

Vo•ro•tion | IP thesis by Ben Paskus |

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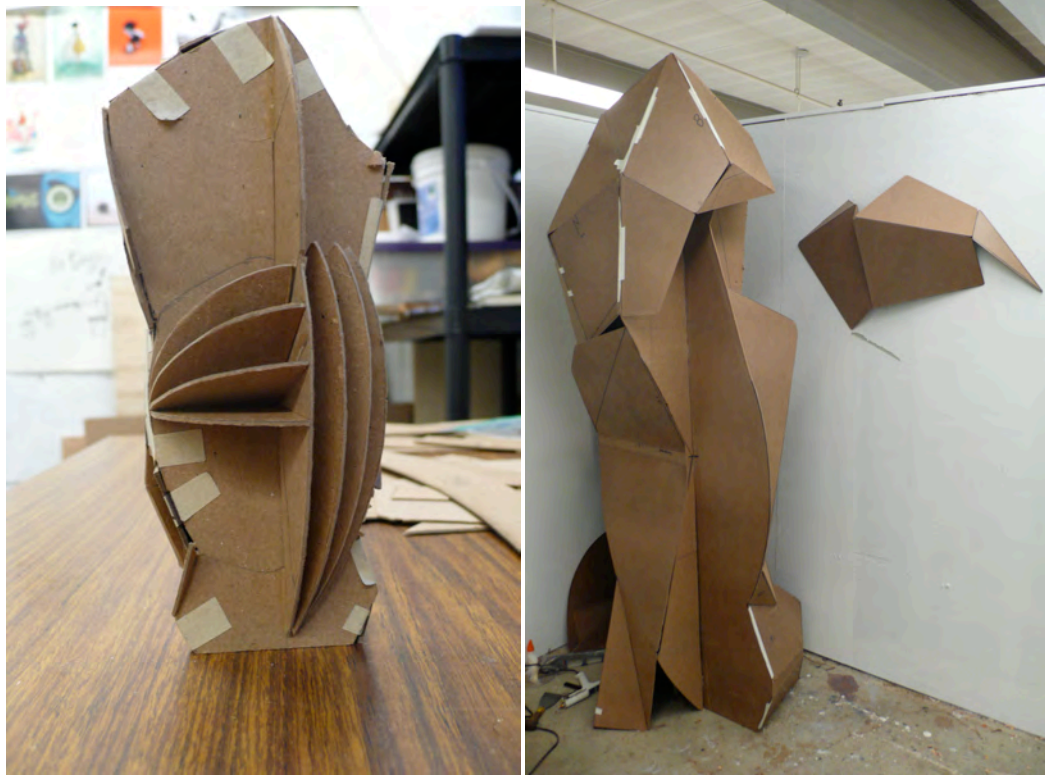
**1** the act of integrating voronoi patterns into the built environment

## *MacGyver and the Subconscious*

I once was invited to a workshop that was to be conducted, led, and proctored by Lee David Zlotoff, creator of the action-adventure television series *MacGyver*. The show, which followed secret agent MacGyver through 139 episodes of sticky situations, received critical acclaim and even left a mark in the English language. The term “MacGyver’d” is used to describe a resourceful action that pulls together disparate items to achieve something. I like to think of myself as a MacGyver. Having said that, I’ve never watched a single episode in my entire life.

The workshop was slated as a study in creativity, if I remember correctly the advertisement mentioned something about tapping into one’s creative potential. Which was perfect because at the time, I was devoting most of my time to learning 3d modeling software. The software had left my creative mind in the dust, exhausted and confused by technological demands. Needless to say, I jumped at the opportunity and fired an email back to my professor in all caps, I WANT IN.

As a subject of the workshop, I was introduced to a series of problems, given parameters, and then sent off to a room to perform origami. Origami, my choice of activity, was intended to divert my conscious mind and leave the heavy lifting to my subconscious. What I learned that day is that the subconscious is hugely more powerful and outperforms the conscious mind any day of the week. However, I still don’t know if I like origami or if I hate it. The reason I mention my participation in Lee’s study is because my subconscious is responsible for my thesis project.

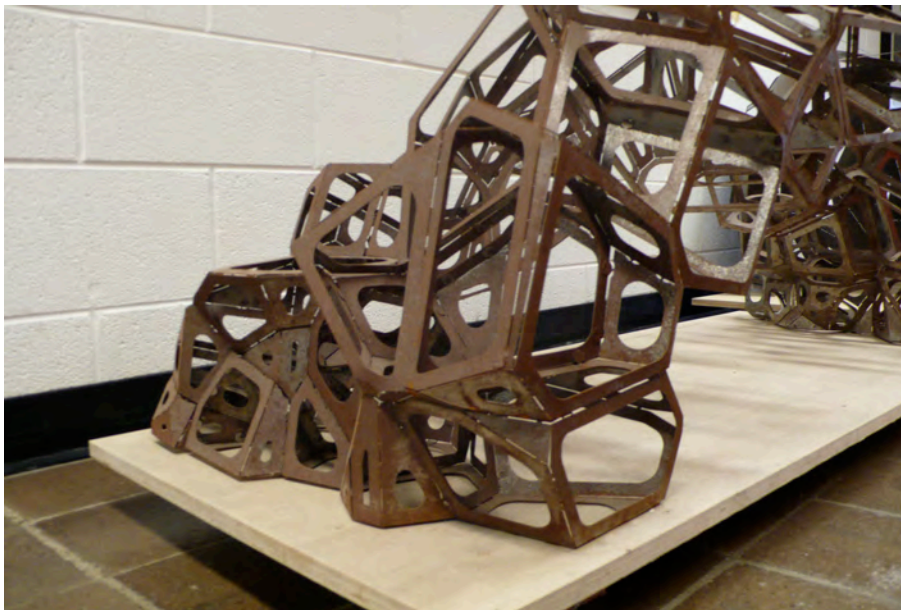
*Lunar Rocks*

*Transition from 1' to 6'. Note how the pieces found their way to the wall.*

I spent almost half of my senior year constructing a giant sculpture by taping and gluing pieces of hardboard together. I know it doesn't sound glamorous but I had reached a point where my output was significantly lacking and I needed to do something. So why not take a series of drawings, which resembled what I came to call "Lunar Rock People", and build them into massive sculptures. Turned out the drawings didn't want to transcend the paper and take on another form. They were very happy on paper and in this case, were desperately trying to tell me something by continually falling apart.

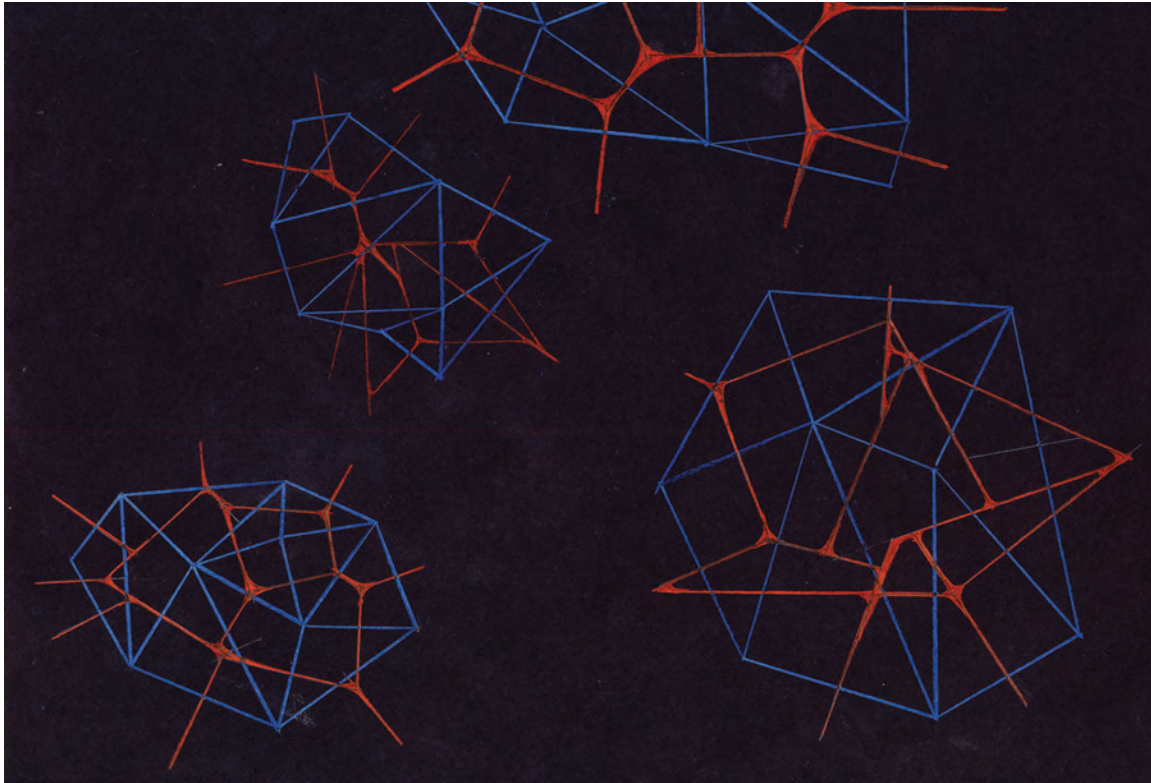
During the same time I was building my first giant sculpture, the architecture school had projects done by graduate students out for display. The works were small structures displaying the possibilities of parametric modeling and digital fabrication. There was one project I grew particularly fond of called *VOROGami*. Set on a piece of plywood, the piece resembled a cellular slinky. Physically the model didn't move but the illusion the piece gave of movement and growth was remarkable, as if the steel strips had formed independently of any manufacturing.

*VOROGami* never ceased to catch my attention. Every time I walked by it I could feel my synapses firing. It was challenging to see materials that obviously spoke to the industrial built environment while the form resonated completely with the natural world. Even more curiously was the similarity in geometry with my attempted sculpture. This must be where my arbitrary geometrical pieces of hardboard were born. I had to find out what the shapes were and where they came from.



*VOROGami*

*This close up shows how the shapes vary in size as the structure grows towards the apex.*

*Voronoi*

*Voronoi and its dual pattern Delaunay. V in orange, D in blue.*

Further investigation told me that the VORO in *VOROGami* stood for the Voronoi diagram. First, a little background. The practical applications of the Voronoi diagram are quite numerous and highly fascinating. In the natural world, Voronoi cells can provide the most efficient structure or spatial routing paths for matter to organize itself into. This frequent recurrence in nature has elevated the Voronoi algorithm to the same status as that of the Fibonacci series and the golden mean.

Of the several ways to describe the pattern this one is my favorite: Imagine a prairie with a bunch of cowboys. Each cowboy wants to claim a piece of territory. Mr. Voronoi comes along and says to the first cowboy, “Every place that is closer to your camp than any of the other cowboys' camps belongs to you. He tells the other cowboys



the exact same thing. The division of territories that results from Mr. Voronoi instructions is called a voronoi diagram, each cowboy having their own voronoi cell.

As my earth science teacher Gregory Dick says about microbes, the Voronoi diagram is abundant and ubiquitous. Although the voronoi pattern does strike many as a structural solution, my project was more concerned with the visual capabilities of Voronoi cells.

### *Biophilia*



*HIVE studio's take on the classic honeycomb pattern with wool-felt tiles.  
Photo credit: hivespace.com*

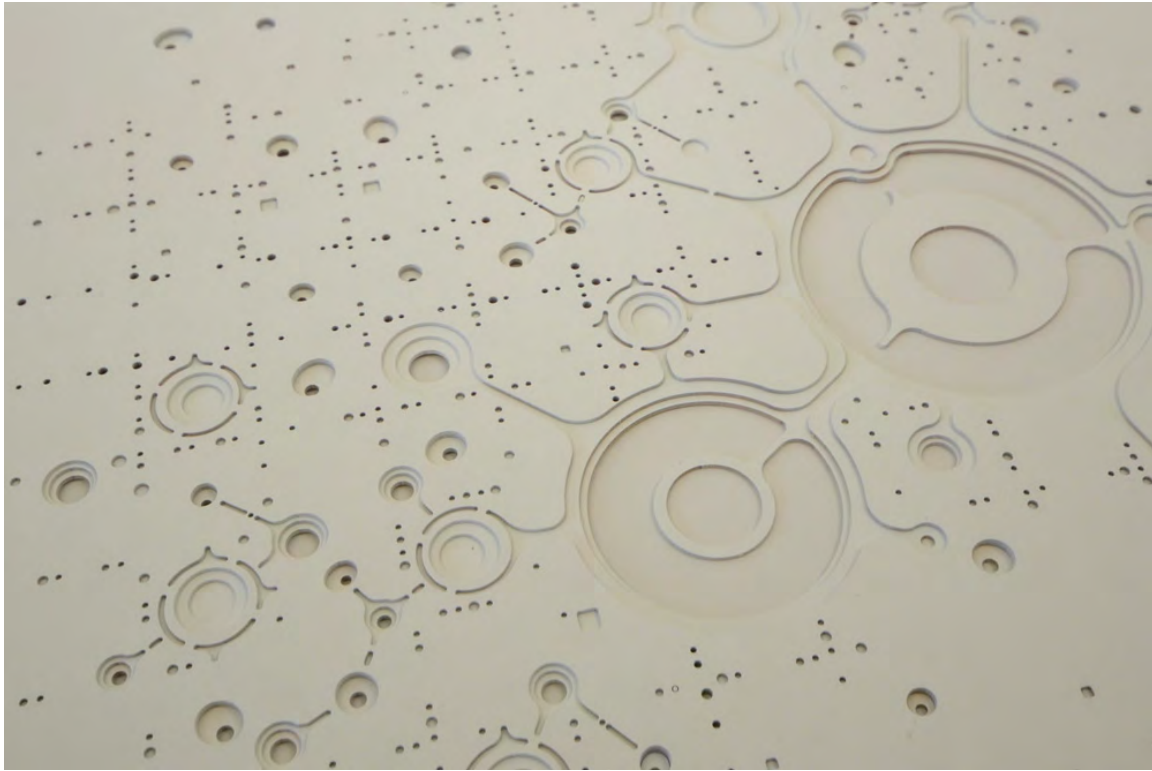
Around the same time I got heavily into the Voronoi diagram I was also introduced to the term biophilia. Created and defined by the biologist E. O. Wilson, biophilia explains why in the first place I was so attracted to the *VOROGami* project. By definition biophilia is defined as, “an innate and genetically determined affinity of human

beings with the natural world.” As I understand it, humans enjoy being outside and have a keen sense of what is from the natural world and what is not.

The human mind and body has spent almost its entire evolution in a sensory rich world outdoors. The outdoors is critical to people’s health, productivity, emotional, intellectual, and spiritual well-being. So what happens when the average American spends 70 to 90 percent of their time indoors? Adverse health affects both physically and mentally. Unless, the built environment is designed with biophilia in mind.

Not surprisingly, for much of human history buildings were designed to integrate the natural environment, use of local materials, and themes and patterns of nature in building artifacts. Only during the past couple centuries did the developing world abandon biophilic design practices and become increasingly alienated from nature. Most built environments resonate with no part of our biology, evolutionary experience, or aesthetic sensibilities.

Of the elements that make up the built environment I’ve had a long time battle with the wall. For as long as I can remember my walls have been covered with some form of paint or poster. A personal favorite for wall coverings are quilts. Growing up with a machine quilter, beds and couches were filled all too quickly and quilts found their place hanging on the wall. In particular was the hanging in the kitchen. Not because of the pattern but because the use of wool-felt instead of traditional cotton. Wool felt has a special quality for absorbing light to soften a room’s appearance not to mention it’s a delight to touch. But I didn’t want to add to the wall, I wanted to subtract.

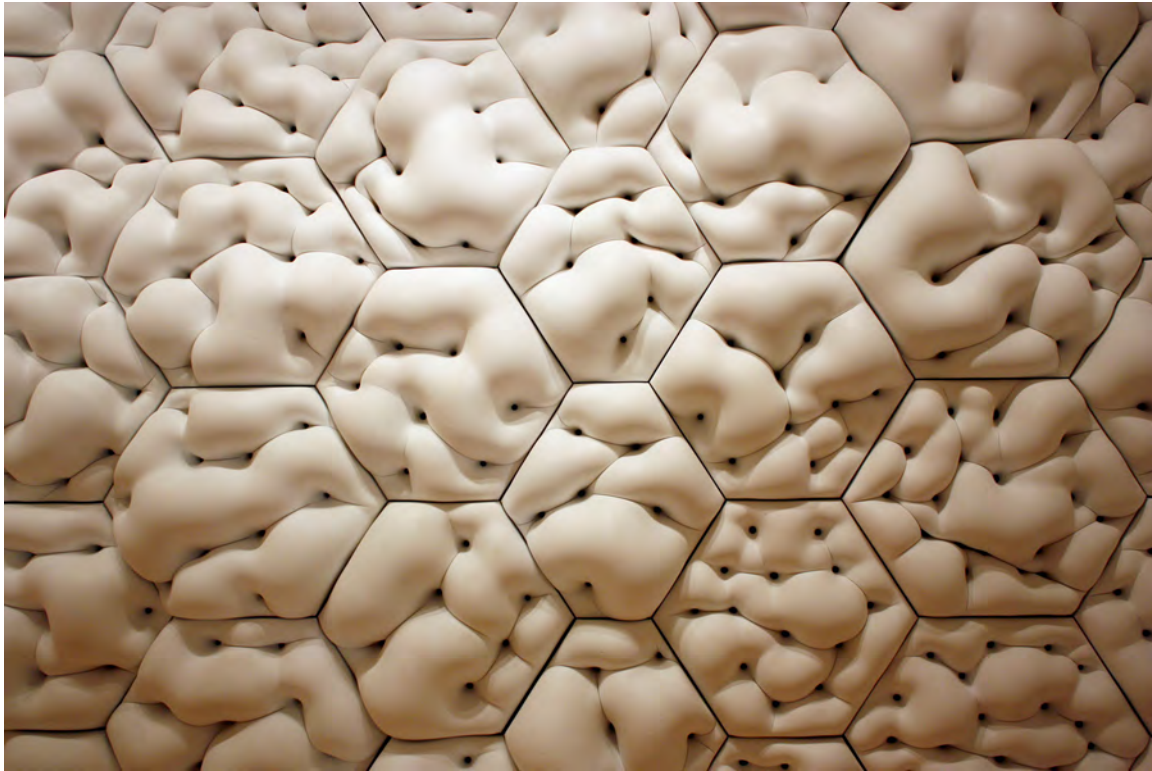
*Excavation*

*Generative art and designer Thoughtform routes out his Code Gardens  
Photo credit: [thoughtform.co.uk](http://thoughtform.co.uk)*

Instead of adding to the existing architecture as Flock's wall tiles do, I took an approach similar to the UK based artist and designer Thoughtform, one of excavation. My intent was to give an illusion that the wall had been introduced with a Voronoi strain. The strain was genetically engineered to conduct "vorotion" wherever it was introduced. Eating away at walls in a similar fashion to termites while depositing wool-felt as the strain dug deeper and deeper.



## *Parametric Modeling: Problems and Solutions*



*Plaster pouring techniques were used to disguise duplicate components in P-wall  
Photo credit: matsysdesign.com*

Tempting that it may be, the voronoi pattern still poses a small problem. The source, nature, tends not to create exact duplicates. Hence the challenge of biophilic design arises during manufacturing. Unless, manufacturing processes start to integrate biological processes and grow products. Or in the case of Matsys designs *P-Wall* shown above, manufacturing techniques may still be able to achieve an authentic organic appearance by combining industrial and natural processes. It's crucial that our built environment resonates with the larger web of life.

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