doors and windows, the stairs and roof. Thus a regular system of order arises, which in later stages expands even to an urban scale, through mass replication in the construction of housing units. The "balloon frame construction" and the later optimized version, the "general panel system", describes a module as a physically identical unit, which is multiplied and repeated. The module is characterized by the greatest possible simplicity and its suitability for economical mass production (Figure 2). The building itself can also be seen as a unit, or a spatial module. This definition of modularity dominated architecture for many decades, with several variations in the modern, late and post modern period, always linked to the emergence of new manufacturing techniques and materials. Here, I could make reference to the modern movement with Walter Gropius´ "Baukastensystem" and the Metabolists.

Figure 2: Modular housing: Bird Fair, Porto, Portugal.

Figure 3: Parametric modules.
Rapid prototype by Bernhardt Bangert.

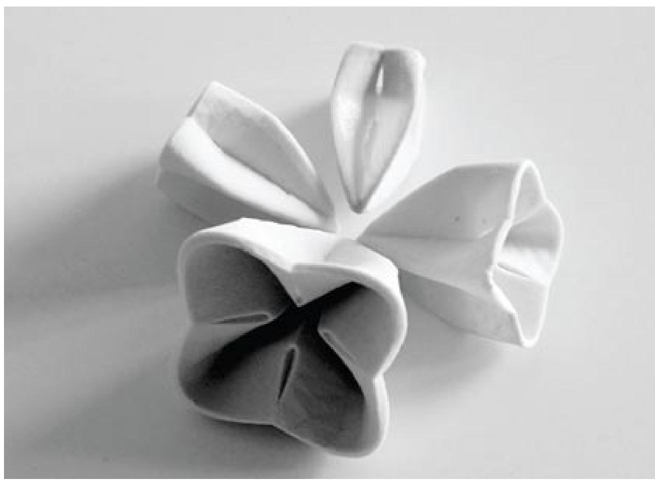


Figure 4: Parametric modules.
Rapid prototype by Olivia Haym, Constanze Joppen, and Sandra Renner.

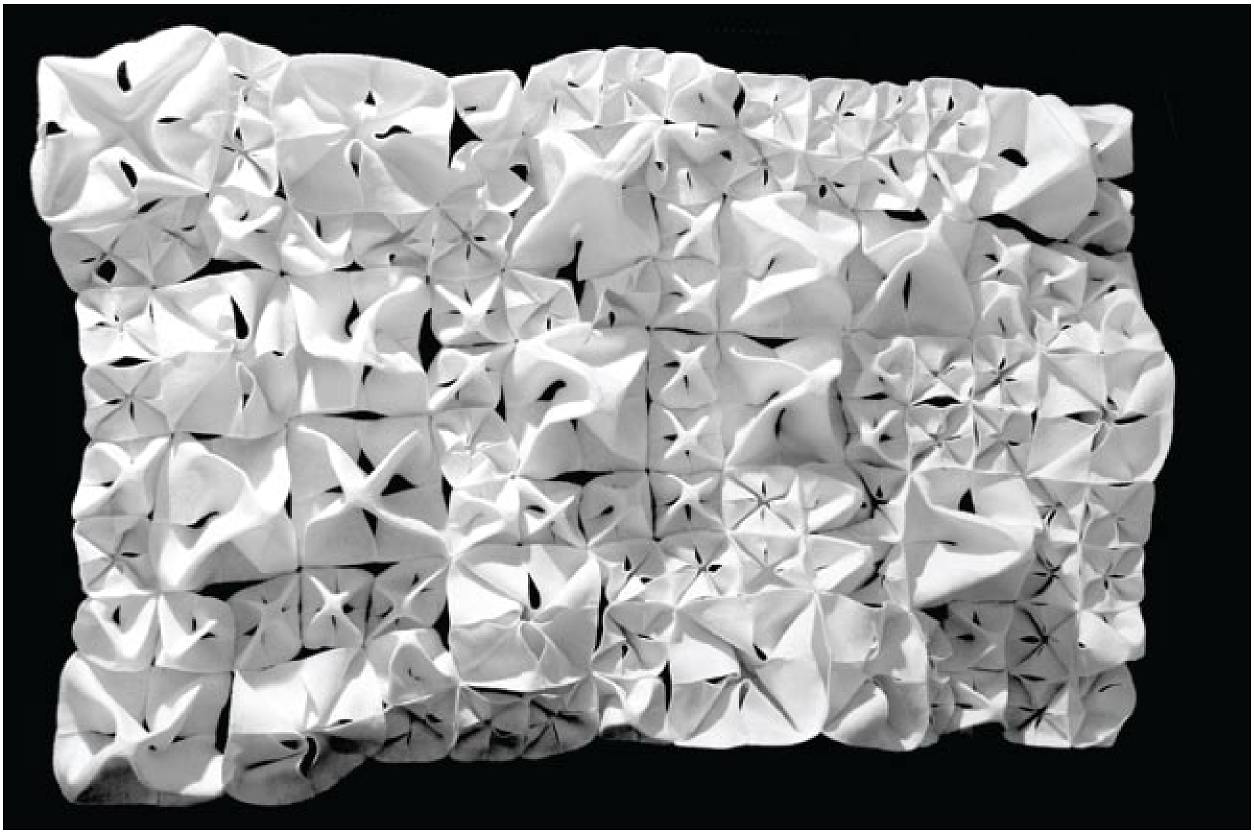


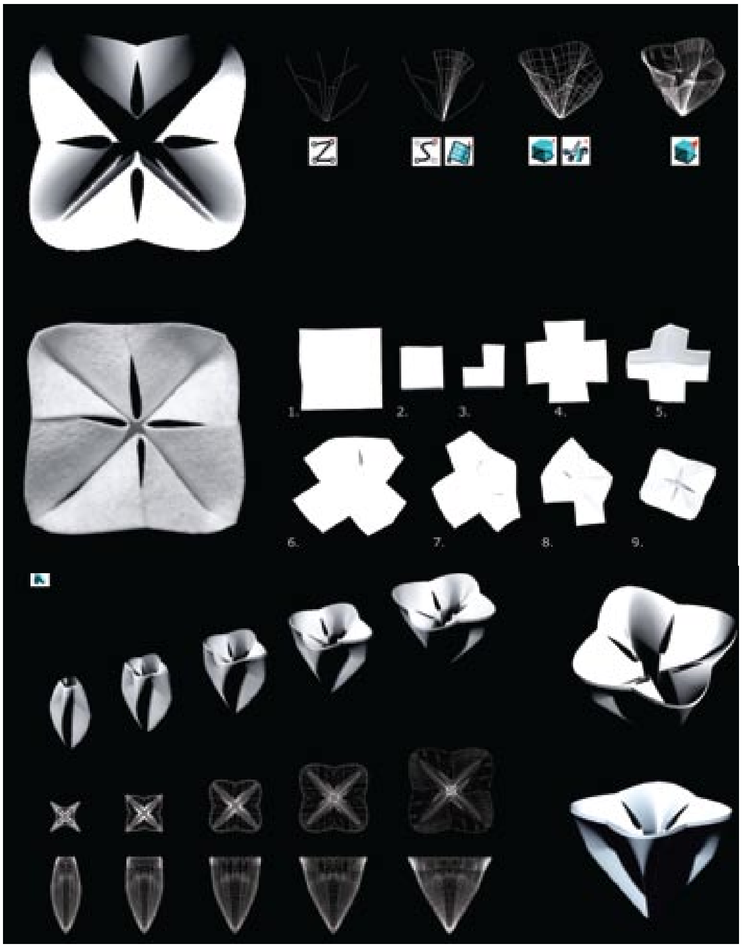
Figure 5: Carpet by Olivia Haym, Constanze Joppen, and Sandra Renner.

Parametric Set

Today, the cultural and social revolution brought on by telecommunication and information technologies is rapidly transforming the field of architecture. We live in an era of accelerated change, in which data speeds invisibly around us, the flow of information superseding the importance of material exchange. Complex digital infrastructures have inscribed themselves within our well-established mechanical and urban patterns. Today the unique character of handicraft and the industrial sameness of systematic mass production can coexist thanks to CAD/CAM, which assists the production of series-manufactured, mathematically coherent but differentiated objects, as well as elaborate and relatively cheap components.

Today's algorithmic and parametric tools in 3D modelling software allow the associative behavior of the unit. Computerised manufacturing allows fast individual production of the different components. The "new module" seems to dematerialise, becoming more of a set of rules and mechanisms defined in a virtual environment (Figure 3). The parameters defining the "new module" expand until present manufacturing, materiality, transportation and cost limitations can reach. Today's modular constructs define an era of neo structuralism, combining technology, complex geometry and ornamental aesthetics in one singular entity.

Architecture is mutating into "firmware,"[3] the digital building of software space inscribed in the hardwares of construction. Soft, complex curved surfaces modelled in data-space will be transmuted to real space as bent or tongued variable panels, as sheets in steel, copper or plastics, or as Kevlar or glass fiber skins; massive involuted elements designed in data-space become milled, routed or turned elements in wood or aluminum, or cut as moulds for quick-setting resins, rubbers or metals. Bridging the boundaries between the real-technical and the virtual-technical, firmware will favour a far more malleable relationship between bits, space and matter.



Analogue tooling: A flower is generated by folding felt. Four variations of the module are put together in a flexible blanket.

Digital tooling: The flower is transformed into a parametric object that can be modified with the Morph tool. Several variations between open and closed conditions are created. The final object is exported as a rapid prototype model.

Figure 6: FlowerZ: parametric modules created with **form•Z**'s Morph tool by Olivia Haym, Costanze Joppen, and Sandra Renner.

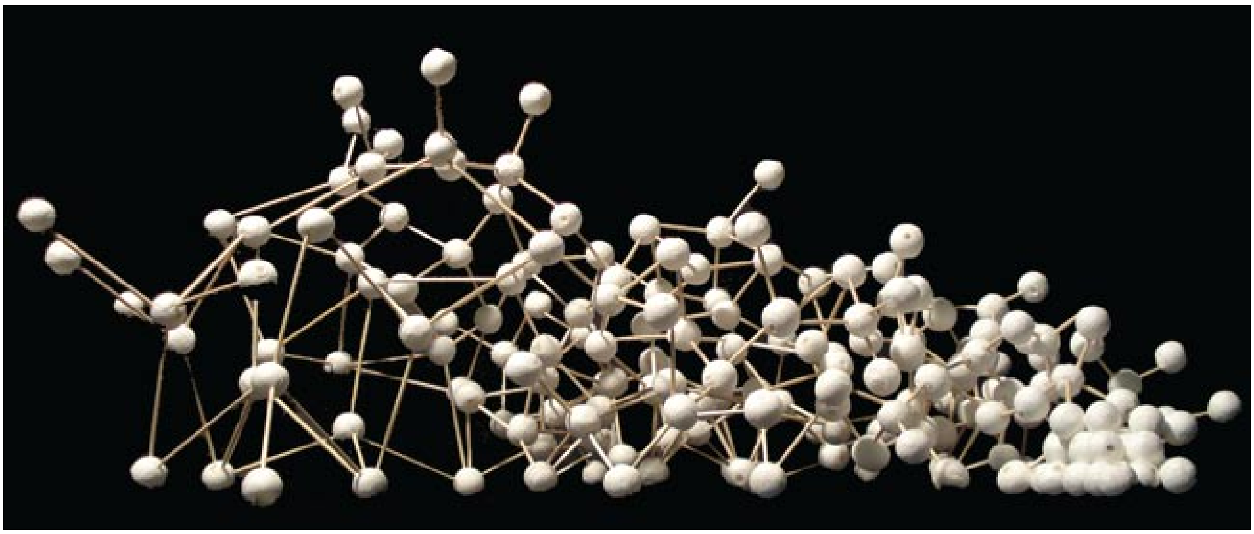


Figure 7: Particle cloud by Egon Hedrich and Rainer Schmidt.

Analogue tooling: A complex geometrical construct is constructed as a cluster by varying modular particle entities.

Digital tooling: One geometrical segment is digitised and its spatial and surface conditions are explored. The final object is a 3D plot.

References

1. Marcus Vitruvius Pollio. Baukunst, Buch IV. Basel: Birkhäuser, 1987.

2. Ludwig Matthias. Mobile Architektur. Munich: Deutsche Verlags-Anstalt DVA,1999.

3. Zellner Peter. Hybrid Space: New Form in Digital Architecture. New York: Rizzoli International Publications.

Figure 8: Modular construct by Mareike Ahl, Bettina Dobschal, and Miao Miao Ma.

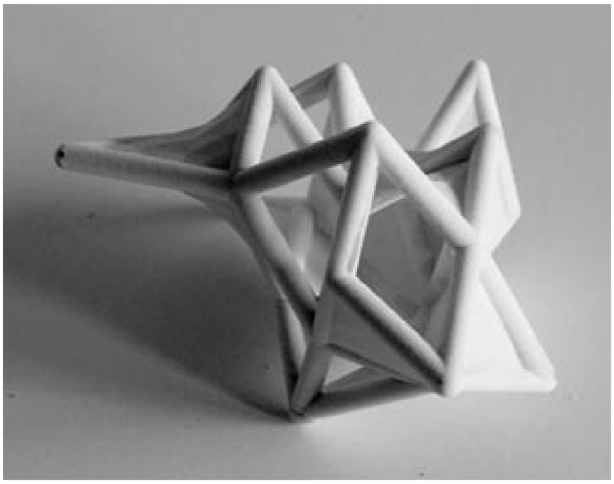


Figure 9: Rapid prototype model.

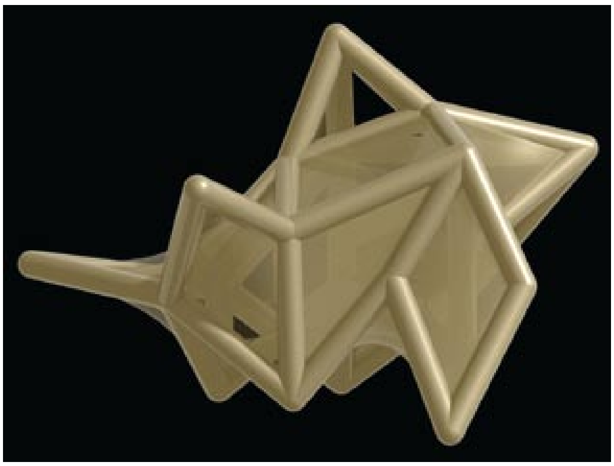


Figure 10: Rendered 3D model.

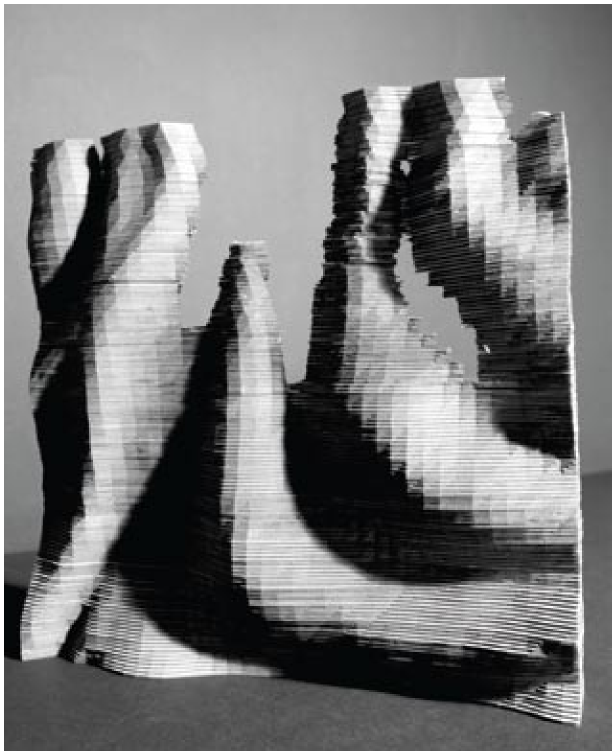


Figure 11: Laser cut prototype by Nina Linde and Johen Vollmer.

Asterios Agkathidis was born in 1974 in Thessaloniki, Greece. He studied architecture in Thessaloniki and completed postgraduate studies in Advanced Architectural Design at the Staedelschule in Frankfurt in 2001, with Ben van Berkel and Peter Cook. He became a partner in the architectural practice b&k+ in Cologne until 2004, then at VMX architects in Amsterdam, until 2005. He later founded the architecture and research platform www.a3lab.org (Frankfurt-Thessaloniki). Teaching and lecturing experiences include AdBK Nuremberg, FH Frankfurt, FH Cologne, FH Bielefeld, Univ. of Thessaloniki, Staedelschule Frankfurt, and Van Alen Institute in NY. Today he teaches at the Technical University of Darmstadt and the Boston Architectural College. His recently published book “modular structures” follows the success of “form defining strategies” in Europe and America.