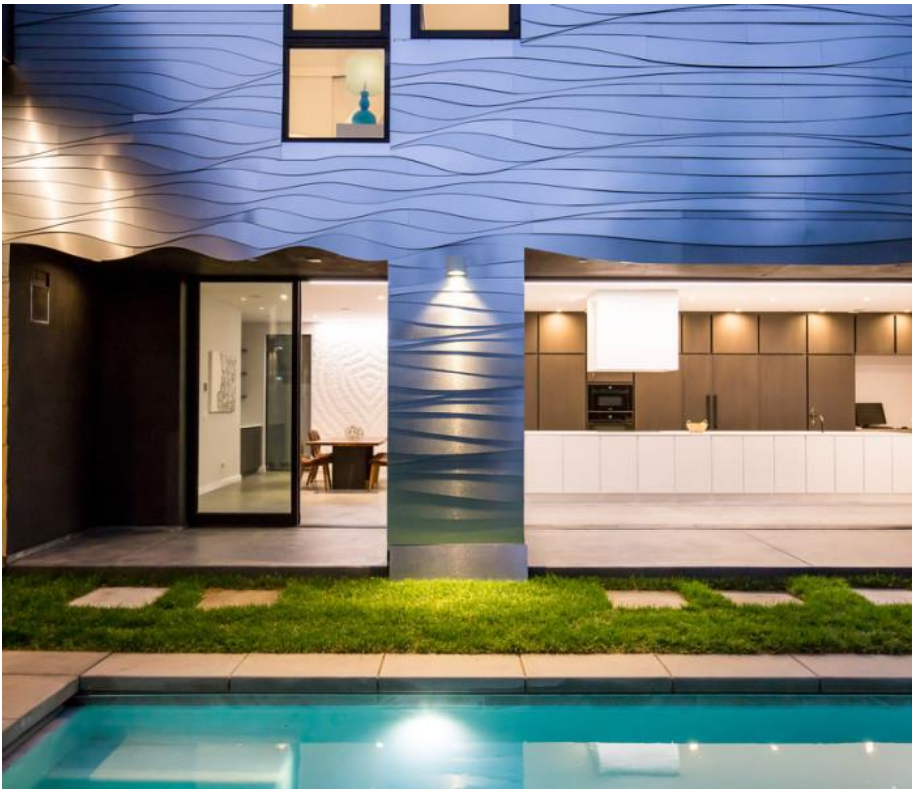




# WORKBOOK: The Wave House

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[Mario Romano](#)'s latest project, the Wave House, showcases an organic aluminum skin that undulates as if it were fabric. Inspired by the natural world, the designer spoke with us about the technology needed to accomplish the project, solving problems and saving money.

**Your projects embody natural, organic shapes. Why is it important to you to connect to nature in this way?**

Nature's underlying logic behind her forms and structures is rich in organized complexity. It wasn't until recently that we've been able to recognize and identify nature's intricate and underlying orchestration. Nature is not as chaotic as it was recently considered.

Parametric forms break away from [Le Corbusier](#)—which considered the right angle and straight line as “man conquering nature”. I think man has done enough conquering of nature. It's time that our buildings embrace fluidity, continuity, complexity and variation. In essence, by challenging ourselves to developing organic forms we open ourselves up to an architectural language that is vastly more intelligent, sustainable, harmonious, logical and beautiful.

Organic shapes are more becoming to the community. They are less domineering, resolving the offensive McMansion while at the same time allowing developers to build the same amount of square footage. I experienced this first hand with the Wave house, numerous times, people passing by would ask me if the Wave house was a single story home. They weren't sure. With the roof gently rising upward, incorporating nature's design rule of gradience, this massive home, nearly 5700 square feet and just as tall as a “McMansion”, but appeared to many people as a single story home, less offensive, unobtrusive, more harmonious, while evoking a sense of wonder.

Another example is experiencing the beauty of lush variation. There is sense of wonder when we consider that no two snowflakes are the same, or no two zebra stripes are the same, everyone unique yet wholly recognizable. That's complexity organized at it's best. The Wave house contains numerous experiences like this, with the facades, walls and floors all filled with non-repeating intricacy.

From the gradient colors of a sunset, to the topology of the grand canyon, to the murmurings of starlings, and on, there is much to derive from nature's orchestration of beauty, efficiency and endurance.

**It appears that the building's envelope is almost as important as what's inside. What inspired your interest in fabrication?**

It's extremely cost prohibitive and almost impossible to find a fabricator that can make complex shapes on a large scale. Currently, parametric style architecture and organic design are only seen in a few commercial projects commissioned by heads of state or mega corporations, like Google's new headquarters. One of my goals is to make organic design available to more people, starting with the structures of residential homes and interior carved walls. When considering how to realize the skin of the Wave house, I was almost forced into starting my own fabrication studio. A fabrication studio created inside the garage of the home it was going to build. In a way, the house was made from within itself. The digital design tools, the fabrication and the building site were all one environment—very much like the Dutch design philosophy of “design research”. Design is a process, a cycle, the faster the

cycle, the more one can iterate and achieve a high level of fluency. My team and I continually cycled the building information from the building site back into the loop of the computational design cycle adjusting and detailing for all the various conditions that the digital environment cannot account for. At our best moments, we were building and designing almost at the same time. We were jamming like Zeppelin.

**What were some of the biggest challenges in creating the skin of the Wave House? How did you overcome them?**

The exterior skin proposed various challenges from waterproofing, drainage, accessibility, engineering, budget, to specifying the right gauge of aluminum. We studied the challenges as a whole, incorporating them into our digital script, building the rule set to build the model to build the house. It required over 12 months of research, experimentation and one-to-one mock-ups. Originally, I started with a sketch in 3d, using [Sketch-up](#), then migrated to [Rhino](#) and [Grasshopper](#) where we developed the most challenging aspect of the complex skin, the substructure. The substructure had to be light, provide accessibility, take rain and wind into consideration while offering certain amount of stiffness. All of this, while still having to adhere to a strict budget. So we turned to my backyard, built a 15 foot by 10 foot wooden shed, and simulated the building conditions that the 3d modeling environment does not account for like attachment and installation methods, weatherization, and material behavior.

**What are the practical benefits of the exterior cladding?**

I strive to blend building science with artistic expression with an interdisciplinary practice. The aluminum skin of the Wave house gradually rises up 25 feet from the ground providing a chase for warm air to draft upward. Incorporating thermodynamics into the roof provided two core benefits: heat is directed up and off the building keeping it cooler, while at the same time this flow of air generates evaporation keeping the building envelope dryer.

**We are interested in how technology helps solve problems and in the long run save money. Can you talk a little bit about the parametric tools you used and how they allowed you to envision the project so it would come together meticulously?**

With an unlimited budget almost anything can be built, truth is unlimited budgets don't exist. Money is one of the presiding constraints for designers. Today's current advancement in scripting software combined with the lowering prices of CNC machining make more innovative and complex building ideas achievable. The design-build is entering a major revolution, almost like the days when recording technology advanced to the point where musicians could record albums in their bedrooms, or look at now, how filmmakers can legitimately make feature films that can rival Hollywood's best movies. This is now happening in the architectural world, and with this new "maker community". It's this very technology that has given life to this latest buzzword, "maker". Makers now have their own reality series.

It's reasonable to say that the Wave house could not have been built 10 or 15 years ago. It was only with the advent of two powerful types of technology that the interiors and exterior facades could have been built: one, massive computer processing; and two, CNC machining technology. The combination of the two are like a low-level building robot. On the digital side, we used Rhino and the visual based programming tool Grasshopper. We wrote custom scripts to design within a constrained set of rules to

ensure develop-ability , or as we call it, “build-able”. As perfect as the computational environment is, it’s lacking, among other things, gravity, and more importantly material behavior. The digital tools are incredibly helpful, but they do not realize the built world. If you want to realize the digital into the physical, I recommend mocking things up otherwise there is too much construction risk. This is where the feedback loop comes into play. It’s not only iterating in the digital world, but combining the built world information into the digital scripting world. A parametric script is only as good as the level of accurate building information written into it. In a way, this is a break from the Albertian architectural model and a return to the Master Builder dynamic of the Baroque and Gothic style. Architecture is about building, and as stunning as the computer can create images, the develop-ability of these 3d models very often only work in the computer, or in a controlled studio. Realizing enduring beauty, that is the objective of the architect, and the digital tools, and in particular the increasing affordability of CNC machine, along with the affordability of various materials make organic design more attainable every day. It’s really a break-out design language that is happening. I wouldn’t say it’s as easy as design and hit the print button, but at certain times it can be just like that.

**Ease of installation:** In our best moments, hundreds of unique pieces would spit out of the machine. The building team would simply lift them up and set them perfectly and indefinitely. So easy at times, my 15-year-old son could aid the building team assisting in the making of a complex facade no more difficult than making a large puzzle. When hundreds of pieces come together as a massive organized whole, there is a sense of wonder how something visually complex can effortlessly come together.

**Cost Savings:** The cost of building and rebuilding in the digital environment saves tremendous cost in the field. The time spent developing a parametric script saves massive hours of drawing and redrawing. As you may know, once the script is functional you can adjust a parameter and the entire model is rebuilt, or redrawn in the computer, depending on processing speed, very often in moments. Whereas in the past, one little adjustment would have required 50 hours of drawing time, a digital script can redraw in moments. A CNC machine is a nominal cost compared to the cost of construction. Prices are dropping on these machines; and though they are not as easy as simply pushing a print button, the learning curve is manageable.

**Time Savings:** On the subject of saving money with parametric tools, there is another key point, and that is labor savings. Honestly, when everything was going right, and the most thought-out level of information was programmed into the script and machine, the installation was incredibly efficient and simple. This applies to both the interior walls and the exterior walls. By the end of the project we were able to build a massive 400-square-foot facade with over 700 unique shapes in a matter of a few days. The reason: it had been built in the computer, albeit hundreds of times before.

**Open Platform:** Having worked these problems out and wanted to expand this design language, I’m planning on providing my design-build platform to other architects and designers who want the ability to be more expressive while at the same time seeking value, and who don’t want the pain staking research and learning curve I had to go through.

**Can you talk a little bit about the interior—the textured walls and floors—the design choice and the durability?**

I wanted to create textured and carved surfaces. The word “flat” is rarely used as a compliment: “flat hair, flat personality, the surf is flat.” Why should our walls be flat? Carved or textured walls and floors

offer an array of dynamic and variegating experiences. With natural light flooding into the home, these carved walls create their greatest affect through the direction of the natural light. Depending on the time of day, and day of the year, these carved white surfaces caste an array of grey scales that offer new perspectives and experiences. A flat painted wall is limited by it's own flatness, offering a consistent sameness. The interior walls and floors I developed are non-repetitive with no tilting, no visible seams, and continually morph their topology over very large scales, sometimes up to 200 square feet and turn corners. This level of expression and organized complexity could only be designed and fabricated with the assistance of serious processing and a super accurate CNC router. The interior material I selected for the walls is known as solid surface, or Corian. It's an acrylic base material that is highly durable, repairable and can be welded together in order to erase any visible connections. It's also impervious to mold, virus or bacteria, and easy to clean. The material offers the ability to erase visible connections providing freedom to direct the lines anywhere, and over any scale. It's a breakout language, emulating nature's intricacy, interconnectedness and lush variation.

<http://www.formmag.net/2016/12/workbook-wave-house/>