Protomoment

"In a sense, what comes next is what we have always done."

—Alain Pottage

"The Charismatic Prototype"

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INTRODUCTION

In 2010 at an international, multidisciplinary conference devoted exclusively to the subject of prototyping, the organizers opened the meeting with a proclamation that we are now in what can be characterized as a "prototyping moment."[1] The reason for the gathering, it was noted, was that prototypes had "acquired a certain prominence and visibility in recent times."[2] This can certainly be claimed as there have been a number of prominent publications and gatherings arising to establish interest across many disciplines. How is it that, now, a practice—prototyping—that has existed, prominently for all of human history[3] is a characterizing object?

The reason, in this case, was attributed to the new engagements made possible through the vast and recent developments in digital technology. The participants of the conference, made up predominantly of social scientists and designers, theorized that the new instruments of engagement, (things like open source access, user-generated design, collaborative media laboratories and dynamic scripting software, just to name a few) were both new modes and evidence of a paradigm shift occurring throughout their disciplines. These new modes of expression and representation had sufficiently destabilized traditional views of invention, innovation, collaboration and authorship to produce an unprecedented explosion of models of/for future, yet uncertain, action—prototypes. These prototypes grew—are growing—precisely out of the need to contend with the unstable nature of the new tools now at our disposal and the means by which users are experimentally employing them. In the end, it is not that prototyping is new, but newly visible by virtue of the vast propagation given the new tools and new (or newly created) materials. That is what makes this, for the first time across many disciplines, including architecture, a moment characterized by prototyping. [4]

PROTOTYPE DEFINED

The prototype is first a social object. Regardless of the technologies employed or techniques tested, prototypes are the constructions around which we craft interaction with our collaborators, our disciplines, and even ourselves.[5] In their very physicality, prototypes put forth the vehicle for this communication; at once materially "proving" a concept while "obfuscating the conflicts and contradictions worked out in the course of the making."[6] The prototype gives us something around and through which to talk.[7]

Perhaps more so than any other class of object, the prototype is inherently and intentionally a manifestation of a projective (and unknown) possibility; it is the "quintessential future-facing object."[8] As such, it must manifest the achievable while coaxing an evolution. For designers, this means that prototypes are also a conceptual object, "a means for ideation rather than production,"[9] advancing a brief future thesis in the rhetoric of a deliverable.

Prototypes are not replicas or facsimiles. They are full scale, operative objects seeking an application. Prototypes are relentlessly physical. They must be made of materials, using tools. They are elevated (and maybe) burdened by technique. Necessarily, there are limits on the acts that a single prototype can perform. They are most convincing when interrogating a narrow question. The specificity of their rhetoric opens the means toward a more productive iterative process. A general, but narrow prototype can find its way to multiple applications, "a proliferation of abductions and transformations, including the possibility of (virtuous) failure."[10] Whereas the reverse is seldom true.

TRACING THE ROOTS OF THE CONTEMPORARY ARCHITECTURAL PROTOTYPE: THREE STRANDS

Looking across the field of architecture today, one is witness to a landscape occupied by a whole class of objects that are neither the scaled versions of a known, but future, thing (a model) nor a full-scaled test of known, but untested, arrangement (a mock-up.) Though the model and the mock-up are instruments that have been utilized for centuries, nowadays we see another category of experimental "intermediate" objects—prototypes—negotiating new and still unstable material, manufacturing, and technological domains. These new objects (and this is why they fall into the category of prototypes) are self-referencing, complete, and fully formed explorations while also remaining open-ended and open to interpretation. Their innovations feel specific and adaptable, in other words, unstable.

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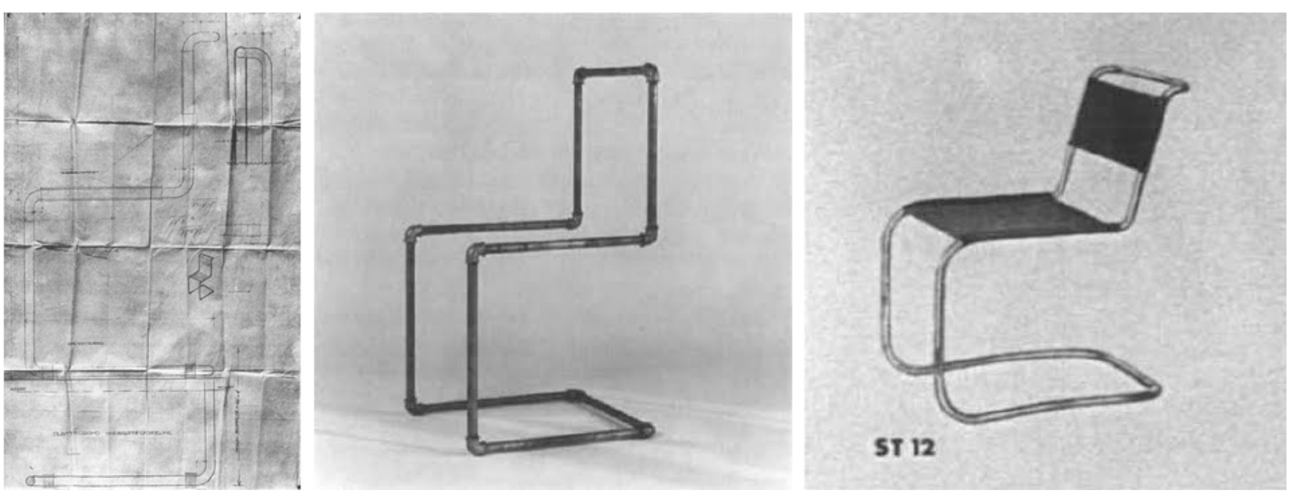

Figure 1: L33, Bent tube steel chair by Mart Stam. Production Drawing (left), pipes prototype (middle), and final production chair (right)

MANUFACTURING PROTOTYPES

While all forms of prototyping have very long histories, the contemporary prototyping in Architecture, that is growing around us, did not arrive out of a vacuum. Today's resulting objects (and processes) have their roots in the experimental objects of the twentieth century. As expanding industrialization demanded speculative application, architects, with their knowledge of craft and construction and their experience in employing (scaled) representations, were good candidates to develop new ideas through fabricated objects. Produced one-offs were devoted to increasing the technical, aesthetic, and manufacturing possibilities of architecture. Some of the best and most illustrative prototypes came in the form (or guise) of practical objects. One recurrent object for this purpose, the chair, in the hands of some architects, became vehicles for testing broader disciplinary questions. The bent steel tube chair experiments (of Mies van der Rohe, Stam, and Breuer) of the 1920s, as one example, were, at first glance, trial objects that explored the newly available steel shapes and tube-bending technologies. Looked at as broader prototypes, however, the bent tube chairs contributed the most significant knowledge in the area of production. As such, these "manufacturing prototypes," though one-of-a-kind and handmade at first, indicate Architecture's early steps toward mass production. In fact, their designs, down to initial conceptualizations in many cases, were created with an eye toward standardization, a debate that was further expanded upon in the 1927 Weissenhof.[11] In the end, why were architects making chairs at all if not to also run small scaled (re: achievable, economic) experimental tests for ideas that may (or may not) be effective in their larger architectural pursuits.

TECHNICAL PROTOTYPES

Whether functional objects were a pragmatic guise for prototypical activity, because of the economic or political climates at the time, or whether their prototypical status was purely accidental, the practice of full scaled testing takes a robust turn away from applied (and toward theoretical) research in the prototypical objects of designers starting in earnest in the 1940s and 1950s. Frei Otto's experimental structures are widely recognized for their capacity to translate and transform structural ideas extracted from observations in nature into architectural components and building details.[12] His multiple research-based practices throughout Germany[13] were heavily dependent on physical objects (and their analogical analysis) to produce the knowledge upon which trial constructions would be based. In some ways, prototypes, at least as they have been described above: full-scaled,

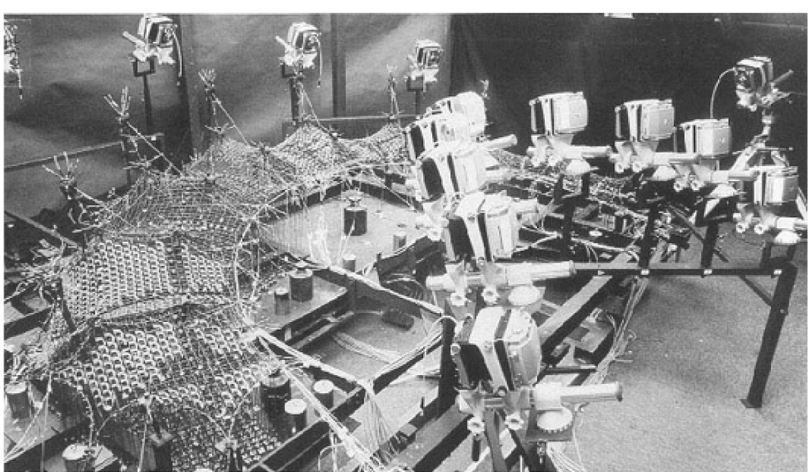

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Figure 2: Frei Otto's studio, using models and photography to analytically measure the structural performance of the Munich Olympic Stadium design.

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operative, nascent and singular in scope, and without exact application, are most readily examined in Otto's earliest works, before the large building commissions and professional partnerships that began in 1964. The early period in his career, when projects were mostly unsolicited, allowed him to experiment—at times at full size—without the pressures and constraints of making architecture. The best examples from this time, the experimental structures were built for the Federal Garden Exhibitions and the German Building Expositions of the 1950s. These design objects, while objectively inhabitable, were primarily designed and constructed as full sized tests of structural and formal experiments. In them, it becomes possible to see the seeds of the forms (subjects) of future explorations with structural optimization in tensile, lightweight shell, space frames, and dynamic post design that happen in the building-design work of the future. More importantly though, these prototypes set up technical testing protocols for the prototyping we see in contemporary architectural practice. Whether in the studio as scaled models or on site at full scale, the prototypes Otto builds at this time were meant to materialize optimized forms as yet only described mathematically. In the studio, their formal and structural behavior is measured and tested against predicted performance, beginning an era of the architect's direct engagement with technical testing and laboratory style "proof" finding we see expanding today.

Otto's models and objects test the innovative technical possibilities that arise out of the computational and (mathematically) descriptive advancements happening at the time. As such I will refer to them as "technical prototypes" to describe them nominally and to differentiate them from "material prototypes," a wholly different type developing contemporaneously. If the overall formal and aesthetic properties of a "technical prototype" arise as a by-product of "scientifically" designing and testing novel structural systems, then the "material prototype's" forms and aesthetic tendencies grow out of a craft based approach but utilizing the new materials of the age. This class of prototypes privileges innovation with new materials over formal or structural optimization.

MATERIAL PROTOTYPES

Perhaps the most radically different new material to arrive on the architect's palette in the twentieth century was plastic.[14] Plastic (though one should really say plastics as their property variations are so great as to imply distinct materials) at first enters the design fields as a substitute for materials such as stone, steel, or wood, all of which were more expensive and required specialized fabricators. Very quickly, however, plastic becomes the very subject of investigation. The first tests,

Figure 3: Joe Colombo's "Universale" chair, 1965, (left); Vico Magistretti's "Selene" chair, 1969, (middle); and Verner Panton's "Panton" chair, 1973, (right)

again, centered on the production practical objects, especially chairs, and tended to be closely related to preexisting craft traditions. The fiberglass chairs developed by Charles and Ray Eames, for example were an adaptation of the stamped steel version originally planned.[15]

By the 1960s plastics were being exploited for their particular capacities. Experiments that foregrounded the unique capabilities of the new material—what could (only) this new material do?—were resulting in a variety of objects

that were now only possible out of those materials, and eventually those materials alone. The production of small sized articles allowed for considerable advancement in both material compositions and their allied forms. The chairs and objects of this period reflect this prolific progression from the first all-plastic pieces ("Universale" chair by Joe Colombo, 1962-1965) to the first plastic monocoques ("Selene" chair by Vico Magistretti, 1965-1969) to the first "single sheet" monocoques "Panton" chair by Werner Panton, 1960-1973) it is possible to witness a dedication to "figuring" (in both senses of the word) out the material based on its unique properties. Most profoundly, the development of these particular "material prototypes" provided both the objects themselves as prototypes for future architectural adaptation (see, for example, the next generation of plastic prototypes for a habitable "junction unit" by Chenéac or the façade panels by João Honorio) as well as, and more importantly, the conventions used in today's inclination to look to material property and process experimentation as a viable and vital means of disciplinary research.[16]

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It would be difficult to trace the three strands above: the "manufacturing prototype," the "technical prototype," and the "material prototype" into three

Figure 4: c_LITH on display

ENDNOTES

1. "Prototyping Cultures: Social Experimentation, Do-It-Yourself Science and Beta-Knowledge" was a two-day conference organized by the Spanish National Research Council, Madrid on November 4 and 5, 2010 held in Medialab-Prado and Centro de Ciencias Humanas y Sociales (Madrid). The organizers, Alberto Corsín Jiménez and Adolfo Estalella. are Social Anthropologists and researchers who work at the intersection of social science with science and technology. Their working definition of "prototype" was quite broad. It included physical and intellectual products and practices. The notion that this is a "prototyping moment" was largely accepted at the conference and was reiterated in the conference talks by at least three other speakers. See the website: http://medialab-prado.es/article/prototyping_workshop
2. Jiménez, Alberto Corsín. "The prototype: more than many and less than one." *Journal of Cultural Economy. Special Issue, Prototyping cultures: art, science and politics in beta*, ed. Alberto Corsín Jiménez.
3. Buchli, Victor. "The Prototype: Presencing the Immaterial." *Visual Communication* 26 Aug. 2010: 273-86.
4. Kelty, Chris. "Prototyping Prototyping: A Preface." Limn. Web. 14 Sept. 2014. <http://limn.it/prototyping-prototyping-a-preface/>.
5. Schrage, Michael. "Crafting Interactions: The Purpose and Practice of Serious Play." Prototype: Design and Craft in the 21st Century. Ed. Louise Valentine. New York: Bloomsbury, 2013. 19-28.
6. Kelty, Chris. "Prototyping Prototyping." Conference talk at "Prototyping Cultures: Social Experimentation, Do-It-Yourself Science and Beta-Knowledge" http://medialab-prado.es/article/prototyping_prototyping
7. Drawn from the Introduction in Daston, Lorraine. *Things That Talk: Object Lessons from Art and Science.* New York: Zone ;, 2004.
8. Adamson, Glenn. "Preface." *Prototype: Design and Craft in the 21st Century.* Ed. Louise Valentine. New York: Bloomsbury, 2013. p. xiv
9. *Ibid.*
10. Jiménez, Alberto Corsín. "The prototype: more than many and less than one." *Journal of Cultural Economy. Special Issue, Prototyping cultures: art, science and politics in beta*, ed. Alberto Corsín Jiménez. p.8
11. Pommer, Richard, and Christian F. Otto. *Weissenhof 1927 and the Modern Movement in Architecture.* Chicago: University of Chicago, 1991.
12. Kotnik, Toni. "Experiment as Design Method: Integrating the Methodology of the Natural Sciences in Architecture." *Experiments*. Ed. Akos Moravansky and Albert Kirchengast. 24-53.
13. Throughout his career, Otto founded three practices in Germany. First in the 1950s the Institute for Development of Lightweight Construction in Berlin-Zehlendorf where early experiments and built projects for expositions were the primary projects. Later, in the 1960, Otto founded two concurrent practices. Atelier Warmbronn was the place for experimental projects; and The Institute for Lightweight Structures (IL), Stuttgart, for research. The decision to split his practice activity into a research branch and a project branch is a significant means to establishing contemporary issues of research in the field of architecture.
14. Plastics are really one of many materials that could be used

equivalent and/or discrete practice trajectories today. The prototyping models of the past have been interrogated and adapted for the present moment at will. Each current project, in so far as it can be termed a prototype, is rather more impacted by the acceptance of prototyping as a relevant component to contemporary architectural practice and discourse.

PROJECT CASE STUDY / C_LITH: CARBON FIBER ARCHITECTURE

PROJECT DESCRIPTION

c-LITH is the reconsideration of the architectural building unit through the exploration of new composite techniques and materials. Our research project develops individual components that exploit the strength, lightness, and variability possible with carbon fiber filaments when paired with computation, digital fabrication, and hand assembly.

Traditionally, building units are made of brick or concrete. They are small and multiple, heavy, difficult to vary, and are much better in compression than tension. Using carbon fiber filaments to create variable units allows for larger, lighter individual units that can vary in both shape and structural performance as needed. Most importantly, however, the c-LITH units address the use of composites at the scale of standard architectural production. Until now, composite filaments have largely been used to produce monolithic shells, as in the hulls of boats and airplanes. The methods to produce shells, however, continue to be impractical for extensive application in building construction. Instead, we designed c-LITH as a unit-based system to exploit the advantages offered by the new material as applicable to an existing industry that makes large wholes from small, manageable parts.

The design of the c-LITH installation shown in this portfolio represents the first testing of the prototypical units assembled at full scale. The overall design in both footprint and figure are imagined as aggregations that could continue growing in all directions and could be scaled. The test installation was designed utilizing a computer script that also generated all of the associated cutting files for the winding molds and jigging system. The direct connection between design generation and CNC manufacturing afforded us the opportunity to explore variation in the design. Hence, each component of c-LITH is typologically similar, yet completely unique in form with all elements fitting precisely together in a single unified structure.

MANUFACTURING PROTOTYPE

A large portion of the effort involved in materializing the c-LITH project was the development of a two-fold prototypical manufacturing process that produces the components and their assembly. For the construction of the components we invented a method to quickly and cheaply construct variable disposable cardboard molds that could withstand the wound casting and baking steps, but could also be easily weakened through water immersion to be removed. For the assembly we developed a rigid, three-dimensional "dummy" jig system to hold the joint plates in space with a high level of precision but could also incrementally absorb the adjustment errors unavoidable in hand-assembled systems.

Both of the processes we developed, variable disposable molding and three-dimensional "dummy" jigging, are the result of wanting to use carbon fiber to make architectural building units. While the innovation of these two processes was initially dependent on the specifics of the composite material we used and the desire to make re-mountable construction, we believe their application is much broader. c-LITH represents one test case of many possible variations and many possible future applications. In this way c-LITH also represents an evolving role for architects in the production of design knowledge for and in the construction industry.

TECHNICAL PROTOTYPE

c_LITH had several technical questions to be investigated: assembly, structural capacity, and translations between digital and analog models. Sizing a unit-based system (for assembly) out of the carbon fiber tow resulted in a negotiation between the size of each part, which, given the overall weight of the material, could have been extremely large. There were a number of mitigating factors which reduced the size of each part considerably: the size of our oven, the size of available form material, the reasonable number of bake cycles we could run, and the resulting hand installation were all factors that accounted for the final dimensions of the parts. Tangentially, because we designed the prototype to be transportable and re-mountable , the system for creating the connector nodes and grouping sections was also part of the ideation functionally and aesthetically.

Given the nature of carbon fiber (high strength, very low weight), it would seem that the primary purpose for choosing the material would be for structural optimization. For us, assembly, re-mountability, and transportability took precedence. The greatest strides we made toward structural optimization were in the design of the winding patterns and protocols, including its codification, for our work force and eventually (soon) our automated robotic tools. Our future plans in this area include more detailed structural testing to further understand the impact of geometry, our node designs, and winding.

Lastly, we had to develop the appropriate translating mechanisms between our digital models and our analog constructions. Because carbon fiber is particularly stiff tolerances were built into the winding patterns to accommodate fabrication, assembly, and installation inconsistencies. These “gives” had to flex, but not catastrophically weaken the structure.

MATERIAL PROTOTYPE

The final area in which c_LITH is prototyping is materially. It would be quite accurate to say that the project began with a material obsession with carbon fiber. We were fascinated with everything about it; its composition, its miraculous capacity, and its aesthetic. For months we got our hands dirty to understand what it could do and how to get it to do things it was and wasn’t designed to do. We convinced clients to use it and to let us design things for them so that we could better understand it and design with it. The form of carbon fiber, a sticky, string-like tow, suggested volumetric possibilities as well as a high amount of flexibility so as to be able to construct a large number of variations within a given size range.

here. Contemporaneous experimentation with laminated wood, new steel compositions, and variations on glass and concrete formulations can also thought of as “material prototypes”.

15. Handler, Kaitlin. “Molded Plastic Chairs | Eames Designs.” Molded Plastic Chairs | Eames Designs. Web. 14 Sept. 2014. <http://eamesdesigns.com/library-entry/molded-plastic-chairs/>.

16. Evidenced by recent turns toward material culture in architecture: Matter by Gail Peter Borden and Michael Meredith, eds.; Material Beyond Material International Conference, UCLA, 2011, etc.

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