Title	Attribution	Location	Reference	Date
Panteon	Raphael	Uffizi Museum, Florence, Italy	U 164 A r	1504-08
Santa Maria ritonda	Anonymous	Biblioteca, El Escorial, Spain	Cod. Inv. 28.II.2, 30 R	before 1509
Pani(e?)ton	Anonymous I not Jacopo Sansovino	Uffizi Museum, Florence, Italy	U 1950 A r	
Pantion	Raphael	Universitätsbibliothek, Salzburg, Austria	Salzberg H 193/2 r	
N/A	Anonymous I not Jacopo Sansovino	Uffizi Museum, Florence, Italy	U 4333 A r	

Figure 22: Chart of Related Pantheon Drawings.

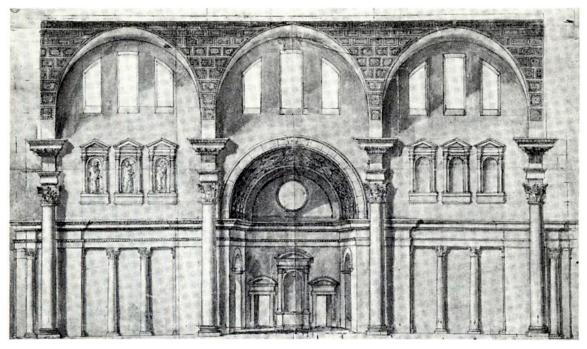


Figure 23: Giuliano da Sangallo, Project for St. Peter's, Uffizi, Florence, Italy, U 131.

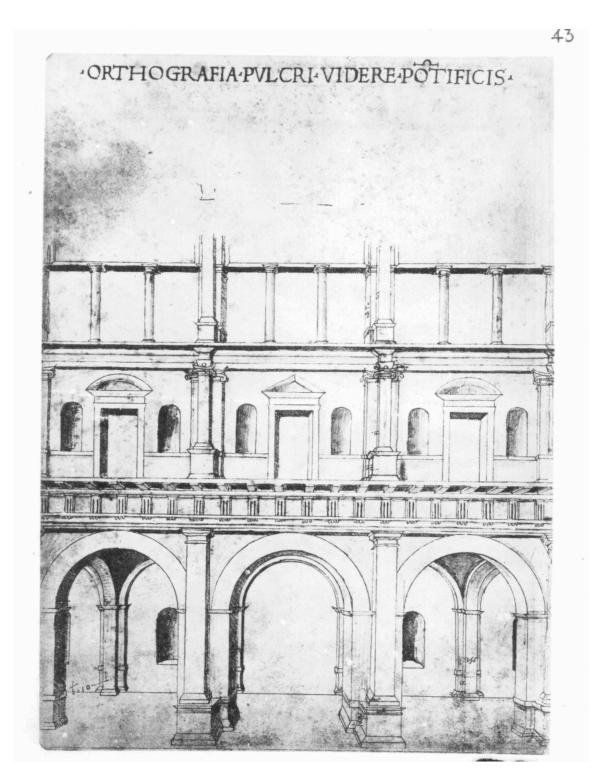


Figure 24: Codex Coner, Sir John Soane Museum, London, England, fol. 43.

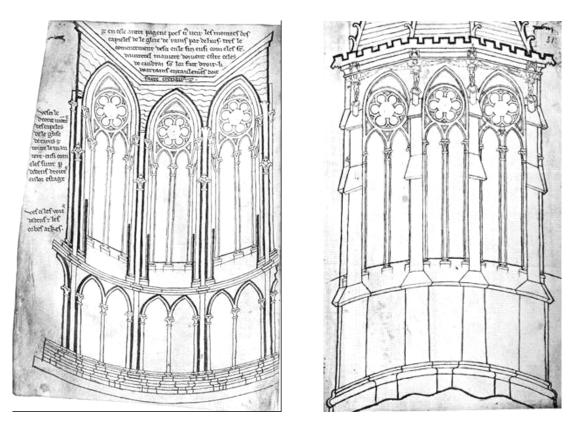


Figure 25: Reims Interior and Exterior "Perspectives" from the Sketchbook of Villard d'Honnecourt, Paris, Bibliothèque Nationale, 19093, p. 59 and 60.

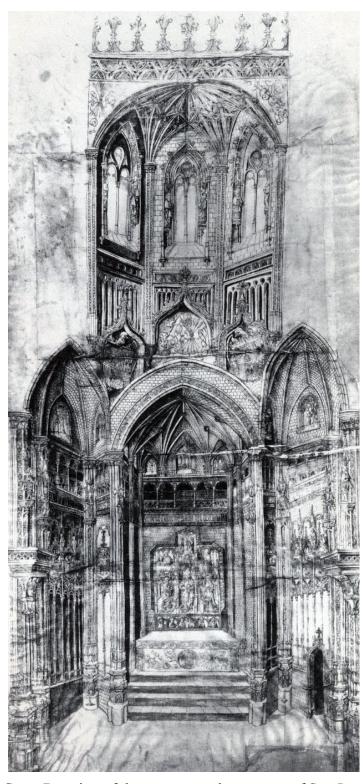


Figure 26: Juan Guas, Drawing of the transept and sanctuary of San Juan de los Reyes in Toledo, c. 1479-1480, Museo del Prado, Madrid, Spain.

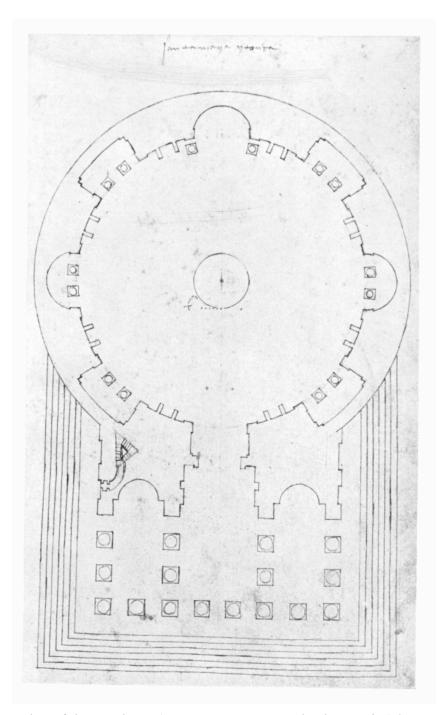


Figure 27: Plan of the Pantheon (Contemporary to Raphael's Interior) by Anonymous Author of the Codex Escurialensis, the Biblioteca, El Escorial, Spain, Cod. Inv. 28.II.2, folio 71 r.

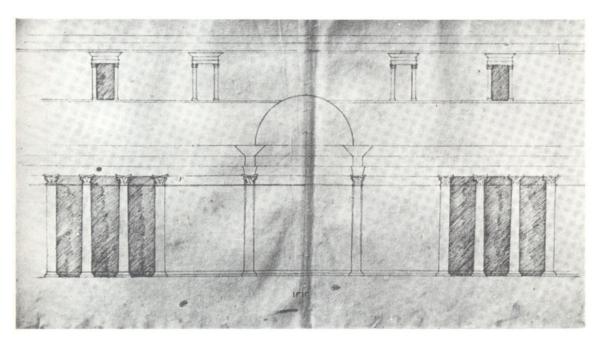


Figure 28: Hermann Vischer's Elevation of the Pantheon Interior, 1515, Louvre, Paris, France. (Image from Lotz, pg 61.)

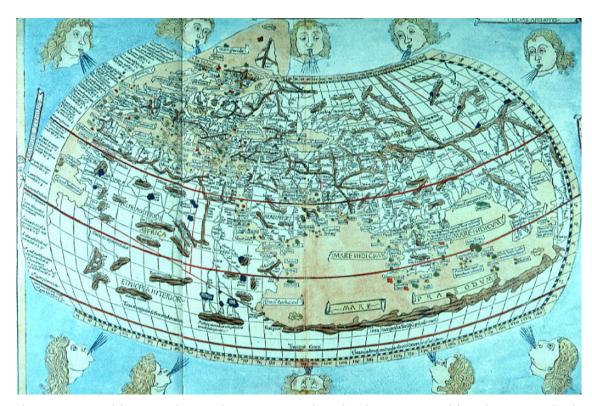


Figure 29: World Map using Ptolemy's Second Projection, Geographia. Florence: Nicolo Todescho, ca. 1480-82.

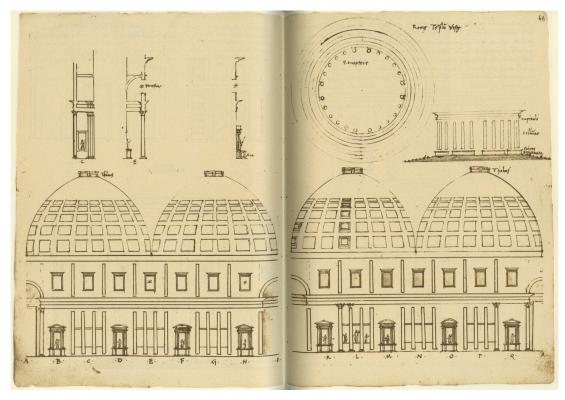


Figure 30: Interior Image of the Pantheon from Vitruvio Ferrarese, folio 66.

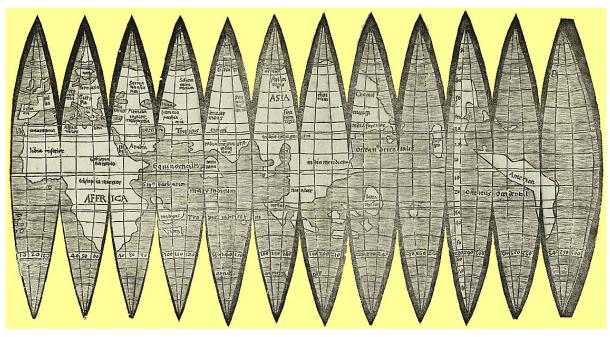


Figure 31: Waldseemüller's 1507 Interrupted Projection of the Globe. (Image from Bell Library, University of Minnesota).



Figure 32: Contemporary photo of the building of Palazzo Rucellai.





Figure 33: The Cortile of the Cancelleria, Rome.



Figure 34: Louis Kahn's Salk Institute showing exposed form ties and the joint lines left from formwork, La Jolla, California.



Figure 35: Louis Kahn's Salk Institute, Exterior Stairwell, La Jolla, California.

A selection of genus morphological illustrations from Conifers Around the World

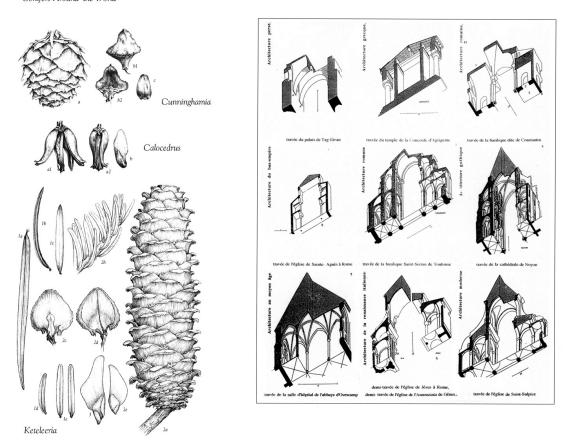


Figure 36: Comparison between the ordering of the natural world based on morphological types and the similar ordering of architecture using Auguste Choisy's Axonometric drawings.

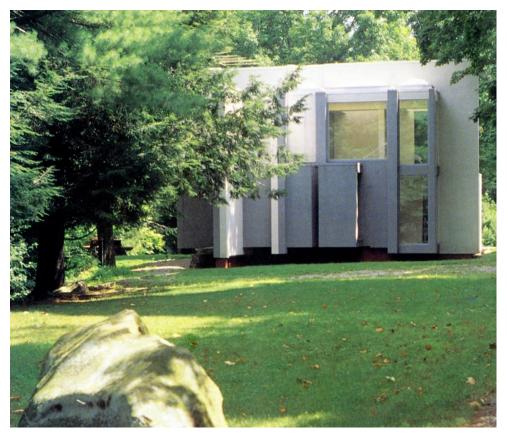
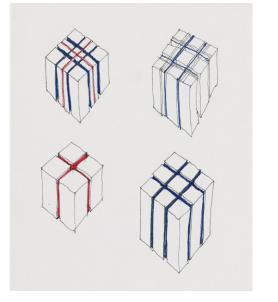


Figure 37: Peter Eisenman's House VI (a.k.a. The Frank House), Cornwall, Connecticut.



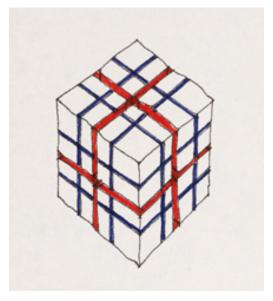


Figure 38: Initial design axonometric drawings showing 4- and 9-square grid divisions. February 17, 1972. © Peter Eisenman. Peter Eisenman architectural drawings for House VI, 1972, Research Library, The Getty Research Institute, Accession no. 920049.

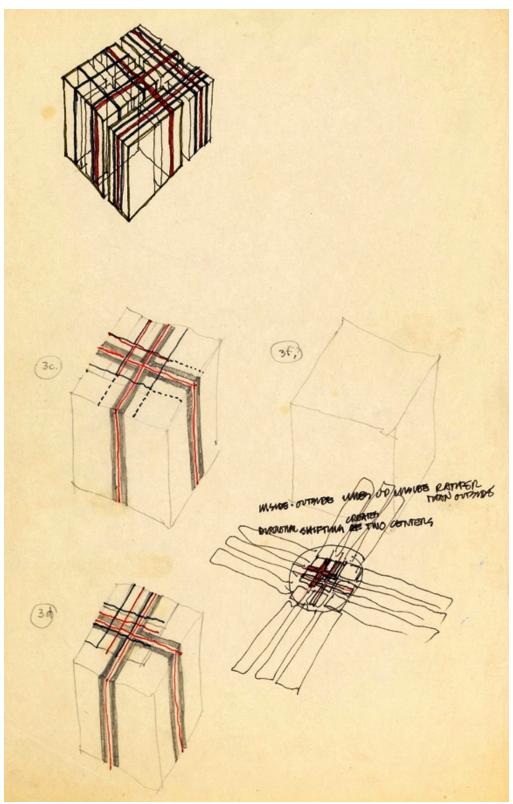


Figure 39: Combination Studies Group Two. © Peter Eisenman. Peter Eisenman architectural drawings for House VI, 1972, Research Library, The Getty Research Institute, Accession no. 920049.

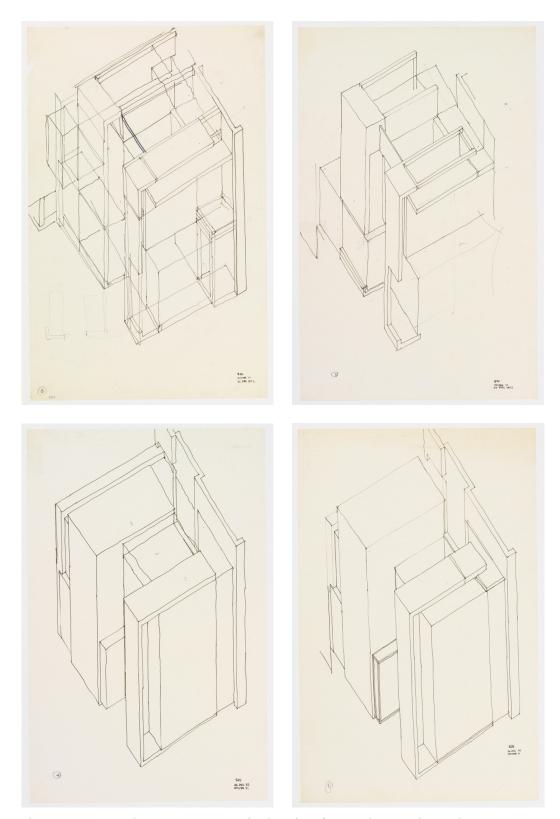


Figure 40: Second-stage axonometric drawing for southwest view. Sheets 2-5. December 27, 1972. © Peter Eisenman. Peter Eisenman architectural drawings for House VI, 1972, Research Library, The Getty Research Institute, Accession no. 920049.

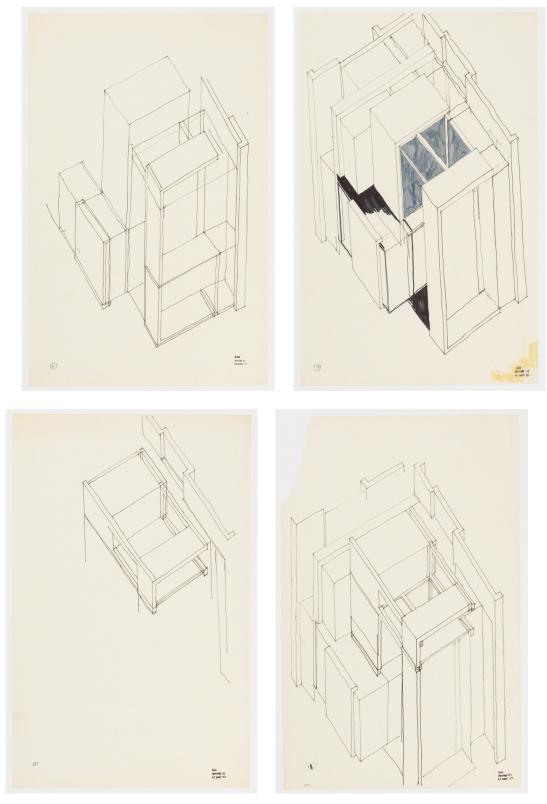


Figure 41: Second-stage axonometric drawing for southwest view. Sheets 6,7,10 and 11. December 27, 1972. © Peter Eisenman. Peter Eisenman architectural drawings for House VI, 1972, Research Library, The Getty Research Institute, Accession no. 920049.

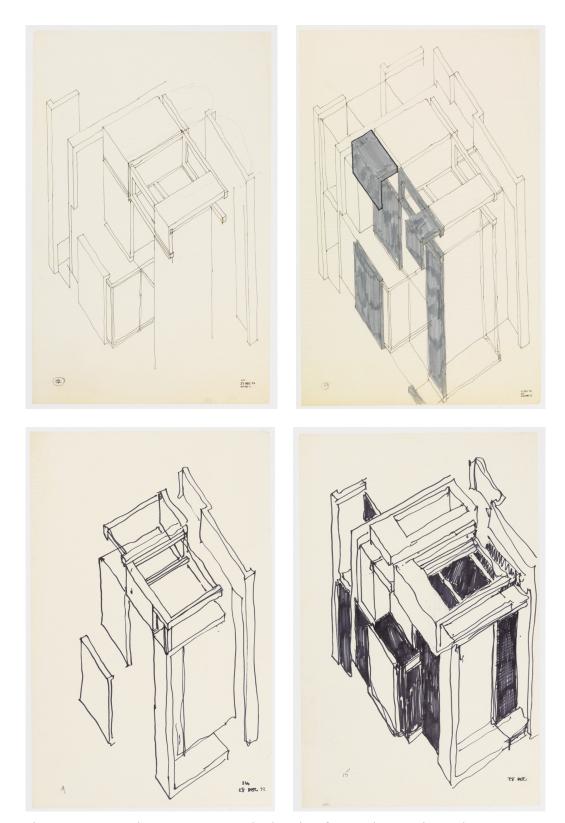


Figure 42: Second-stage axonometric drawing for southwest view. Sheets 12-15. December 27, 1972. © Peter Eisenman. Peter Eisenman architectural drawings for House VI, 1972, Research Library, The Getty Research Institute, Accession no. 920049.

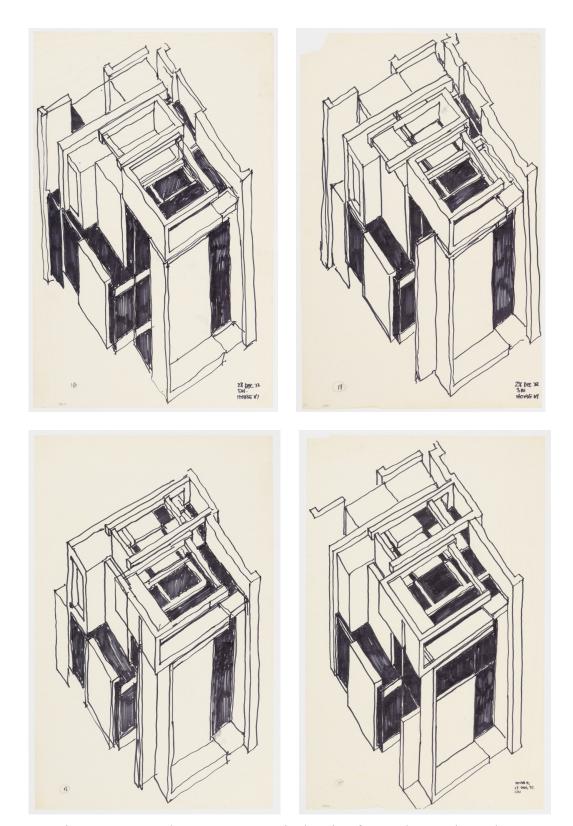


Figure 43: Second-stage axonometric drawing for southwest view. Sheets 16-19. December 27, 1972. © Peter Eisenman. Peter Eisenman architectural drawings for House VI, 1972, Research Library, The Getty Research Institute, Accession no. 920049.





Figure 44: May House, Exterior View (Top) and Julius Shulman Preparing to Photograph the May House, Los Angeles, California, 1954. © J. Paul Getty Trust. Used with Permission. Julius Shulman Photography Archive, Research Library at the Getty Research Institute (2004.R.10).

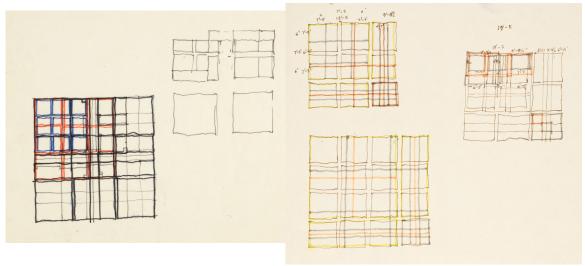


Figure 45: Grid drawings for House VI. © Peter Eisenman. Peter Eisenman architectural drawings for House VI, 1972, Research Library, The Getty Research Institute, Accession no. 920049.

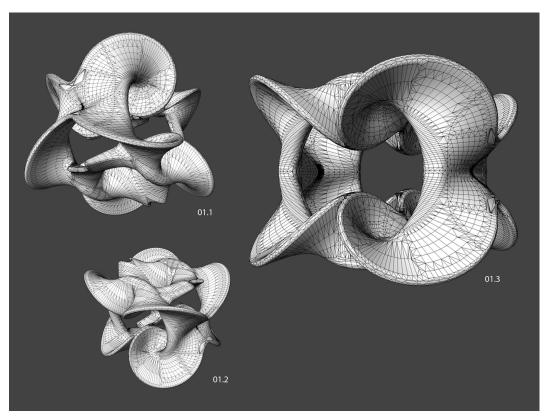


Figure 46: Evan Douglis, Intial stages of fLORA\_flex brick design examining forms produced by a variety of calligraphic lines.



Figure 47: Evan Douglis, Prouvé Exhibit demonstrating Auto-braids wall system.



Figure 48: Evan Douglis, Auto-braids wall system under construction.



Figure 49: Evan Douglis, Interior of Haku Restaurant (Demolished) using REptile on walls, New York, New York.

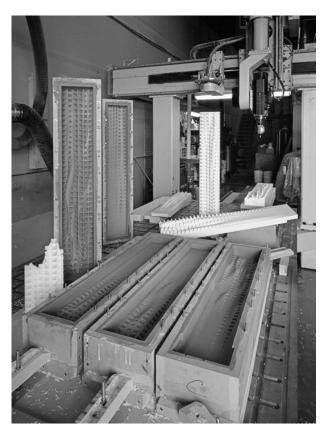


Figure 50: Evan Douglis, Tile forms for Reptile.







Figure 51: Evan Douglis, fLORA\_flex bricks being pieced together from slip-cast moulds.



Figure 52: Evan Douglis, fLORA\_flex brick in kiln.

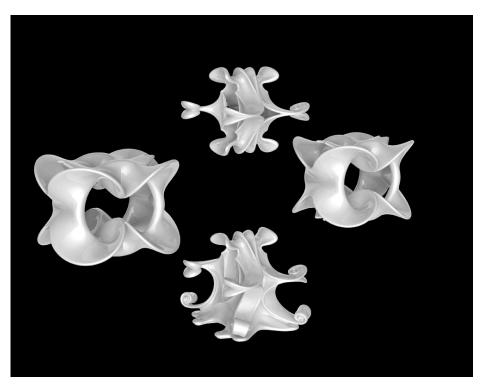


Figure 53: Evan Douglis, fLORA\_flex brick system showing main brick and two "mortar" units.

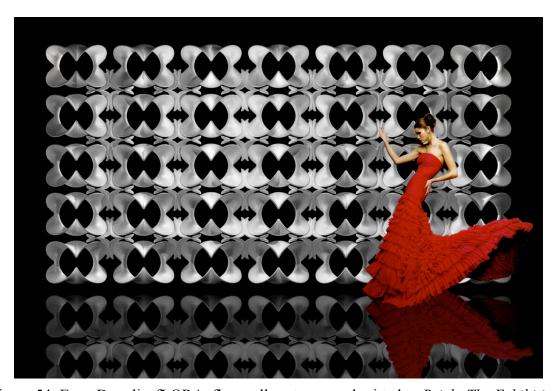


Figure 54: Evan Douglis, fLORA\_flex wall system as submitted to *Brick: The Exhibition*.

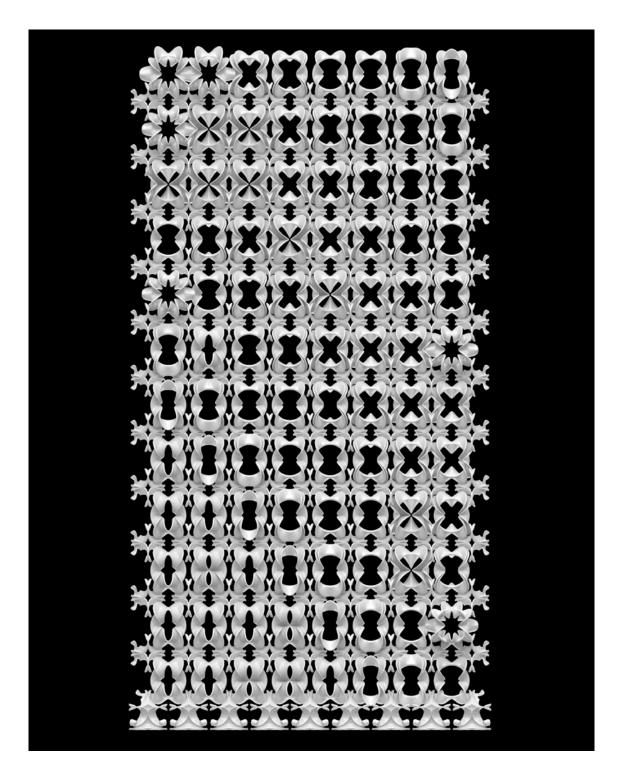


Figure 55: Evan Douglis, fLORA\_flex wall system demonstrating formal modifications as a result of a changing the speed of rotation in the form-generating flange.



Figure 56: Evan Douglis, Detail of Ceiling Tiles for Choice Restaurant, Brooklyn, New York.



Figure 57: Evan Douglis, Ceiling Tiles for Choice Restaurant, Brooklyn, New York.



Figure 58: Evan Douglis, Chandeliers Showing "Line Work".



Figure 59: Evan Douglis, Mock-ups of Chandeliers for Choice Restaurant, Brooklyn, New York.



Figure 60: The Yas Island Hotel



Figure 61: The Yas Island Hotel from Formula One Track



Figure 62: Yas Island Hotel Night View



Figure 63: Yas Island Hotel Grid Shell Design Showing "Stuttered" Axis. \*at the time of submission, permission to release this proprietary image was not yet granted.



Figure 64: Yas Island Hotel Grid Shell Design Showing "Relaxed" Mesh. \*at the time of submission, permission to release this proprietary image was not yet granted.



Figure 65: Yas Island Hotel, Excel Spreadsheet Used to Create Interoperability between Gehry Tech and Schlaich Bergermann. \*at the time of submission, permission to release this proprietary image was not yet granted.



Figure 66: Yas Island Marina Hotel showing spacing between panels and framework.



Figure 67: Yas Island Hotel, Panel Optimization "Stacks". \*at the time of submission, permission to release this proprietary image was not yet granted.



Figure 68: Yas Island Hotel, Grid Shell Design Showing Effects of Panel Optimization through Families. \*at the time of submission, permission to release this proprietary image was not yet granted.



Figure 69: Yas Island Hotel, Grid Shell Design Showing Effects of Integer Optimization of Panels. \*at the time of submission, permission to release this proprietary image was not yet granted.



Figure 70: Yas Island Hotel Grid Shell Design Showing Panel Rotation being "Painted" onto Design. \*at the time of submission, permission to release this proprietary image was not yet granted.



Figure 71: Yas Island Hotel, Scaffolding Optimization Simulation. \*at the time of submission, permission to release this proprietary image was not yet granted.



Figure 72: Yas Island Maria Hotel under construction showing scaffold.



Figure 73: Yas Island Marina Hotel under construction showing panel system and contractor standing on scaffolding system.



Figure 74: Yas Island Hotel under construction showing the ladder bounding box assemblies being stitched together (grey struts).



Figure 75: Yas Island Hotel Welding Optimization Simulation. \*at the time of submission, permission to release this proprietary image was not yet granted.

## **APPENDICES**

## APPENDIX ONE: A PROBLEM WITH STARCHITECTURE<sup>350</sup>

If you were to ask an average American to name one contemporary architect, it is likely that Frank Gehry would be that one. After his successes with buildings like the Guggenhiem in Bilbao and the Walt Disney Concert Hall in Los Angeles, Gehry has become an architectural star with his own identifiable brand, or signature look. The problem I have is that when viewing Gehry's buildings in all of their glittering complexity, somehow I am dissatisfied. The buildings are beautiful, sculptural monuments, and yet I am left wanting. Recently, I had the good fortune of viewing a lecture by Jim Glymph, co-founder of Gehry Technologies and one of the partners that make up Gehry Partners. Glymph's lecture clarified how the firm moves a design from concept to built form. It also inspired in me several thoughts that go a long way in explaining my dissatisfaction with Gehry as an architect.

On their website Gehry PaL3!rtners announces that every project undertaken by the firm is designed personally and directly by Frank Gehry. According to Glymph, during this design process Gehry avoids giving architectural shape to things until it is necessary. He waits for inspiration to come while working with program-block study

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<sup>&</sup>lt;sup>350</sup> Originally published in *Printculture: A Daily Blogzine on Culture, Politics, and Academic Life.* October 22, 2005, http://www.printculture.com/item-417.html.

<sup>351</sup> Glymph, "Gehry and Partners/Professional Work."

<sup>352</sup>LLC Gehry Partners, "Company Website Home Page," http://www.foga.com/.

models, continually rearranging spaces looking for their optimum relationship. Gehry discusses these options with clients until one day something clicks. Again according to Glymph, what you want to "achieve is the client as a non-architect, sitting around and looking at piles of crumpled paper and have intellectual conversations about them." The goal of this process is to bring the client on board with the decision-making. Once it is necessary to move into architectural shape, Gehry generates hand-drawn sketches. He brings a sketch to the point where he sees everything he wants in it and then translates the sketch into a model. Gehry Partners then digitize the physical model, and it is refined in the computer. The partners transfer these refinements to the physical model, and the process is iterated as long as is necessary for the design to be considered "done." <sup>354</sup>

This process is revolutionary in several ways, but most strikingly in its effects on building fabrication. Because the shapes that Gehry prefers are not easily modeled in typical architectural modeling programs, Gehry Partners began using CATIA, a NURB-based modeling program developed in by the aerospace industry. CATIA is CAD-CAM software. In other words, it is not only a design medium but can give computer-driven fabrication machines instructions for building the necessary parts of a design. DIGITAL PROJECT is Gehry Partners' proprietary name for their modifed CATIA based program. They use DIGITAL PROJECT to make a "master model," which is a complete digital model that forms part of the contract documents. The master model incorporates the actual structural steel shapes, helps to coordinate the mechanical systems, analyzes the design for repetition of parts and other cost-cutting measures, and can even tell the fabrication machines how to craft each piece of stone, steel or cladding. Another

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<sup>353</sup> Glymph, "Gehry and Partners/Professional Work."

important strength of this method is that it creates a single three-dimensional model that every one can reference. For example, in the case of the Disney Concert Hall, it was not necessary to use a tape measure on-sight during construction. Instead, workers used laser-surveying equipment, and took the "ideal" placements directly from the master model. This last advantage significantly cuts down the change orders during construction that are a major source of cost overruns in a typical project. 355

In all of these ways, DIGITAL PROJECT and the Gehry Partners design process are inspiring. So much so that if I am not careful the excitement I feel for their process can make me forget that I have a problem with their product. Why is it that the process Gehry Partners use, and the meaningful revolution that it suggests for the discipline of architecture, is not reflected in the design of the buildings that they create (excepting that it is expressed generally by the fact that cad-cam fabrication is the only practical means to create Gehry's structures)? I think the answer lies in several comments Glymph made regarding Gehry's role in the design process. Glymph explained that the where by Gehry translates his sketches into hand built physical models, the digital processes are overseen by the partners. This bifurcated process has enabled the firm to "introduce the computer without interfering with Frank's traditional process that he has used for the last 30 years." In other words, Gehry as master designer is insulated from the revolutionary processes that create architecture from his designs. As the creator of the Gehry brand, Gehry has become the signature designer in his own firm. His pursuits and questions remain on the abstract level, while the innovative and exciting integration of fabrication with design, the quality that makes Gehry's architecture revolutionary on more than a cosmetic level, remains unexpressed. Because Gehry has been able to maintain his traditional design

<sup>355</sup> Ibid.

processes, a rupture exists between the designing and making of his forms. This breach is further revealed in a causal use of materials (as in the Walt Disney Concert Hall where stone was replaced by metal without significant rethinking of form), and in the undeveloped potential of the structural details that are arguably the most articulate and expressive areas of Gehry's complex geometries.

These realizations have made me ponder whether or not, contrary to the opinion of Philip Johnson, Gehry's buildings embody those qualities that distinguish truly great architecture. I wonder if his buildings will stand the test of time. Specifically, I think they lack the legibility and signification that traditionally great designs possess. From his process, it is obvious that Gehry places great importance in the program interrelationships, but the expression of any power or social relationships that are significant to Gehry and/or the clients are lost in the final form of the building because the shape isn't legible. Even more than illegible, Gehry's buildings are un-imageable. Not only are visitors denied the ability to read meaning within the architecture, the geometric complexity of Gehry's designs denies a visitor's ability to create a lasting particular image of the building. This is the gap that the three-dimensional process leaves, it is streamlined and fast, but it also prevents the development of clarity which the generation of two-dimensional drawings brings. Two-dimensional drawings do take effort to create and understand, but these efforts offer a payback. Drawing is not merely documentary. It is a tool for analysis that requires an architect to filter out excessive or superfluous design moves in favor of a legible structure. Scalar drawings distill selected relationships within design and force them to be more clearly expressed. Yes, drawing favors certain types of relationships and makes others difficult to analyze. But, because the generation of a twodimensional drawing is an exercise in legibility, it also ensures a building's potential to express meaning. Without a similar system of distillation, architecture can become little more than bricollage. It is the pursuit of meaning that transforms architecture from a craft to a fine art, but without legibility meaning can not exist. This is why Gehry's buildings disappoint. Their beauty and seemingly impossible construction promise to say something profound, and instead they say little at all. Gehry creates pretty architecture, but without something deeper behind it, pretty things are mere ornament.

## APPENDIX TWO: FIRST INTERVIEW WITH EVAN DOUGLIS<sup>356</sup>

- D: Our latest work includes the fLORA\_flex, an entry for the EKWC competition for a ceramic modular wall system. The competition is to design a new brick in ceramic (stoneware) for the 21<sup>st</sup> century. Competition is subsidized by a group of manufacturers in the Netherlands who are looking to update their product line. The work went into the Rotterdam Biennale and the manufacturer will contact a few of us about really assessing what they are producing to make their line more contemporary. Our entry was much more radical than anything else in the show because of our engagement with parametric design and with the production of surfaces that have certain experiential and perceptual effects that anticipate the observer or spectator to produce surprise. We are one of eight finalists chosen comprising a cross-disciplinary group of both architects and artists, and the competition is providing an opportunity to "continue this fascination in building components"
- L: Is this the first time you've worked in ceramic?
- D: The first time since I was much younger, but I love the idea of using ceramic because it is such a common material. And we are using CCD milling to produce a positive from the digital file which is used to make a plaster mold for slip casting. The plaster mold is very much a puzzle because of the complexity of forms.

Throughout this transcript the notation "D:" denotes Evan Douglis speaking and the notation "L:" denotes Kristina Luce speaking. Evan Douglis, Interview, July 2, 2007.

- L: Do you feel a sympathy between the emergent or uncontrollable processes of ceramic and your engagement with the translation of the pure digital to the physical?
- D: More so with a ceramic process like Raku but the industrialized ceramic process seeks to create exact and predictable results—it is seeking to tame that unfamiliar so that you can get a close approximation to some kind of exactitude. To me the great thing about ceramic is its inherent warmth and the timelessness appreciation of residing next to it.

So in this project we were exploring a freestanding wall system and we were testing its load bearing capabilities and its ability to divide space and modify space, but it represents as well a kind of new alphabet which could certainly move outside in terms of a cladding system which makes the next challenge that we would take on a far more ambitions set of proformative interests whether it is in terms of closing air or dealing with visuality or the transmission of electricity, information, energy.

- K: So are you thinking of using some kind of smart ceramic for the energy transmission issues or are you thinking more of working within current systems and running conduit through this system?
- D: Running conduit through it, so it would be a kind of composite material, we were invited in to work with ceramic and we certainly learned a tremendous amount but we are already thinking of moving into a polymer material. So here we have 3-d prints.

In terms of how we work, we will design on the computer and print it out at a number of scales to try to identify certain proportional, compositional or structural issues and then we'll go up to the scale we intend to build it at, and then we have a finisher on long island who will paint them so that we can see what we have if we do

15 or 20 of them. So here we have the main piece and then we have the secondary piece, so we have A and B units.

- K: And then I see a third piece between the A-units? Sandwiched in between?
- D: Yes, that piece is specifically for the context of ceramics where you can't have any mechanical fasteners so that was an additional piece. But in the light weight polymer system you can have mechanical fasteners so you can literally float the piece in the middle, the A-pieces which would allow the piece just to stack.

Curiously enough the game beings with calligraphy, a digital calligraphy. We build this as a parametric process so the game begins with a single line.

- K: So is that line a line that you draw or is it a line that you write? Are you working graphically or otherwise?
- D: Either way, either way. Because it's scripted there is an equation linked to every form. And these guys are amazing because they can see in their mind the equivalent space of an equation. SO its gotten to that point and scripting has become a kind of dominate strategy play, but its not a matter of one versus the other, they are inextricably linked now so that every form you produce is linked to a computational command and if you understand the deep logic of the command you can make and adjustment there and you will see the outcomes.
- K: So the equations have truly become an entirely new notational system for the forms you are creating and they are understood as such?
- D: Yes. So the genesis of this forms is really rather simple because it is a ring and a flange that is attached to the ring that begins to spin either clockwise or counterclockwise around that ring and this quadrant is cut and mirrored four times.

And so this iteration is one of thousands we were studying for certain effects that begins to suggest a certain kind of topological exercise. I have been working with strategies of aggregation for years so within the techniques of growing, the priority is to keep up a level of interest in the piece that defines alive.

- K: And the legibility of the platonic solids that you were talking about before changes depending on your aspect.
- D: The flange becomes a kind of mortar for the phantom cylinders. In this project there has been a drive to find a certain mathematical unit that can be repeated. Now in Rotterdam the drive was to create a certain number of pieces that could be repeated indefinitely. Variation doesn't take place a the local unit but how the shape is packed and your aspect on it. More recently about 4 weeks ago MOMA contacted us and we were one of five firms invited to submit a proposal for modular wall systems for a future exhibit that tracks the history of prefab construction and at the end of the exhibit they will be thinking about what will take place in the 21<sup>st</sup> century. And they know our work so they gave us four weeks to submit a proposal.

SO what we did with that proposal was to take the system and ask what would be the next set of modifications and decided that the flange itself would undergo a whole series of modifications both in terms of length and in terms of double flanges, so that now each one of those units could assume an entirely different set of interests and if you had a façade of 3-4-500 of these the façade could take on a relief and could begin to open and close through dilation and take on a much more robust relief or turn into silence.

K: Do you feel that you have a particular stake in the idea pre-fab in the 21<sup>st</sup> century?

- D: Well, given the technology available in the computer with the advent of 3-d printing the level of surface exuberance could (doesn't have to but could) increase 100-fold. So this whole notion of structure and ornament as separate entities is defunct. The physics and story-telling in fLORA\_flex are intertwined so that at certain points the piece could could leap out of physical and into a place of a different purpose and story-telling.
- K: Even so, the way you think through your work at multiple scales seems to have a sympathy with the necessary rules and systematization of prefab. You seem to share a certain structural sympathy in this way.
- D: Well, for an architect working at multiple scales seems to have a number of purposes because you are always moving through representational stages. So to fill miniature scale is to assume a kind of overview of a project. It is the scale of assessment even though it isn't the scale you will be building at the way you would contemplate for a detail. And then there is the idea of scaling as an operative technique which in the game that I am playing is essential because you are always running the risk that in the context of repetition you are going to produce redundancy and redundancy could turn into stasis and boredom. So how are you able to keep afloat variation in fact the economics of the plan is some form of mass production with definitive pieces?

So this is then next stage, in these studies we are starting to play with the flange, here is a double flange and here it is starting to close down so that here is the final closure where it pinches in the middle...and for me it has started to take on a botanical flair. Although the t-section has been maintained as a constant, although this

is the beginning of a much more complex and elaborate alphabet because right now from a structural standpoint you always have to go from A to B for connections like a brick system. This will develop the A will develop into a much more robust framework where this will be inserted. This gives you a good sense of where we are going. So, this is the piece that you are familiar with, and here is the piece that will be lag bolted to the floor.

The rules of the competition were that it would have to be 5 feet by 10 feet high. So this is one swatch within the larger parametric alphabet, that will certainly transform considerable. So we haven't tested for example that the ring diameter would increase or that the T-section would change. So while I can certainly imagine the system becoming much more exuberant, it could certainly become more quiet. I like having the juxtaposition.

- K: Both in this project and at Haku you are juxtaposing the orthographic or rectilinear which you use as a foil against which you position the parametric or algorithmic forms.
- D: The reptile and the Autobraids are both projects where we had to deal with certain pressures of time and budget. The complexity of taking these complex surfaces that reside along a datum and then bending or introducing a curvature into that datum from a conceptual standpoint is certainly a nice move. From a logistical standpoint it increases 10 fold the level of difficulty. In the restaurant, absolutely financial. Pick your battle. Stay within the Cartesian matrix of the plane and it will be affordable and then inject the topological complexity at a small scale. The same thing with Pouvé, I thought that I needed to maintain the horizon line because without that I thought I

would have taken over. And you can already argue that there is a kind of curatorial controversy because there were a number of people who argued that I was competing with the work and if you are doing that you are stepping over a curatorial boundary. And there are others who don't feel that way because they said that I had acquired certain lessons from the work and injected them into that surface. That was certainly my intention from a tactical level the hyper-speed of that surface would make me leave the blue and go to his surfaces. I acknowledge the necessity of keeping a certain dialectical tension in the work.

When it comes to these pieces we are actually in the process now of going not only going beyond the effects that I am showing you here but figuring out how a much more clear structural proposition would manifest in the context of moving this into something like a house and how the house would deal with certain challenges of the envelop and does that mean the surface turns the corner at 90 degrees or 30 degrees or does it begin to be like clothing and drape.

I find that this term "blob" is seriously problematic because I think it's a term that tries to categorize a whole arena of form and space making that requires much more heightened set of terms and without having those terms you run the risk that you misunderstand a work and in certain cases you elevate extremely banal projects against very sophisticated ones.

So to get back to your interesting question. I think your orthogonal and the continuity of the straight line against this local complexity is in many ways a wonderful juxtaposition, but I conceptually recognize that there would be moments at

a larger scale, and I am talking about the typology of a building, that it could acquire a similar set speeds in enveloping that is happening at the local scale.

But in order to manage this game because it is so complex I needed to turn certain variables off and other ones on so I figured in the context of working this full-scale, it would be in my best interest to make a wall out of it. Ok, and then once you can do that, can you bend the wall, can you turn a corner, can you close space and then whatever other programmatic interests would start to invade the genetics of this so that it was no longer so self referential. That is where the question of a kind of internal intelligence...with lighting, is there any kind of luminosity to this surface, what other kinds of technologies would be injected into this, but also how might it undergo a kind of evolutionary change where it turns to furniture, or it acknowledges the context of something as primal as the floor it is going to have to deal with a hyper-functionality where a foot can easily glide either horizontally or diagonally what happens to the genetic material? How does the script adjust itself? Does it turn into a kind of local braille so that its almost pure inscribed linework and then it starts to lift in the context of the body responding to it, so I envision this thing as a kind of flesh especially since I am working from the detail out to the building. If that surface could take on a much more colossal and robust surface, that would be my goal. In context of how to build this we would have to do some enormous research

K: So with the constraints of MOMA in mind, you can begin to ease off of the totality of demands were this system to be immediately deployed in a fully architectural situation, things like durability, waterproofing and structural demands...

D: We would probably approach it with an immediate concern with how would we build this at the scale they want to build, and could we find an approximate equivalency of surface refinement to what comes out of the computer through 3-d printing or do I have to build an intermediary 3-d print to model it and to cast it, and in consequence what kinds of materials could we use. We have thought of Corian and have begun conversations with Dupont.

But running along side this is that we intend to take this forward into a house, into a pre-fab house that means that we would have to build on the computer animations that would show how it would be assembled and what the components would be which means that there would be many more pieces and much more information than accompanies the wall panel or just the full-scale piece.

And at that moment its about writing the program and not that these are just the elements, but what would be the consequences in terms of a lifestyle and what kinds of anonymous of inhabitants would occupy this world and what kinds of domesticity would be changed as a result. So we are realizing that some of the technology that we are theorizing about may not necessarily be possible. I would like to go there because I think this kind of work warrants thinking as a kind of futurist. So I think that between the two one would get a full picture of the new fLORA\_flex house and have something definitive in front of them that is detachable. So whether or not we are selected by MOMA, I think we will be moving forward in this direction.

Um, I don't really have enough to show you on that, but if these are discrete units where the lines are closed, the other methodological technique we are thinking of is weaving where the lines are open and infinite.

I don't think you've ever seen this...this is how the REptile was conceived: so you were talking about the unpredictability of ceramics, and this is a game of chance which we play again and again and again, and what were doing is with very specific commands over the fluctuation of the smooth surface and the how the pyramids are told to move, and so they are working at different patterns of oscillation.

- L: So for the design of the REptile, the array of pyramids are ordered along what appears to be a grid-when you were designing this control pattern did you have in mind already the installation at the restaurant, and did you know that you were going to order the space with these strong gestures to the grid and orthographic geometries? In other words, are these two systems gesturing to each other intentionally? I am just looking for the degree of intentionality in the intersection of these two patterns.
- D: The pyramid was chosen because the lighting grid is a like a cloud and I knew the pyramid would be an ideal geometric pixel to create the greatest variety of light and shadow.
- L: So in fact the pyramids were responding to the array of light.
- D: Yes, it really wasn't about a certain kind of imagistic appreciation of the pyramid, but rather on a purely performative level in terms of optics, and I knew the pyramid as a figure could be transformed quite easily in the context of the undulating smooth surface that introduces all these scales, so that the iconicity of the pyramid wouldn't be fixed or dominate and it would function literally as a kind of pixel. So, every time the smooth surface begins to lift, we elevate the "flood" and get a different scale.

  Now, can I easily imagine that spaces in there could take on a far more monumental scale in terms of these as buildings? Absolutely, but you pick your battles.

- L: And that battle for the floor is always a big one.
- D: Well, yes. Nonsense can reside in certain locations-in other locations it has very serious consequences, which isn't to say that the floor can't be part of the equation, but you just have to be more civil.
- L: And even then, the Guggenheim is a great example of even a simple manipulation of the floor creating an on-going controversy.
- D: It's such a good floor. Although you know it's funny. There are so many museums in New York, the idea that just one of them couldn't use the section of the building as the dominant exhibition tactic? I think its fine. Is it true that there is a lot of art that would be best suited for the MOMA? Yeah, but that doesn't mean that the Guggenheim's tactic is without value.

## APPENDIX THREE: PHONE INTERVIEW WITH EVAN DOUGLIS<sup>357</sup>

- L: Updates from July?
- D: Working on pre-fab architecture and robotic architecture conferences at Pratt. The MOMA entry did not go forward, but project is. Still pursuing that work in the context of a house. Also working on another project still in its formative stages based on braiding or developing surfaces as a woven matrix. In the near future hoping to produce this project through 3-d printing since it is the only manufacturing process currently capable of making these forms, particularly interested in the newer metal or metal composite possibilities.

Re: flora house, the system was originally a closed one, closed loops that received a flange...the house is exploring a series of alternative units some of which will be closed as discrete pieces, albeit pieces that stack, while others will work off an open line. The open line system, like the new woven project, will be more seamless. And in the context of developing these pieces, we are looking at new materials and how to invite in a series of sustainable propositions to the house-so the topology of the membrane is also smart...responsive to outside environment as well as the interior requirements. There is nothing out there right now that indicates that the marrying of materials to the formal system will be seamless. But that doesn't mean the project

<sup>&</sup>lt;sup>357</sup> Throughout this transcript the notation "D:" denotes Evan Douglis speaking and the notation "L:" denotes Kristina Luce speaking. ———, Phone Interview, October 27, 2007.

can't be projective for the time being...hopefully, this project might represent a new avenue for the discipline and certain manufacturers could be brought on to help in the research and development.

For example, the European Ceramic Workcenter created prototypes of the brick project in stoneware with a porcelain glaze for Rotterdam, and those are great, but the second avenue really thinks about a more contemporary materiality.

The beauty of working with algorithmic processes is that it can scale, it forms a library that can be adapted to various materials, which doesn't mean there is a seamless crossover, each material has its own tolerances but you are never starting over.

Surface magazine is doing a piece on American designers coming out in Nov/Dec here Douglis' wok will be featured.

- K: When we were in the café, we talked some about your engagement with algorithmic design, and your rather unique position occupying the space between the conceptual and the physical. I would like to hear you speak more about what you think is at stake, what you see as the challenges that arise from occupying this position.
- D: My background and my undergraduate from Cooper Union have certainly influenced my perspective on design. At that time and location, there was an incredible investment in the material arena for architecture and in establishing a dialog between the conceptual and material intent...so rather than now seeing design as a linear sequence where one moves from a practice entirely derived on the

computer after which at some point you have to figure out how to build, I believe there is a critical reciprocity between the analog and the digital.

If the analog is a series of experiments that occur outside the computer where one has to deal with the physical reality, there are a whole series of participants (material behaviors, thermal factors, etc) that are essential along the way to the final outcome, and these can't be entirely predicted or regulated on the computer. This is not a problem, but it means that you need to be flexible and allow your work to be inflected from the top down and bottom up. I also have an enormous reverence for the behavior of materials and I think there is a kind of latency within certain materials that needs to be worked with and understood.

For example, there is a project we are working on, I don't know if it was out when you were here, where we are conceiving design from sheets of material (currently polypropylene, but we are moving to other new materials) Cut from these sheets are forms that connect and interact in such a way that they are seamless and in the context of receiving weight they transform morphologically. So, in thinking about materials you can generate something compelling and advanced even if we aren't using anything particularly hi-tech to conceive of this new project either conceptually or materially. But we ARE still using many of the same concepts that we use in algorithmic space. I think this affirms that the author can move into different arenas and maintain their critical stance.

It's interesting because one of the lessons is that given the acquisition and the arrival of a new technology can literally inform ones own work, it can also represent a paradigm of thought that can leave the specific origin and drift to other locations with

respect to influence. I have always felt as a teacher that you can use any material, although you don't produce the same thing, you adjust to the material, that doesn't mean the work need be any less contemporary. I am uncomfortable with a debate that puts the analog and the digital in conflict with each other. Once it moves over to a fabrication stage, some serious re-positionings have to take place to figure out how to deal with a new set of priorities and pressures. This assumption with new technologies that things are easier is wrong. You have to bring in a whole new family of experts, and the missing building is going to arrive as a result these kinds of negotiations.

- L: One of the things I want to use your work to help me think through is architecture's engagement with form. I will be picking this thread up again with when I look at Lynn's Embryological house, but your work and engagement with dazzle topologies impresses me as an active contemplation or engagement with form. I wonder if you can talk for a bit about your views on form's role in architecture in light of what someone like Brad Horn would say about computation "finally" divesting architecture of its engagement with form?
- D: I certainly would not be an apologist for an obsessive fascination with the complexity and opportunities afforded in space making with these new toys. My reading of that statement is can one go beyond technique and begin to enable the emergence of something much more spectacular and enigmatic to resonate out from the work. And this is a much more universal idea, at what moment does any great architecture perform a much more ambitious abstract goal and challenge communities of people to participate in imagination. I would like to think the intricacy we seek to

manifest is something alive and participatory-and as such it must have a formal consideration. Form, it's a general term, is the flesh of architecture, and architecture occupies boundaries and limits while it creates space for occupation and ritual. It is those edges of architecture that are agents for change, triggers to be able to contribute to a series of anticipated spectacles.

Although the irony is that one is working with parametric software effable as a number, but one is projecting of those numbers into equations, into surfaces, into space, into time. SO it's a wild journey for an architect moving throughout these scales and at one moment architecture is static and in another it re-engages a place where time is essential.

We architects spend a lot of time figuring out how to become conscious of these new tools, and I think at some point in the middle to late 90s it became less about the strangeness of these tools and the forms they produce, and more about their purpose. SO it's a return to technique and process being something less about surface and more about something substantial.

There are certain kinds of universal codes in architecture, like one has to build in space and contain space and deal with the reality of the world. No matter how much the world evolves, the physics remains constant. Radical opportunities have been afforded in the last 2 centuries, but there are a certain set of bottom line requirements. Where the material presencing of the art is less important that a conceptual idea, I'd like to think architecture can operate on more planes of thought. That the best of the work can locate itself in a similar conceptual role while it deals with the sentient nature of the body moving through the building, and that movement can be a line a

thought as well. There is something beautiful about how architecture reveals itself to the occupant, which can be both a physical and conceptual experience.

Art can afford to be formless b/c it resides within an architectural boundary. So we have some interesting challenges that have to be negotiated and synchronized. And are there architects that are dealing with a much more minimalist palette? There are, and I am not one of them. I am probably working out of the kind of performative unit, whether that is computational or built, so there is a kind of local alchemy that is being grown or generated with the hope or promise that it will grow into a more dimensional swell that will envelope bodies and influence those bodies.

## APPENDIX FOUR: SECOND INTERVIEW WITH EVAN DOUGLIS<sup>358</sup>

D: Years ago I showed you a project with four inflatable weather balloons with a structural corset formed by each of these concentric rings which resides at a critical moment in the growth of the balloon, bifurcating it and allowing it to develop a more extreme morphology. And each of these would be hooked up to an air compressorideally the whole thing would be regulated by a computer. You would have a whole ceiling of these where this would be a prototype or a module. It was called Liquid Assets.

So in the context of Choice Restaurant, I was looking for controlled chance. And in the case of these chandeliers, this network of lines was put in at specific locations to get certain growth conditions, and again, there are some fascinating lessons that you learn about the specificity of materials about what to do with the glass, the timing of the glass, the thickness of the wire. Here, this one was done later...and I wanted to go to thicker wire because I think a heavier line-weight looks better, but the glass doesn't behave with it. It doesn't want to move. It comes back on itself, and it gets straight. It doesn't have the same elasticity.

And so this client is into aged things, so I have to figure out how to develop contemporary strategies, but mask them with patinas that liberate him from his fear of

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contemporary work. So, all of these chandeliers are going to be amber and we're going to put an Edison light bulb in it. And this is really exciting. This is for the perimeter of the restaurant. It's a stone from China that looks like petrified wood. It's great because all my work up until this point has used rather shocking, cold materials. And the other interesting thing about this client is that he cannot project it all, so I have to make things, make actual things for him, otherwise, it's not going to happen.

- L: What is the timeline for this project?
- D: At this rate we are looking at July for the opening. And so here is the stone running around the perimeter of the building. This is cor-ten steel that the lettering that you see here is steel that is attached by magnets. So all her menus are going to be made from laser cut 19th century fonts, that can be removed because its all magnetic. And we will probably have to develop a color scheme and probably cool colors in there. So, all of a sudden, you got this warm face and then cool. These are glass containers for pastries, since it a sort of French bistro. And then behind that, there are these openings that people can look through this whole ceramic service wall. That is made from this tile where the ceramicist has used this glaze that produces this pooling giving the tile this beautiful erratic pattern.

Now, this is the same ceiling tile as at Choice, but I was approached over a year ago from a design firm that saw the FLORA\_Flex project and was interested brining it to Las Vegas in a casino, but they put it on hold, and then they came back and I showed them this one and they said they love it, and then the recession has really crushed a lot of opportunities, and they now don't have the budget and this is not that expensive to do it but you are seeing in a different context... so this is the system and

it's a hex tile...right here and it was purposely developed to challenge the authority of the centrality of the hex because each one of these is a cone that comes down; this is upside down obviously. These are the high points where the chandelier is coming out, here. And where masking those high points, with an undulation in the surface. These secondary nodes actually become half the height of the cones, so there is that kind of turbulence and then there's a series of surface scrolls that are beginning to meander and set up pin-wheel effects. And so you've got the chandeliers, you got the, these are going to house the sprinklers heads. So, each of the nodes can either be closed up with caps and remain absent, or they actually take on program.

- L: And the small ones, the small nodes?
- D: Those probably won't be large enough to fit anything, except your finger. Each of the nodes represents the fastening hardware underneath them, so they are working as caps for what would be exposed fasteners. So, this thing is about this big, each of the units, and we are having prototypes made so that the clients can see like the chandeliers and say, "go for it," but, to make the long story short, although in Las Vegas this thing, I probably make an automobile paints smooth finish, just you know sexy as can be, for these guys, you see that bag of rubber things...Those are all little rubber doughnuts of different diameters and sizes. They were glued on to the 3-d print of the fiberglass surface. And what they are intended to do is, we're painting the entire tile a burnt umber, but the nodes get a platinum metal, so the points come out of the burnt umber, so this thing looks literally like an old ceiling.

Because I can't foreground the geometry - they just can handle it. So, I have to use my interest in a certain iconography as a way to control the associative projection of the client. So, it's really...

- L: And it was also very interesting to me is that you are very much controlling the iconographic associations through a deep understanding of the procedures of the craft of making, in order to mask, in a way, the procedures of geometric making.
- D: Its very much living simultaneously between the 21st and 19th century and it's sufficiently complex that the audience can find their own meaning. But I realized that some strange forms of manipulation are hovering around this process. I am into the aesthetics of it, but I'm also interested in regulating the aesthetics. I'm participating in some weird play and I don't win all the time because, you know, the furniture. I just couldn't win that. So, in that case I think the furniture is going to become so minimal.

The final thing is the windows. If they buy this, it will be so cool. And there's a product here—that is the other thing. I've been told would well in the market. To me that becomes really important because, I'm producing things within the very singular event condition, but the idea is always that these things could be mass produced and disseminated at a larger scale. Which is important because, like all of who move into these radical means of production, you've got a find an economic model because otherwise, it's crazy.

- L: Would you be able to market the tiles as a product, as well?
- D: Yeah, but you can sell the chandelier certainly separately, and you can do it any color, and the truth is I want to get a residency program in the glass workshop because it is so wild, I made we will make a video of this. You have no idea how, talk about a

kind of animate condition. I mean the glass is like living and it is bouncing and pushing and twisting and breaking and oozing off of this line work. And I see this as a kind of diagram for a whole series of installation pieces and I have a glass glower who I connect with beautifully, and the more we worked on this, the more I understand how the behavior of glasses working. And so, the intersection of commerce becomes more important as you move your practice forward, but I think there are still questions that reside within this gaming, this kind of productive interference that are unrealized. I have to shut this experiment down momentarily to get the restaurant out.

So, elevations, the interior elevations have a lot of a storefront windows and we have to put something in those storefront windows. So, I figured it that with the window, we could do a diamond system. This was just to figure out how many glass diamonds would it take to fill up the window. So, that's the ground, these are made of slumped glass. The outline will be at the same, but the axis of slumping will vary. So the glass will either be 90 degrees to the bottom of the kiln, 15-degrees, 30 or 45. So, you get this kind of balloons coming out in a different angles, and then we are going to use three shades of amber glass, one shade of blue and one shade of blue and one shade of clear. And so I'm back into processing which is the software that we are using on the cover of the book, and I've been teaching that in a number of studios, where we can begin to make hundreds of iterations to figure out what the aggregation of the color will be. Right? Yeah, very simple but the question is affordability. So, during the daytime, the light coming through the pyramid of the restaurant is going to

illuminate those membranes and then at nighttime those will become recessive and the chandeliers will dominate. So, it's an interesting juxtaposition.

And so what we're doing is I'm building the slump. This allows us to put 12 pieces of glass simultaneously here, and put the other ones...kind of cool. It's great because you get to work with the most refined details, you know, like the miter joint in this stainless steel table will determine whether the glass will stick to the metal or not. If it sticks, you've just lost the pieces.

L: Really?

D: Yeah. So, here's your opening. You cut the glass first. You put it here. Now, this gets changes so that I can regulate the angles of the slump. And then there are the details, like the edge condition, and how the glass is going to end itself. And if a glass gets stuck, I can disconnect this with set screws and pull the remaining pieces out. So, that's that project!

Was that model in the office when you were here last, the white model?

L: No, no.

D: Well, that project would have been an incredible opportunity. It's a \$625 million project because we did the cost estimate. We were approached by a developer who saw the work that we we're doing with this. He has seen a lot of work but he loved this kind of hyper decoration that was taking placing within a week. And there's a UPS building on the West Side Highway, in New York City. It's three blocks long. One of two streets go through it. It's longer than the Empire State Building, so it gives you a sense of scale. What he wanted to do with a group of developers is put residential pavillions. It was going to be a totally open-air roof, keep the existing

building, make it an elevated city of sorts, put a series of stores and a hotel on the north side. And then he asked mem would I come up with a scheme which proposes one continuous surface, and I said, "Absolutely!" So, these were earlier schemes. And then the later scheme...well, he wanted to reduce the building. He put an enormous amount of emphasis on keeping the price down. So, the way to accomplish that, I'll show you. Here, we worked with ARUP engineers on it to become immediately conscious of the economic unit that could simultaneously be built and reduce the cost and at the same time could receive our interest in the kind of branded rigorous skin. So, it's a dia-grid where we have four elements that made up the diamond, and to change the angles and lengths you can essentially produce a minimum module. This is a trellis in the horizontal orientation and a *brise-soleil* in the vertical, and you are only looking at the structural system because at the scale of this model you can't put in more information. But the rest of the pieces are indicative of what would be the massing blocks of the building. And we have unzipped the fabric at critical moments so that there's this kind of complete release to the sky. And the idea was to come back here with water-jet cut panels that would be powder coated and install these after the structural system was complete, so that you can create a micro climate. You know, because if you just keep it open, obviously, at times this thing is just going to bake, and the hope or the larger promise with Arup was beyond understanding this is a structural composition, was trying to figure out how the choreography of the sun in relation to surface qualities will create this wonderfully changing shadow through this but also reduce the temperature at critical moments.

In the end the project didn't go forward, but it was really interesting project to work on because a lot of our work remains at a scale of the restaurant and domestic settings, and here we were moving to a colossal scale, and we had the opportunity to test this question of excess in relation to environmental pressures. I mean, from a theoretical standpoint that would have been a wonderful opportunity. And if I can open the schedule, I intend to go back to this. You know, it's being challenged to go to this massive scale which I normally would not gravitate towards because I can't get into the intricacy of things. I need to solve that. But the beauty is just like I've been working on them from the bottom up for a long time so that's kind of top down expression.

This is really interesting, I've become friendly with a woman named Sashiko Kodawa who works with ferrofluids. She is activating magnets by running electricity or something through this solid and then that's causing the pool to respond by something like this? When I think of this project, I think the next stage, other than the larger scale in which it is programmed, an occupation, the surface shifts. Like flowers should be able to expand and contract and go from transparent to opaque. It's a total kind of biology. I mean, this article in the New York Times was saying that this attempt to look at the larger kind of genomic library of the human body in the context of trying to decipher diseases, that it's so much more complex than we thought. It's like this whole myth that we could do this in the next decade or so, its just all too advanced, but it's interesting to step back every once in a while and realize that we assume or really imbue technology with having the intelligence to be able to take us to some other places, but the fact is there's natural matter and phenomenon

that is just so unbelievably rich and that sometimes you need to get out of the computer to kind of go back into this thing. I don't even know if you could model this in the computer. I mean, the amount of power you would need and you might just as well make it. Just make it! And then you use the computer to diagram the vast library of the effects, but it's never about recreating the physical modeling of it. I mean, it's the same thing with the glass.

So we're going to make little scientific experiments with materials so we have to get stuff from NASA. It's like that project. She's going to challenge me to get into a much more evolved material science, and I need to because the project is sort of kind of calling out for that. I also think there's a larger ideological bias that's a much longer discussion against the excess, like it's threatening. You know, this stuff may work on that.

- L: Talk a little more about this idea that excess doesn't necessarily have to be excess... I mean, I think arguably the excess in some of the pictures that you're showing, arguably that is more excess than what you're creating because what you're creating has more potential for meaning, for use, for all sorts of things to be placed into these "excessive" gestures than what could be easily be dismissed as simply excess.
- D: Right. And if you can justify it economically that's the interesting thing, where you can kind of find creative ways where the economic value of the things that you're making can compete with that which is more minimal than you have access to this other arenas of influence.

So, this is the kind of opening image to that project. So I see this is as an ideogram and each of the colors to me would have a certain programmatic value. So,

that's one of my futures to figure out how to inject behavior into the chromatic field of architecture at a variety of scales. And so this is an experiment now, starting off with a very simple figure-eight weave and beginning to regulate the script so that certain flanges almost become monstrous. And by doing that they exceed their boundary and make take on...they first may become transgressive in the sense that they kind of violate a certain, let's say territorial zone, but in the same time they unmake one thing and they make something else. And so to me I'd like to work on more of this and I'd like to build this stuff. I call it the L tower, e-I, because it's an L. This is very complex and it looks simple but it's not. The inflection of the surface here now created many problems in terms of the ability for the control of the flanges locally to be sustained. So, from a computational standpoint, we're finding problematics along the way and then we have to go back into the script and change them. So, this was the first scheme...

- L: Before it was simplified to the diagrid?
- D: Well, we had a diagrid but this is a 21 story skyscraper versus what turned out to be 12, and this went through a whole series of smaller 3D print models and this was what I was proposing before I unzipped it, these radial zones would be where outdoor space will be located in terms of open sky, gardens, out of the commerce zones. But they loved it, and this was all about a kind of schematic provocation. This is what that system was starting to look like.

So, these are shots of the 3D print model. I had to make this in Belgium because we don't have a machine big enough in the Unites States to make a big 3D print. They have one large enough that they can 3D print a whole body. They built their own.

That's pretty amazing because you don't' have to cast anything. You know, you can within 5 to 10 years, you should...they're doing the medical industry. They'll print an object right off the computer then it's done. Because it's not just a study model, it is the thing. And it's fascinating, you know, this whole notion of, kind of, releasing the tension in the surface, you know, but very complex because when I was working on the oblique angles, I had to figure out how to mediate between the orthogonal of the city and the oblique force of the building. So that is a project that you had to see.

## APPENDIX FIVE: INTERVIEW WITH GREG LYNN<sup>359</sup>

L: So you've written a lot about how calculus is freeing architecture from its reliance on rectilinearity, but I wonder if you see calculus as also freeing architecture from it's investment with form?

Lynn: Well, I would use a term like eidetic form which just means identically reproducible, never existing, and perceivable in its ideal state. I think, calculus challenges one of the three: it produces forms that are not immediately graspable. The geometries that are based on calculus tend to be so variegated that they can't be reduced back to some ideal model the way you could with a pyramid or sphere. I think to a certain degree they don't exist as an ideal. Calculus doesn't really have points and lines and position in the same way. I think that's probably like dividing it down to fine. I think in the end, it is an abstract tool. But, you know, it has ver different qualities.

I think the biggest fundamental changes have to be with dimension, but like modularity, part and whole relationships, symmetry, proportion--I'm still interested in every one of those principles, but as they are thought of today. So you say symmetry today, it's just a simple mirror image; it's more elaborate and involves part-to-whole relationships. You could only think through the problems in a contemporary way with

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<sup>359</sup> Greg Lynn, Interview, January 24, 2008.

mathematics like calculus. I always like think of myself in the Renaissance tradition of these values, but with today's mathematical and geometrical principles--rather than saying mathematical and geometrical principles of the Renaissance are tied to the questions of proportion and harmony and symmetry. So, in a certain way I would like to detangle some of those Renaissance principles that are so tied to these eidetic forms, and when you detangle these concepts and now bring those concepts into a contemporary mathematical system, what do you get? So, for me, calculus is like a more advanced form of fractional dimension which was part of the Renaissance and digital dimension which was another phase of the Renaissance and a lot of the problems I think are still interesting.

L: And I guess the question I have is, what happens to form when the manipulation of it sort move away from the form itself. How do these eidetic principles still apply when we the forms have no ideal states?

Lynn: You know, architects still do drawings. They don't know make buildings they do drawings. In the Renaissance, a sphere might have been easier to produce and describe with those techniques than, you know, a Norman Foster cucumber. But now, we need a computer and we need calculus because we are representing the dimension of every piece of that building and the variations of those dimensions and there is a great deal of complexity in that description. Design today has more to do with advanced mathematics and also more to do with advanced drawings and probably even not using the drawing or construction in a sense that you're thinking because we're sending manufacturers dimensional information. You're not really

sending them a plan or a section. This is a big change to the media: drawing as ink on paper versus drawing as a digital file. But its still the same field.

Then, if you go to say something I would do, I don't think that it's easy to extract an ideal form of that, the way it is with the Renaissance. I think in the Renaissance there was also this controlling geometry that was visible in the form of the building, and I think now it's less easy to do that. And it's less easy to also reproduce and recall the building in typological manifestations the way it was with, you know, Palladio. You aren't going to see, for example, Gehrism. Palladio's designs were patterned for reproducibility, to be typologically reproduced, but you don't see that today. And I think it's a little bit of a crisis, now. It's hard, there's definitely a kind of OMA typology that's possible, but now its not so much a typological reproduction of building that is possible, but more like Victorian architecture where you're looking at motifs and things rather than spatial formal typologies.

L: And you think that there is someway that a display of process in the way calculus can be deployed in order to generate form, does that not create a topologically related architecture?

Lynn: Probably so. I have to say that evidence in architecture does not support it, yet.

But I do know, there are a lot of people that use calculus to come up with that kind of spatial formal ty quest, but I would say evidence in architecture so far would not support that. It might be but honestly I think you're probably on to something which is the inherited medium of plan section elevation versus the computer and its ability to think in terms of, you know, surfaces and arrays, which have nothing to do with plan section, and just the kind of dominant aesthetic, I think those three things are

going to indicate to me that you're not going to find any kind of rigorous typology in calculus based forms.

You should look at Peter Schroeder's work because what's interesting is, if you take calculus in which you locate points in space but generate form that's not coincident with any of those points, you keep on infinitesimally dividing it, you approach points, but you're never really get points. To get points you have to convert it into a poly-line. So, if you go from the other direction which is using partial differential equations, its like saying there are points in space, and you start cornercutting those points and calculating between all of them to come up with a finer and finer array. In architecture, we're always going to be in the middle because we need the coordinate points, it's got to be built out of pieces, the pieces have to start and stop somewhere, they have a contour. So it's not so abstract that you can live without real dimension, you actually have to have dimensional description. And you know working it from simple equations to more complex finer equations. It's very quick and light, so physically if you model it, it's very easy to get a higher complexity. Whereas with calculus its dealing with this cumbersome equation all the time. And so, other designers are moving more and more towards differential equation modeling, which has more to do with the way we classically draw. I mean, you even can start like with a cube and end up with a super convoluted as a surface. But you're starting with something which is something much more familiar in architecture.

L: And what I'm not familiar with programs that are functioning on that model? Are they out there yet?

Lynn: Typically, we call them subdivision surfaces but, you know, all the polygon modelers were from that end of the spectrum and allll the spline modelers model work from the calculus end. But, you know, maya, auto desk, 3-d studiomax, they all have both. And so, we could see 10 years from now, it might actually shake out where you start to see plan section elevation entering into the equation in a different way than it does now.

L: So you don't foresee plan section elevation disappearing in architecture the way some like Glymph have forecast?

Lynn: Well, in that persistence of plan section elevation, I think on a disciplinary level they're still very important. Whether or not on practical level is a not really the question, it's on the disciplinary level that I think they're important. Well, like if I'm hanging out with industrial designers, they have no obligation to elevation. If you hang out with them too much, like say Future System does, you end up with an architecture that doesn't address its audience in architectural mode. And so I think like a façade, you know, which is the expression of an interior volume on the exterior, it's the address, you know, outward of a building. I mean, all the things that façade does might be tied to elevation, to think through the disciplinary history and requirements of a façade with a technology that doesn't permeate elevation is what I would do. But elevation is a very helpful tool to be checking how you're doing all the time. So even though I live in a three-dimensional modeling environment, I use elevation a lot to just check and see that in fact the architecture is dressing the city and its audience in a way that architecture has to make its address.

So, that's what I think such things are so important. Not to mention the fact that like level floors, despite the last 10 years' attempt to eliminate them, are still like super practical but also just a cultural norm. And so you play around with that but you still have to address it, and so section and plan are also really important. So, yeah, I don't necessarily design in that medium but during the process of design I use those things all the time and can't imagine not using it.

- L: So, you're not designing in that medium nor are you just producing it for the construction, but you are still using drawing.
- Lynn: It is very much part of the design process. You know, I agree with Glymph that everybody is sending three-dimensional files to people to fabricate. Except in large buildings, it's not so normal to have like a job supervisor sitting there with a 3-D program, but it will be soon. I mean, at every scale of construction. So, I think people won't build so much in plan anymore. But I still think it's an important tool.
- L: So, that is definitely a way you see plan section elevation maintaining its historic presence within the discipline?
- Lynn: Sure. It's a major disciplinary tool. I remember finding out like 10 years ago automobile designers went to elaborate ends to build tools that are like their metal blades for scraping. But I think the residue of these old ways of designing is what keeps you in your discipline and keeps you from jumping into a much more like free floating field like industrial design. Which for me doesn't have a history, and doesn't have a discipline really. But I think some architecture is really more and more like industrial design, and it's funny how it just takes a minute and you lose your whole relationship to history, so I think that's important.

L: And design's move toward process and away from the object? There are a couple of architects that I've spoken to who believe that form is not the thing anymore at all. I mean the forms that are generated are used to check, but those forms are manipulated at an abstract the level, at the level of the parametric equation. And the design becomes the process of manipulating these equations rather than the forms. In on case, the entire role of the "architect" is to serve as an archivist to coordinate the process through which the digital model is manipulated.

Lynn: You know, I'm seeing more. It's interesting, because take Frank Gehry as an example. Now, Frank is always working like at a scale. Like at a quarter-inch scale with a piece of paper that behaves like stainless steel with scoring lines given to him in this earthquake pattern, and so even though he sounds disinterested in the computer, he's now got an intuition about how surfacing of his buildings works and what you can achieve with the materials. Maybe he doesn't even know how to talk about it, but he's very smart about surrounding himself with physical media that behaves like his digital media, and then getting the Gehry Technology software to have a lot of same principles as his physical stuff. So you see less of him making a thing and then scanning it, and much more of him like draping metalized paper over the thing and then going straight to the computer model.

But that's very different than saying like it's going to be a sphere and it's going to be a sphere. You can also work more like Foster, which is the other paradigm, where you say, let's work out the modular component but use it in a non-modular way to produce something like this. And they really do work parametrically where they

build the custom tool which is really linked to construction system, and then use that tool to give them things that they didn't know they were going to get back here.

L: So when you say tool, would that be like the component of generative components?

Lynn: Exactly. So, there, there is a focus on the parametric model. There's the focus on, you know, the rationalization of something. And I think that is the project.

L: Okay, so then the other question I had is how consciously do you feel you engage in the idea of authorship, particularly in the embryological projects or in your teapot.

Lynn: Well at the time that I started using animation software, I had the idea of a collection where each one of the members of the collection is perfect, and there are no ideals, and what was involved in designing or collection like that. And so I started with a family of curves which had to be usually compatible—they couldn't generate anomalies or some thing like that. And the task became the crafting of the component and the constituent elements of the form so that they were mutually compatible, and then testing the combination of them to make sure that the family they were generating was all aesthetically and formally correct. Then I could say, "Well, we can do 500,000" and I've never looked at them all but I can tell you they're all perfect. With the teapot, for example, I am sure they were all exactly the same volume and perform the same way, so more and more I've been interested in the design of the collection rather than a design of the singularity.

It's really more about producing family copies than it is this whole discourse around the computer that says now everything can be different and everybody can have a different one. I never liked that.

About 12 or 14 years ago, I used to buy my toothbrushes at Bigolow Pharmacy, and they were all natural bristle...And then one day I went to a supermarket and I saw that what used to be the toothbrush shell that become like this massive thing. And they were interesting. They were co-injection molded, and they had like material things that I like. And so I started asking around who designs them, do they have a conference, do they have a publication? What's going on in a world of toothbrush design and everybody said they're anonymous people at Proctor and Gamble, and you have to do like five different toothbrushes every quarter-and it just has to do with variety. And so I realized like the velocity of design and the number of things we have to design and the changes and it's just eating up like in every industry. Back to cars again--10 or 15 years ago, a company would have like four models of car. Now, every car has to be re-designed every three years, and they've got seven or eight different series of car. So, it's just more design, which means you need more variation, but you also need brand identity. So, that's like seven models of BMW and seven models Lexus, and then looking at each other it's really important that the 100 series is different than a 700 series, but it's also important that either one looks like a Lexus. So signature, variation, all that stuff, I'm very, very conscious of it. Even from like a building to a fork. I'm conscious of somebody being able to recognize above this line.

L: I think it was a similar pressure that helped fuel specialization and the acceptance of the specialization of the architect in the Renaissance as the person who only prefigured form as oppose to the person who's on the building site and who knew how to carve all the stones. So, slowly you see this pulling away from that holistic building

model into variety of specializations due to a pressure for production. So it's interesting that you say this is one of the things you're responding to. What I hear you saying is that you're very invested in each one of these objects in the family, still being yours absolutely.

Lynn: Yes, let's use a flatware as an example. Alberto Alessi said, it's time to do flatware, and he's really great about always showing you the history of the thing you've got to design and also explaining how they'll make it and then also the design process that's worked in the past. So he said, "Let's do flatware and let's get together and talk about it."

Well, the way it usually works is you design a spoon and if you give us then the spoon, our artists and designers will be able to then get the form and the knife and all the certain stuff, but the basis is always the spoon. And I was just like...Do you even know me? So, you know, I came back and I really rely a lot on this person, William Bateson, from like 1890, he coined the term genetics, but with it he also coined the term generic. And he has the argument if there is generic form and there's genetic information which adds to it, so we're individual. So, I said, well we have to design the generic piece of flatware and then we'll just take that into or fork or knife as you need it.

It's not like we're just taking flatware and embellishing it or taking a typology and modifying it. We're actually going back to first principles defining the primitive, the generic primitive and then, you know, moving into specificity. It means that you can play that whole game and these things are always going to be part of the same

family. And it's not just because they have the same ornament or shape or anything it's because they have the same process of design.

## **APPENDIX SIX:** FIRST INTERVIEW WITH NEIL THELEN<sup>360</sup>

- L: Is the transformation in architecture, as described by people like Hani Rashid, happening as quickly as they say, or is it a longer shift?
- T: What I am so interested in is that you are talking about things in terms of their slowness, but I am predicting the opposite. Market forces are going to dictate the speed, not so much the aesthetics of scripting and of formal generation, but the collaborative infrastructure that allows these kinds of projects to happen. That is what is going to pull these things along, and all the sudden these kinds of forms are possible, so these kinds of twisty scripted things are happening because of the software, but the software is happening because of the market. So that is really great, and its fast. It happens really quickly.
- L: So the collaborative move is happening in response to the market forces?
- T: I think it is. Architecture is expensive, and abstraction is expensive, and mistakes are expensive, and change orders are very expensive. And all these things are wrapped up in the building process, and it's going to come true that projects come in on budget. Gehry is doing projects that come in on budget. They are expensive and huge, but they are coming in on budget. It's going to cost this much and it's going to be done in this time and that is what happens. That is because we are working directly

<sup>&</sup>lt;sup>360</sup> Neil Thelen, July 16, 2007.

with the 3-d model. That result is entirely enabled by this process, and you're going to see that trickle down to smaller and smaller projects. You will see rapid transformation in the industry. When CATIA finally ends up in the hands of the architect, then all these forms are possible, and then it's like, we can produce these things quickly and accurately, and we can generate estimates and take offs, and all this kind of stuff that the market wants, but the off shoot is that the formal possibilities are wide open. So I don't know how that fits into your ideas about how transformations have happened historically, but I see it as reversed. I see it as less about people and more about markets-less about inertia or any kind of story that is being told and more about market forces.

- L: I am not trying to contradict the rate of change that you are seeing at all, I want to try to represent the scale that you are seeing, but there are other levels to this transformation, levels that have to do with this one, aesthetic transformations that have taken decades, for example.
- T: It's complicated, because I think what is coming about is not what was expected.

  We have been processing the aesthetic, but it is not the aesthetic realm that is pushing these changes. It's coming out of Boeing. It's coming out of industry. It's the promise of re-fabricating architecture actually coming into existence. It's not about form at all. I think the form is going to be a total by-product of this process. I work on this project and it's like a servo. It's like I am over here and making it all work out, and the form is just happening. It's not a sculpting or composition process. Unlike a firm who still works in MAYA, for example, where forms and the things you can do in MAYA are still driving design, SHOP is really engaging this. They really take on the forces that

are producing the projects. As a practice, they take it on more closely than anyone.

The big IEC building, the glass is cold formed, shipped flat and bent into place on site, and the limit of the curvature comes from the warrantee on the silicone, which means that the warrantee of the silicone results in the form of the building, in a sense, or at least it places a constraint on it.

- L: And where does that constraint get inserted in the design process?
- T: We can vary it. It is very easy to embed that knowledge into the parametric model. It works much better with hard material constraints, than it does with sculptural compositional constraints. I am working with a design architect right now and it's frustrating for them because they are like, why can't we just model something? And we can, but it's less useful as a tool unless we add material constraints to it. And that is a broad category of constraints: they can be zoning constraints, or programmatic constraints, or construction process constraints. But the process works better with those kinds of things rather than any kind of sculpting.
- L: So maybe what we're talking about isn't relinquishing form totally, but relinquishing the traditional top-down formal/aesthetic route to design?
- T: It is. It's like programming behavior into form, or it's like programming a range of motion, or a diagram of possible outcomes, and then steering that model to be more and more specific over time. And you add those constraints and the diagram gets more specific. So, initially this diagram is dumb, but as soon as we learn what is cladding it, what's inside it, what's outside of it, what it's sitting on, and all of these things, it gets more and more dialed in. But the initial layout of that behavior is

the architectural act. The diagram takes on a new life. It is the diagram of formal behavior. But I don't think there is anyone who is really doing it, honestly I don't think there is a good example of someone doing architecture like that. Maybe because of how the architectural process is traditionally set up: certain drawings required by certain times for certain approvals. We can create those types of drawings, but what the model really creates is an amazingly robust diagram. What we have is an unarticulated blob of knowledge that gradually is becoming more and more articulate over time, but that doesn't mesh well with an office that needs to produce a hard and fast documents and revisions every two weeks. So the processes are in conflict, and we are compromising our process because our clients need it.

- L: So is this one way that the change you were talking about is being complicated, where the profession and market want one speed of adoption, but the institutional and cultural and bureaucratic and governmental processes can only move at another?
- T: It's this little everyday conflict that is a result of two worlds colliding. Its frustrating because there is a lot of friction there.
- L: Yes, and it is this moment of being in-between systems, this transition that works out the specific directions the profession is moving in.
- T: But that is why this week has been so frustrating because we keep getting these demands for the client to water down our system, we're in the middle of some real negotiations. It's interesting to be working both with architects but doing something different, and we can water down this system so much that, what do we have in the end--new way of doing the same old thing. I mean do we provide assistance in that process or do we argue for something else? And then what are we, in the end? Are

we trying to do what they want or something new? Our thing as I see it has more impact on the final outcome than anyone else along the process, but we are also not designers. We make a point of being completely hands off. We don't give design input even though everyone knows the way we structure the meta-model has more influence on the end product than anything. The meta-model is like, you want to make it this way, well there are about 50 ways I can set this up, knowing that in a year it's going to be something completely different, and when you are engaged only with the form it doesn't matter how you set it up, but then you deny yourself access to all those other logics. But we can embed that knowledge into the model now.

My picture of all of this is that there is an awareness of complexity that didn't exist 50 or 100 years ago or longer. What we are doing now is really the closest we have come to having that awareness and attending to our desire to explore the richness of that complexity and kind of order it, and the constant push to find tools to that allow us to that. With today's new tools, we can structure this diagram to be the recipient of or the generator of these kinds of manifestations of complexity. As a designer I am out in the world and absorbing all of this, and now I have a tool that allows me to put it together and make a picture, to design a system by which to deal with it.

- L: Is that the definition of the new architect then? The designer of systems, not a programmer which was thrown out there for a while...
- T: Absolutely, 100%. But you are designing a tool more than you are designing a thing, so I am not sure there is a difference between being as programmer and a designer of systems. It is almost like if you could design a new system of projection

for every project. You are designing how you draw—rethinking the drawing process with each project. You are re-conceiving how you conceive with each project. It is a new awareness or a desire to redefine that every time.

Architects have an aversion to the arbitrary in any way, and there is something about this software that creates at least the illusion of objectivity. The idea that you can register complexity in some way with this tool is what I think is so seductive. The idea that you can have all this material intelligence and all this programmatic necessity, and you mix it all up and the building comes out. The tool can kind of do that, but it's how you structure the meta-model; that is where the difference happens.

## APPENDIX SEVEN: FACSIMILE OF NOTES FROM SECOND INTERVIEW WITH NEIL THELEN<sup>361</sup>

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<sup>&</sup>lt;sup>361</sup> Thelen. Due to a mechanical failure, I was not able to transcribe this interview. Instead on the following pages I am providing a facsimile of my notes from the meeting.

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## APPENDIX EIGHT: INTERVIEW WITH RICHARD SARRACH<sup>362</sup>

- L: So, Evan says you are the expert on *GenerativeComponents*. I went to the Smart Geometry Conference as part of my research, and Robert Aish was pretty interesting theoretically because, it seemed to me that with GC he was moving the work of design to an upper level of abstraction by using the symbolic or metaphor view, but it is interesting because he is, in a sense, allowing architects to design in ways that echo the past but have implications in computation. During the conference, people would often discuss the best project as being the one that yielded the most complexity with the most simple symbolic view. This of course makes sense because if you're designing a system, you need to be able to make sense of the system structure. But it is interesting that the point is to get at that complexity graphically, in a way that architects are used to working.
- S: Well, it's a piece of software that's updated daily. There's Robert at the helm of the show and then a very sophisticated group of PhD candidates and also professionals that have access to all of the back door content. So, it's going through it's natural growing pains as a piece of software. But, if you begin to see other companies like McNeil Associates, the makers of Rhino, following in Bentley's tracks, but they are Robert's tracks because he is like a rogue agent within Bentley.

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<sup>&</sup>lt;sup>362</sup> Richard Sarrach, Personal Interview, July 10, 2007.

Robert is very much of a whimsical dreamer. To hear him speak about an evolution of interface and how we begin with migrate from a representational system that is still locked in code to a more of an object based representational system. And how this relates to how humans begin to process the hold and capture information is really exceptional. I don't know if he spoke about that conference, but he is very invested in the making of the tool that facilitates the ease of production, whatever that means. So for us the tool was really quite phenomenal because it was a piece of software that allowed us to produce sub-facets of that software, and to build up new tools that would create new things is really quite that simple. What they did that was of somewhat exceptional in relationship to, if you look at the groupings of software from Catia to the Autodesk Suite, whether that is Max, CAD, Maya, Nero, they are all one big family now, or any of the smaller periphery, they produce an interface that gave you different levels of depth within the software. One could go extremely deep and extremely deep would be into the C-sharp and C+ complete backdoor content. And then if you can again stepping yourself up, it would be moving into scripting which I believe is C++ at that stage. And then you would have access to the parametric content on the far left, and then you have access to the more, what we see today, as the more traditional user interface, where you begin to push and deposit information on either hand or the mouse click. So, I think that is for me as one who teaches, it becomes a very easy way to begin some breakdown information and convey to others so that they would be able to pick it up and I mean for the most part almost all software is highly dependent on global ambition one has. And so, I think that to be

- able to move deeper into the software if one so desires, is extremely critical, and I think they've done that quite well.
- L: It sounds like you're saying they have actually balanced quite well—an entry level software that allows you that exploration.
- SWhat was extremely encouraging was that when we first set out with this software and we were working in China a year ago, we had Tom Hanraham staying with us, and sitting in some the lecture classes. And afterwards, he was commenting on the way the operates is the way he learned how to use CAD. I mean, because it's very much based on a dependency system that goes all the way back to the point, and so one cannot create lines unless they understand where the points are, and so and so forth. So, I thought another really excellent thing that it was able to accomplish was to bridge a gap not only within offices but also within the environment of academia is something that is really a buffer between generations. This was a way to begin to connect to us because it was so obvious. So the students coming from a completely different way of operating, they never had to engage with the computers in such a way where they have to specifically know what their agenda was. They weren't allowed play. And Tom coming from the other end of the spectrum was educated in this fashion, and was curious on why weren't they getting it sooner. They had a level of difficulty working all the way back to nearly a coordinate system within the world. And before they were just allowed to deposit it and forget about it. That sort information was always invisible to them. So, it drastically forces you to begin to reposition your means of engaging, back to the agenda of what it is that you want to get out of it. There are ways of playing, but it's not of a free-form plane. It's a

playing within a very hyper specific set of constraints. It's like one is trying to build a bird and we know that it needs to pivot; the wings need to pivot at a certain degree and there should be about two of them with some sort of a steering mechanism, but the body mass, the length and all of the joinery are variables so we could produce chickens, penguins and ostriches, or on the other side of it, osprey, eagles or humming birds. And so, coming from the student body, is how to get them to begin to think that they are not creating one bird but they're creating a family of birds. And how do we begin to work our way back to the core componentry to be able to do something like that.

- L: So we're talking about how to teach the deeper logic system that you're working within and understanding that the bird and all birds manifest that system?
- S: And that's with GC. That's what it is able to do extremely well, it is able to show you immediately what that is. Now, we're finding that because of that, it forcing us to have a different perspective on a whole range of software, and we're finding that more and more. We're actually building our own tools within even more stripped down interfaces. So, we don't necessarily even need a symbolic view of it because all of the associations are embedded within the author. It's sort of embedded within the individuals. So that means that, you know from my standpoint, I have to convey that to others within our office to be able to build and work through that.
- L: And to communicate that deep logical structure to others what do you use? How do you use it if you can now reject the symbolic view?
- S: It's recorded within the code. So, it means that one has to be able to speak that language. And you're looking at a very small percentage. Because what's happening

today a lot is that people pick up code, and they fiddle with it and manipulate it but they really don't understand how it's built. And from my stand point, I'm a bit suspect of all of that because they are never going to be able to move to the next level that's beginning to ask more and more of the things that we are creating. So, what's happening is that it becomes very easy to begin to identify those who have just coopted a script from someone and not really built it or finessed it, because it's really extremely superficial. I mean, you can begin to break it down. There's like maybe five different typologies that were pieces that were built up mostly from people from MIT and a couple of other places, and you know, they're not necessarily claiming it because the hopes would be to put it onto the world, people will advance this and its open source. That's what we're really trying to promote within the institution. It has been extremely difficult because ideas and identity are very fragile. But I've given up on the idea of the offer of any individual a long time ago. Just like I've seen the rewards of collaboration. I've seen a willingness to put content out there. You know, any software developer needs an army of individuals and contributors but from my standpoint, it's been extremely open source.

When we start to talk about manifesting stuff into the real world, the problem is the pressure of an investment with geometry. It's a big of pressure. I see it as a good pressure. You'd be surprised of the inability of an undergraduate student or even a graduate student to do basic trigonometry...I mean, it's not practical math for the most parts. But it's forcing us to begin to question the educational process and could we go back in the beginning and run analog exercises in anticipation of the arrival of the digital. In such a way that if they were in a position to pick up scripting, it would

become much easier for them—starting with 17-, 18-year-olds. Re-tooling how we educate could a much more facile workforce. Meaning that, having individuals that have a much more sophisticated understanding of the computer up to this point, which would allow them pick up and run away with any type of software.

- L: And here again, it seems that we're returning to Aish and his idea about the way people learn in trying to create a bridge perhaps between people who comfortable with scripting and people for whom it's not quite so natural. I've had conversations with people about this, and the general view I get is that you just can't substitute for coding. You have to go back to being a programmer. These are people who are more anti-GC, but basically they argue that the attempt lay any kind of representational tool on top of the code doesn't work in the end because you keep restricting the code in order to do that. But, it sounds like you're saying these representations have to happen because we just don't have the workforce that has the facility with code to be able to support a different mode of working...
- S: I think there are some individualist that are absolutely amazing at scripting and understanding the procedural logic of scripting, their brain just absolutely locks into it. They can retain information. I mean that's what makes a good programmer –the ability to walk back multiple steps. I'm talking like going back 10,000 lines of code and understanding how those could begin to relate. I think it takes a very special individual.

But let me just tell you something from the anti-GC crowd talking about the purity of the code, and then the ones who lay interface on top of code. I think it's a very romantic idea to think that one should build up from Visual Basic or any of the

C languages some thing that has the levels of aspiration that we're projecting into 5 to 10 years from now.

In our case, we've had an opportunity to approach design at a multitude of levels. It's almost in an industrial design level where we've been a bit more vested in coupling design with computer driven manufacturing techniques. FloraFlex does this. The design functions at multiple scales. And to be able to manage that degree of information, if we just break that down to small-medium-large scales, it's something that we're going to have to be able to do for whole buildings, but we don't yet have computational power to deal with that, and so there's two different routes and relationship for that. Part of the problem within GC is that it cannot manage because of its premature engine, millions of components. So, we moved to another software just because it could manage the information much better. But we're working blindly so we don't have the immediacy of really sculpting the pieces and we have to be a lot more attentive to the moves that we're making. So, that's really one of the nice things about GC is that even though you have specific character set, it would be very easy to jump in and change their wardrobe. Wherein in Rhino, which is Visual Basic, it becomes almost difficult to do things like that.

It becomes a matter of how the processors are actually utilized in the program. And it really breaks down into this problem that within procedural process if we break down two different ways of computing information and we look at rendering for example. We have field of vision and that field of vision can then in turn be broken down into smaller squares. I can take out one of those smaller squares work on it and put it back where you found it. So, if I have 32 boxes, I could have 32

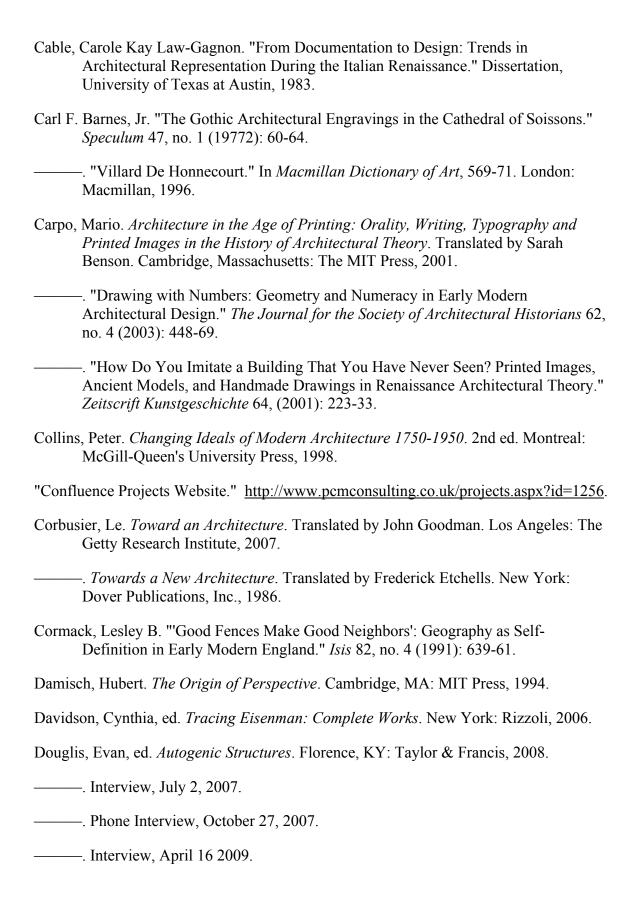
processors. And I can do that relatively quickly. The difference is that within a parametric problem, it's procedural so I can't take line 150 and work that up and put it back. Someday we will be able to, but no one's going through the effort of really devising the subsystem that would be able to manage that type of information. So now, even if I have 16 processors, it's only going to use one.

Because they develop their own software, the videogame industry is really driving a lot of how processors will be used. I mean they have developed RenderMan. But they released that, but it's like the tools they develop are so specific and that's what's happening within architecture industry...we're not going to our tools from the movie industry anymore. I mean, that was part of 1999-2000. But what we really benefitted from was their light systems. And what's happened is that with the introduction of that, it allowed once again two communities to come in to have a conversation. You have a massive knowledge base because of a relationship with the photography community, and if I want to begin to understand my shutter stop in relationship to aperture, I can go onto a photo blog and take that knowledge base and bring it over with me. But now I think the ones that we're going to be learning from are the interface designers.

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