34° 20' N, 108° 29' W
Quemado, New Mexico

A log cabin at the edge of Walter De Maria's Lightning Field (1977) is a way station for modern-day pilgrims eager to see lightning dance between the 400 polished stainless-steel poles the artist laid out in a grid, stretching one mile by one kilometer in the New Mexico desert. The installation's ordered footprint contrasts with the surrounding natural environment; its rationality reminds visitors that ever since the machine forcefully invaded the American garden, there is no "natural" landscape. Similarly, the seeming rusticity of the Quemado log cabin belies other regional histories. The "Land of Enchantment" (emblazoned on the New Mexico license plate) was also home to the first detonation of the atomic bomb, at Trinity Site on July 16, 1945, which is today preserved as part of the White Sands National Monument. De Maria's fusion of science and landscape yields a kind of techno-pastoral sublime that suggests the peaceful deployment of technology to harness not only nature's potentially destructive power, but man's as well.
Machine Language

How does one work in a visionary way today that is neither utopian nor avant-garde, but in the present? Participating in the moment is the toughest task for architecture. Architects are comfortable living in the future and the past. Even though architecture perhaps defines the contemporary more than any other field, as a profession we deny this fact. It might be that architecture has never been stronger in the public realm and the cultural imagination than it is right now, but the discourse that architects provide for their discipline has probably never been weaker. One symptom of this is the current vacuum of critics, commentators, platforms for debate, and general internal discussion about architecture and the city. The idea of contamination is representative of this condition because the field has a strong outer image but is weak at its core.

In my work there have been a number of contaminants — things that separated me, in one way or another, from the usual architectural world. Among these are: robots, my life as a mechanic for the art world, cars and bombers (which are really about the industry of Southern California), media, the new math, the problem of designing a whole family of forms, thinking in plastics (which is really a love letter to my wife Sylvia Lavin), and evil cuteness. These factors illustrate a logical progression of cultural interests linked with intra-architectural disciplinary concerns, and all of them are integral to looking at my practice today.

First, robots. In my office, my staff, which is not so large, keeps asking for more new machines, and every time I get a new machine I fire two or three people. If this continues, I will eventually be alone with a bunch of robots. This is my dream and my business plan. We have a very large computer numerically controlled (CNC) cutting machine, a laser cutter, a 3D printer, and soon we will have an articulated arm robot. All of these machines allow us to make models, which are very important to architects, but they also teach us machine language. Everyone in my studio knows how to talk to machines. We spend a great deal of our time speaking their language, and their language translates much more easily than ours — we can go to any country that has an automobile or aircraft industry and give their machines instructions to
fabricate things at an architectural scale in a very efficient and affordable way. The spread of machine language and programming is in some ways more significant than the worldwide spread of English. Machine language also enables us to work with a furniture company like Vitra by prototyping all of the furniture in our office, and then moving directly from those prototypes to tooling. For our Vitra Ravioli chair [COLORPLATE 4], we conversed with the three-dimensional knitting machines that created the chair's surfaces. For our Alessi Supple Cups, we 3D-printed prototypes in our office, and a couple of months later, a ceramic version that could go straight to the market arrived from Korea. Architects have a skill set that allows us to talk to the worlds of production and product in terms of assembly, manufacture, mass production, shipping, logistics, and wholeness. We are also open, through this language of machines and production, to different flows of culture and design with specialists and consultants, while at the same time staying connected to architecture. In my office, when we design, we understand the constraints, preferences, logic, and sensibility of contemporary robotic fabrication. Therefore, the language of our forms incorporates the intelligence and vocabulary of present manufacturing and also connects us with the forms and surfaces of other design fields that understand these principles as well.

Another contaminant in my career began a dozen years ago when I had a show at Artists Space in New York. After the opening, sculptors and painters began asking how they could use the kinds of technology I used to cut the Sintra panels in the show, or how to use rapid prototyping to make sculptures at the scale of my models. They treated me like a mechanic—perhaps a mechanic with vision, but a mechanic nonetheless. Working in this realm opened me up to a whole different way of collaborating. The Predator project I did with the painter Fabian Marcaccio focused on the architectural problem of repetition of panels, while he concentrated on translating painting into three dimensions. Predator was a self-supporting, plastic, vacuum-formed shell with integral digital printing. In order to realize it, we created all 250 of the four-by-eight-foot molds in my office, and then vacuum-formed them at Warner Brothers, which has since become a popular location for architects to build vacuum-formed installations and interiors. Another project in this vein was done in collaboration with the fashion designer until recently leading Dior Homme, Hedi Slimane, for the one-off magazine Visionaire. We designed a case with a rippled interior surface that the magazine floated on and that
also acted as the hinges and closures for a monolithic block with no visible hardware. For this project and others like it, I entered the creative equation more for the technology and the design technique than for content.

In Southern California, not only do I enjoy being a mechanic for the art world but also, and even more so, I like the value placed on the creation of popular culture. The design studios and high technology of the aerospace and automobile industries, the innovations in computation, and the popular culture industries of film, television, and theme parks are unique to Southern California. A lot of amazing technology comes to the commercial market through aerospace and auto studios (and more and more through boats as well). When I received the Alessi brief to design a tea set that would sell at a near loss for $50,000, I went down to San Diego to work with Hi-Tech Welding, a company that superforms titanium for private plane water tanks and combat jet landing gear and bomber doors. I found that we could make tea sets for much less than the budget by using CNC-shaped graphite molds, which are placed in ovens with the vacuum atmosphere of outer space, heated to over 1,000 degrees to soften the titanium, inflated with oxygen in between a clamshell of titanium sheets, and then detonated. With this technique, we achieved better resolution in the titanium than we could get in vacuum-formed plastic. The technique was even more affordable than the 3D printing, silver plating, and polishing for the other coffee sets. In contrast, all of the designs in California and Italy were made by designing or scanning the objects in a computer, rapid prototyping, and then manufacturing. As the techniques trickle down from aerospace and automobiles, they are moving into an affordable architectural scale. The greatest cost remains the translation of the designer’s desires into the language of the machines. Speaking directly with machines, we eliminate the intermediate step of designing for fabrication; in most cases, there is no translation necessary. Remaining open to these kinds of flows, being adjacent to these industries, and being contaminated by their technologies is extremely important, both creatively and financially. For the interior of the Pretty Good Life shop in Stockholm, we used Caran, a company that builds full-scale prototypes for Saab and Volvo, to build the interior walls. We found that the footprint of a car prototype is a couple thousand dollars per square foot, roughly the same cost as a retail interior on Madison Avenue. That one could build a one-off fiberglass car with automobile paint and finish, thermoformed windshields, finished
upholstered interiors with formed panels, and custom seats (but no engine) for the same price as a Prada or Giorgio Armani store tells me something about the problems in architecture and the construction industry.

Another example of experimenting with fabrication is the Bloom House, in which more and more of the interior is made out of plastic. It started with lights I designed for the Institute of Contemporary Art in Philadelphia that were made on CNC-cut foam molds and then constructed in fiberglass by a surfboard manufacturer. We applied the same approach for the 50-foot-long luminous ceiling in the Bloom House. We also designed three-dimensional elements in the kitchen and two of the bathrooms, which have voluptuously formed walls that incorporate cabinets, countertops, vanities, and sinks all in one surface. The house is like a row house in its massing, but its interior is a very fluid, organic, and continuous space with folds and pockets. The walls are all plaster on lathe over custom jig-cut framing that gives the space a curvaceous quality. The windows are barely custom—they are “cathedral style” windows flipped over to create teardrop shapes. All of the custom elements are manufactured by preparing code for machines that carve, cut, and route materials, making the drawings for these elements meaningless in terms of fabrication and installation.

Another issue is that of electronically animated surfaces. I believe that the media saturation of façade and surface has hit its apex. It is no longer surprising to see another façade with yet another piece of media applied to its surface. A better strategy, becoming more and more prevalent, is incorporating media into architectural space rather than doing digitally decorated sheds. On almost every project in the office now we are working with Imaginary Forces, a company that started off doing movie titles and is now at the cutting edge of thinking through media environments at the scale of architecture. They are both aggressive and progressive in how they think about space in terms of image. We started working collaboratively in print and some motion graphics—a pitch we did together for the Sci Fi Channel and
a contribution to *Visionaire* magazine. In addition to working with Imaginary Forces, we were independently commissioned to design four planets for the film *Divide*, as well as to contribute casino designs to the film *The Grand*, so there have been opportunities to work with film, but, more importantly, the film industry is restless to get into architecture.

Thinking through media in such a way that new families of forms and spatial qualities emerge is central to our practice. We recently won a competition for a project on Wilshire Boulevard and Ogden across from the Los Angeles County Museum of Art. It is in front of a 31-story building that was nearly vacant and is now being renovated into a class-A office building. Our project is a new gateway to the multibuilding office complex that includes a café with outdoor seating under a shaded trellis. As we began thinking about the context of Wilshire Boulevard it became clear that we needed a presence on the boulevard that addressed the speed of the cars as well as the movement of pedestrians. The restaurant is only a few thousand square feet, but spanning above it is a vast luminous ceiling that provides shade during the day and is arrayed with hundreds of dynamic lights at night. We can determine the color and intensity of the lights to produce varying images, moods, and patterns across the site. During the day the trellis produces dappled light through the undulating shaded roofscape and at night it becomes a luminous glow reflected off the metallic surfaces of the building. Thinking through media as a first principle was essential to incorporate these dynamic surfaces into the design of the space and forms, and the animation of the lighting was designed with Imaginary Forces to accentuate the outdoor seating, gateway, and park spaces.

Another contaminant that is having a big effect on contemporary design is the new math, that is, calculus. Using calculus instead of whole-number, fractional, or algebraic dimensioning allows every component of a building to be unique yet within a rigorous, complete, closed sequence. In this way, intricacy is possible in wholes made of individuated elements. The big task for architecture is connecting this new potential with our disciplinary history, which is about part-to-whole relationships, that is, how elements relate to a larger grouping and a larger catalogue of components. Architecture is unique in this way – our particular strength is in creating relationships between elements, creating assemblages of discrete elements that form wholes. Whether one does it through symmetry, modularity, or proportion, this is what architects do. In a project for a nearly kilometer-long...
façade to reclad an existing building in the Netherlands, we approached every single element as potentially unique but embedded in a continuous, tempered, and interconnected series. The design begins with 11-story columns, along which we arrayed horizontal structural spreaders located at each floor of the building. We shaped the span of these spreaders to accommodate escalators for vertical circulation up the face of the building. There are 122 structural frames, and each one has over 1,000 components. Every one of these components responds to every other component during the design process by adjusting itself proportionally to seven of its neighbors to the left and then seven of its neighbors to the right; the next component similarly adjusts itself. As each of the 122 trusses has over 1,000 elements, this means that each move of any element implies approximately 850 million calculations throughout the array. Because of this interdependence, every time a single element along this façade is moved, a calculus equation is employed to recalculate every single component in the entire building. Every dimension of the construction elements is a variable that depends on another one in a relationship designed to achieve a specific smoothness and continuity while giving distinct features and character to the length of the façade. Because of the rigor built into the custom design tools used in the modeling process, we are able to take the structural elements directly into steel detailing and documentation, eliminating any premium to this kind of formal variation. The real problem for architects is designing in the space of variation and calculus in a rigorous way that gives the designer control over the character, and even signature, of the work.

This leads to designing families, where there is both individuality and an overall identity of the group as a collection. We were asked to rethink living arrangements for a housing project in Valencia within Vicente Guallart's Sociópolis master plan. When introduced to our developer, we were given two telephone books of restrictions for their typical unit plans. I learned at that moment why most architects choose to make
every single unit plan the same. In response to these restrictions, we tried to give each of the 28 units a unique floor plan, but within the umbrella of a fixed set of requirements. The technique we used began with polygonal constraints that were progressively blended and smoothed one into another. In this way we could start with simpler unit variations and gradually build up their connectedness and complexity. The specific technique we used is called Chaikin’s Algorithm, but the more familiar modeling technique to architects and designers that uses this mathematics is called Subdivision Surfaces. The basic difference between SubD surfaces and the previous example of tens of thousands of equally connected elements is that SubD surfaces are based on partial differential equations instead of calculus equations. The variables are discrete and can be expanded into greater and greater degrees of continuity. The resulting surfaces are designed to produce chasms of space that cut through the project, making every one of the units different. At the same time, each unit has a logic and rigor that grows out of their variation.

We used the same approach to families when Alberto Alessi asked me to design flatware. He instructed me to design a spoon, which Alessi would adapt to forks and knives. He said this is how they have always worked: one designs the spoon and everything comes from the spoon. This really rubbed me the wrong way, so I began with a thing that was not yet a spoon but was a yet-to-be-specified primitive piece of proto-flatware. Embedded in this primitive are all the elements necessary to be deformed into a spoon, a fork, a knife, etc. Deformation is a dangerous term here, as most designers think of deformation as taking a finished, complete, and ideal thing and messing it up, but I define deformation as the method by which a change creates something more specific in something that was previously more generic. Each deformation moves away from a simple generic thing to something that has more traits without ever stepping out of its internal logic, never adding or subtracting elements. Working in this way I could start to blur the boundaries between common flatware elements and rediscover and invent new functions—things like fish forks and cheese knives and so on. We ran through countless deformations of these elements, then started to develop them continuously, from dessert forks to salad forks, table forks, serving forks, meat forks, all the while fusing elements—adding a bit of spoon quality to the dessert forks, taking some traits away and adding others to table forks, and then going more toward a knife, and on and on. I became an expert on the history of
flatware design: the set includes chipped beef forks, strawberry spoons, bacon forks, food pushers — all flatware relics from centuries ago — as well as some never before seen utensils [see page 22]. In all, there are 52 unique elements, each with specific functions. We were able to 3D print plastic prototypes in the office and then print them directly in metal without tooling and plate them in sterling silver. We learned that the task is designing a family of forms, rather than designing one form and varying it. This is partly because of the principles of infinitesimal calculus — the one and the many are equivalent. The design of the set and the design of the single form are the same conceptual problem. This fact was initiated with the Embryological Houses I designed, but it is more directly visible in the flatware. The architect's skill set is uniquely equipped to deal with this issue, as we have been trained to bring tens, or even hundreds, of thousands of elements together to make a single whole. Instead of approaching the problem of designing a set of elements from the detail of the element, most architects begin with the larger whole and its relation to the parts. In this way, architects are particularly well-suited to designing families of industrial elements, because they do not fetishize the unique or the detail but address the whole and the constellation simultaneously.

The final project that brings together many of these themes is a house I am doing for my family. My wife, the architectural historian and theorist Sylvia Lavin, and I constantly affect each other's work and we are always in a creative exchange around similar themes. We have been playing around with a design for our house for a couple of years, and the design has been deeply affected by our mutual love of plastics, pop culture, and contemporaneity.

Among my interests in design culture that have informed the design of the house is a custom Matt Hodge-built motorcycle using rolled tubes and metal. The house's structure looks like a gilded metal chopper supporting a floating slab. We found many manufacturers that roll steel tube, contacted them early, and developed parametric models of how tight the radii of the tubes could be and the number of curves we could construct, working with the engineer Klaus Bollinger. We came up with a logic that is like a Vierendeel truss — meaning the walls of the house are working rigidly in plane — but instead of having beams with columns, we have a continuous 500-foot-long steel tube that rolls though the whole house, intersecting itself for stability and creating the vertical structure. Every element is a radial element, and again, because calculus drives the model, if any one of the elements
moves, the change trickles through the whole thing. The process can be seen in still frames of the design model, which reveals a series of deformations. By lofting the rolled tubes that form the bearing walls through each other, I started generating what I call "Bleb" volumes, which form the interior rooms of the house. Through the same process, every other room in the house becomes a void, hence the secondary bar floating above the courtyard has giant light wells cut though it. In the summer most of the courtyard is in shade, with just these light wells above, and because it faces south, during the winter the whole courtyard is flooded with light. At the points where we chopped though the house, the braided structural steel tube is revealed. Between every bedroom there is a courtyard, and the north face of the building is all translucent glass, with operable ribbon windows in it.

The language of the materiality of the house is a kind of Asian pop culture evil cuteness like the work of Takashi Murakami or Jeff Koons – things get plastic and bubbly. My wife's office sits half in and half out of the house. We are vacuum-forming giant pieces of acrylic, as well as creating multidomed skylights, for that space. The result will be spittle-form façades that cut into the taut exterior volume of the house. I designed a new kind of brick for the interior and exterior walls of the house, called "Blobwall," which is already in production with the company Panelite. It is a modular, plastic, roto-molded, meter-long brick that we array in self-supporting curved wall and dome forms. In the design software we locate the lines of intersection between these modular bricks and then export these cutting curves to a large robotic arm with a cutting tool that trims each modular brick with a unique cut. This allows them to be stacked and welded together to create self-supporting structural walls for the interior and exterior. The house has a lot of geometric complexity and intra-architectural gymnastics, but the most exciting thing is the way it is contaminated by materials, forms, and sensibilities from the everyday pop culture of our lives. The architecture here is not a cabinet or a container for these elements, but rather is infected through and through, until it is difficult to find a distinct boundary between plastic toys, baroque rusticated walls, the rolled tubular frame of a custom chopper and a truss; it is the mixture that is important.

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