Electroform(alism): Masters, Substrates, and the Rules of Attraction

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INTRODUCTION

The project explores hybrid ways of making - reviving 19th Century metal electroforming techniques and adjusting them to contemporary design and fabrication methods. In re-imagining electroforming as an intrepid, present-day process that moves beyond the simple replication of metallic objects on a master form, the strategy tests novel aesthetic, material and economic possibilities in service of mass customization. Using expendable and embedded substrates, the prototypes generate distinct metallurgical ornament and articulated skins. More importantly, perhaps, the process also conceives of a new mode of small-scale fabrication – one that is adaptive, nomadic and generative.

TECHNIQUE

Electroforming is a deceptively simple process, produced through the deployment of a series of variable and contingent components: matrix material, chemical bath, and substrate. Conventionally, the practice begins with a mold, or master, whose surface is made conducting with a thin coat of graphite powder or paint. A wire is attached to the conducting surface and the mold is suspended in an electrolyte solution. Electro-deposition of the material - typically alloy foil, silver, nickel, or copper - is activated using electrical currents. When the mold is coated to the desired thickness, the object is removed from the bath and divorced from the mold.

The outward straightforwardness of the process disguises the range of effects that can be achieved through the adjustment of the matrix mix, plating bath composition, and conditions of the depositor. All of these factors contribute to the production of components that cannot be realized via sheet metal fabrication techniques. When correctly calibrated, the operation economically allows for unmatched dimensional accuracy, thin material sections, complex curvatures, and refined detailing with no limit to the size of the object that can be electroformed. By re-conceiving the master as a disposable, or inexpensive artifact, the process is perfectly adapted to contemporary logics of mass customization.

ORNAMENTAL SKIN

In developing a series of prototypical articulated hollow metal modules, we were interested in maximizing efficiency and variation. To that end, the project explores the potential of a single interlocking module with three discrete topographies to create the appearance of endless variations as an ornamental interior or exterior cladding system. A catalogue of 100 adaptations illustrates how the tessellated pattern can be tailored to particular aesthetic requirements. Mindful of the expense of customized fabrication, the project deploys vacuum formed styrene plates produced from cnc milled medium density fiberboard in order to effectively diffuse the cost of the original millwork over the span of the production run. And by ensuring that the cost of the replicated master remains low, playful ornamentation makes a plausible comeback.

RELEVANCE

Electroforming is relevant to architecture today for four reasons: first, the process works at any scale, from a cufflink to a submarine. Second, recyclability is embedded in the process, meaning any failed units can be dissolved back into the solution. Third, the technique lends itself to short-run production—a midpoint between the artisanal one-off and mass replication. And, finally, electroforming offers the potential of “nomadic production” with a compact, portable lab.

ELECTROFORM(ALISM):

MASTERS, SUBSTRATES, AND THE RULES OF ATTRACTION

ANYA SIROTA + AKOAKI

Electroform(alism) explores hybrid ways of making - reviving 19th Century metal electroforming techniques and adjusting them to contemporary design and fabrication methods. In re-imagining electroforming as an intrepid, present-day process that moves beyond the simple replication of metallic objects on a master form, the strategy tests novel aesthetic, material and economic possibilities in service of mass customization. Using expendable and embedded substrates, the prototypes generate distinct metallurgical ornament and articulated skins. More importantly, perhaps, the process also conceives of a new mode of small-scale fabrication – one that is adaptive, nomadic and generative.

THE APPEAL

Electroforming is an appealing fabrication technique for a number of reasons. First, size doesn't matter. The gamut of scales at which electroplating can be deployed makes working with virtually any size unit possible. In the 19th Century plated cutlery was all the rage. During World War II, Americans plated entire submarines in Detroit's automotive manufacturing facilities, producing virtually infallible metal monocoques. And everything in between can be plated as well. The scale of the project depends on the size of the tank and the amount of electrolyte material it can hold. In our case, we started our exploration with a tank approximately the size of a garbage can. More precisely, we started with a garbage can. And this allowed us to experiment with artifacts about a foot squared.

Second, the method is molecular. Electroplating is a chemical process that works at the molecular level. Metal particles move from the ingot and deposit on a master or substrate – and this happens gradually – which allows for an unmatched level of control, enabling the buildup of material to a precise thickness over time. Meaning plated components can be designed and engineered to a specified tensile strength with virtually zero waste. It also implies that recyclability is embedded in the very logic of the process. The insufficiently beautiful, the structurally flawed and the not so endearingly ugly can be tossed back in the tank and put back to work as source material for a new deposit.

Third, the process privileges short run fabrication over artisanal and mass production. Artisanal craft emphasizes the auratic value of the one-off – which can produce beautiful artifacts. But value is produced in the private exchange between a patron and a craftsperson, which is terrific as a single instance of pre-industrial exchange. As a strategy, however, the project is interested in delivering a generative method for economic resilience; a way of making that is greater in scope and enterprise.

On the other spectrum, mass production is ubiquitous and prosaic. As a rule of thumb, it invariably culminates in outsourcing. Accepting that the misnamed post-industrial phase is simply a global market shift toward more exuberant material extraction, it's safe to say that manufacturing competition is fierce out there. And regions uninhibited by labor laws and other civic constraints possess a preemptive economic advantage when it comes in making lots of things in big quantities. Where casting and sheet metal forming require a minimum run to compensate for the production of an expensive mold or master cast, electroforming can be deliberately frugal and foxy. In the spirit of entrepreneurial exploration, we set down some ground rules. Our masters would be cut rate and dollar store economical. In fact, no master could run over a 99¢ cap.

Fifth, Electroform(alism) explores the potential of nomadic fabrication. Electroplating facilities can be compact and mobile, as small and itinerant as the sum of their component parts. Depending on the desired output, the facility can be transported with relative ease. All you need is a source of current, the rectifier, a plastic garbage can and you're ready to plate. Collapsing the distance between the site of fabrication and installation allows for a certain level of demonstrative pageantry. Making (as) spectacle. We imagine deploying the nomadic fabrication facility in multiple scenarios: within industrial sites, adjacent to facades under construction, at the Astana International Biennale's American pavilion, and so on. Finally, Electroform(alism) is slow cooked. Where hyper-articulated aggregation is dependent upon low cost sweet equity or free labor, electroforming can be deployed toward the production of the snap in – simple interlocking units that connect with the unfussiness of tiles. And so the advantage of working with plating as a fabrication technique recalls the logic of a crock-pot. Choose the right ingredients, the right proportion, and let the process go.

BACKSTORY

The ascendancy of electroforming as a mode of metal fabrication was irrepressible. It fulfilled the Victorian era's insatiable enthusiasm for industrial ingenuity, superficial beautification and economical manufacture. By the 1860's the process, well suited to Beaux- Arts sensibilities, was deployed in the production of saturated, figurative ornamentation and monumental sculpture. Over the span of close to a century, cathedrals, operas and institutional buildings in Europe and the United States were populated with articulated bronze effigies to preeminent national personalities and other worthwhile fictions. On the market, the method made refined but attainable objects of consumer desire available in an array of possible simulacra: romantic, orientalist, or decorative. And, in perhaps the most ubiquitous operation, the printing and engraving trades customized the technique in the production of electrotyped copper plates, which replaced wood block as the standard method in the production of letterforms.

In the twentieth century electroforming was co-opted by the military for industrial fabrication of highly accurate and stable parts for high density "baby" submarines, antenna masts, molds for explosives, radar and electronic components, and so on, with much of the manufacturing taking place in Detroit, Michigan. Eventually, however, with the rise of Modernist visual austerity, post-war distrust for mimetic public cenotaphs, advancements in offset printing, and shifts in the global labor market, electroforming became relegated to the realm of a small group of experts and craft specialists working with architectural conservation, heritage curation, exquisite art objects and jewelry design.

TECHNIQUE

Electroforming is a deceptively simple process. It's produced through the deployment of a series of variable and contingent components - matrix material, chemical bath, and substrate – impacted by time and scale. Conventionally, the practice begins with a mold, or master, whose surface is made conducting with a thin coat of graphite powder or paint. A wire is attached to the conducting surface and the mold is suspended in an electrolyte solution. Electro-deposition of the material - typically alloy foil, silver, nickel, or copper - onto the mold is activated using electrical currents. When the mold is coated to the desired thickness, the object is removed from the bath and divorced, partially or totally, from the original mold.

The outward straightforwardness of the process disguises the extraordinary range of metallurgical effects that can be achieved through the adjustment of the matrix mix, plating bath composition, and conditions of the depositor, allowing for the production of components that cannot be realized via sheet metal fabrication techniques. The operation allows for unmatched dimensional accuracy, thin material sections, complex curvatures, shapes and refined detailing with no limit to the size of the object that can be electroformed. Most exciting, however, is that an electro-deposit can be applied to virtually any solid material: aluminum, zinc, nickel, Kovar, glass, plastic, foam, or synthetic fiber. The process can be deployed progressively, building up fine layers of multiple metal matrices in order to achieve the desired finish, tensile strength and complex form.

Electroforming differs greatly from metalworking techniques such as punching and milling in that it produces virtually no waste other than the substrate material that, if strategically considered, remains at the core of the finished product and enhances the structural performance of the composite.The continued existence of the substrate, embedded within the final metalized object, offers a particularly fertile area for study within the broader scope of the project. As in reinforced concrete, these composite constructions can combine the positive performance characteristics of both materials. Electroformed structural foams could combine visual mass and scale with very minimal weight; substrate fabrics like Kevlar could yield composites with incredible tensile strength at nominal thicknesses

THE LAB

To begin testing, we would need a laboratory. So we built one: an adjustable, mobile copper plating unit that could be broken down into an 8'x8' base module, with 4'x8' additional expansion modules. We were thinking ahead. Maybe our enterprise would grow. The chamber needed an exhaust fan in the ceiling, a floor of 60-mil EPDM liner (to catch any electrolyte spills). The unit, placed on casters, could be relocated easily within a facility. It could also be broken down and transported to an alternate fabrication site, exploring the idea of a nomadic fabrication unit. Inside: a lined tank, a 10 amp rectifier, clamps and lead set heavy gauge wire for bus bars, anodes, light gauge copper wire, electro-conductive paint, containers, copper electroforming solution, rinsing bath, safety goggles, aprons, shelves with base matrices, electroclean solution, replenishing brightener, acid dip solution, red lacquer, small pump, or other solution agitation devices.

The testing was tricky. It was easy to over cook by cranking the voltage too high. Get the levels in the solution wrong and the copper doesn't take. Estimate flow improperly and one side of end of the substrate might grow a sprout, or worse, a cauliflower. Make the master too deep, or textured and the process won't take. The first months of work produces an extraordinary series of experiments with materials that failed as substrates. Each test took time and patience. For the amateur, the process is finicky. And it is difficult to isolate exactly which components are all wrong or need to be just slightly adjusted. But the lab allowed us for to test a tremendous matrix of possible substrates in order to explore new material and fabrication possibilities. Of the myriad of experiments that we initiated four emerged as particularly generative. The productive tests have names: Blobby Tile, Horney Tile, Tankini, Lacey.

The Electroform(alism) project is made possible through a Taubman College of Architecture + Urban Planning Research Through Making Grant.

Photo creditss: A. The mobile lab unit inserted into barn in Ann Arbor, Michigan; B. Nate Doud preparing chemical bath; C. Prototype module number 14; D. Prototype module number 54; E. Prototype module number 92.

Electrform(alism) was awarded a Research + Design Award by Architect Magazine , June 2013.

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