/* {*Matthew Bitterman*}*/

*/ /{*Arch. Portfolio; Updated 2011.02.19*}

::000_Portfolio::

/* Projects 2007-2011 */

fig.0001 starch 3d prints showing different member parameters across the same surface.jpg

::000_Portfolio::

/* Projects 2007-2011*/

/*2011.02.21*/

::000_A::

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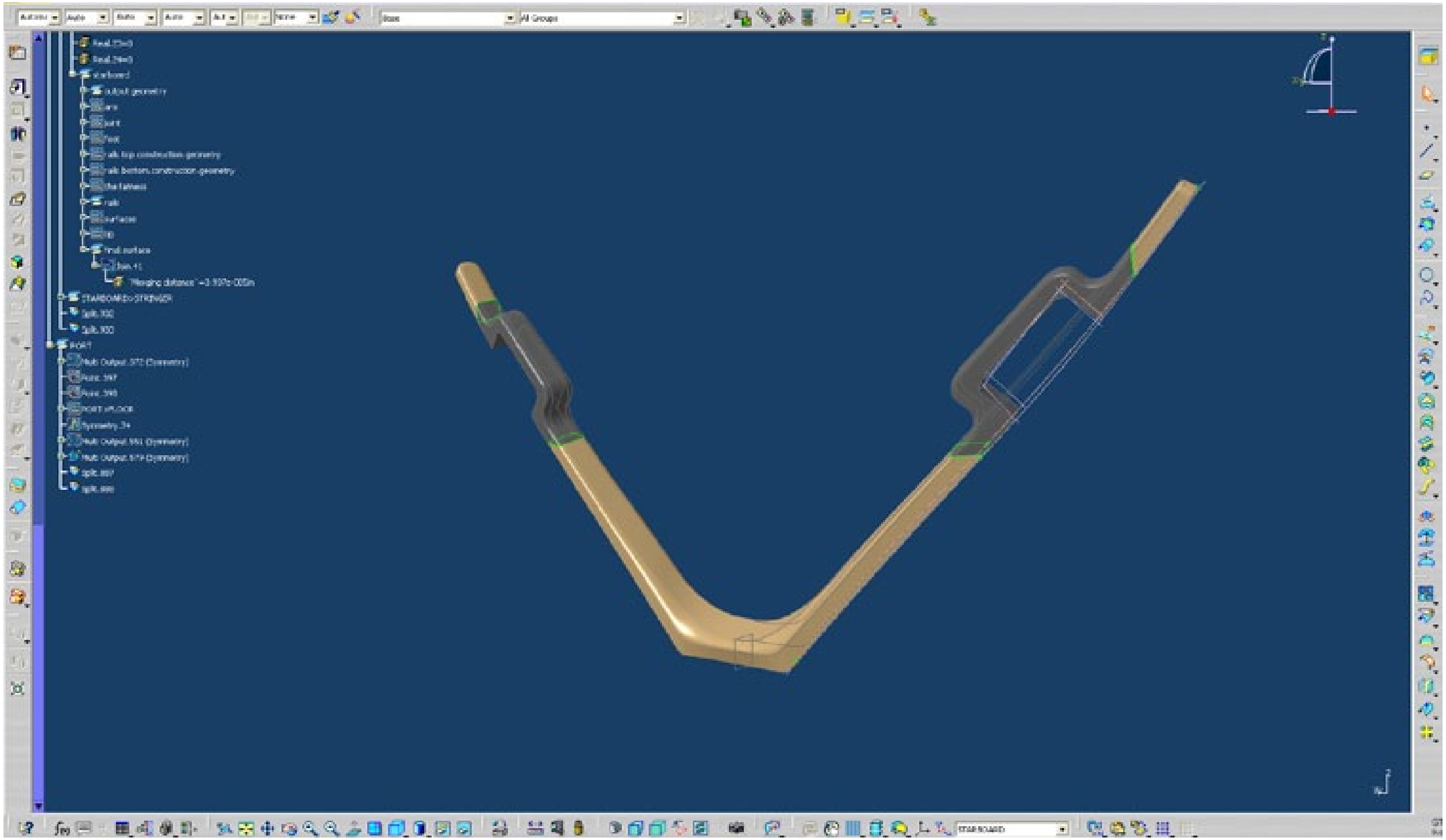


fig.0002 dp floor definition model with stringer-hoppers.jpg

::000_A::

//* {*Parametric Bronze Floor Castings*}::

//{2010.12.08 ~ Professional Work : Loisos & Ubbelohde}

fig.0003 shireen in restoration.jpg

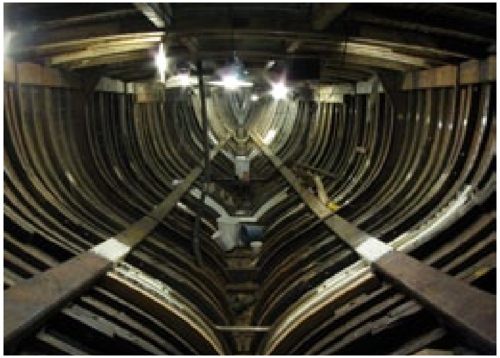


fig.0004 shireen interior ~ looking forward.JPG

fig.0005 shireen interior ~ looking aft with new floor casting.JPG

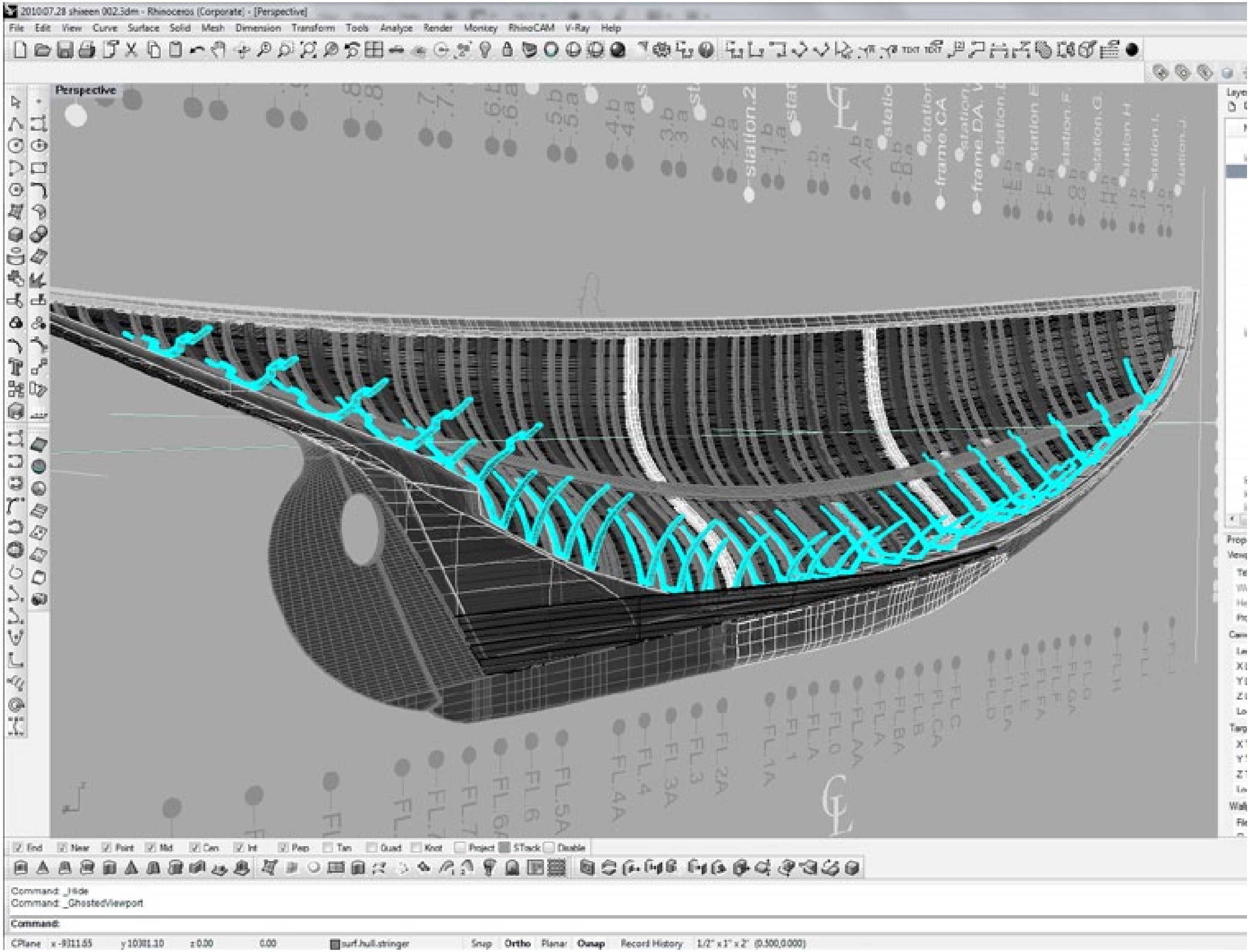
Shireen is a 51' Frederick Shepherd designed ketch wooden boat, built by Camper-Nicholson Yachts in the south of England 1934. Shireen's teak planking on oak frames have twice been around the world, and across the Atlantic 9 times. I was actively engaged in her restoration from June of 2009 to January 2011.

One of the larger components of Shireen's restoration was the bronze casting of 36 different structural members along the keel, known as floor members. Traditionally these members were individually wrought of iron to fit the boat, and then hot-dip galvanized to prevent corrosion. Over time, the salty air and pooling bilge water wasted away the iron, which is traditionally replaced with bronze during restoration. The task at hand was to cast 36 new bronze members to replace the iron components, no two of which are the same.

The traditional process for sand casting requires making a positive pattern for each component, against which foundry sand is packed creating a negative, compressed-sand mold to pour the molten metal into. The owners had previously completed four of these components, and each pattern took them almost a month to complete, and then cost over 2000$ to have a foundry make the molds, and cast the bronze.

This traditional patternmaking process consists of measuring the boat precisely for the final desired dimensions, scaling these dimensions up to accommodate the contraction allowance (or shrinkage bronze incurs when it solidifies), and then building/carving/shaping/sanding/painting the pattern to make a 3d positive model of the desired component. This pattern would then be handed to the foundry, and they would begin a process to determine the best way to cast the part. This process includes determining how the part can be drafted (which way the sand can release from the pattern), the best strategies to make the mold, and determining the proper gating/risering arrangement - tubes and reservoirs that allow the liquid metal to both quickly fill the mold cavity, and compensate for uneven shrinkage distribution during solidification. It can take many iterations to determine the correct gating arrangement for each component, depending largely on the complexity of its geometry and size of the part.

It quickly became evident that the project was of a scale that could payback investments spent in process engineering, so figuring out a faster and more economical way to produce the components was of the essence. The first step was to internalize production by building our own foundry, and the second, employing digital technologies in the process.



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Command:
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fig.0006 shireen section ~ showing the 36 discrete floor members along the keel.jpg

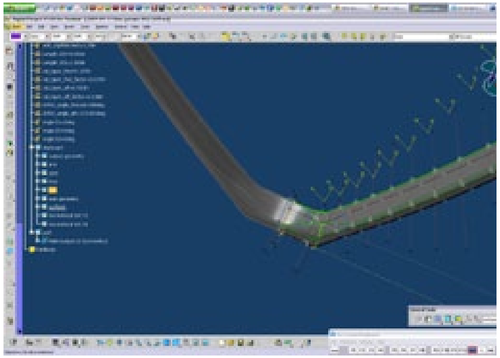


fig.0007 dp floor model ~ defining the arm geometry.jpg

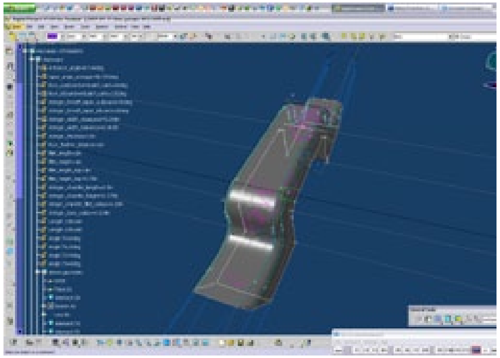


fig.0008 dp floor model ~ defining the stringer-hoppers.jpg

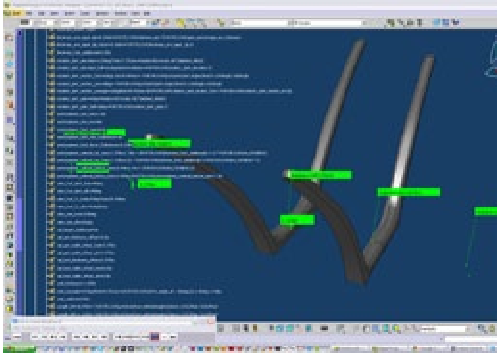


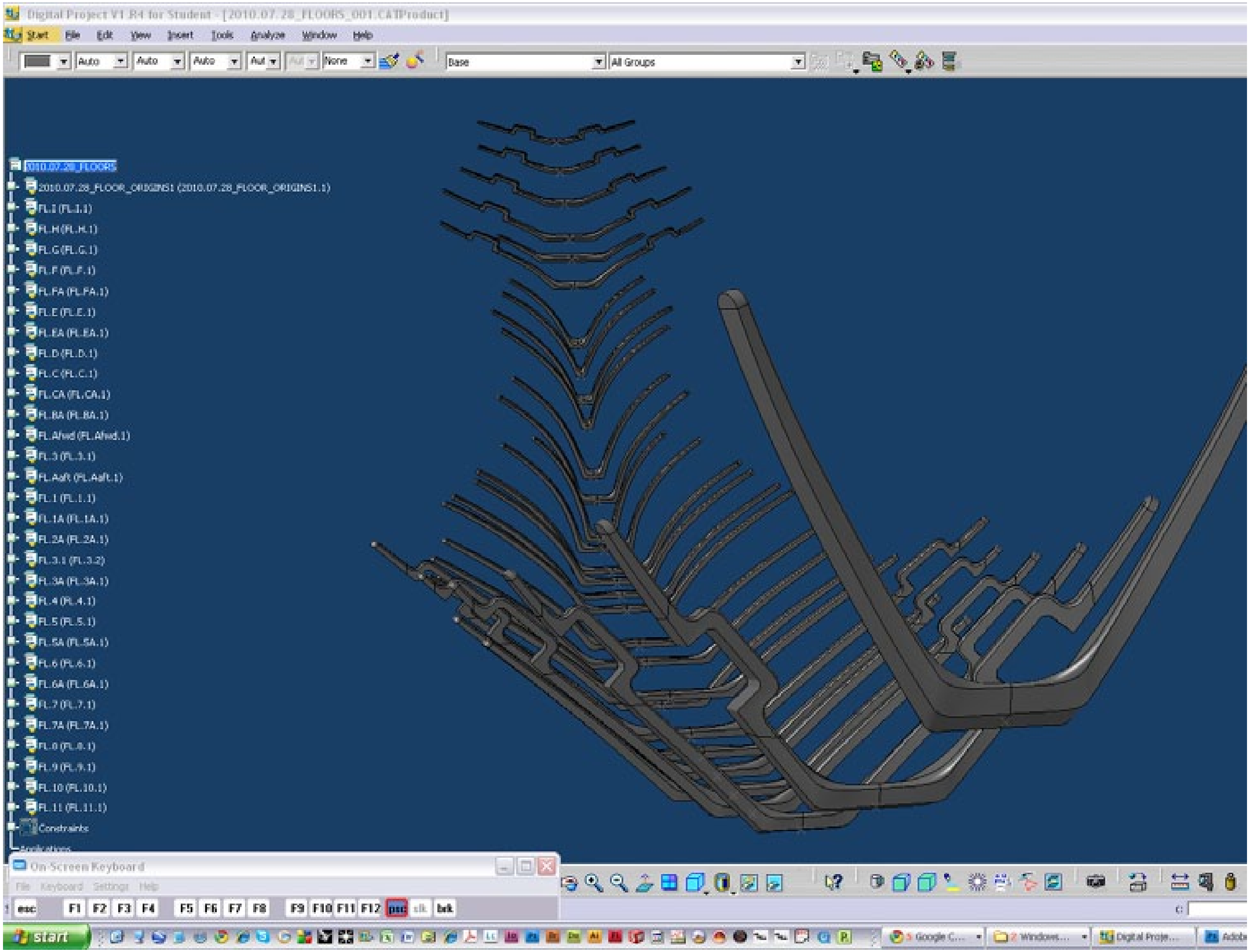
fig.0008 dp floor model ~ spitting out volumetric data.jpg

A parametric model was created for the basic genetic coding of the members, which defined relationships for the following: a basic structural diagram distributing the mass, scaling up the iron to a softer silicon bronze, creating draft angles on all sides for molding in sand (release), creating flat planes for the bolt-head locations, and other geometric/aesthetic criteria. The definition was then instantiated into the measured geometry for each location throughout the length of Shireen. Using the parametric definition not only saved from having to model each component individually, it ensured the components would all follow the rules necessary for casting and structural integrity, while sharing a kindred aesthetic. Having everything parametrically controlled allowed for changing the rules, geometry, aesthetic criteria, or thicknesses downstream - for all the components simultaneously. The models also easily fed back volume distributions, component weight, and drawings for the owner's review.

Significant savings are made in the process of mold-making simply by virtue of having the floor geometry defined digitally. Rather than producing a free component in-the-round, one can produce two half-patterns mounted on a board (in relief) called a match-plate, which speeds up the molding processes significantly. The gating & risering design can then also be drawn digitally in the computer based upon volumetric distributions etc., and incorporated directly into the half-patterns, resulting in a complete model of the casting cavities and precise data on how much weight/volume was necessary to cast the part. The product of this is two perfectly registered and drafted half-patterns that can be easily used to ram the sand molds against.

The final and most critical part of this project was the switch from making traditional wood patterns to milling the sand molds directly on the CNC router. Please see "milling sand molds" for a more complete description of this process. This step alone saved the project thousands of dollars in labor and material costs by eliminating the need to produce positive patterns altogether, as well all of the associated waste. The digital form is simply inverted into negative geometry and milled from solid billets of resin-bonded foundry sand, into which the metal is cast.

What has been outlined by this project is a process that could be scaled for the mass-customization of metalcastings, which I believe is without precedent. In this particular project there was a lot of long-handed digital design dealing with the gating strategies and the complex parting lines of the various components, however I believe these things could be parametrically defined and automated to production given greater resources & time quite readily.



Digital Project V1 R4 for Student - [2010.07.28_FLOORS_001.CATProduct]

2010.07.28_FLOORS
2010.07.28_FLOOR_ORIGINS1 (2010.07.28_FLOOR_ORIGINS1.1)
FL.I (FL.I.1)
FL.H (FL.H.1)
FL.G (FL.G.1)
FL.F (FL.F.1)
FL.FA (FL.FA.1)
FL.E (FL.E.1)
FL.EA (FL.EA.1)
FL.D (FL.D.1)
FL.C (FL.C.1)
FL.CA (FL.CA.1)
FL.BA (FL.BA.1)
FL.Afwd (FL.Afwd.1)
FL.3 (FL.3.1)
FL.Aaft (FL.Aaft.1)
FL.1 (FL.1.1)
FL.1A (FL.1A.1)
FL.2A (FL.2A.1)
FL.3.1 (FL.3.2)
FL.3A (FL.3A.1)
FL.4 (FL.4.1)
FL.5 (FL.5.1)
FL.5A (FL.5A.1)
FL.6 (FL.6.1)
FL.6A (FL.6A.1)
FL.7 (FL.7.1)
FL.7A (FL.7A.1)
FL.8 (FL.8.1)
FL.9 (FL.9.1)
FL.10 (FL.10.1)
FL.11 (FL.11.1)
Constraints
Applications

fig.0010 dp floor project file ~ all floors looking aft.jpg

fig.0011 the chimp milling the drag half of a floor mold.JPG

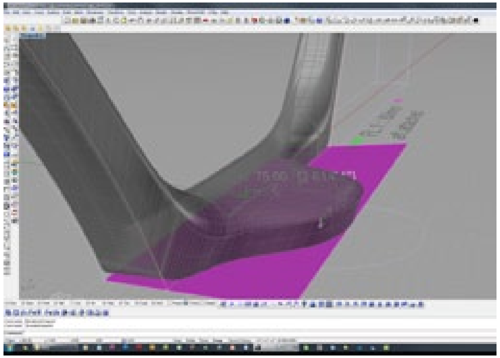


fig.0012 floor foot blobs for picking up keel bolts.jpg

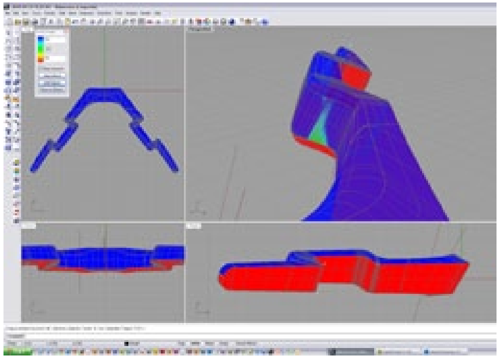


fig.0013 rhino draft angle analysis tool with parting line.jpg

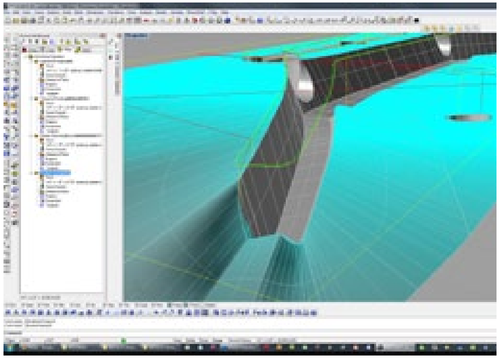


fig.0014 rhinocam toolpaths for milling sand billet.jpg

fig.0015 complete milled silica sand molds for a floor component.JPG

fig.0016 milled olivine sand mold for small floor member.JPG

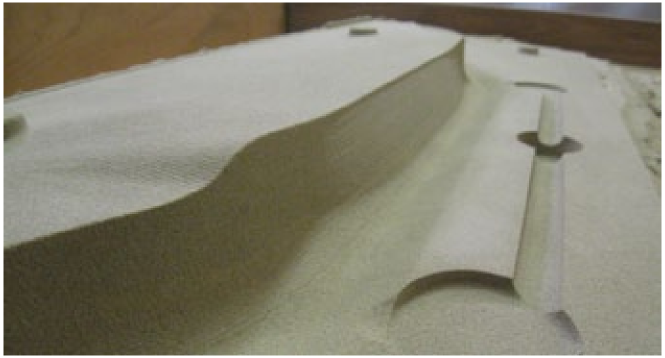


fig.0017 surface texture detail ~ milled sand floor mold.JPG

fig.0018 casting bronze at the loisos & ubbelohde foundry ~ image credit will clark .jpg

fig.0019 raw casting with gating & risering ~ fl.3a .jpg

fig.0020 raw casting with gating and risering ~ fl.7a.jpg

Using this process, myself and one collegue were able to cast all 36 members in two months flat, at a rate of nearly one component per day. Prior to implementing this process, producting one per week would have been fast. In total, we cast 1,800 lbs. of bronze into 16,500 lbs of sand. I expect these efforts to have saved the project tens of thousands of dollars in materials and labor costs, in addition to funding the building of a foundry, saving truckloads of material waste, and making possible the production of higher quality, more beautiful components in a quarter of the time. ~

fig.0021 chased & completed casting ~ fl.3a.jpg

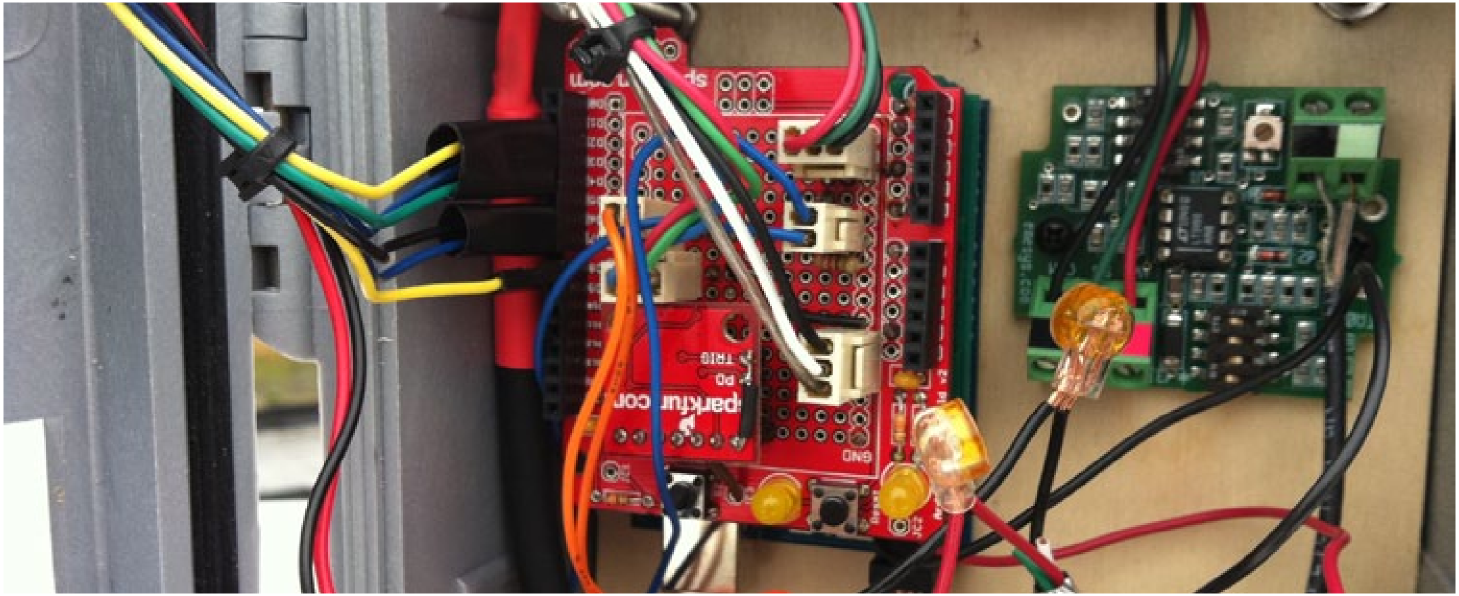


fig.0021a weatherstation aduino wiring.jpg

::000_B::

//* {*FROG Building Monitoring System*}::

**//{2011.03.02 ~ Professional Work : Loisos & Ubbelohde}*

{Clients} ::
Project FROG, San Francisco Redevelopment Agency (SFRA) at Hunter's Point Shipyard, Golden Gate National Parks Conservancy at Crissy Field, Loisos & Ubbelohde Architects (In-house Development)

{Loisos + Ubbelohde Credits} ::
Electrical Engineering :: Matthew Bitterman, David Sheer
System Hardware Architecture & Fabrication :: Matthew Bitterman
Software Coding & Server Architecture :: Santosh Philip, Nathan Brown
Building Dashboard Design & Programming :: Nathan Brown, Ibone Santiago
WeatherStation Sensor Programming :: Chris Human, Elliot Nahman
WeatherStation Wiring & Calibration :: Chris Human
Peripheral Hub Engineering & Design :: Matthew Bitterman, David Sheer
Installation :: Matthew Bitterman, Nathan Brown, David Sheer

{Consultants} ::
Controller Hardware Consultants :: Ken Brown, Shawn Brechbill of AMX
Arduino Coding, Processing :: Elliot Nahman

{Contractors} ::
Contractor @ SFRA :: Alten Construction, C. Ray Green Jr. Superintendant
Wind Turbine Contractors @ Crissy Field :: Reinhold & Ziegler
Solar Contractor @ Crissy Field :: Luminalt Energy
Electricans @ SFRA :: Decker Electricians Andrew & Russ, Matthew Bitterman
Electrican @ Crissy Field :: Dion Flynn

{Team at Project FROG} ::
Ryan Olson; Product Design Engineer, Teddy Mekuria; Product Engineer, Craig Hamburg; Product Engineer, and many others.

fig.0021b frog san francisco redevelopment agency building. photo credit: project frog.jpg

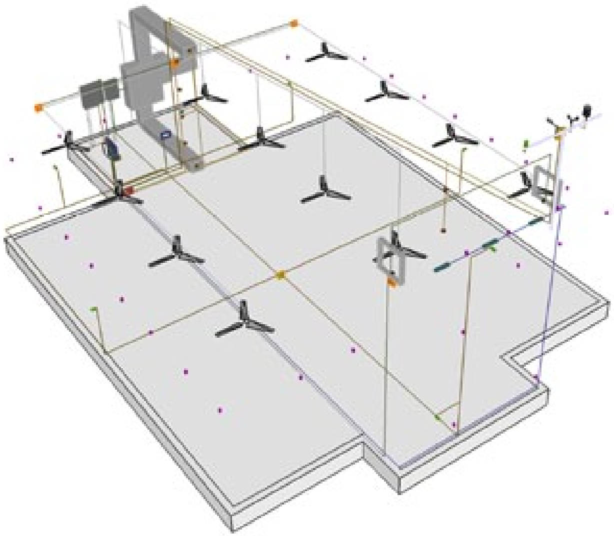


fig.0021c monitoring system diagram, ventilation module. drawing credit - david sheer.jpg

Energy mandates have placed increasing demand on all aspects of building performance and the green movement has solicited the integration of a plethora of new products, systems, and accredidation requirements that remain largely unmeasured, tested, or monitored over time.

Project FROG is a prefabricated, modular classroom designed closely with Loisos + Ubbelohde as energy and daylighting consultants, to produce a 'net-zero' energy building which is designed and produced as an architectural product; dozens have been and continue to be built throughout the United States. Loisos + Ubbelohde worked with Project FROG to develop a building monitoring system that could be integrated into every building they produce, in order to verify actual building performance, as well as automate optimization functions. Sensor arrays are organized throughout the building to provide data points to track energy use, system performance, heat distribution, and variables related to occupant comfort.

Internally at Loisos & Ubbelohde we produced a graphical dashboard to display building data, and all of the software architecture necesssary to database information from many buildings, through a cloud server accessible remotely. The system is capable of integrating building controls and actuation (windows, fans, shades, air handling, etc.), such that, the data archives can be mined to automate buliding systems and optimize performance or meet occupant's personal preferences. The conceit is to give these buildings brains of their own, and there is no system on the market capable of integrating sensor networks, databasing, and automating systems based upon optimizing performance and occupancy comfort... which is why we did it ourselves.

I was responsible for the electrical engineering and system hardware architecture, as well as the prototyping, staging, development, and installation of the first two systems. Each system deploys over 40 sensors in a variety of locations and configurations depending on the monitoring package chosen, including temperature sensors, relative humidity, water & gas metering, C02, wind direction, wind speed, solar radiation, solar hot water, rain gauges, barometric pressure, occupancy sensors, and current transformers to monitor electrical consumption or production of all circuits.

In addition to the clear initial benefits of verifying & optimizing designed building performance, the system will serve as an invaluable platform for continual research in building science. The data will be gathered and archived from virtually the same building in climates zones across the United States, and the scale of the building is such that the variables affecting performance and comfort are distinct and few in number.

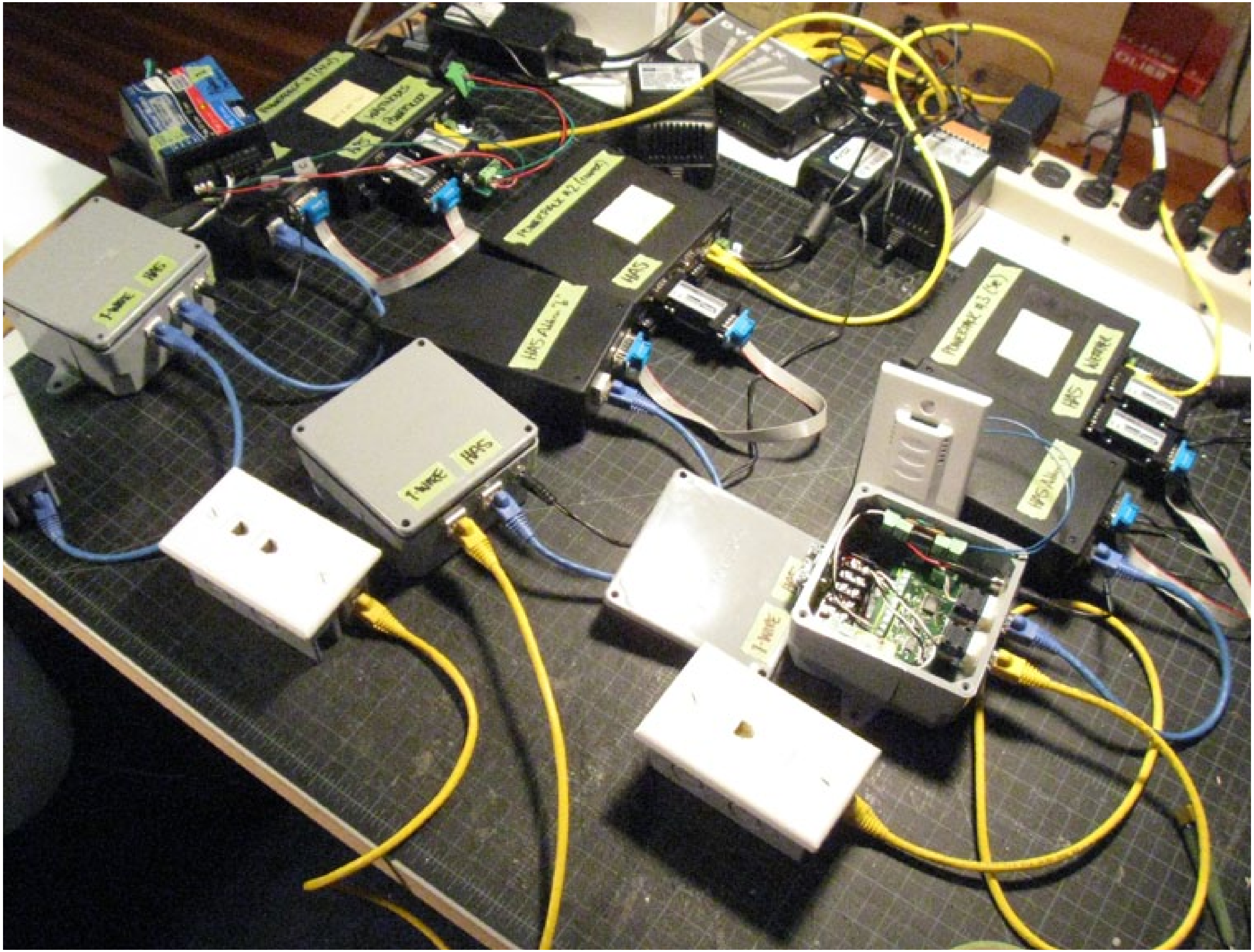


fig.0021d staging a 3-module monitoring system.jpg

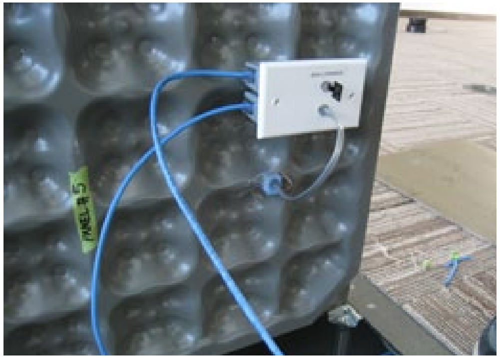


fig.0021e underfloor air plenum sensors.jpg

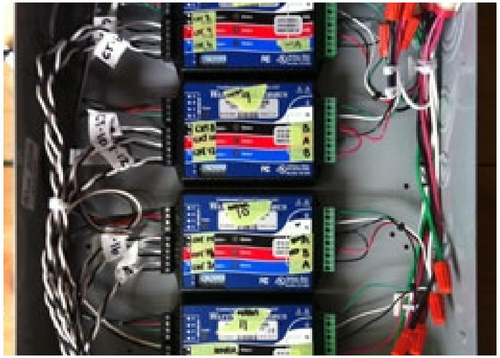


fig.0021f electrical circuit monitoring hubs.jpg

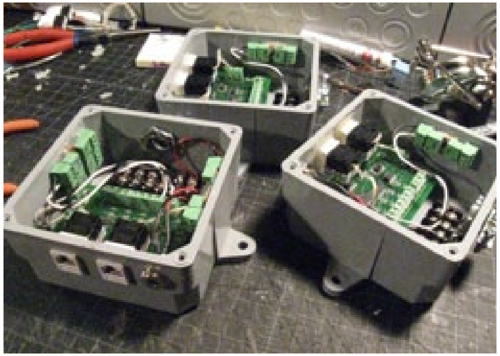
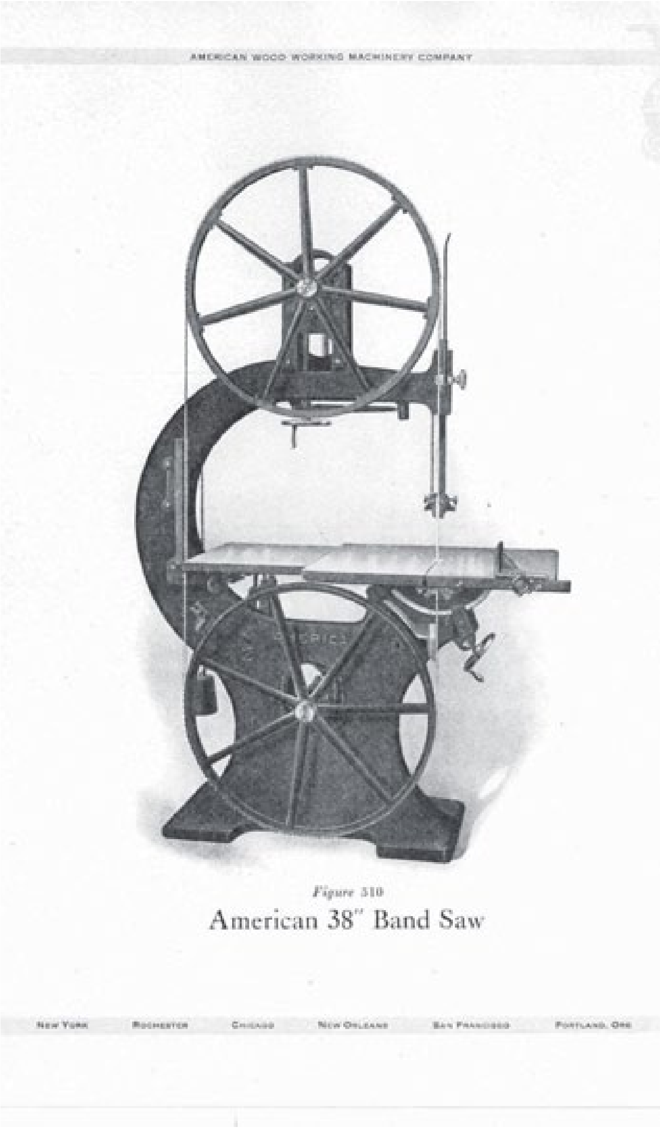


fig.0021g one-wire network digital & analog sensor hubs.jpg

fig.0021h research-grade weatherstation installed.jpg



AMERICAN WOOD WORKING MACHINERY COMPANY

Figure 510

American 38" Band Saw

NEW YORK ROCHESTER CHICAGO NEW ORLEANS SAN FRANCISCO PORTLAND, ORE

fig.0022 american machinery company 36in bandsaw.jpg

::000_C::

//* {*Bandsaw Iron Castings*} ::

//{2010.11.20 ~ Professional Work : Loisos & Ubbelohde}

Design :: Matt Bitterman, George Loisos
Foundry :: Matt Bitterman, Mike Feeny, George Loisos,
Special Thanks to: Tom Fox, Kyle Milligan, Darren Cockrell & Diablo Valley College

This project represents the first phase of restoring a 1930's 36" bandsaw made by American Machinery Corporation, for the Loisos & Ubbelohde boat shop. It is a large cast iron machine with a pivoting table that was lost in a move, so we set about designing and casting a replacement for it along with a series of supporting components.

The table was designed in Digital Project parametrically using the solid modeling tools for a variety of subtle but important reasons. One such concern was that the center of mass of big 300# table needed to be located directly over the pivot point so a human could lift it. This was made a little more difficult because the table itself was necessarily asymmetric based upon the blade location, mortising fence track, and joint with its sister table. Another was the need to have all the vertical surfaces drafted (angled) for releasing the pattern from the sand during the molding process, which is actually really easy to do in Digital Project and allows these things to be redefined and updated downstream. It was also important to continually be able to change the designed thicknesses based on feedback from the total weight/volume of iron that would be required to pour the components, as there were tipping points regarding how much metal we could heat and pour within an acceptable time frame necessary to cast the parts. After design the the patterns were CNC routed and meticulously coated, and prepared for molding.

The cupola-casting of iron (especially in an art foundry) is a pretty crazy process compared to crucible casting - it is mayhem - metal is flying everywhere, people are everywhere, and the pouring temperatures are much greater than that of bronze or aluminum foundry work (around 3200ºF +). The high side is the process yields a whole lot of cheap metal really quickly - the cupolas we were using put out about 120# of hot iron every 7 minutes. It is sheer chaos until the last mold is poured off or the iron runs out.

From a design perspective grey iron has a smaller contraction allowance compared to bronze, however is prone to heat distortions, slag inclusions, and other inconsistencies that should be considered in the design of the gating systems in particular. Keeping the cupola running smoothly and consistently is also not a given for a variety of reasons and some taps of metal can be very hot, others quite cool, and there tends to be a lot of impurities in the metal as a result of sourcing it by breaking up old pipes and bathtubs.

This was actually a really challenging project due to the sheer scale and weight of these castings, and working with cupola casting and art foundry made things much more difficult. The sand molds from the large table alone weighed 1200lbs; we had to do the molding under a crane so we could lift and flip the 600lb half-molds. The iron kids from San Diego had to drive up a quarter-ton capacity bull-ladle just to pour the large casting, it was really an all-out effort.

We ended up nailing and all the components on the first try, and also the smaller half of the tabletop with only minor defects (still an 125# casting!). We lost the huge mold because we were not able to keep the iron hot enough in the bull ladle, which was a disappointment. The pattern however I believe is in route to an iron conference in New Mexico; there is a group of iron kids that want to see if they can cast it.

The raw castings of the tabletop will be heat-treated to relieve internal stresses created during the solidification process, and then blanchard-ground flat to a ten-thousandth's of an inch tolerance before installation on the saw. The two-part tabletop will weigh 455lbs in grey iron, and measure 40" across.

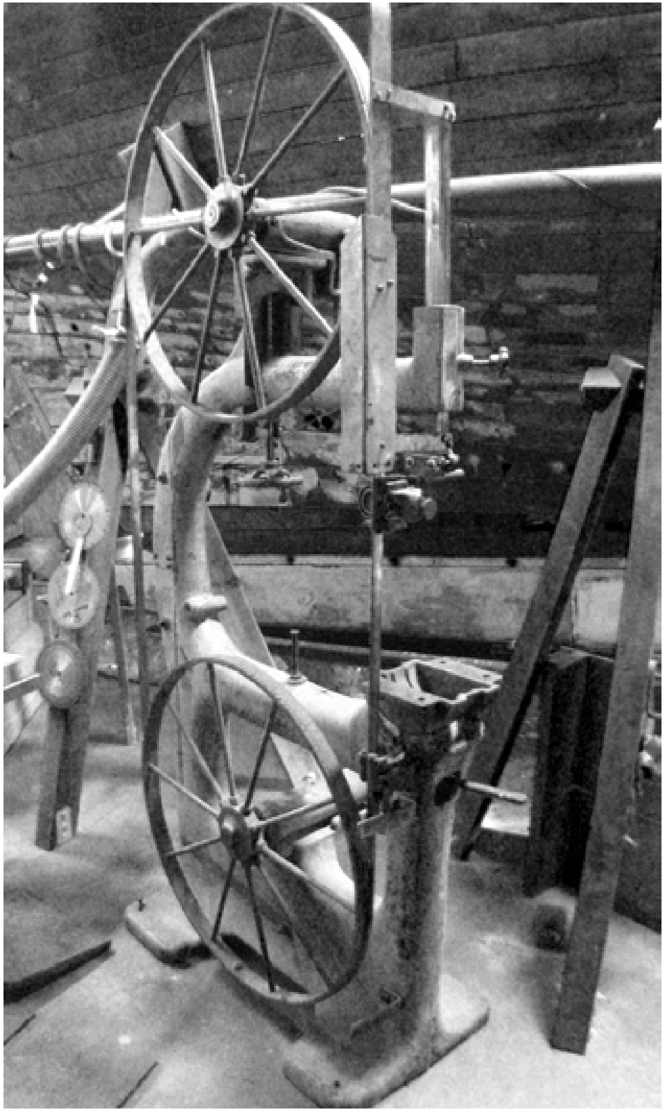


fig.0023 the bandsaw.jpg

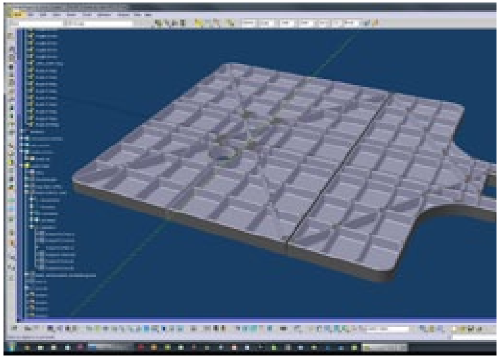


fig.0024 dp table model ~ iron coffering underside.jpg

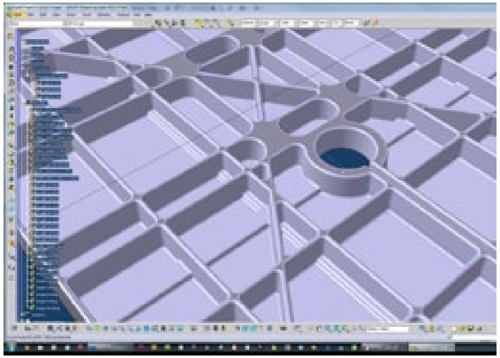


fig.0025 dp table model ~ underside detail.jpg

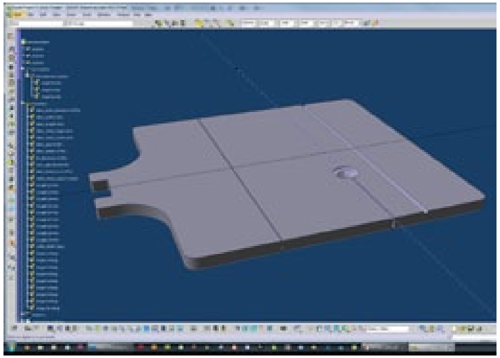


fig.0026 dp table topside.jpg

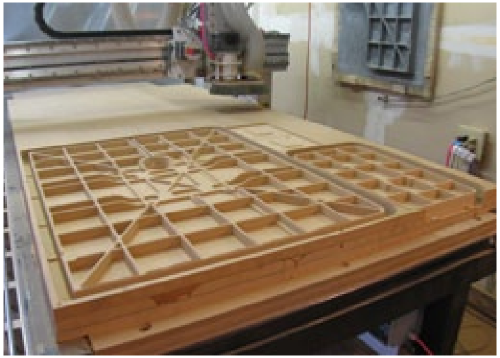


fig.0027 milling table patterns.JPG

fig.0029 table molding.jpg

fig.0028 table molding with crane.jpg

fig.0030 sand mold cavity detail ~ bandsaw table.jpg

fig.0031 cupola iron casting, tapping the furnace ~ image credit george loisos.jpg

fig.0032 iron casting, pouring the small table ~ image credit nathan brown.jpg

fig.0033 iron casting, pouring the big half with the bull ladle ~ image credit eleanor pries.jpg

fig.0034 small table raw casting ~ underside.jpg

fig.0035 small table raw casting ~ topside.jpg

fig.0036 sand milled surface.jpg

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//* {*Milling Sand & A Quick Ingot Mold*} ::

*//{*2010.11.04 ~ Research*}

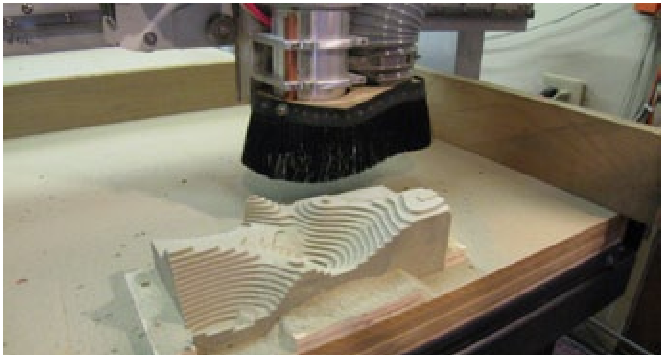


fig.0037 horizontal roughing pass ~ sand milling.jpg


fig.0039 milling sand detail.jpg


fig.0038 milled sand surface.jpg

Background ::

Sand casting has been around for over 5000 years, but has nearly always relied upon a positive pattern, against which sand is compressed, to create the mold cavity. There have been many advances in both patternmaking and moldmaking, however the fundamental process has remained relatively unchanged since the bronze age, relying upon some sort of pattern to make a mold. A single wood or aluminum pattern can produce thousands of molds with care and maintenance, and it is not economically viable to produce and engineer a pattern for the production of one or two components. A component to be sand cast must be designed for both the molding, casting, and chasing processes - drafted for the release of the sand, filleted to aid the distribution of the liquid metal throughout the cavity, thickness transitions thoughtfully coordinated and minimized, re-entrant corners designed to facilitate access to finishing tools, etc. Moreover, the design of the gating (plumbing) used to distribute the hot metal throughout the mold cavity is specific to the volumetric distribution and geometric configuration of each individual component, and must be engineered through software, heuristics, or trial and error.

Abstract ::

If the patternmaking could be eliminated from the process of sand-casting entirely, and castable molds are produced directly from CAM tools, then the opportunity to produce castings in limited production runs becomes an economically viable proposition in addition to the production of families of differentiated components. Volumetric distrubution changes throughout differentiated components can serve as drivers to determine the necessary changes in gating design based upon a proven initial model. Waste in the production of patterns could be eliminated, as would be the time necessary to fabricate them.

Through the construction of a CNC router setup to deal with the invasive and abrasive nature of loose sand, and the testing of different sand-bonding resin chemistry and different types of sand, I was able to deploy a process for the CNC milling of sand molds directly from digital parametric models for the production of differentiated cast metal components.

fig.0041 resin & sand density and resolution tests, with a wrench.JPG

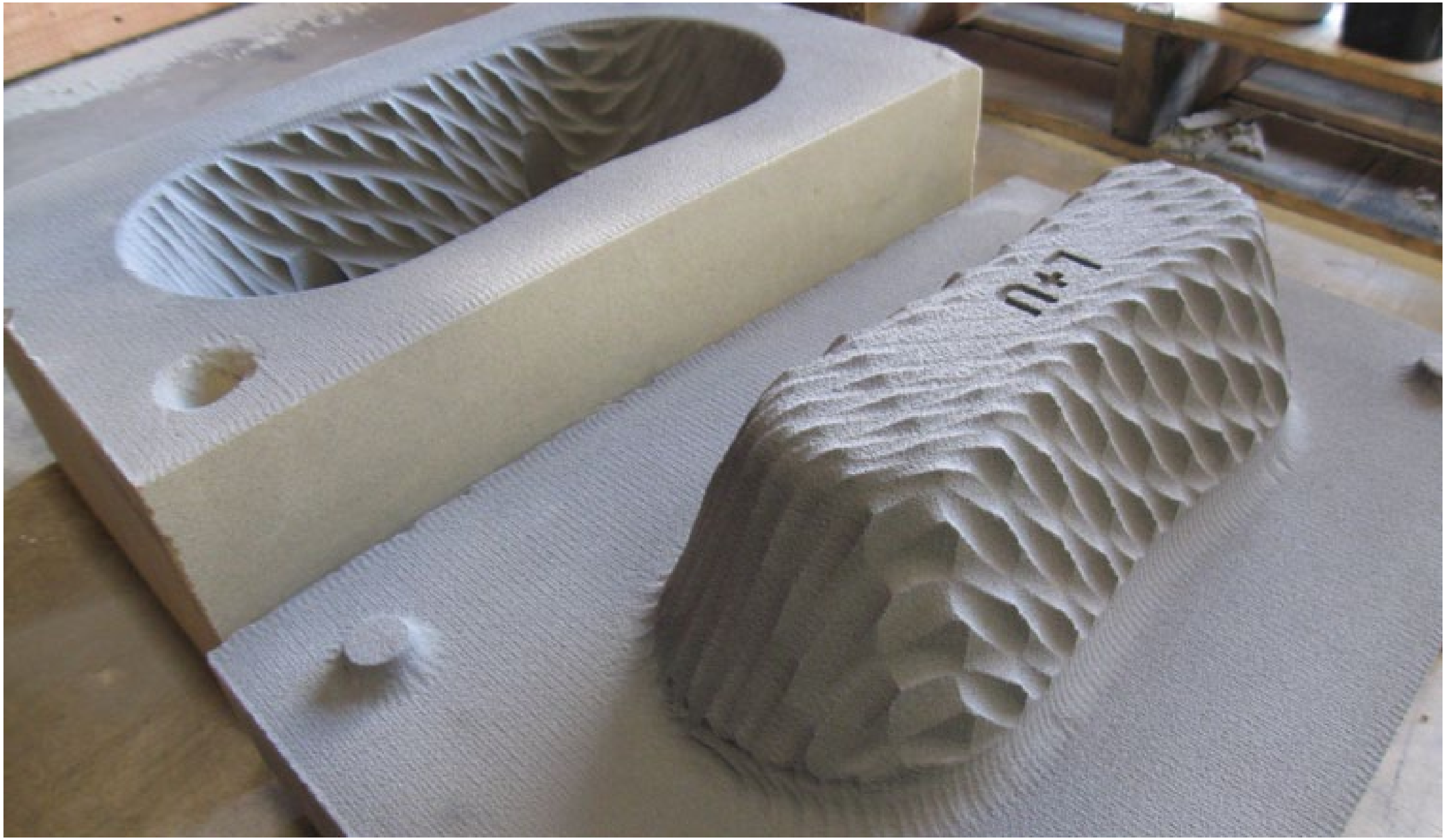


fig.0040 milled sand ingot mold, cope and drag.JPG

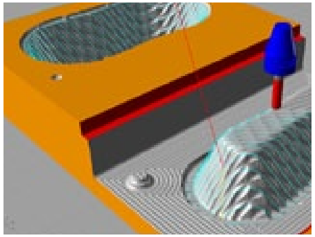


fig.0044 toolpath generation.jpg

Quick Exercise ::
I milled a few ingot molds in an afternoon, that would have taken days or weeks to produce using traditional patternmaking processes, and brought them to an iron pour to cast the next day.

fig.0045 kyle milligan dousing the cupola.JPG

fig.0046 ingot molds, raw casting.JPG

Using this process abnegates the need for draft angles because there is nothing that must be delicately removed from rammed sand, as well as eliminates any intermediary steps between machining and casting, freeing up the design process to express the tooling itself directly inside the mold cavity. I took this to the max (why not) in milling these ingot molds, which turned out a sweet, ugly, & medieval ingot mold... which also makes sweet, ugly, and medieval ingots.

fig.0047 ingots cast using the ingot molds.JPG

fig.0048 the chimpanzee milling trupan MDF.JPG

::000_E::

//* {The Chimpanzee 2010} ::

*/{2010.10.02 ~ Nights & Weekends}

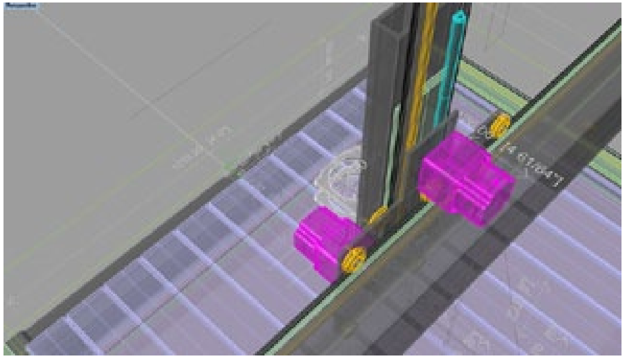


fig.0049 the chimp ~ x-car.jpg

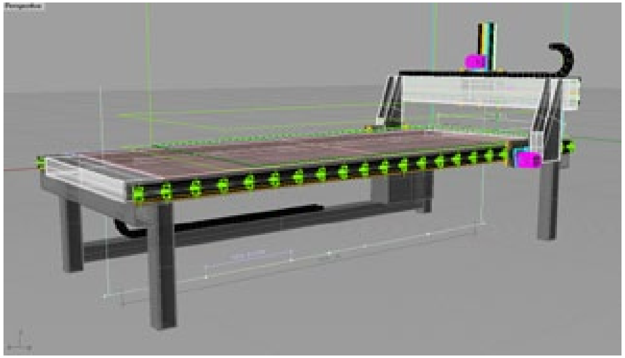


fig.0050 the chimp ~ table design.jpg

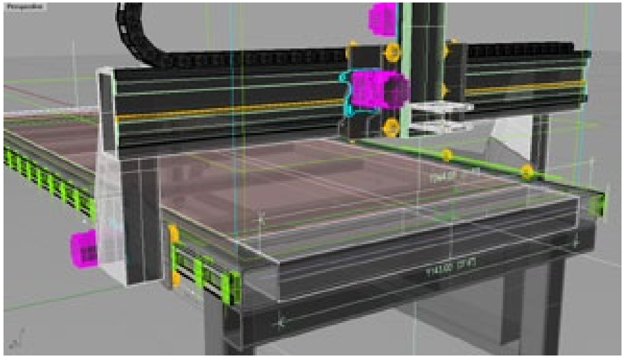


fig.0051 the chimp ~ gantry design.jpg

Designing & Producing The Chimpanzee 2010

The Chimpanzee 2010 is a steel and aluminum 3-axis production CNC router which I designed and built for conducting architectural research, with the added capacity to mill and resist foundry sand. The design was kept as minimal and mechanically simple as possible, while maintaining the ability to upgrade the system for closed loop operation, vacuum workholding, toolholders, etc. whenever I have more money to spend on it.

The take-away from this experience was aquiring the knowledge and skills to design, specify, and fabricate CNC motor driven assemblies in low tolerance applications; embedded computing which can be readily deployed to control just about anything. Coupling physical computing with the increasingly user-friendly open-source programming interfaces or parametric modeling platforms is becoming increasingly easy to do, and holds huge promise for changing both the ways we interact with buildings, and the way in which we make them.

This is a project that would never have been possible without the internet, and the massive amounts of knowledge archived in online forums. The electrical layout of the machine is based primarily on the MechMate CNC router's design, with advice found in the forum archives. After 6 dedicated months of long nights and weekends the Chimpanzee came to life. Thanks are extended to Christian Cutul & Nathan Brown for their many selfless contributions, and to Eleanor Pries for her patience & support.

Specs.

~PK296A2A -SG7.2 Oriental Stepper Motors, 880 Oz. In. Holding Torque, Vexta Series
~Modern Linear VX3 Series Guides, Track, Bearings, and Track Clamps
~Porter Cable 7518 4HP Router
~GeckoDrive 203V Motor Drivers
~Mach3 Controller Software
~Smoothstepper USB Control Interface
~Proximity Sensor Limit Switches, 4 Axes. (Auto-Squareing Gantry)
~48x108x8" Work Area

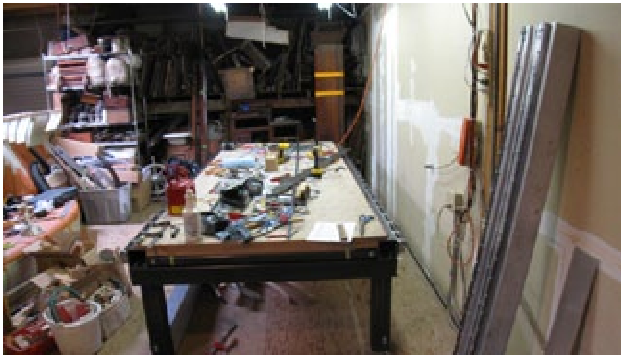


fig.0052 mess.jpg


fig.0053 gantry arms.jpg


fig.0054 nathan & the z-car.jpg


fig.0055 whoops.jpg


fig.0056 gantry wiring.jpg


fig.0057 control box wiring.jpg

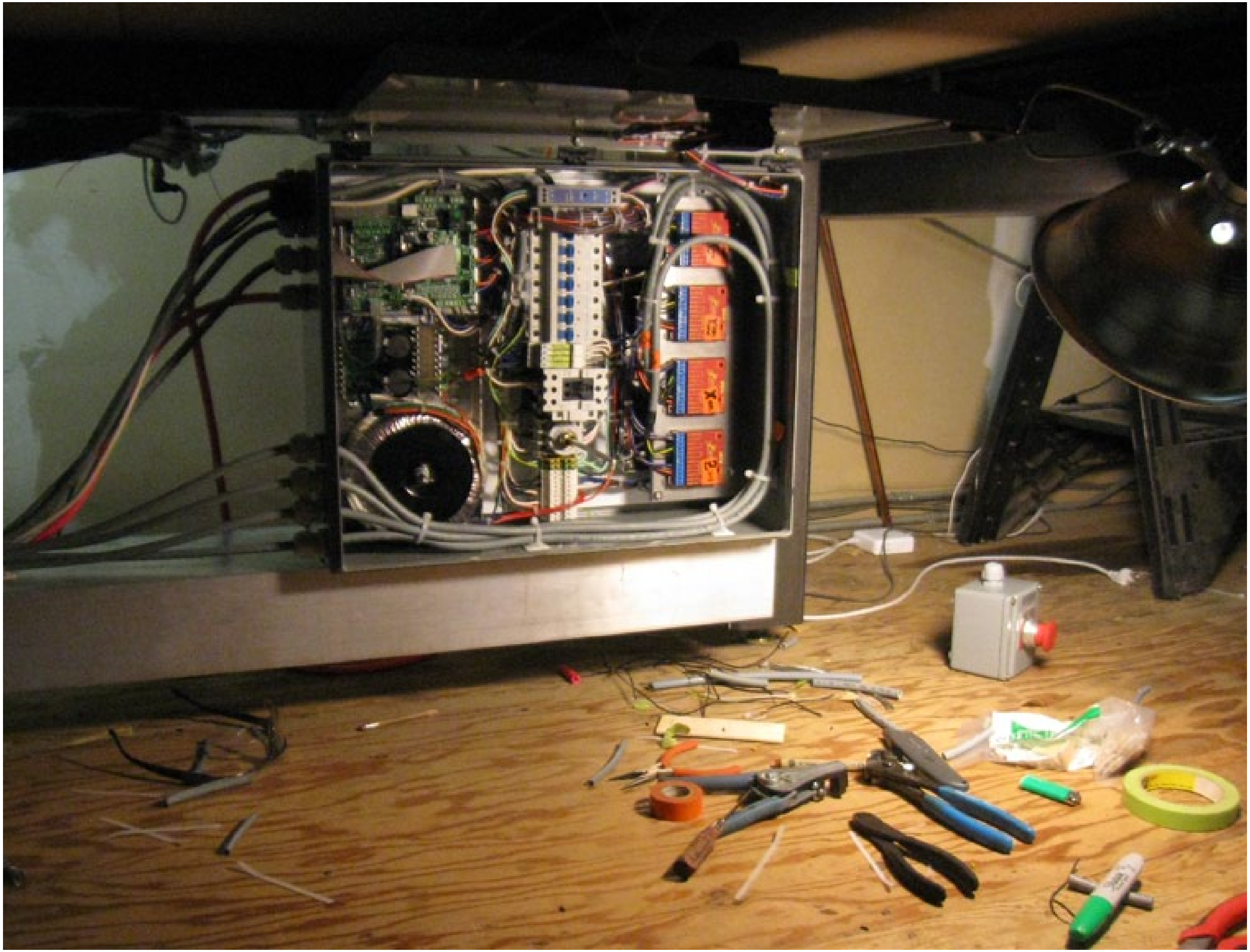


fig.0058 control box wiring.JPG

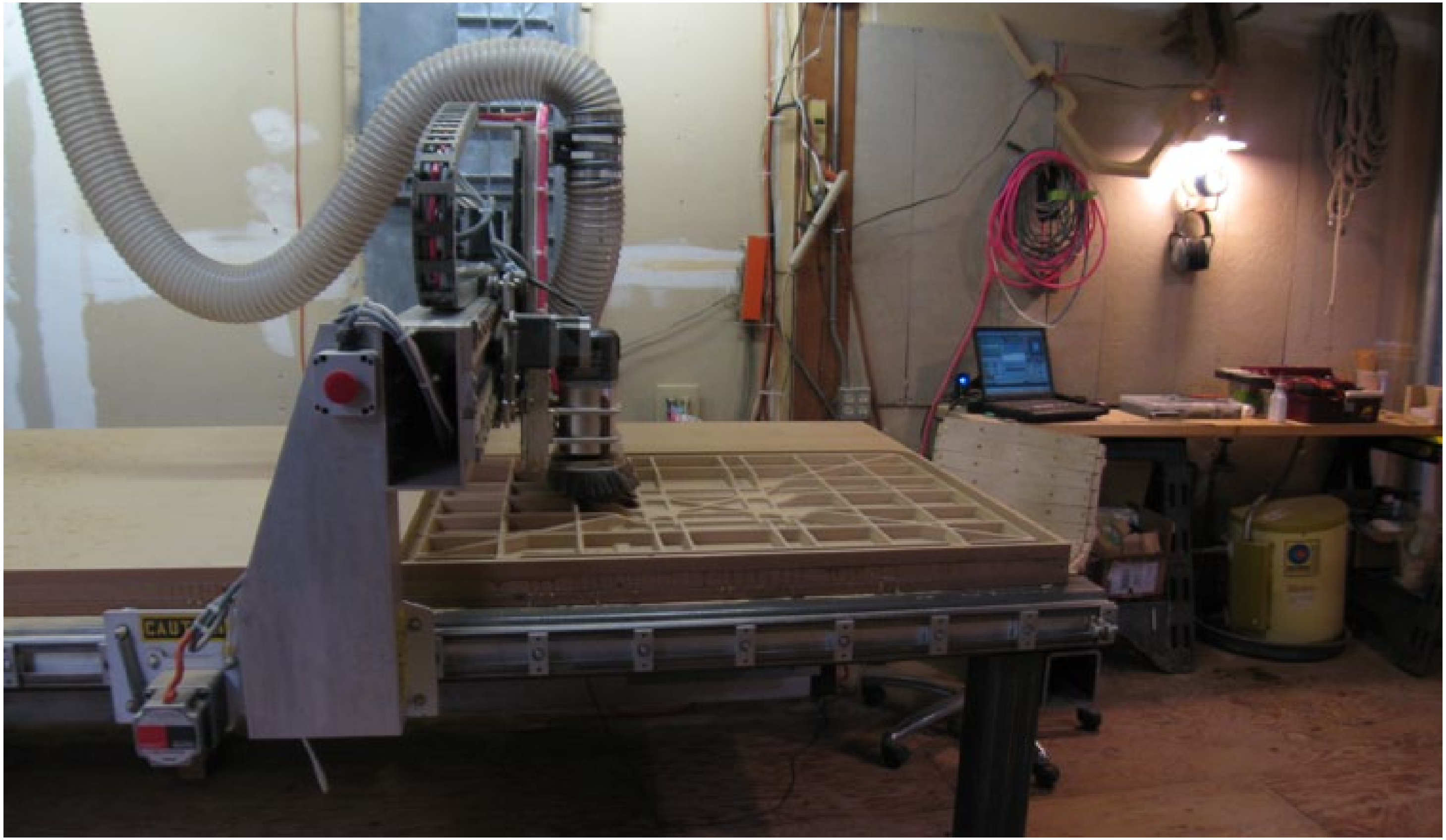


fig.0061 completed chimpanzee.JPG

::000_F::

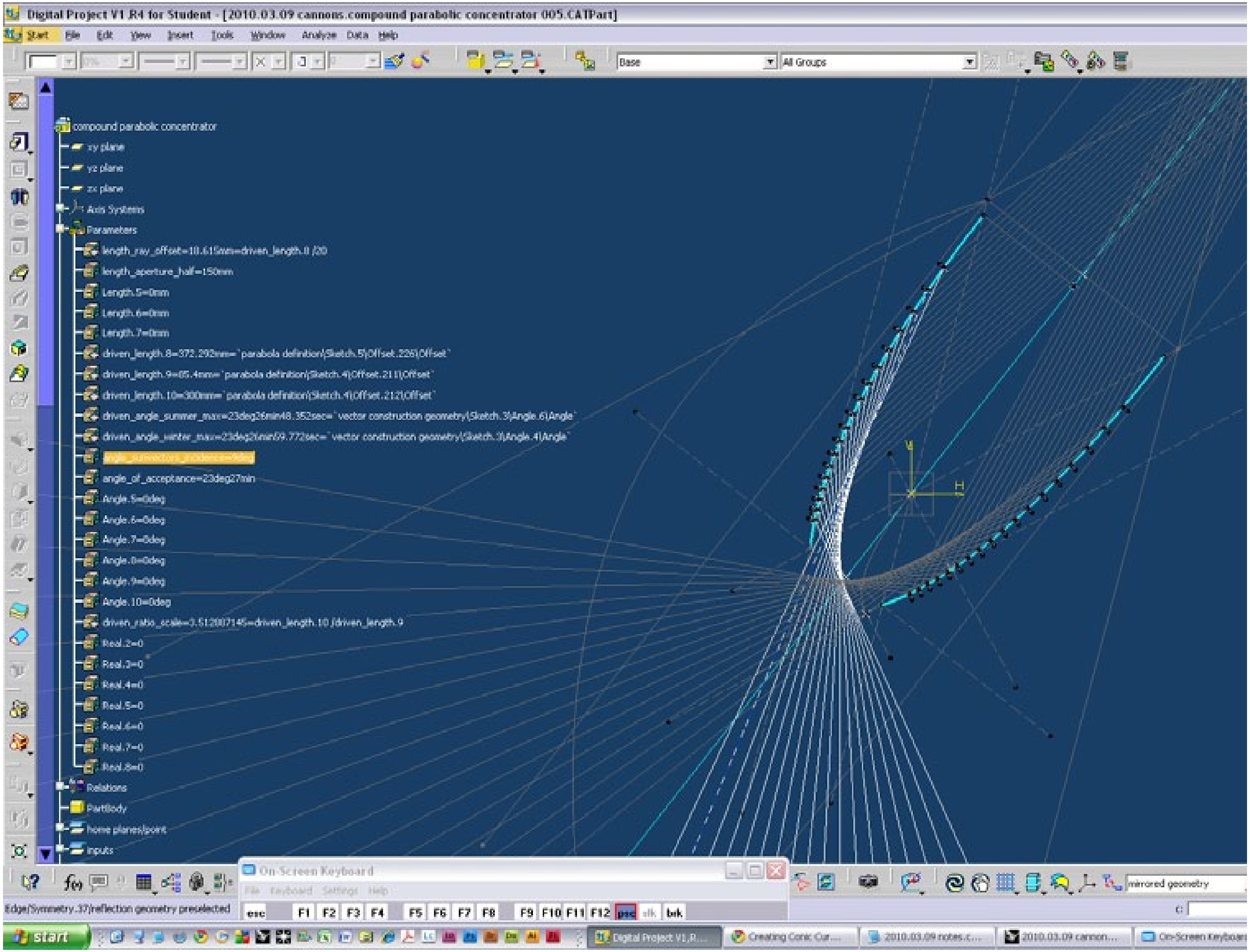
//* {*Light Cannons*} ::

//{2010.04.20 ~ Professional Work; Loisos & Ubbelohde Architecture + Energy}

Clients:: *Smith Group Architects, Lawrence Berkeley National Laboratory, University of California Berkeley, Helios Energy Research Center*

Light Cannon Design, Optical Design :: *Matt Bitterman, George Loisos*
Light Pipe Design :: *Matt Bitterman, Abe Shameson*
Structural Engineering :: *Susie Douglas*
Mockup Fabrication :: *Matt Bitterman, Abe Shameson, David Sheer, Eduardo Pintos, Ibone Santiago*
Monitoring Equipment and Data Analysis :: *David Sheer, Chris Humann*
Materials :: *Various weaves/biases S-2 + E-glass Fiberglass/West System Epoxies, PVC 2lb/ft3 Closed-Cell Foam Core, Mild Steel, EMT, Stainless Steel, Aluminum Extrusions, Acrylic, 3m Optical Lighting Films, Reflective Mylar*

fig.0064 the loisos & ubbelohde light cannon ~ image credit mike martinez.jpg



Digital Project V1,R4 for Student - [2010.03.09 cannons.compound parabolic concentrator 005.CATPart]

compound parabolic concentrator
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- yz plane
- zx plane
- Axis Systems
- Parameters
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  - Angle.7=0deg
  - Angle.8=0deg
  - Angle.9=0deg
  - Angle.10=0deg
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  - Real.2=0
  - Real.3=0
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  - Real.5=0
  - Real.6=0
  - Real.7=0
  - Real.8=0
- Relations
- PartBody
- home planes\point
- inputs

Edge/Symmetry.37/reflection geometry preselected

fig.0065 dp modeling compound parabolic concentrator behavior across seasons ~ section.jpg

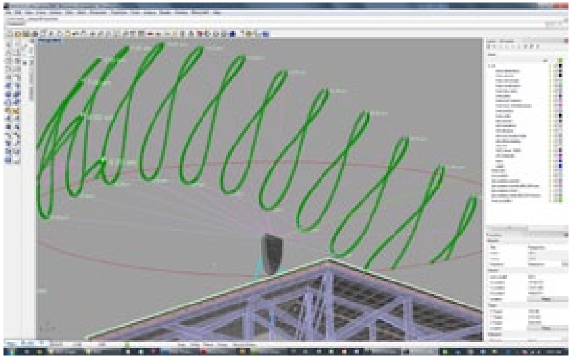


fig.0066 cannon on roof with analemma for year ~ grasshopper definition.jpg

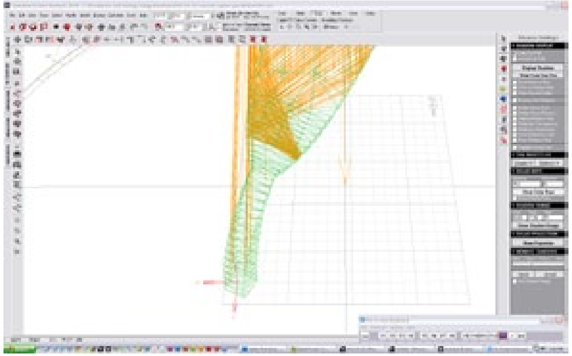


fig.0067 ecotect solar raytracing of cannon moments before turing on.jpg

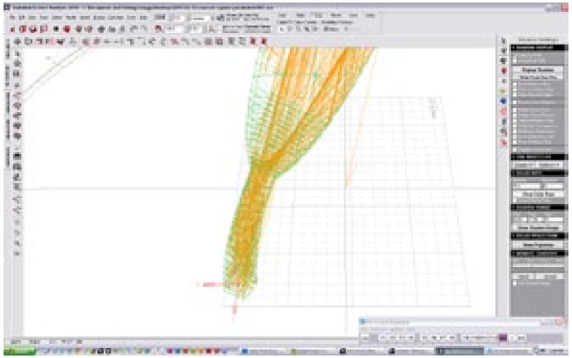


fig.0068 ecotect raytracing when cannon is firing.jpg

Light Cannon Design & Performance ::

The Light Cannon project is a mockup for an 85' {26m} daylighting sculpture proposed for a new building on the University of California, Berkeley's campus. The conceit is for this sculpture to act as an experiential mechanism for understanding the solar/celestial calender. These cannons concentrate direct solar radiation from the sun through a series of penetrations in the roof, and shoot it down the center of the main circulation stair in this proposed research and laboratory building .

The cannons are designed as passive, non-mechanised reflecting devices, which concentrate the sun's energy six times and illuminate a fixture inside the building at different set times throughout the solar day and year. For example, this mockup cannon installed at our office in Alameda is calibrated to illuminate for 1.5 hours per day, all year, from 12:45pm - 2:15pm solar time, or at present 1:45-3:15pm daylight savings time. Through the use of advanced optically treated films from 3m, the cannon's light can brought to great depths inside the building with an evenness comensurate to the sky conditions above.

The optics, while relying on the simple principles of reflection, are a delicate balence of complex solar geometry, radiation in the form of heat, and luminous flux. Two mockups were built to before the final mockup. Controlling the focal points and heat was a critical component of design to avoid materials reaching their flash point and cauing fire, while still ensuring enough luminous flux reaches the fixture below to make a notable impression. Thermocouples were added near the concentration points to monitor the heat while the cannon operates, which reaches 190degress on a daily basis as the sun is focused and passed through.

The challenge of the optics however truely likes in accepting and effectively concentrating such a wide angle of acceptance, as the sun moves 15degrees in asimuth per hour and about 46degrees in altitude around the year. Our solution is a type of asymmetric compound parabolic concentrator sometimes found in solarthermal devices, however finessed for the use of daylight in an application to our knowledge is without precedent. Parametric modeling was a necessity to finess the reflecting surfaces, in addition to various raytracing software used to test performance. The molds for the laminates were all digitally produced and vacuumed bagged for tolerance control, and the final product was within a 32ths of an inch. The cannon is working +- 3minutes from its designed illumination schedule.

fig.0069 fairing the cannon.JPG

fig.0070 digitally produced mold eggcrates.JPG

fig.0071 molds for fiberglass components.JPG

fig.0072 vacuum bagging composite parts.JPG

fig.0073 the light cannon mockup installed at loisos & ubbelohde.JPG

fig.0074 cannon.JPG

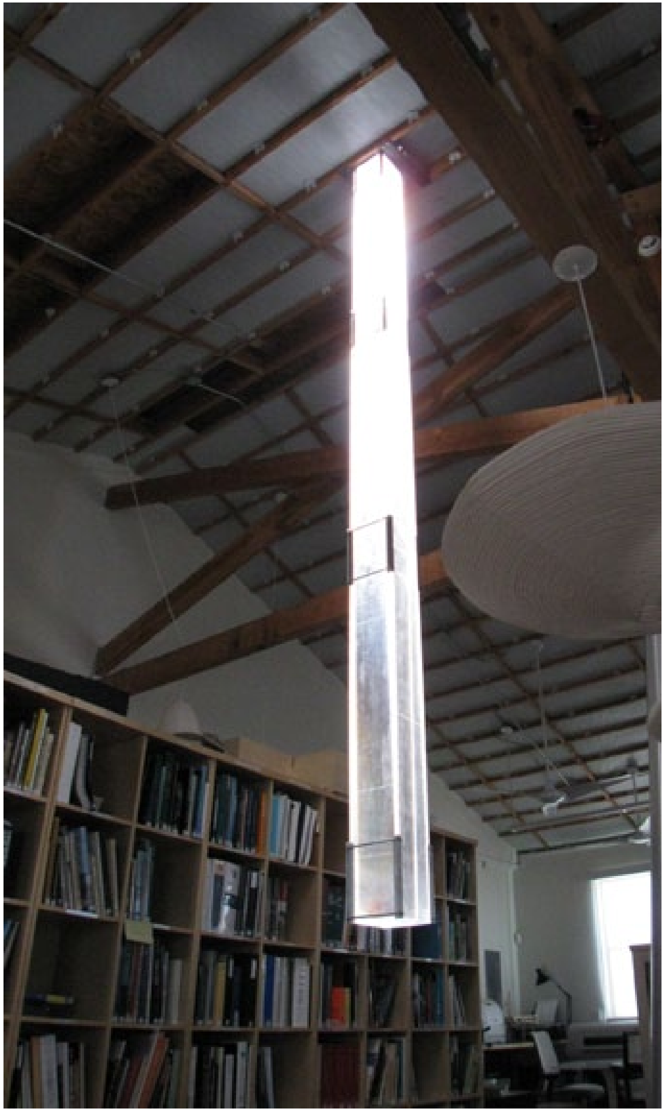
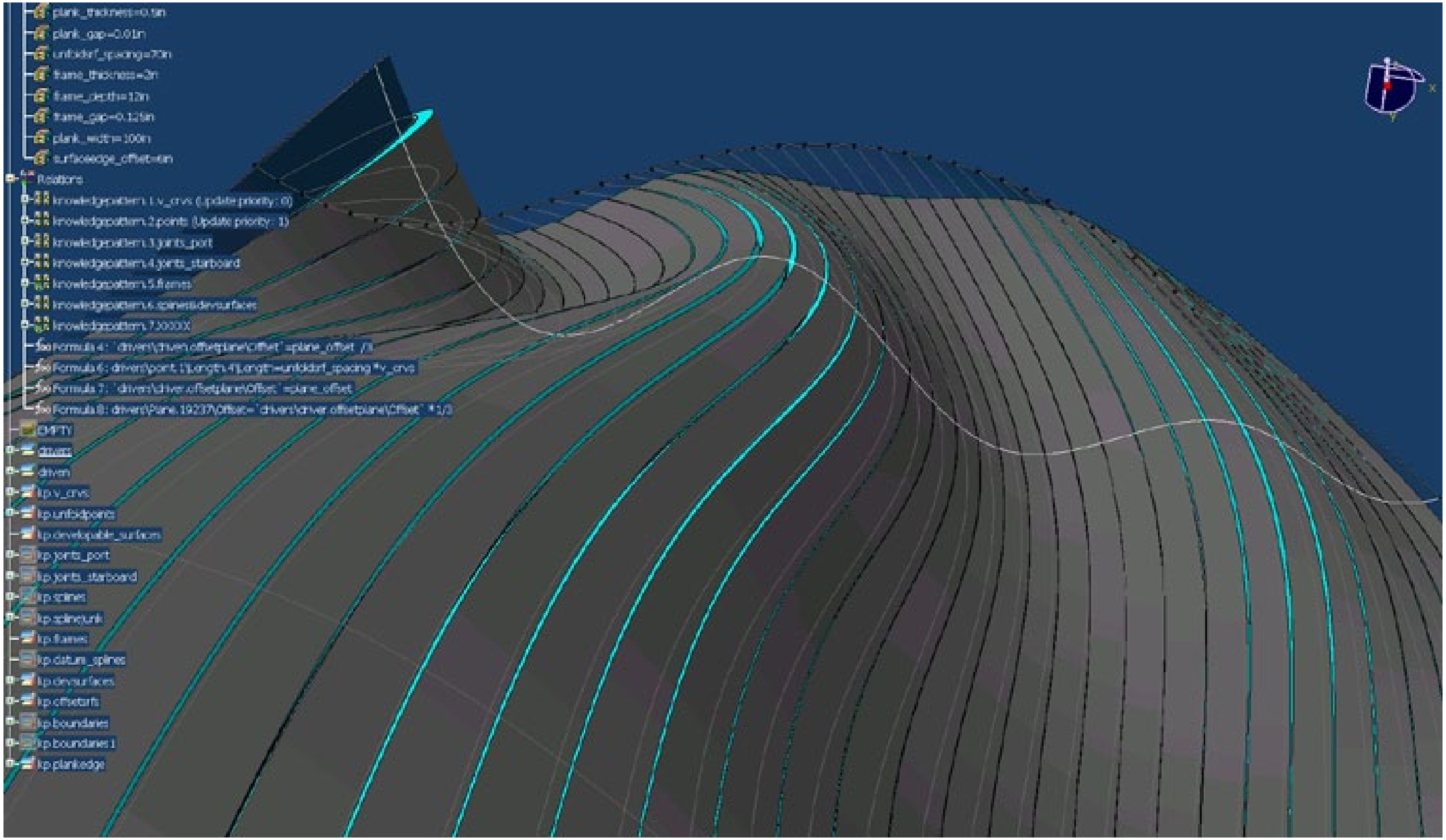


fig.0075 light cannon illuminated.JPG



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knowledgepattern.2.points (Update priority: 1)
knowledgepattern.3.joints_port
knowledgepattern.4.joints_starboard
knowledgepattern.5.frames
knowledgepattern.6.splines&devsurfaces
knowledgepattern.7.XXXXX
Formula.4: `driven\driven.offsetplane\Offset`=plane_offset /3
Formula.6: drivers\point.1\Length.4\Length=unfoldcrf_spacing *v_crvs
Formula.7: `drivers\driver.offsetplane\Offset`=plane_offset
Formula.8: driven\Plane.19237\Offset=`drivers\driver.offsetplane\Offset` *1/3

fig.0076 wood linguine.jpg

::000_G::

//* {*Mass-Reinterpretation*} ::

//{2009.12.17 ~ Thesis Design Project, University of California Berkeley}

fig.0077 shireen's teak planking looking aft.jpg

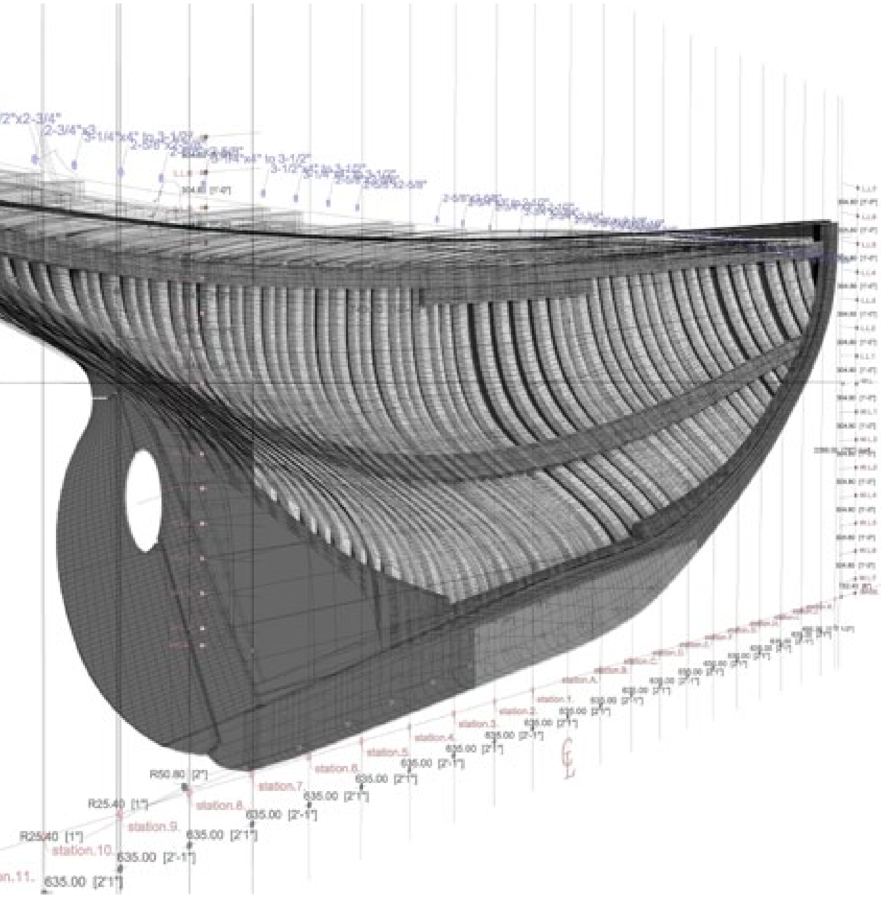
*/*abstract*/*

New digital tools for design and fabrication have made possible the coordination and realization of buildings of unprecedented complexity, however simultaneously they solicit abstract geometric design practices that are inconsiderate to material behavior, fabrication limitations, and construction implications; often necessitating extensive reverse-engineering operations. A new praxis for digital tools and parametric design must be cultivated - one in which designers consider process, materials, and machines as the *medium* of architecture, understanding architecture as a *material practice*. Working within the parameters and implicit/explicit forces of manufacturing, fabrication, and construction from the outset of the design will make accessible unprecedented economies in production, new possibilities for the form of architecture, and further, it will give us the ability to evolve and improve these systems (parameters) over time.

Mass-Reinterpretation suggests rather than using digital technology to reverse-engineer the construction of complex form, that the digital tools become a mechanism to better understand material and fabrication potential. It is an argument for developing & refining *precise* parametric systems of material properties, tooling/fabrication behaviors, and construction contingencies, and using them to forward engineer use and architectural form. It is in essence an argument for architects to begin developing systems of constructional knowledge, by and through which we can design.

This investigation begins with a 51' 1932 Camper-Nicholson wooden boat, representative of both an origin (albeit contemporary site) for solving the constructional problems of doubly curved geometry and the pinnacle of handcraft at an architectural scale. The project then reinterprets this craft into the digital era through the associative parametric design environment *Digital Project* V1,R4 {CATIA} and 3 axis CNC routing, through creating an inherently mass-customizable & constructionally-solvent system of knowledge governing its use. This thesis elucidates the various affordances and limitations of working within this media, and aspires to illuminate a praxis for architecture expressive of its material and fabrication incarnation. ~

The following images are some of the products of the design component of this thesis. The process was effectively training the computer in various aspects of the craft of wooden boat building to precise material and machine tolerances, to begin to identify new opportunities for finding value and form in the process of design in architecture.



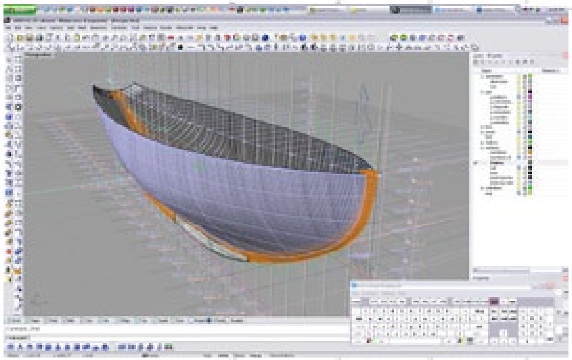


fig.0078 screenshot ~ shireen rhino model.jpg

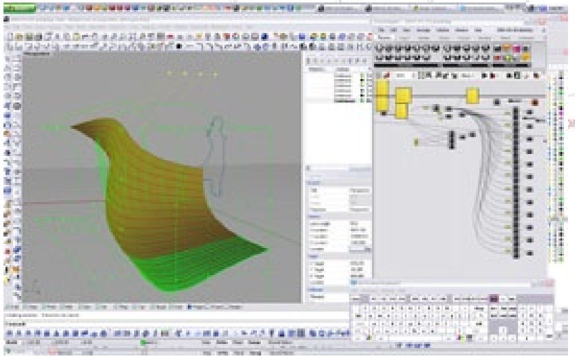
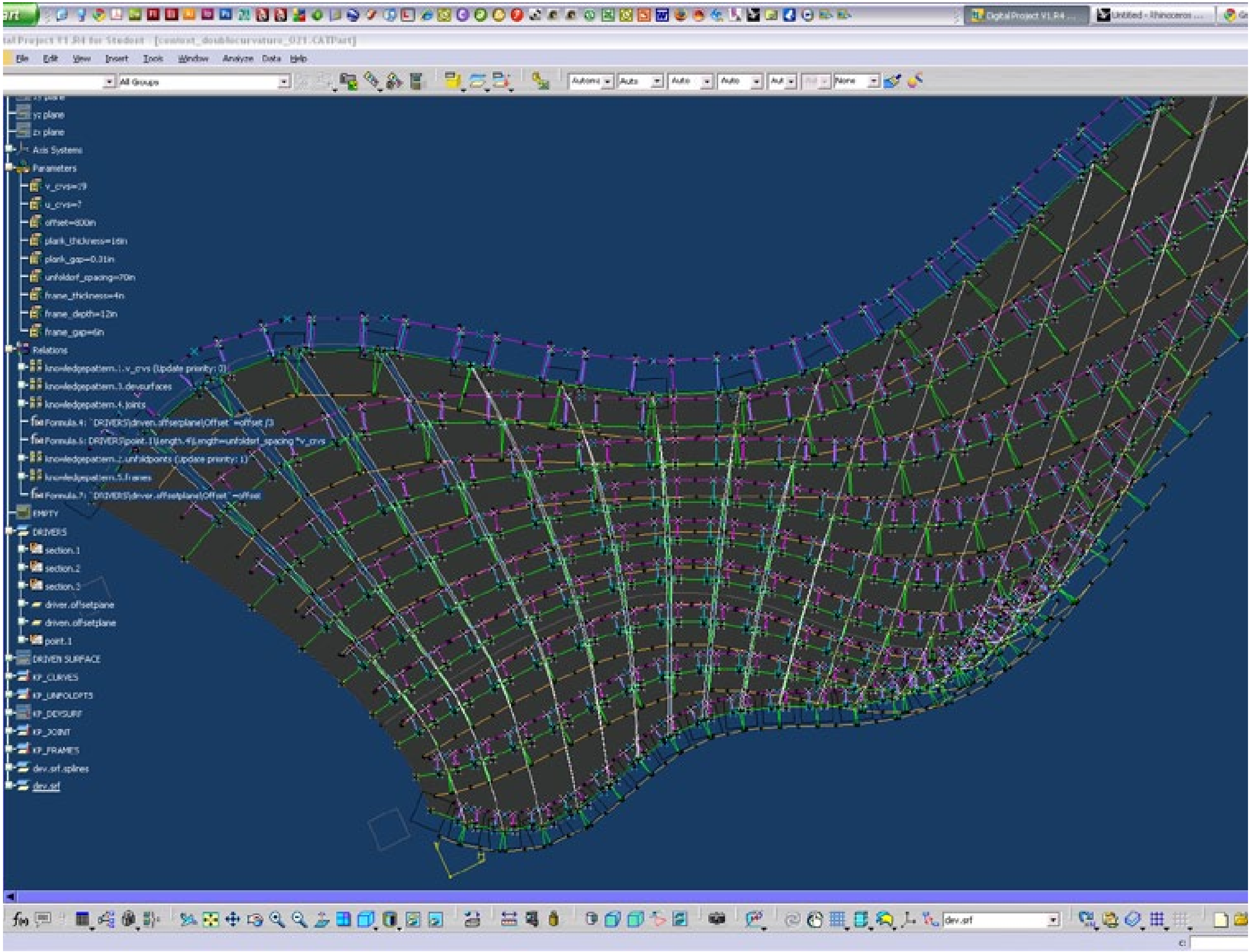


fig.0079 screenshot ~ early grasshopper definition.jpg



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zx plane
Axis Systems
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knowledgepattern.3.devsurfaces
knowledgepattern.4.joints
Formula.4: `DRIVERS\driven.offsetplane\Offset` =offset /3
Formula.6: DRIVERS\point.1\Length.4\Length=unfoldorf_spacing *v_crvs
knowledgepattern.2.unfoldpoints (Update priority: 1)
knowledgepattern.5.frames
Formula.7: `DRIVERS\driver.offsetplane\Offset` =offset
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DRIVERS
section.1
section.2
section.3
driver.offsetplane
driven.offsetplane
point.1
DRIVER SURFACE
KP_CURVES
KP_UNFOLDPTS
KP_DEVSURF
KP_JOINT
KP_FRAMES
dev.srf.splines
dev.srf

fig.0081 screenshot ~ instantiated parametric machines across surface.jpg

fig.0082 two different definitions of the same surface using different member sizes.jpg

fig.0084 plank chair.jpg

fig.0085 plank chair.jpg

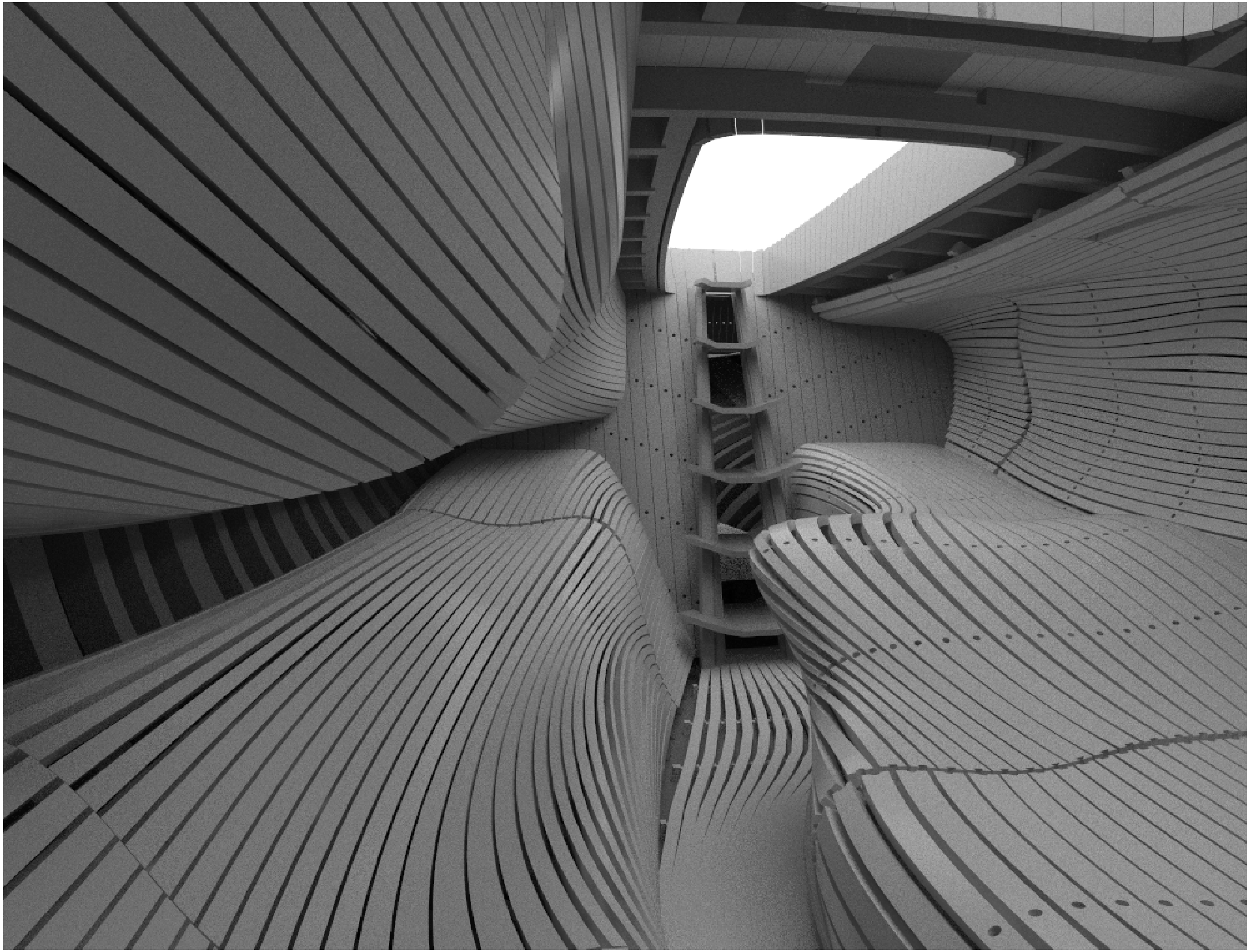

fig.0086 interior sketch.jpg

fig.0087 interior sketch.jpg

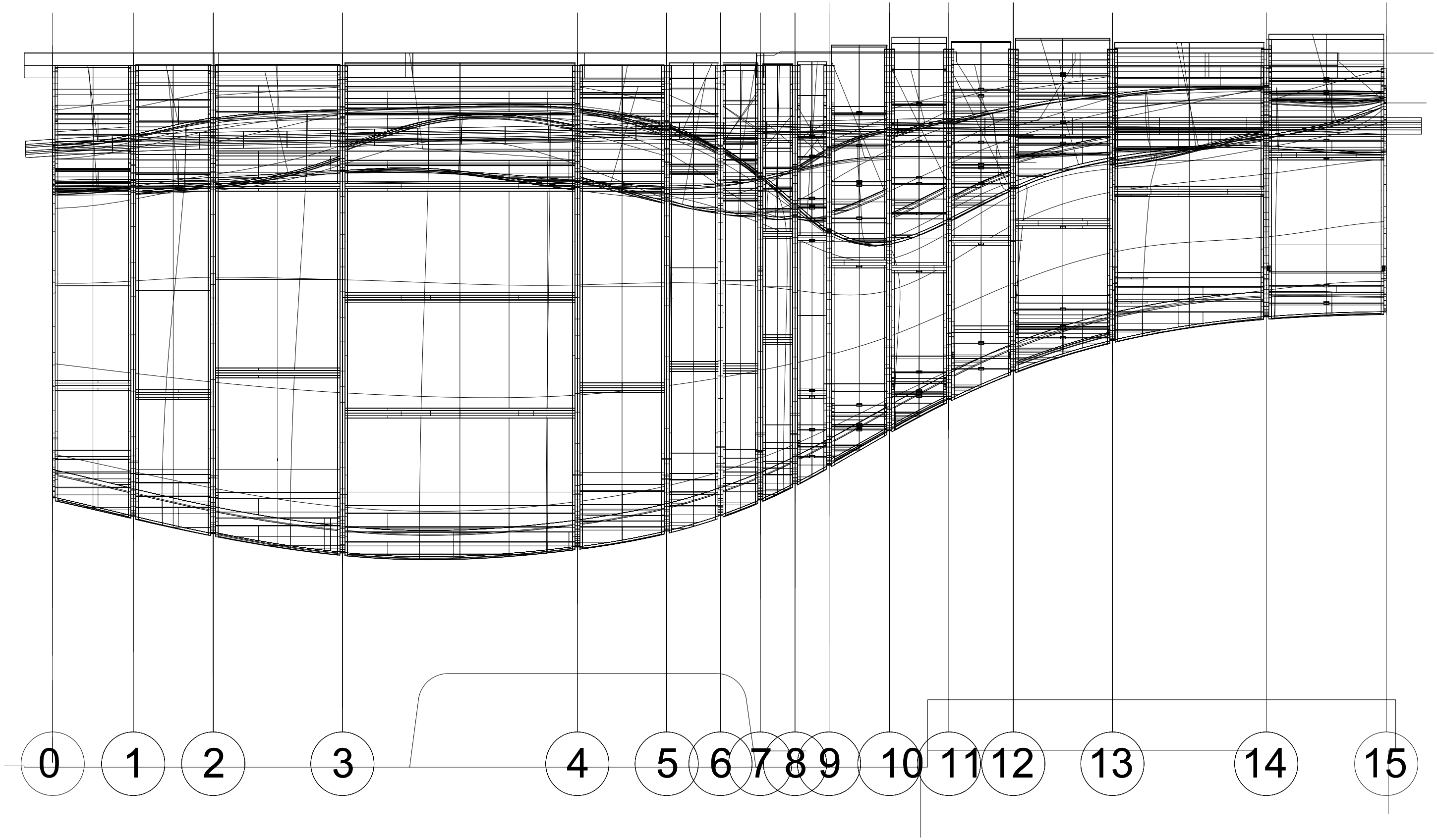

fig.0087 3.8125   tesselation in plan.ai

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//* {*Synthetic Tectonics*} ::

**//{2009.05.18 ~ Seminar/Extracurricular, University of California Berkeley}*

> *It was always disappointing to see that what I could really master in terms of form boiled down to so little.*
>
> ~Alberto Giacometti

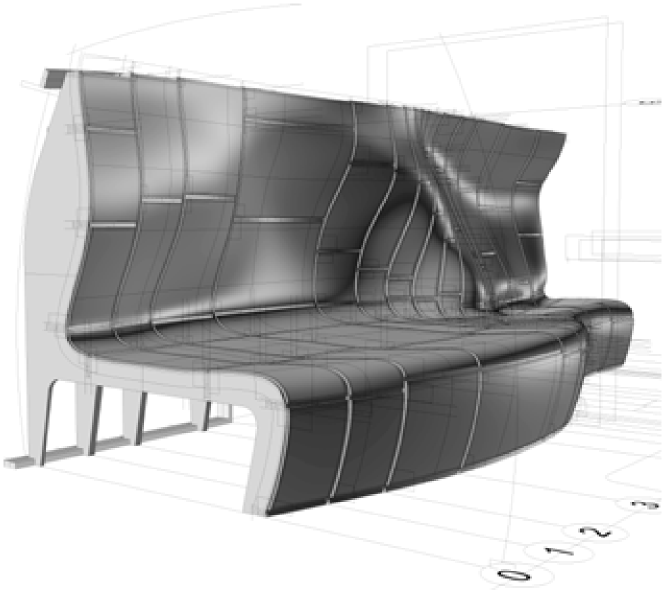

fig.0088 3.8125 rear perspective.jpg

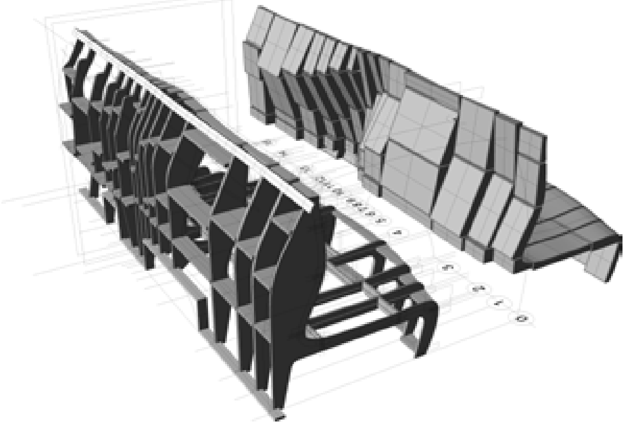

fig.0089 3.8125 eggcrate & panels.jpg

*//*Three & Thirteen-Sixteenths*

The seminar in which this project was initially imagined was taught by professor Maximilano Spina and functioned as a workshop for testing and generating tectonic studies through all forms of digital tools and manufacturing techniques. The challenge was to "develop formal and spatial configurations that demand the development and use of new hybrid, synthetic, or composite tectonics, in which not only the form but material incarnation is integral to the architectural expression."

This project began as a tectonic investigation as a part of a class, but became emblematic of a variety of latent issues I was interested in, that would later form and culture my thesis research. Like much of contemporary practice, the desire to fabricate complex, doubly-curved surfaces forces the issues of fabrication to be considered from the outset of the design process. Rather than abstractly stylizing and shaping a surface and reverse-engineering it to form, the conceit behind this project is really to let the materials and fabrication systems do the talking from the outset of design, in a precise way. I was interested in what grain they could provide to the formal resolution of the project, and thus allowed them a front seat as drivers of form – however had yet to realize or actuate the benefits of associative parametric design tools and scripting practices.

I think what is important to understand about the gestation of the project is that from the outset of the design process, there was a precise understanding of machine and material limitations, and that they were contiguous to the formal strategy. Care was taken in understanding the behaviors and tolerances specific to each material, and the idiosyncrasies of the process of fabrication, and these in turn were used as the medium - and strategy - to inflect the form of assembly in an accurate and measurable way. A full-scale mock-up was built of the first section of fifteen in order to gain valuable feedback with which to inform the design.

The design is a simple surface that provides the program of storage, lighting, two seats, and a bed for living/traveling in a Ford Econoline van. The project takes the name "Three & Thirteen-Sixteenths" as a reference to the vertical limits of the Techno Isel CNC router which would be used to fabricate it, as it became the primary driving parameter in form. The design specifically exploited this maximum millable depth as a parameter to determine the tessellation, creating a direct relationship between surface deformation and panel size - where deformation was greater, the panel size was smaller, creating a scalar modulation. There was a back-and-forth throughout design to ensure reasonable panel sizing and numbers through finessing the surface geometry, yet a concerted effort was made not to sacrifice complexity and idiosyncrasy to convenience or simplification.

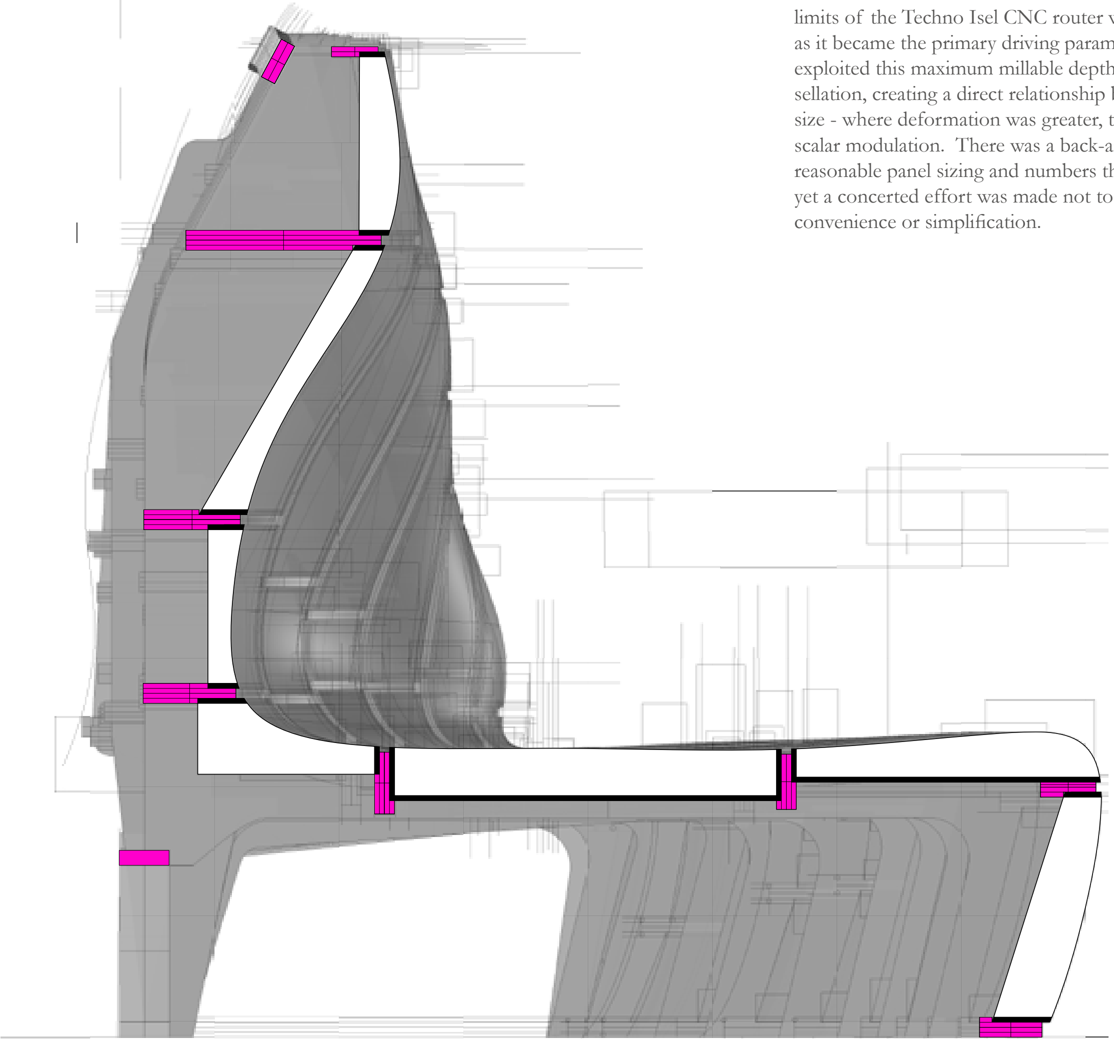

fig.0090 3.8125 section of limited foam thickness.ai


fig.0091 3.8125 routing of plywood components.jpg


fig.0092 3.8125 router detail to avoid chiseling interior corners.jpg


fig.0093 3.8125 eggcrate assembly.jpg

Project Description in Detail ::

I conceived of and built the projct entirely as a static digital model. I used Maya primarily for defining and finessing the initial surface geometry, and Rhino for the solid modeling and post-production. Grasshopper had not yet been introduced, and my knowledge of scripting syntax and parametric design was minimal. Hence, this project took absolutely forever. Never from the outset could I have imagined how tedious, meticulous, time consuming, and painful it would be at times to deal with the mass-differentiated parts at every step of the way, from design to construction.

Into the Digital ::

There are over 1,000 unique machine fabricated parts in this project, and each had to be modeled in solid geometry in Rhino – meaning - no part of this project was scripted or automated, parametric or otherwise. I had acquired the fabrication knowledge regarding what would be needed to address upstream and downstream in fabrication through a good bit of experience – and, in fact, based my design almost entirely around the exploitation and exhibition of this knowledge – yet knew no way to automate its encryption into the model. What ensued was effectively a process of handcrafting each part... just in the computer.

Things like points where there would be screw-holes, regions to define milling operations, labels, parameters for tolerance controls, etc., had to be executed by hand for every single part, in all their orientations and arrangements. To determine the tessellation of the surface based upon the millable depth of the machine, I sat for almost 6 days moving a curve representing this depth around in plan and then section, and broke down the surface in such a way as not to exceed it. As I went, if I found a spot that had too great a deformation that I had missed in a previous check, I would have to redefine the surface topology and begin again. I was eyeballing something that could be done with perfect precision mathematically, parametrically. As I went I was guessing intuitively at the necessary structural depth of the spanning members. I created a detail to prevent having to chisel out the radius of leftovers a router bit leaves at 90deg. re-entrant corners downstream, but in order to implement it I had to create geometry, orient it in space, and boolean it from hundreds of parts and individualized places to implement its use. After the first hundred or so parts, I resolved to just chisel these corners out by hand after they were milled. This could have been easily scripted. After I had modeled every single one of these 1,000+ parts and all of their foibles, for the first time I had a chance to look at what the finished project geometry and tessellation would be like. Finessing the aesthetic at this point was absolutely not an option (in light of the tyranny of infinite variability and flexibility afforded by parametric software, this point in hindsight could have been a blessing…). Maybe most painful, even after all this, was that I then had to pull each part out of its position in space, orient

fig.0094 3.8125 eggcrate rabbet detail.jpg

fig.0095 3.8125 eggcrate assembled.jpg

fig.0096 3.8125 gluing panel frames together in place.jpg

it, move it a few times, label it, nest the parts, and begin to generate tool-path regions, screw-hole locations, relief break geometry (to keep the tool head from crashing into the parts)... In short, every single part, curve, solid, point, etc., needed loads of lovin'. Worse still, if anything needed to be modified later it affected a hundred other things which was extraordinarily difficult to coordinate, with an almost certain series of unanticipated effects. Sounds like architecture?

Into Construction::

The construction process was much more streamlined as a result of the up front investment in digital crafting, and the valuable feedback given by the preliminary full-scale mock-up. The eggcrate frame of the project came together in less than 24 hours– every part friction-fit together snuggly due to the precise 1/64" undersized rabbets/dadoes, eliminating the need to hold them in place while the glue set. Because each section was somewhat structurally solvent, they could all be built and completed independent of one another - rendering any area of the parts within an arms reach at all times – something which turned out to be extremely valuable during the lamination process. The milled screw-hole locations that served to fix the material to the bed of the CNC machine were the alignment guides in the assembly process, and fastener locations for those parts that were not adhered to one-another. The aforementioned re-entrant corners that were addressed in the some of the digital model, meant most parts were ready to be assembled once they left the bed of the machine; only minimal sanding was required on the rare occasion. Similarly, the frames for the foam inserts fit snuggly in the rabbets of the eggcrate, and the foam in those frames. Grooves were cut in both the panels and eggcrate for the insertion of rare-earth magnets, which presented itself as the cheapest hardware solution.

As soon as the assembly of the digitally produced components was complete, the laminating, electrical work, upholstery, and hardware installation began… and it was at this moment the burden of mass-differentiated components and associated complexities was most painfully apparent - and started really draining resources and time.

If the panels were ever going to fit into the eggcrate again after they were fiberglass-ed, and to insure visual fairness from one panel to the next, the panels had to be laminated in place. This required masking off the entire eggcrate, and each of the individual panels with some level of precision to prevent the epoxy from getting into the eggcrate during lamination. The insertion was broken up into five sections roughly the width of a roll of fiberglass, however the fiberglass had to be cut to shape everywhere. This ended up having to be done for 12 different laminations, which was time consuming. The wall and riser surfaces would have to be laid up and left to cure, then the insertion rotated


fig.0097 3.8125 installing milled eps panels into panel frames.jpg


fig.0098 3.8125 layup.jpg

to laminate the deck surface. Because the fiberglass was originally intended to be the finished (or unfinished) surface, care was taken to preserve clarity and to prevent bubbling in a process akin to laminating surfboards, supplemented by the use of an epoxy with special UV inhibitors to prevent yellowing and degradation. After all 12 laminations were completed, each of the 108 panels had to be ground out of the larger lamination, and their edges belt-sanded to final shape. By the end of this process, I felt like each one of these panels was a small child of mine; a sentiment quite contradictory to the premises of mass-customization. After this, a little over half of the panels were upholstered with individually-cut overhead-liner foam and "basketball" vinyl where they would come in contact with the body, and resistors were soldered to 216 red and white LED's to be wired behind each of the 108 individual panels for backlighting. Various hardware for the larger apertures through the eggcrate, and miscellaneous electronics were also later installed.

While I knew much of what I was getting into from the beginning in designing such a hybrid assembly, I had never imagined all the small moments throughout the tectonic that were both idiosyncratic and time consuming as a result of the differentiated components. That last paragraph, for example, took almost 7 weeks of dedicated work over the course of two months to complete, very much in contrast with the expedience of assembling the digitally fitted components in one day.

Into Parametric's and Scripted Relationships ::

This project was really eye-opening in terms of realizing the potential for new parametric design tools and scripting languages to be used in creating systems of constructional knowledge and material crafting which are not explicit or finite, but rather relational, in order to eliminate much of the tedium that bogged down and limited the project throughout gestation. Paradoxically this one-off static model served to illuminate a paradigm that is entirely parametric: while details were hand-instantiated in this case, they were nonetheless simple mathematical and geometric relationships which could be easily set, then automated to produce the g-code machine toolpaths used to fabricate the parts – precise to thousandths of an inch in infinite arrangements - & inherently mass-customizable. Calibrating the design for fabrication and assembly up front proved to be both generative of architectural form, while harboring intrinsic constructional resolve. The shortcoming was primarily my inability to script or parametrisize these crafts to allow for greater evolution, sophistication, and precision of the system throughout its design and construction, or possible further iterations in different geometric arrangements and scales.

fig.0099 3.8125 sanded & glassed panels.jpg

fig.0100 3.8125 glassed panels in place.jpg

fig.0101 3.8125 ready for upholstery & electrical work.jpg

The work illustrated that it is possible to forward engineer form based on precise fabrication and material contingency. The problems were many, but it was apparent that if these simple machine and material based relationships could be made into mathematically accurate ranges and automated (parametric design practices), the project could be instantaneously and infinitely permutable to any desired surface condition, yet never beyond the limits of this designed, understood, and precise constructional solvency. Further, since it was largely CAM produced, the output and fabrication could be automated as well (scripted). This is of course an example of a customizable architectural product, which could be easily given to a variety of applications and further evolve to enjoy some of the associated benefits of lean production techniques and mass-production. What became evident however through futher thinking, and much more interesting than mass-customization alone, was the possibility of parametrisizing or scripting material and fabrication limitations to derive the possibilities for form given a set of parameters. This project aspired to generate a tesselation based upon the limits of one particular CNC machine, but what if we could generate architecture in a precise way based upon a number of days for construction, the bending radius of a given thickness of plywood, or zero material waste? What if the physical possibilities for the form of architecture could be understood by a given material choice, or fabrication technique, from the outset of design in a measurable way?

The project served well to elucidate one potential application of these nascent tools for the practice of architecture, paradoxically by not deploying them, but rather by rendering a mandate for their use, research, and development. Within these methodologies the value and power of computation can be actively exploited, for both unprecedented economies in the production of architecture, and the generation of novel form tighter to its material and fabrication incarnation. Realizing that architecture is a material practice, and that its incarnation invariably will confront material and fabrication contingency, this project and description - albeit retrospectively - aspire to reveal a praxis for the use of new parametric tools and digital fabrication techniques that could be both constructionally solvent, and formally generative.

fig.0102 3.8125 ford e-250 extended cargo aft view.jpg

fig.0103 3.8125 ford e-250 extended cargo forward view.jpg

fig.0104 pneu border proposal.jpg

::000_I::

//* {*U.S. Mexico Borderwall as Architecture*} ::

{2008.12.21 ~ Studio : Professor Ronald Rael}

"The true issue involves harnessing the political willpower to involve an educated community in the determination of its future and its economy."

~ **Marras, Amerigo.** Hybrids, Fusions, and Architecture of the In-Between.

fig.0105 morphological study of river avulsions over time.JPG

fig.0106 cuidado.jpg

Pneu Border Proposal :: Us/Mexico Border as Architecture ::
Professor Ronald Rael

This proposal is a pneumatic border wall that primarily resides along the political border in the lower Rio Bravo/Grande valley, eliminating the controversies and land division created by the separation of the political and security boundaries. The pneumatic wall creates a series of volumes which float along the Rio, which can be programmed by the adjacent communities in a variety of ways which could benefit from either close bi-national contact or adjacency, or from being in an international zone or interstitial space between countries. The wall itself is primarily two parallel tube sections which vary in section based upon programmatic needs or river morphology, with virtual-wall infrastructure in between which could potentially identify migrants as they cross the political border, for various purposes. The project aspires to encourage bi-national development, and cultivate cross-cultural contact and coordination in border towns and cities along and aside the Rio Grande/Bravo, which most have largely turned their backs to. I am providing a system, a skeleton or carapace, to yes the Department of Homeland Security, but also to the communities in border regions along the river.

This investigation began with an interest in researching migrant death along the border, which identified two primary sites where this occurs- death by drowning along the Rio Grande/bravo, and hyperthermia in the frontier conditions of Arizona and New Mexico - too much water, or too little. Death however was just a by-product of a myriad of larger issues, which can be considered human ecology- the social, political, economic, and cultural environments in addition to a more environmental ecology. Aspiring to address some of these larger issues in addition to death along the border I began by looking at the river, as it forms nearly 65% of the nearly 2000 mile border, and the avulsions over time that have made what could be considered a "living border" - defining areas which have been both united states and Mexico for some period of time, and what could be considered a general sort-of international riparian zone.

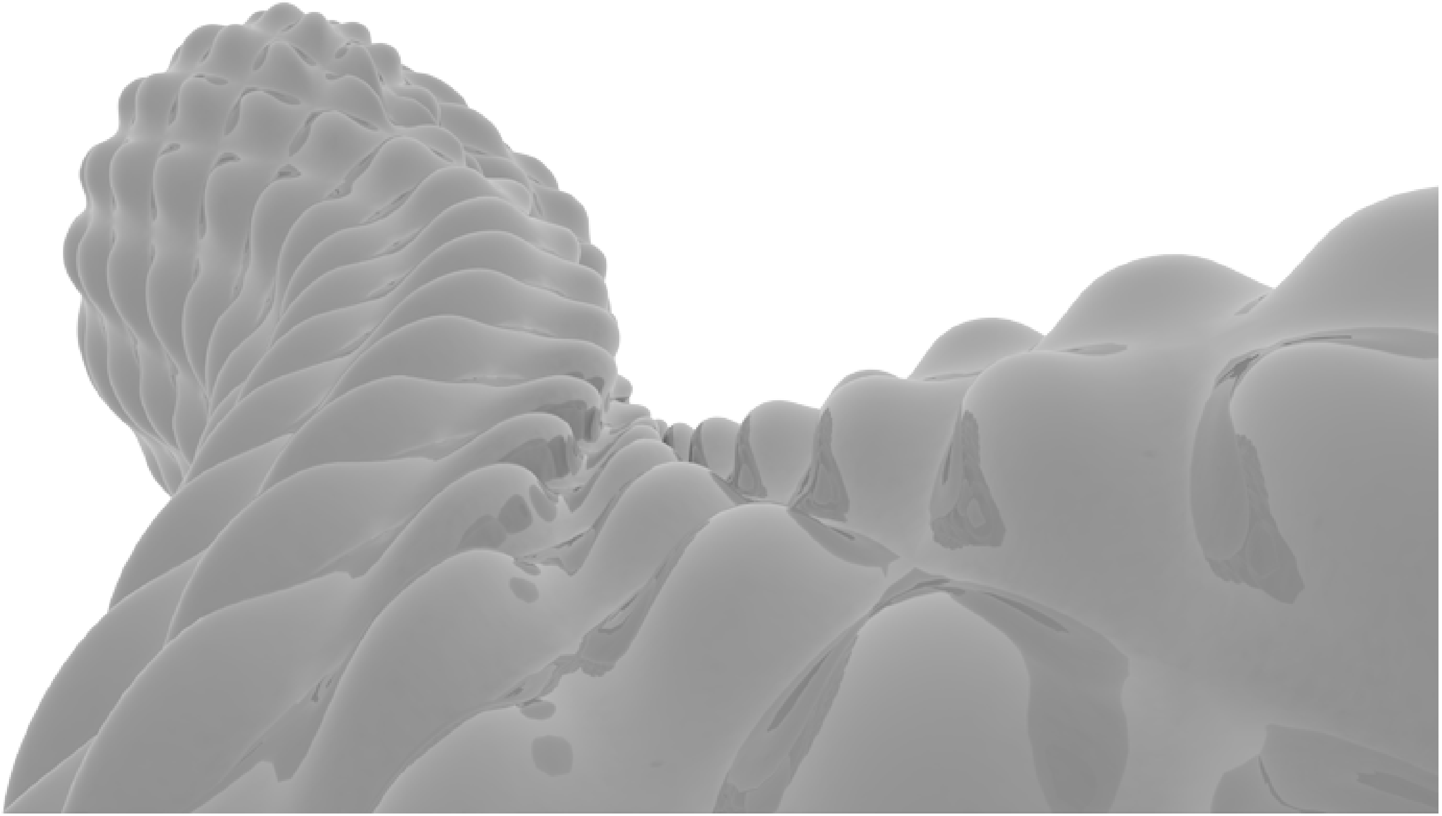
fig.0107 pneumatic tesellation.png

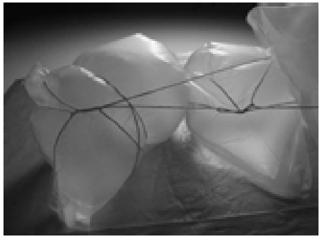
fig.0108 pneu sketch.JPG

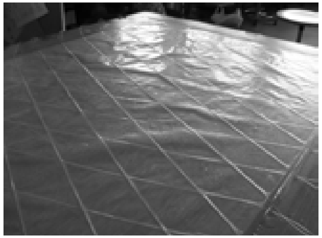
fig.0109 test laminate.JPG


fig.0110 inflated laminate.JPG

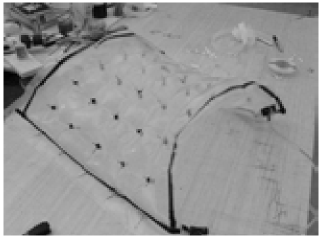
fig.0111 pneu model.JPG

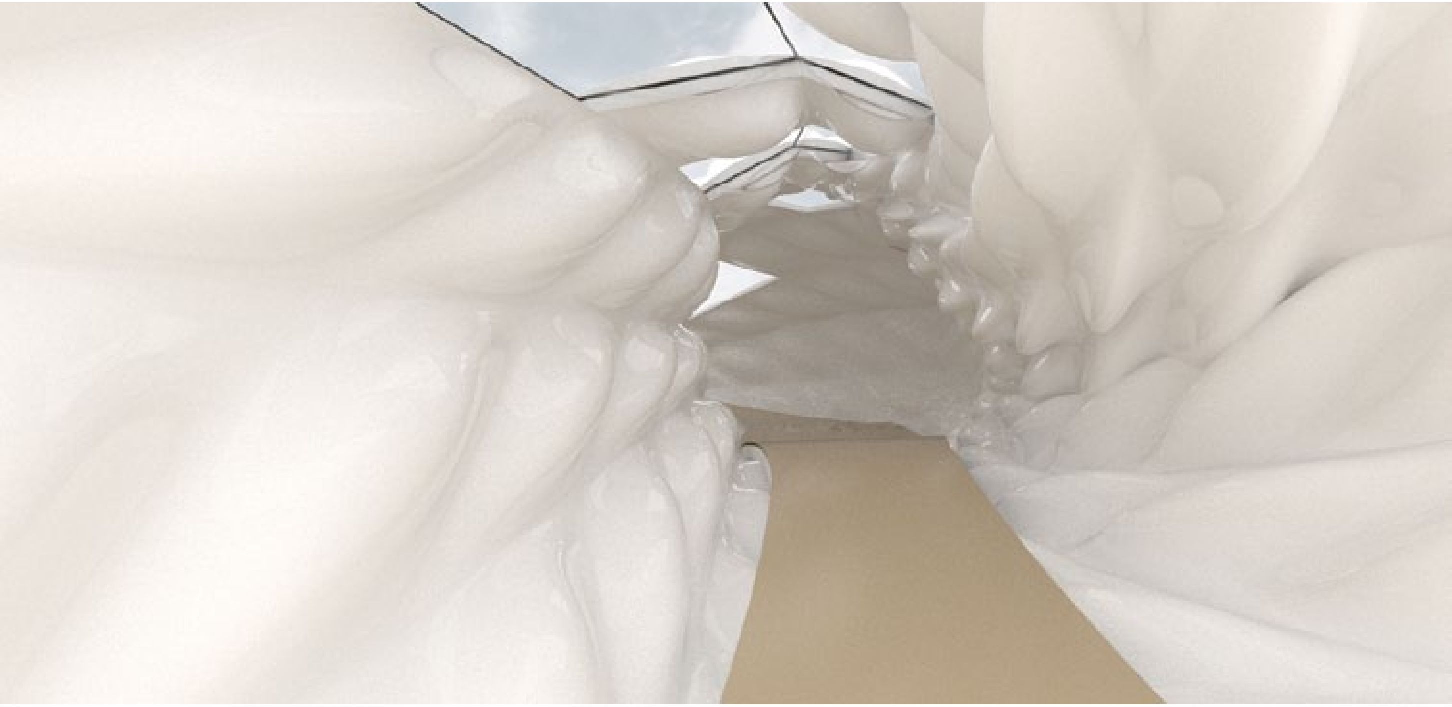

fig.0112 interior, pneu border proposal.jpg

The project is anchored and accessed by a series of bridges which are built as the communities or governments desire to occupy the provided international spaces on the river [however discontinuous - divided by security gates and the virtual wall along the political border], and pneumatic pressure in conjunction with a to-be-designed vertebrae controls the shape of the inflatable where the bridges cannot to follow the river. in addition to a rather static condition along the river, the existing riparian zones - historically disputed lands or otherwise discarded spaces - can be developed in a variety of earthworks and landscape projects which can be shared bi-nationally with the intentional and controlled shift of the security border from the political border- moving the pneu border in a sort-of mimicry of the river avulsions.

The intermittent bridges serve as access and a track system to pull the pneu border over land, defining new bi-national or shared cultural riparian zones. The border wall can illuminate to serve these spaces at night and become a surface for projection, and the additional earthwork and landscapes could become anything from in-ground theatres and sports-fields to migrant potters fields. Optimistically when the wall is taken down {or deflated}, what is left in concrete are bridges and public spaces along the rivers edge.

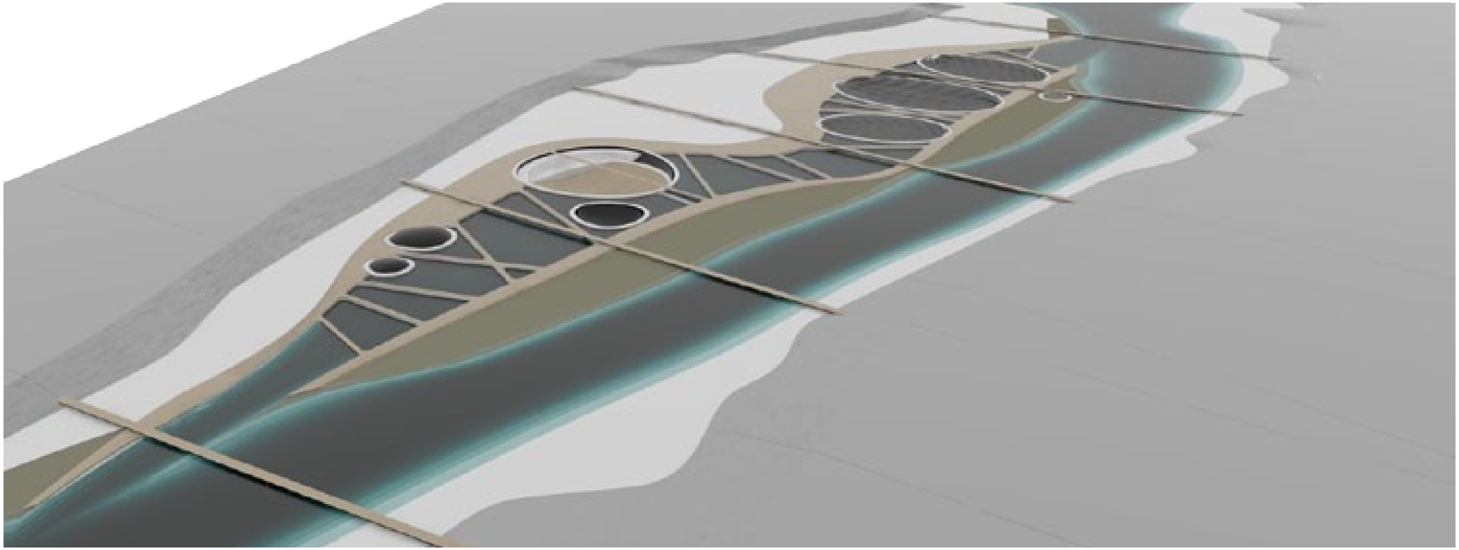

fig.0113 site proposal ~ theaters, wildlife habitats, potters field.png

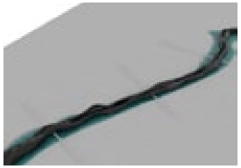

fig.0114 border on water.jpg

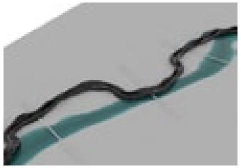

fig.0115 border moving creating internation zones.

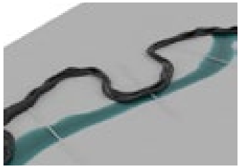

fig.0116 international zones.jpg

The wall itself will be a series of individual pneumatic chambers. The pressure cavity is within the wall system, a double skin system that operates to modulate surface area by "poofiness," which morphes the form based upon necessary length and shape dictated by the river morphology or shifting across the riparian zones. This renders the interior spaces neutral in pneumatic pressure, and the floor and wall systems expand and contract as the length and shape of the border wall shift. Various opacity, thicknesses, gradations, and unit modulations could be explored in further tectonic pursuits. I hope the section of these tubes can vary in a big way over the length of the borderwall, and various formal typologies could be created to address the programs housed within - {i.e. "nave" section, "aviary" section, "office" section etc.} Aperture and penetration, rigidification etc. could also use further consideration and exploration in this pursuit.

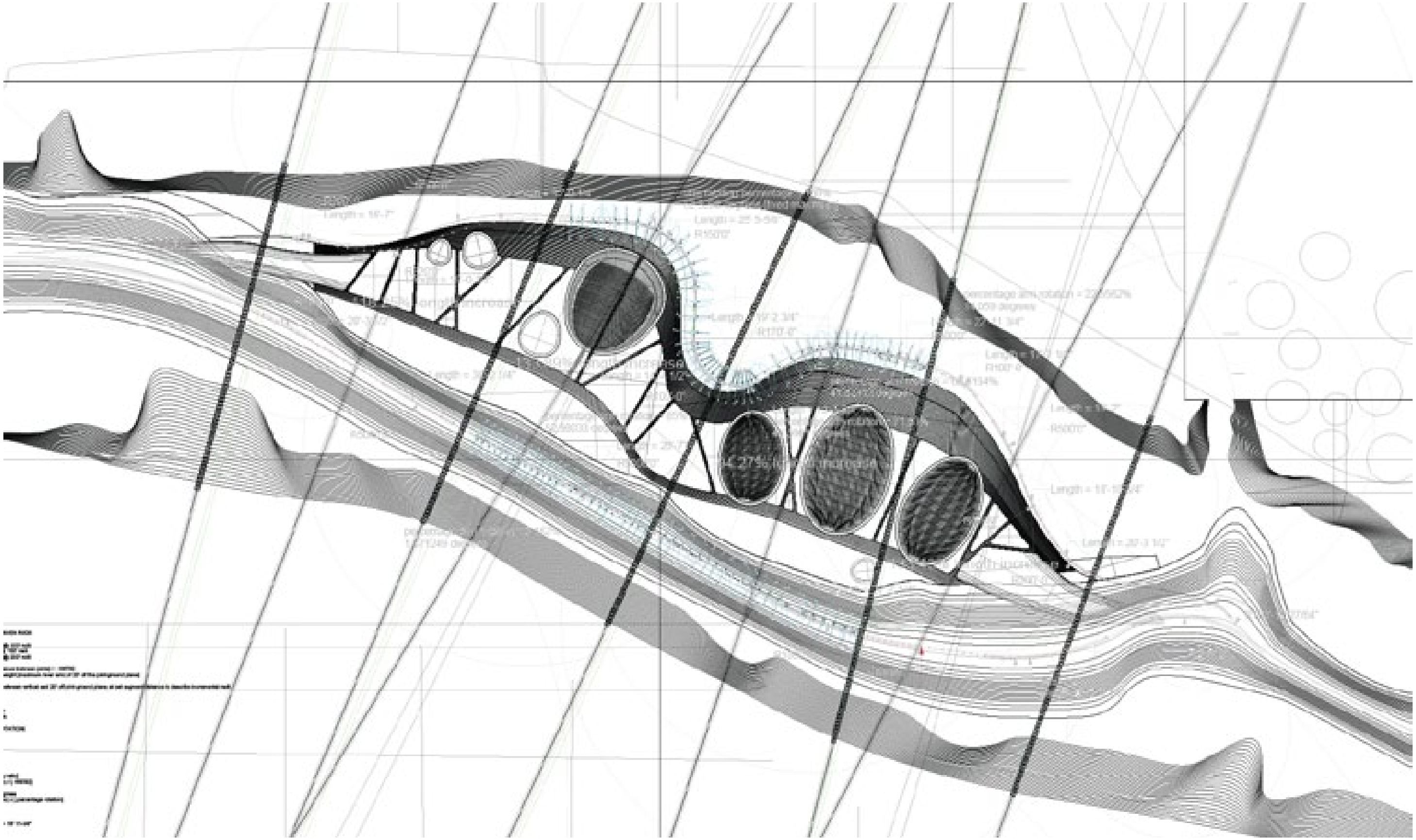

fig.0117 site plan.jpg

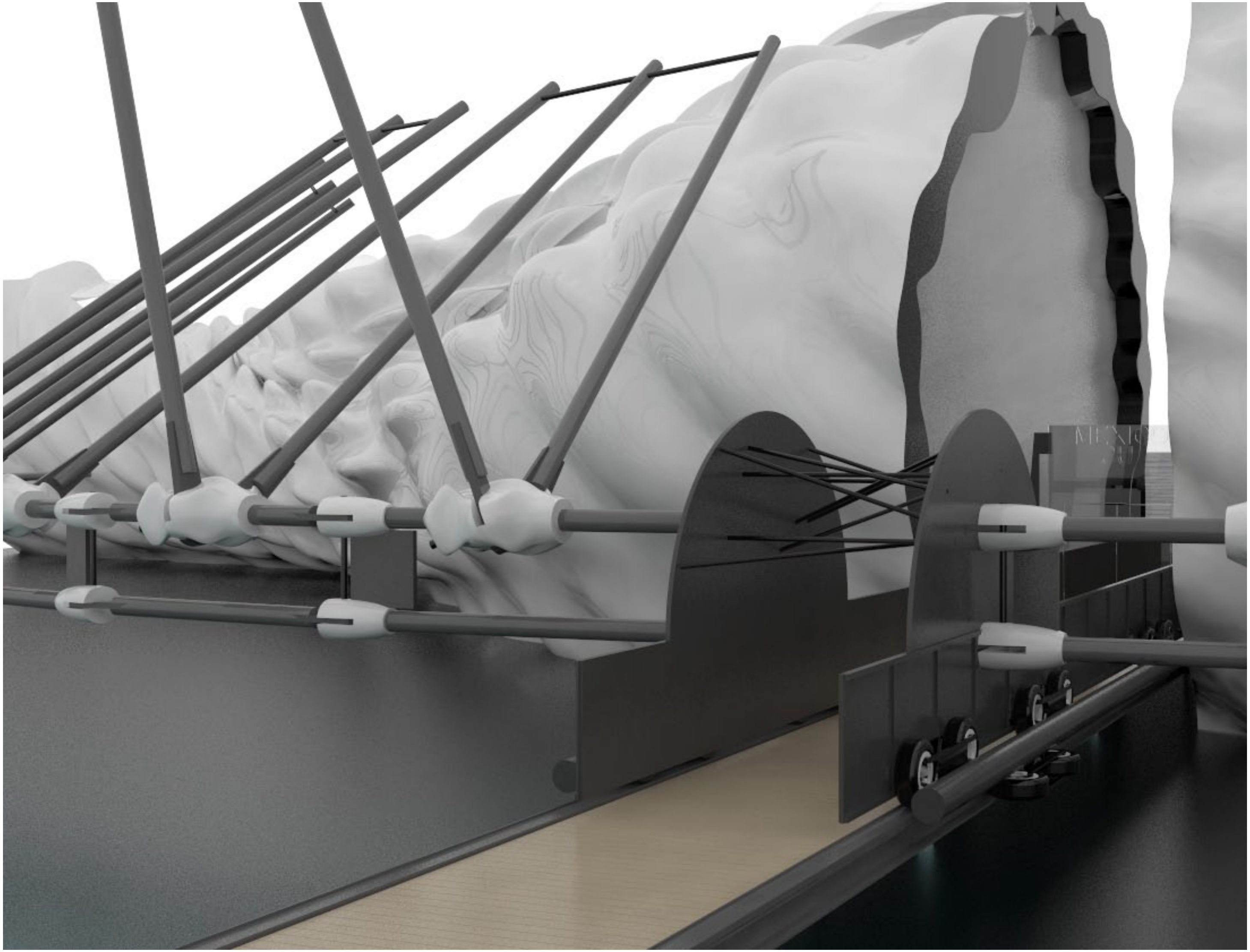

fig.0118 international crossing points, movement tracks for wall.jpg

fig.0119 aerial view pneu border.png

fig.0120 border over international theater.jpg

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//* {*CNC Facility*} ::

{2008.06.24 ~ Independent Studies, Work : Professor Lisa Iwamoto}

fig.0121 material samples wall.jpg

Setting up the CNC Facility :: University of California @ Berkeley

Professors Lisa Iwamoto and Mark Anderson in the College of Environmental Design at Berkeley did a great thing and bought a series of desperately needed digital fabrication tools in 2003 and 2004, however the resonsibility of setting up, maintaining, and operating these tools was and is left largely to the graduate students. A preliminary installation of the CNC router had been made, but for whatever and lots of reasons it had been kept locked up and inaccessible to student use largely since its arrival, without the necessary infrastructure, tools, support, knowledge of use, nor policy for safe and continual use/operation.

Incorporating this valuable tool into the curriculum at the CED and getting access for students and faculty alike has been the focus and goals of two semesters of three-credit independent studies I have undertaken under faculty sponsor Professor Lisa Iwamoto. Professor Dana Buntrock and Shop Assisant Paul Morrison also obtained a grant to create a position to help compensate me for all the infrastructural and organizational improvements that were necessary to open the tool to student use. The work entailed building the infrastructure for ventilation, providing proper dust collection at the head of the machine, research and development in the use + operation of the machine, buying new software by which to run it, creating a material samples library, building tool libraries, building the school's CAD/CAM website, creating online tutorials, training faculty and attendants etc... The work is on-going, however the machine now has several trained technicians, the physical resources have been improved, and several courses now employ the facility for student projects.

The project would not have been possible without the continual dedication and persistence of many individuals. Special thanks and credit for their various contributions should be extended to the following:: Paul Morrison ~ Shop Supervisor, Ben Golder + Chris Lesnett ~ new lab technicians, Steve Murray and Guy Vinson ~ Computing, Julio Reyes ~ CAD/CAM lab coordinator, Chris Williams ~ Management Services Officer, Dana Buntrock ~ Associate Professor of Architecture, Lisa Iwamoto ~ Associate Professor of Architecture, Ronald Rael ~ Assistant Professor of Architecture, Kerry ~ Electrician, and Joseph ~ the Machinist.

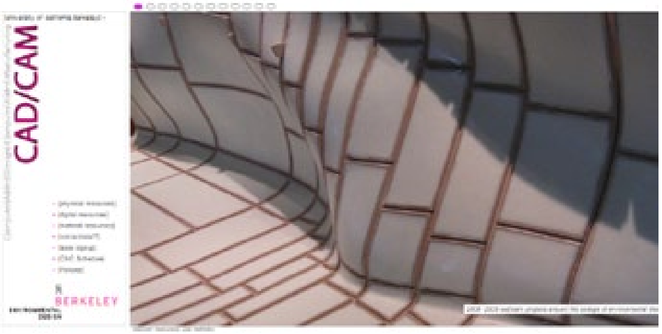

fig.0122 cadcam website screenshot .jpg

fig.0123 dust collection infrastructure.JPG

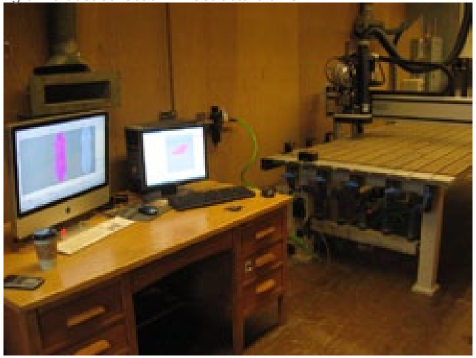

fig.0124 techno router facility.jpg

fig.0125 incremental shift gathering space.png

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//* {*Incremental Shift*} ::

{2008.01.24 ~ Competition, Architecture for Humanity}

AMD Open Architecture Challenge; Asia

Nyaya Health Clinic

Project Team ::
Luke Perry
Nicolette Mastrangelo
Matt Bitterman

Honerable Mention Winner

INCREMENTAL SHIFT is a proposal for a new tele-medical center in Sanfe Bagar, Nepal that addresses the present and future state of the digital divide by presenting a framework for gradual change.

As digital technology is introduced to Nepal, improved access to health care through internet technologies has the potential to transform the lives of many people in the rural community. The proposal recognizes that this revolution will not happen overnight; the advance of technologies will build on and enhance the knowledge of local people and place facilitating a change that will happen slowly and lightly. It encourages equity through a flexible, growth-oriented, distributed and local network of Wi-Fi access and international medical knowledge exchange.

This "building as infrastructure" approach suggests new datums of thought, methods of construction, and use of materials to negotiate between the known (existing Nepali traditions and customs) and the unknown (new digital technologies and educational opportunities). Incremental Shift is the first physical phase of the tele-medical center, acknowledging the future by planning for its role as facilitator and hub of digital technologies in northwest Nepal. Incremental Shift is a double bar, inflected scheme alluding to the biased duality of the digital divide. The north-facing public "high-tech" bar contains the computer facilities, learning labs, and meeting rooms – spaces for long-distance and local knowledge exchange. The south-facing private "low-tech" bar consists of staff quarters and living spaces – spaces to house the local labor and flavor that maintain, operate and facilitate the center. The public and private bars converge at the center's nexus, the community multi-functioning meeting space and adjacent, wedged, common, sheltered courtyard. Here the division of the bars is dissolved. Interaction between bars is unavoidable and encouraged, as is the interaction between rural Nepal and an equitable global digital network.

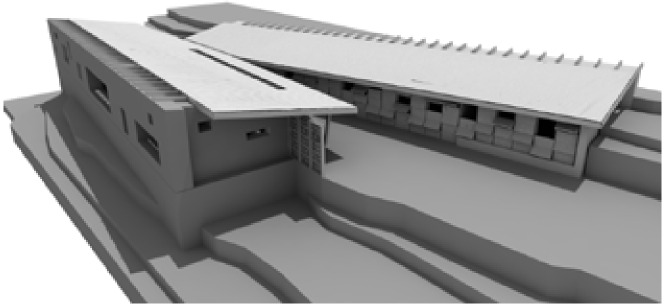

fig.0126 aerial view.tif

fig.0127 computer lab.png

fig.0128 interior exterior.tif

fig.0129 hula hoop.JPG

Programmatically, the center anticipates growth over time and future needs of the digital communication age by the incorporation of flexible spaces. In the private bar, staff quarters include six individual sleeping rooms, but up to twelve sleeping spaces depending on the number of beds allotted for a flux in the number of workers employed.

The staff kitchen and living area becomes public or communal based on an opening or rotating of the immediate operable partitions. In the public bar, the largest space – a meeting room that accommodates up to 100 people – spills out onto the main courtyard space via sliding partitions. The space can be closed up for digital projections and opened for larger social events. The main computer lab includes interchangeable nooks for computers and books (accommodates a small library). This learning lab facilitates supervised instruction (computers around the perimeter of the room) and a central collaborative workspace. A separate administration space doubles as an auxiliary computer lab.

The two bars of the building work in harmony to compliment the low-tech, site-responsive passive heating and cooling strategies of the center. Bars open to the courtyard in warm weather to exhaust and cross-ventilate the spaces. They close in colder climate to take advantage of the insulating value of the corrugated partitions, thermal mass temperature regulation of the earth walls, heat from machines and equipment, and an as-needed centrally located wood-burning stove.

The tele-medical center exists as an extension of the local Nepali landscape. The inflected scheme follows the geometry of the terraced site and uses local, commonly used materials in new ways. Building materials include site-based earthen walls, mud-brick interior partitions, local recycled timber framing, and corrugated metal. The formwork used to construct the primary earthen walls becomes a panelized and operable secondary building enclosure system, regulating light, view, and ventilation. A similar system of using local materials and labor in new ways can be applied to other locations and other potential tele-medical centers or Wi-Fi hubs in Nepal and abroad. This incremental shift in building, technology, and ultimately life will allow the introduction of the new digital age to proceed in respectful, but necessary manner.

fig.0130 airtight intake experience.jpg

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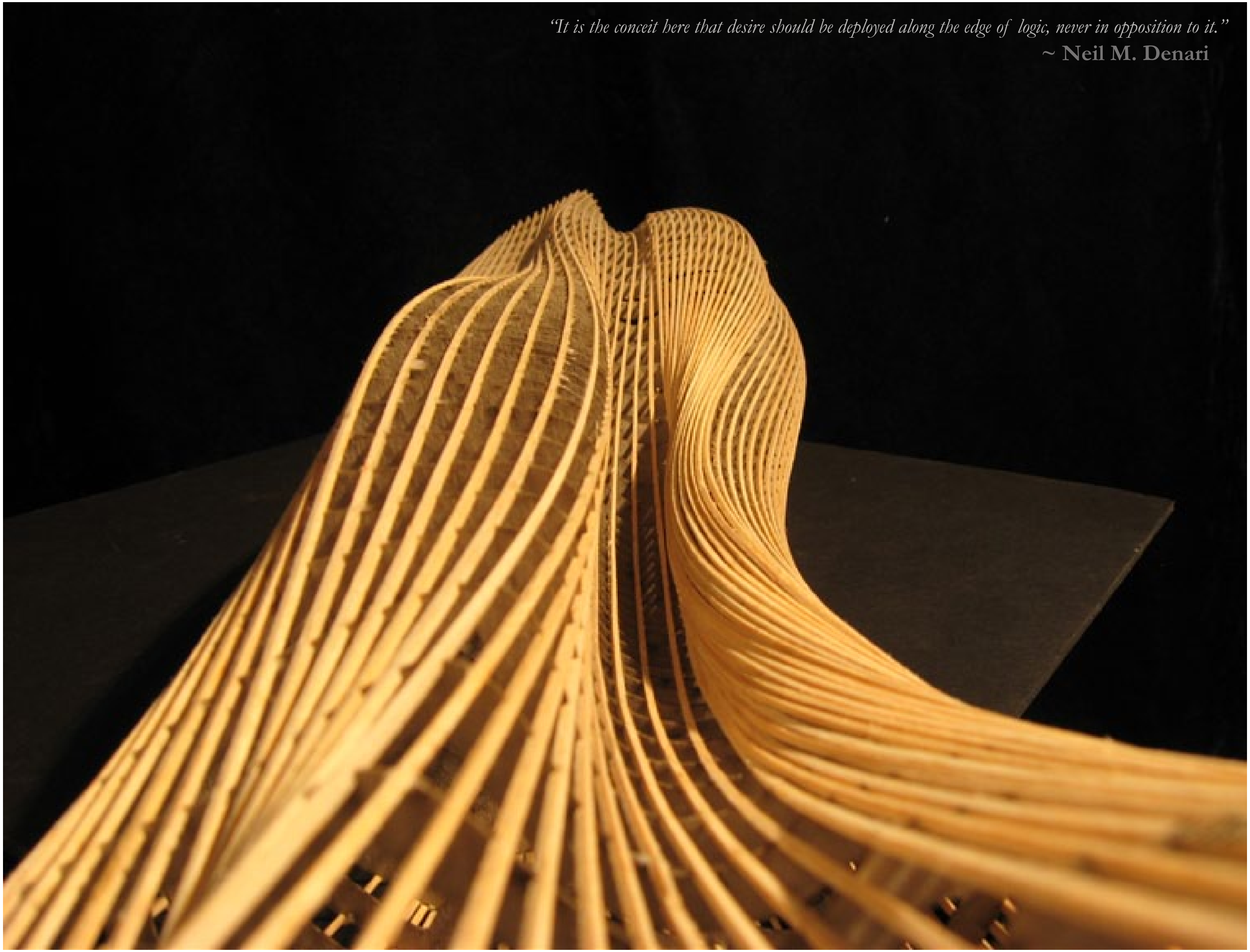
//* {*Airtight*} ::

{2007.12.10 ~ Studio, Professors Neil Denari, Robert Shepherd}



"It is the conceit here that desire should be deployed along the edge of logic, never in opposition to it."

~ Neil M. Denari

fig.0131 stringer and former model.JPG

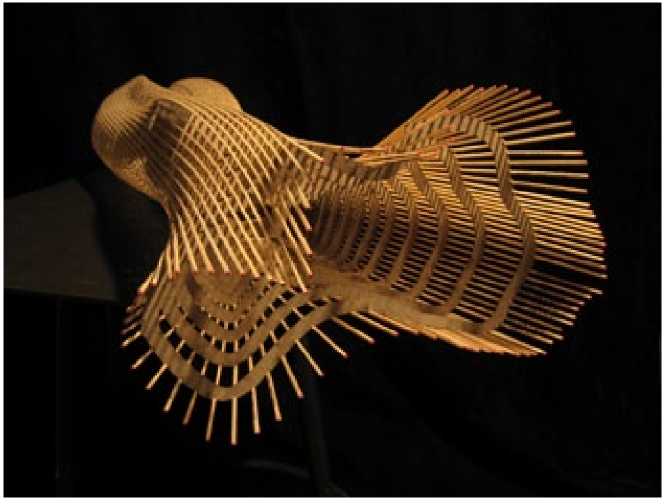


fig.0132 stringer and former model.JPG

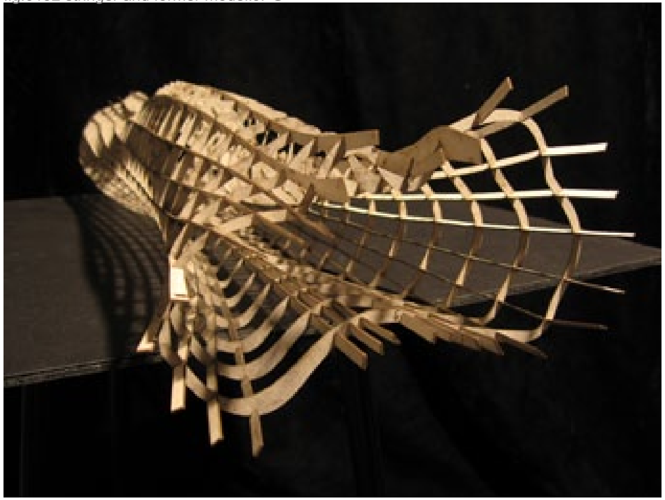


fig.0133 eggcrate model.JPG

//AIRTIGHT introductory exercise ::

The first component of the studio was an exercise in understanding digital ecologies and their relationship to physical construction techniques. This model was made in response to a reverse-engineering exercise intended to illuminate the implications and ecologies of constructing complex NURBS geometries in a stringer & former structural system, with an implied stressed skin {akin to the semi-monocoque construction of a contemporary passenger airliner}.

This particular shape was comprised of six individual surfaces made by sweeping static spline profiles down shared edge rails, resulting in a tube section of adjacent panels that vary in surface area, and go in and out of tangency along its length. Each sweep was carefully calibrated to be at or near the elastic limits of its algorithmic definition to prevent surface cusps etc., by modifying either the rail or profile definitions. Because the profile of the tube was originally divided into six gentle splines and swept along rails, the moments where the surface deformation was greatest was also the moment where the rails were closest together - a result of forcing equal curvature into less space. Each panel was then divided to contain the same number of stringers based on U or V divisions; each stringer follows one of these isoparametric paths down the panel. Thusly, as the width of the panel changes along its length, the stringers modulate accordingly. They bunch up where the width is more narrow, and spread apart where it is wider. Similarly, the frame spacing was modulated to be more dense where the curvature was greatest, understanding that - as a model in the absence of skin, more definition would be needed to describe the geometry and support the increased density of stringers at these points {contrary to a structural p.o.v.}. These inflections were then tied to in rough respect to the material behaviors of and module of thin 1/16th inch balsa strips, pretty much at its elastic limits.

The form of the object is hence a direct expression of the intrinsic limitations/opportunities of creating and dividing NURBS surfaces based on its algorithmic definition, expressed through a kindred material behavior. While this object is the expression of near pure digital ecologies, the ecologies which were chosen were those that could be synergistically paired with structural or material implications, never those at odds with them. Each digital tool carries with it its own paradigm that dictates the ways it is used, which can be both generative, and also quite at odds with material, fabrication, or constructional considerations. It is possible however to calibrate and exploit digital ecologies to those of materials or manufacturing contingencies with interest if they are mutually informative.

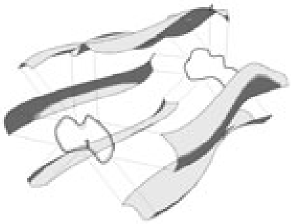


fig.0134 airtight model surface construction.jpg

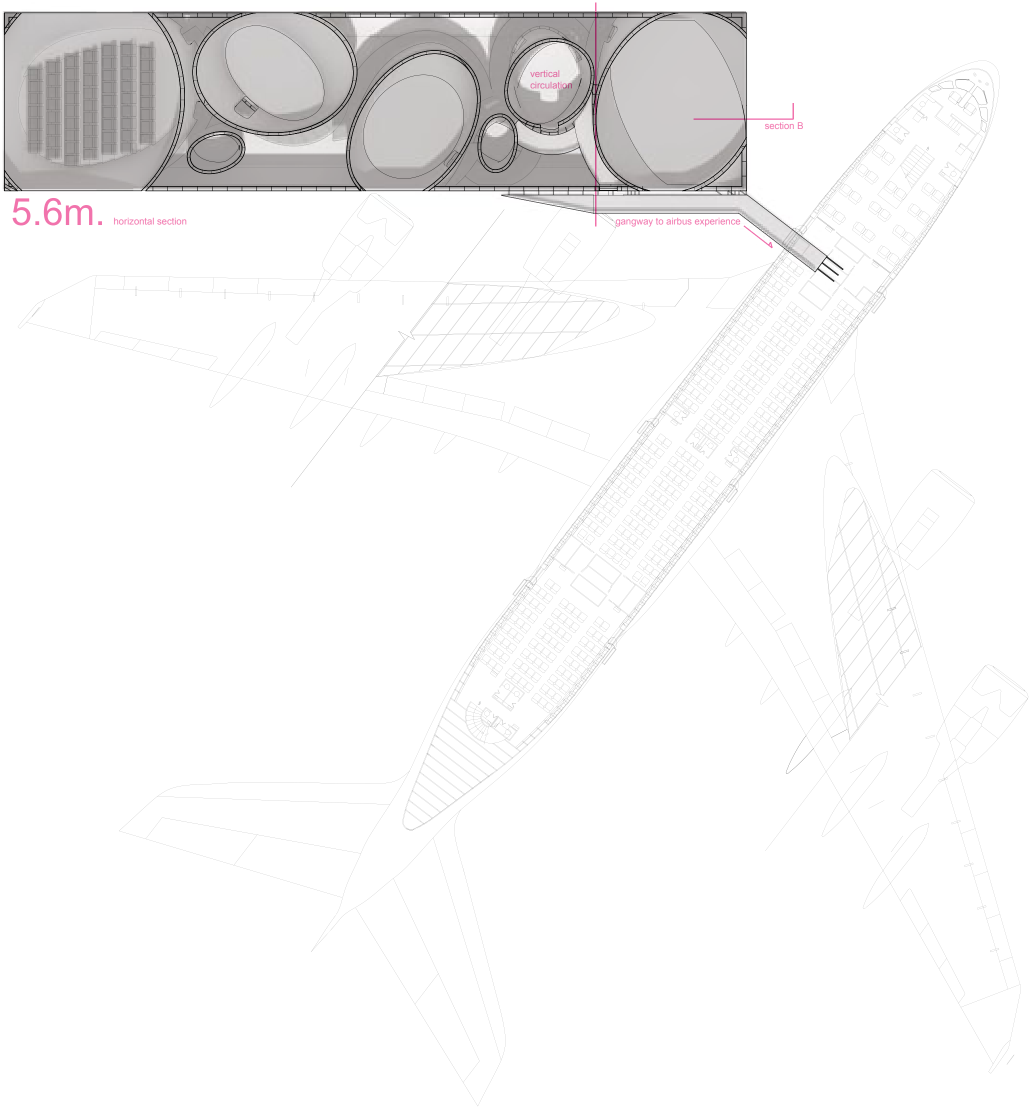


fig.0135 6.6meter horizontal section.pdf

//AIRTIGHT final project ::
Intake Experience

This studio was designed as an exploration of the issues of formalism within the larger discourse of contemporary architecture. The challenge was ultimately to design a sales office/ interactive museum [intake experience] to showcase the new Airbus A380, that would directly connect to the full scale operational aircraft - approximately 700 sq. meters that would serve as an immersive mediated experience by which to view the plane.

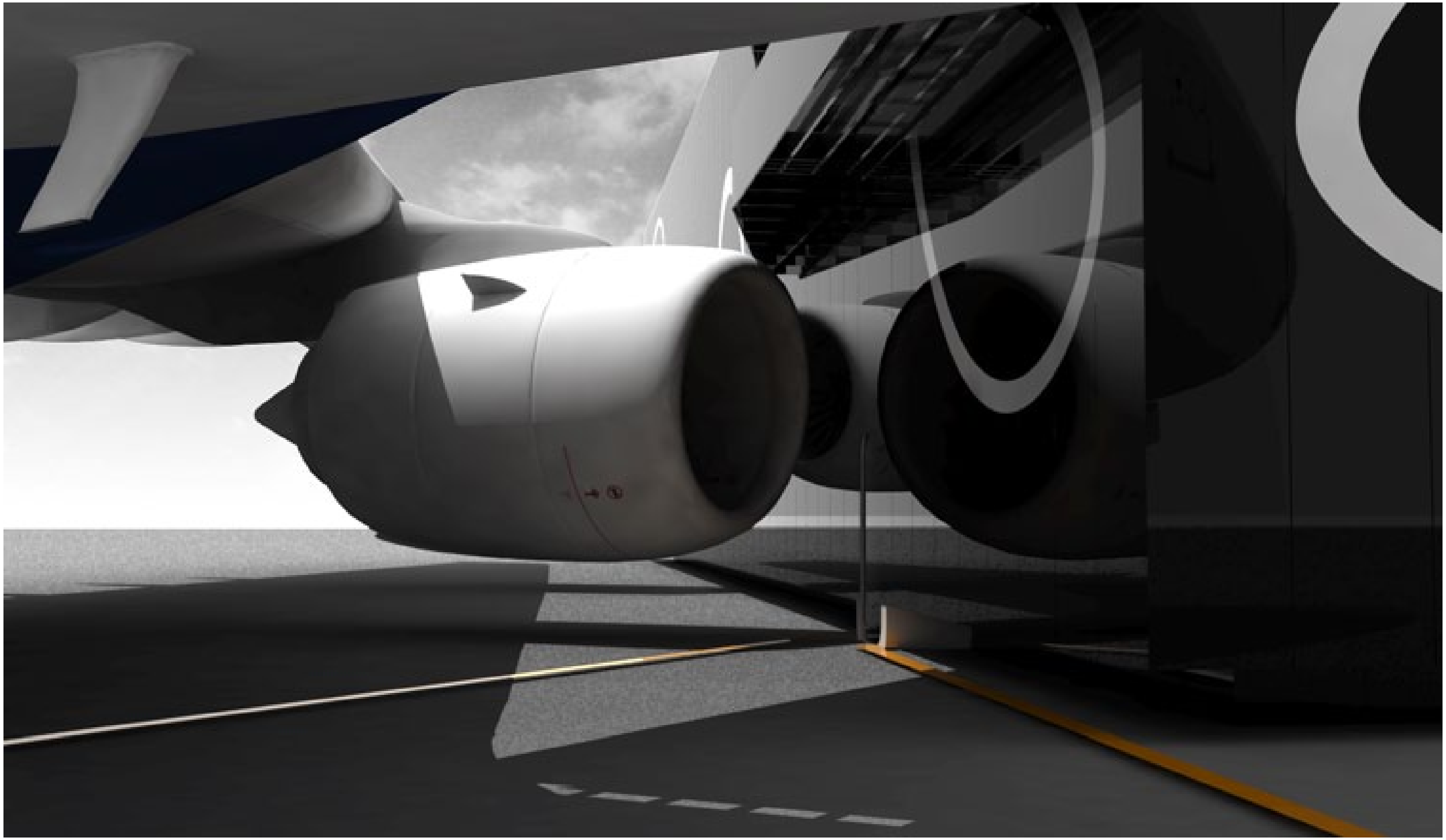


fig.0136 intake experience entrance.tif

This solution hinges on the contradistinction between two global generic genres of fluidity – expressionistic shape-making, and a more smooth modernism exemplary in Apple design, staging a discourse in surface geometry as the functioning experiential device, and straddling the division between architecture and industrial design. Static orthogonal geometry [a box] was employed in the exterior of the intake experience to differentiate yet not detract from the sublime experience of the airbus aircraft, while referencing a typology of architecture. This box functions as a container to allow the intake experience to be autonomous from the airbus experience, and the realm of the mediated experiences and that of the airbus itself are differentiated.

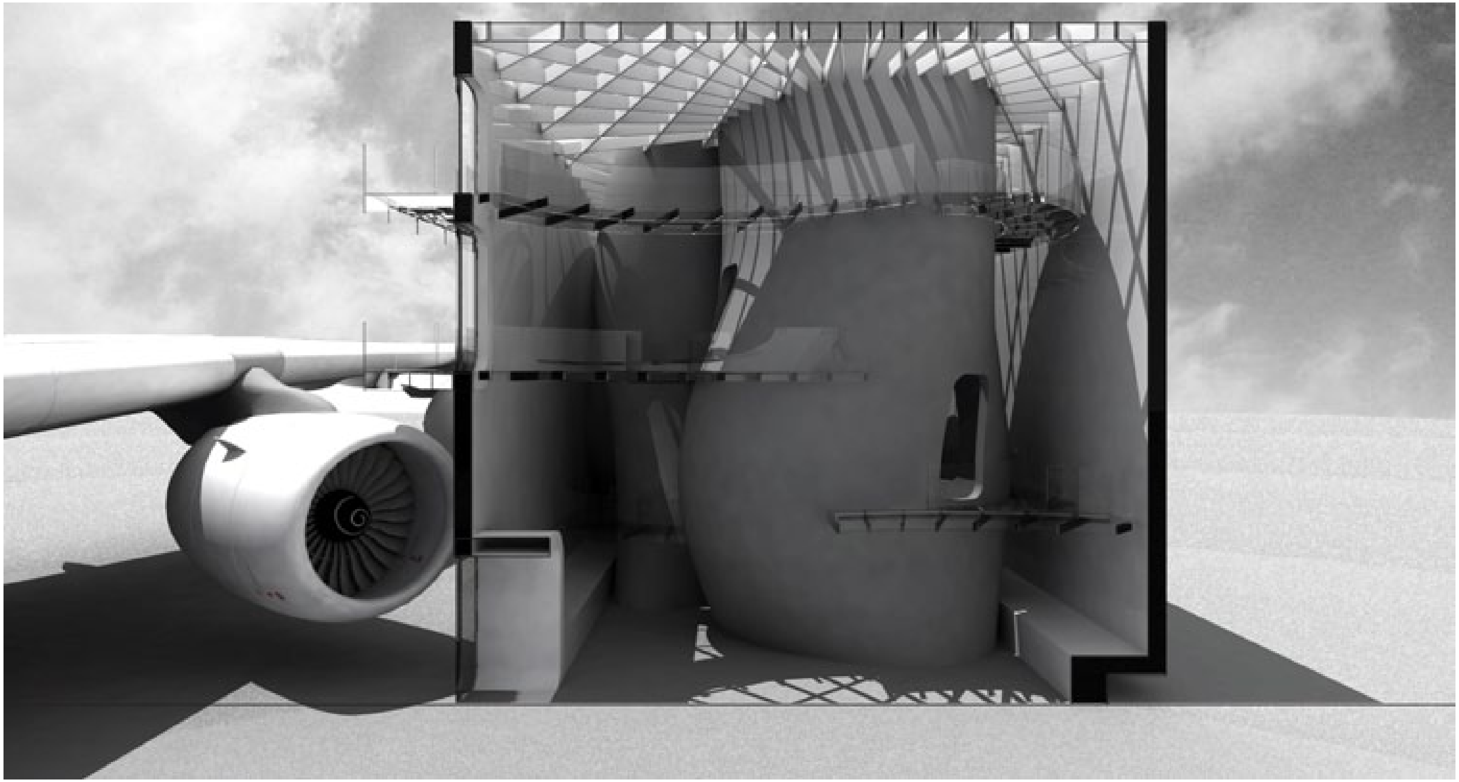


fig.0137 intake experience section perspective.tif

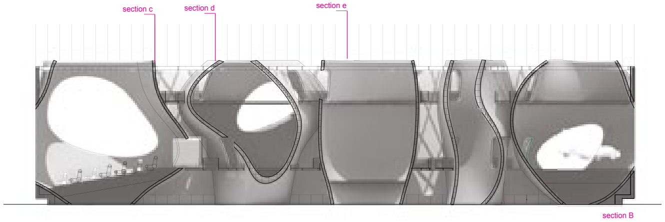


fig.0138 intake experience longitudinal section.pdf

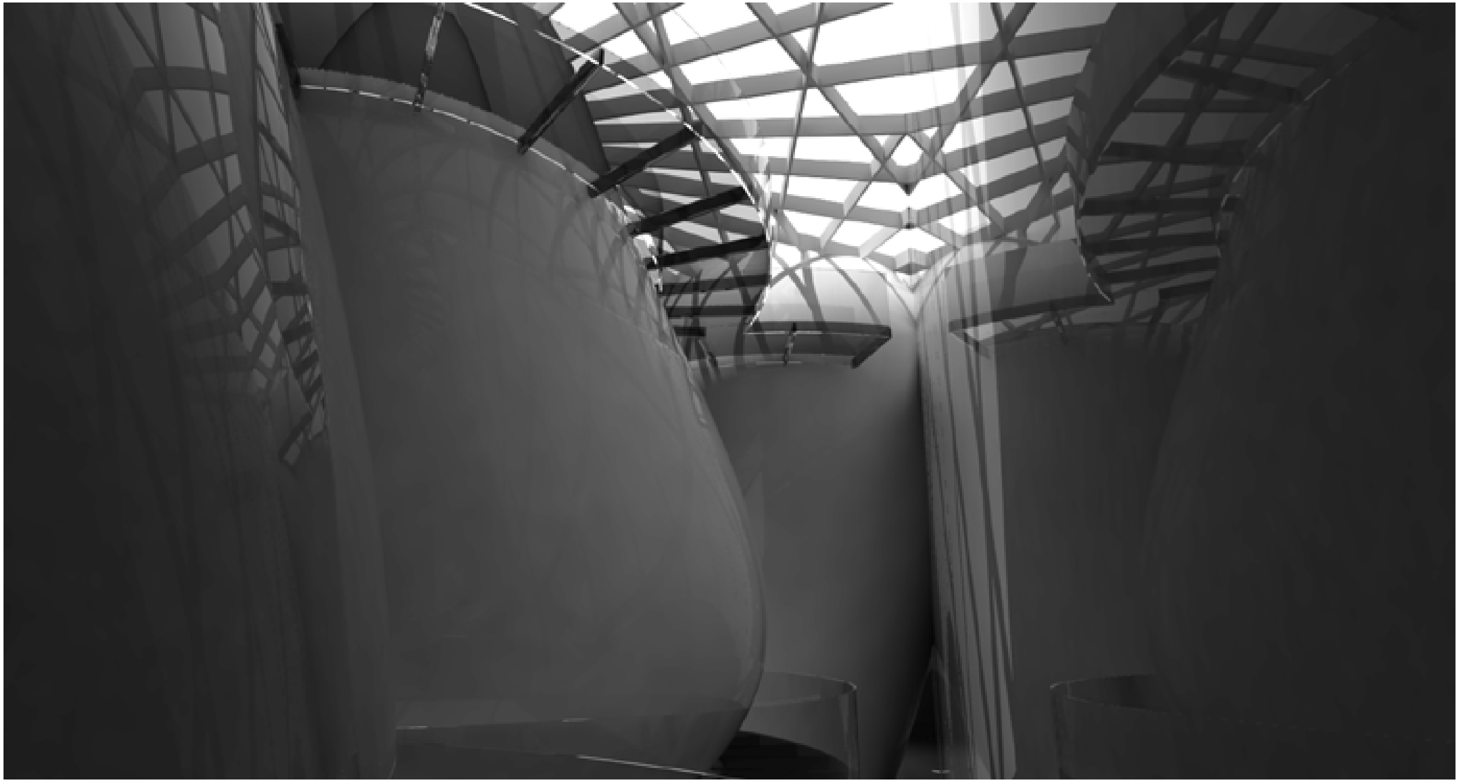


fig.0139 intermediary zone, interior.tif

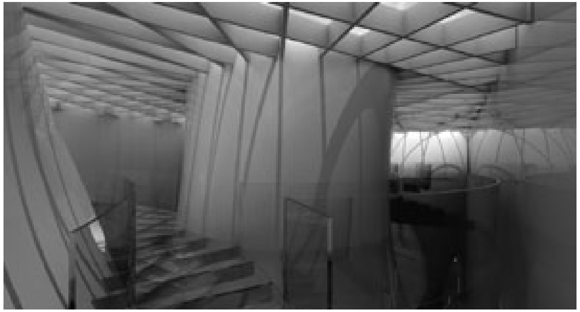


fig.0140 intermediary zone, interior.tif

The Airbus then functions as a memory device while one is inside, except when a view of the plane is provided to create a point of distinction [issue of scale between the airbus model and the airbus itself, power with the conference room and the engine, distance with the offices and landscape.] The interior's topological surfaces continue the dialogue of surface geometry and experience begun by the airbus itself, fully exploiting the possibilities of design and manufacturing processes used throughout the aircraft industry and placing them on exhibition, where the occupant circulates between genres of surface geometry.

The tectonic echoes the conceptual dialogue between genres of form-making – the collision of two inherently different structural solutions. The airbus's performative surface geometry and its concomitant [the topological interior of the intake experience,] are divided by the normative box. The carefully choreographed collision of the interior morphological surfaces with the box operationally erases surface or diminishes poche, creating aperture and at the same time the exterior graphic project - linking by view the morphological interior with the airbus for a prescribed experience. The autonomous structural systems of each morphing blob and the exterior box then converge to form a lattice of structural members holding up a translucent glass roof, creating the light patterning on the interior. ~

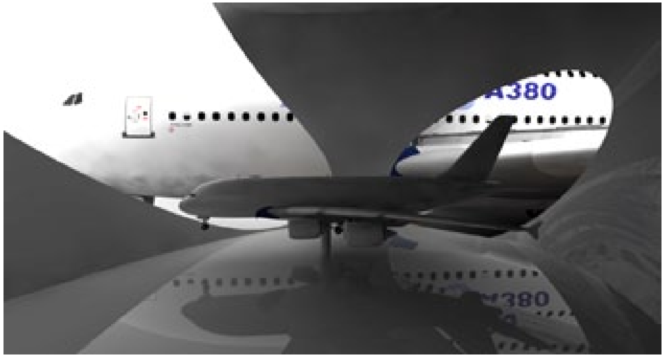


fig.0141 airbus model exhibition space.tif

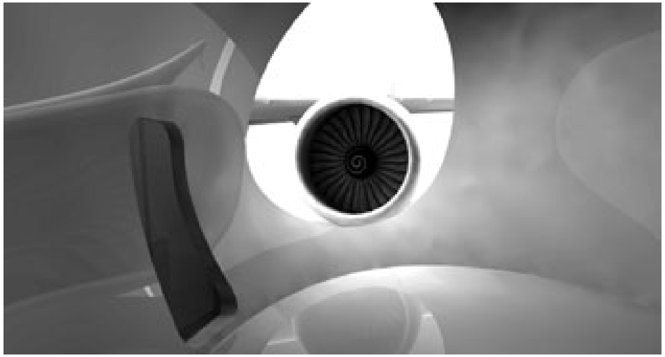


fig.0142 conference room.tif

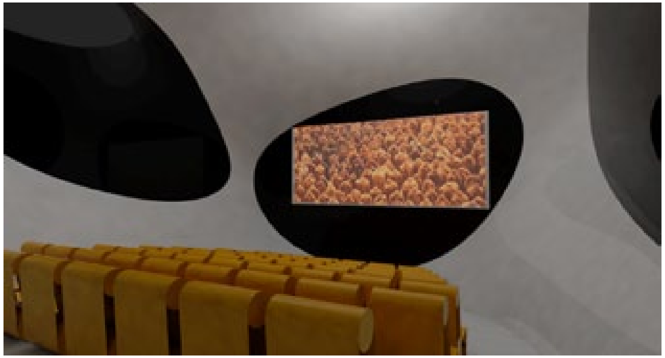


fig.0143 theatre.tif

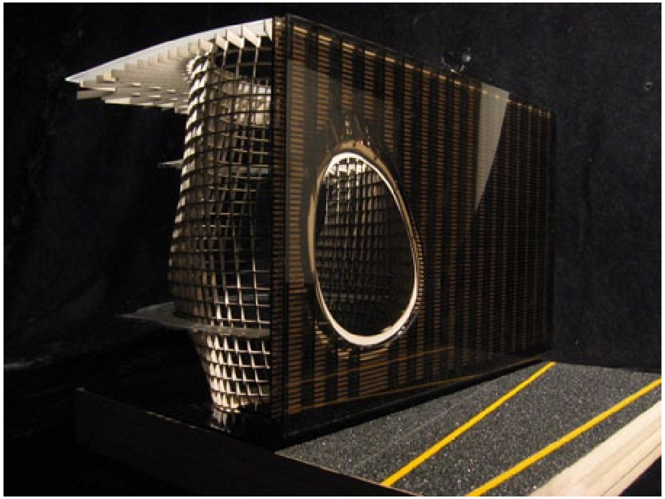


fig.0144 section model.tif

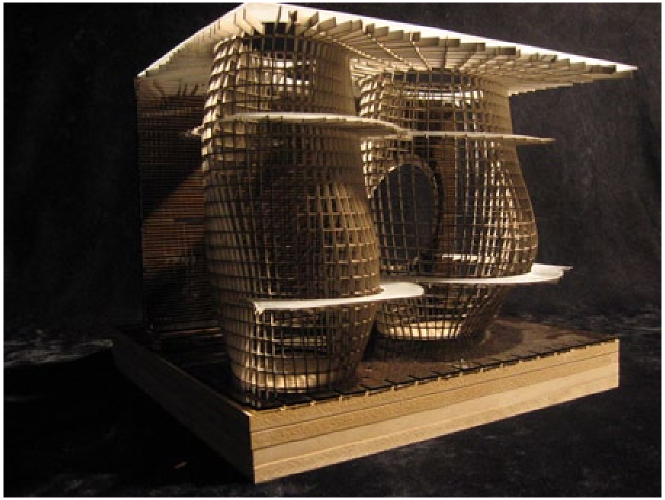


fig.0145 section model.tif

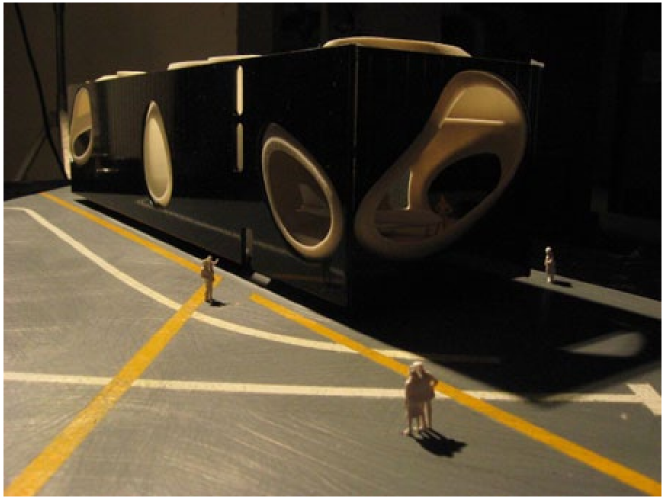


fig.0146 site model.jpg

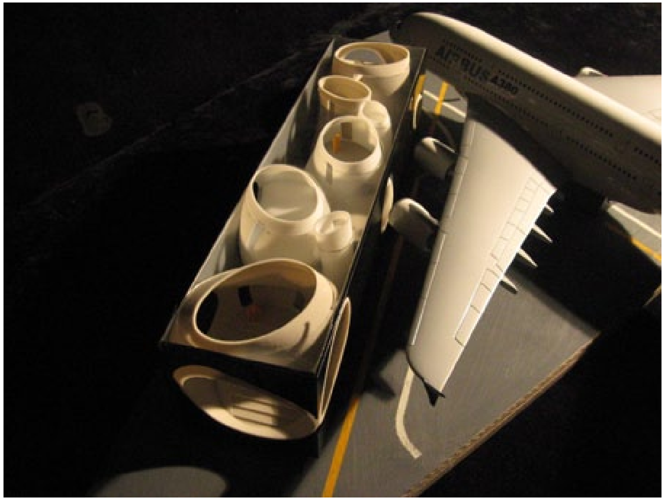


fig.0147 site model.tif

fig.0148 building d south elevation.jpg

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//* {*Building D & Knight Hall*} ::

{2007.05.29 ~ Professional Work : PBC+L Architects}

fig.0149 building d entry courtyard.jpg

Wake Technical Community College Northern Campus, Building D classroom and office building

Pearce, Brinkley, Cease, + Lee Architecture

Architecture Team: Doug Brinkley, David Hill, Marni Vinton, Matt Bitterman, + Jenny Olson.
Plumbing, Mechanical, and Electrical Engineers: Stanford White Associates
Civil Engineers: Mulkey Engineers + Associates
Landscape Architects: Reynolds + Jewell
Structural Engineers: Stewart Engineers + Associates
Budget: 28 million || Sq. footage: approx. 80,000
My time on the project: 2006.08.11- 2007.04.01 in CD's

This building is the forth on a new sustainably minded campus PBC+L has master planned, designed, and followed through construction. The masterplan maximizes favorable solar exposure to the north and south while straddling the existing wetlands. The first three buildings have been completed and occupied as of august 2007, and Building D was recently completed in 2009. All of the buildings on this campus will be LEED certified, and Building D reached Silver Status.

I joined the team at the beggining of the production of construction documents and saw them to completion. It is to the credit of my teammates Doug Brinkley, David Hill and Marni Vinton, and to the client Wake Tech. Community College to have produced such a sensible and responsible design for this campus and campus buildings, and I feel very fortunate to have been able to be a part of this project.

The building itself is attenuated along the East/West axis to maximize glazing along the North and South facades to more efficiently control solar exposure and maximize natural lighting. The building's tectonic is quite simple - a four story metal panel plane delineates the glass volume composed of classrooms + offices (etc.), and the stairs fall behind masonry and GFRC (glass fiber reinforced concrete) precast panels. The bent plane continues past the thermal threshold of the building to frame the main entry and create a plaza overlooking the stormwater retention pond below.

fig.0150 building d south elevation.jpg

This project was one of the first in our office drawn in Autodesk Revit, which turned out to be a wonderful tool. I was primarily responsible for the drafting and continual development (but not without the help of the whole office) of the plans, elevations, building sections, column details, curtainwall elevations, door details, door schedules, ramp plans and details, and the enlarged plans (toilet details.) It is also to the credit of our many consultants and engineers for their advice, patience, and hard work completing their portion of the construction set.

fig.0151 knight hall west elevation.jpg

Knight Hall was completed in 2009 as well and is a new building on the University of Maryland at College Park's campus. It houses the Phillip Merrill College of Journalism.

I worked with Shann Rushing and Maryland local architects Grimm + Parker to complete the Schematic Design phase of this project. The building has since been built, winning the 2010 AIA Maryland Citation Award. It is also the first LEED building on the University's campus, achieving GOLD-level certification from the USGBC.

fig.0152 knight hall north elevation.jpg

fig.0153 david ~ detail.JPG

::000_N::

//* {*The Breakfast Series*} ::

{*2007.05.07 ~ The Morning Times Gallery ::* April 6 ~ 30, 2007
10 E. Hargett Street :: Raleigh N.C. 27601}

fig.0155 robin ~ 6ftx4ft.tif

fig.0154 jenny ~ 6ftx4ft.tif

fig.0157 untitled ~ 6ftx3ft.tif

fig.0156 kyle ~ 4ftx6ft.tif

fig.0158 david ~ 4ftx6ft.tif

fig.0159 carrie 6ftx4ft.tif

fig.0160 carrie ~ detail.JPG

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//* {*Van Interior*} ::

{*2006.04.01 ~ Extracurricular, Professor Jeremy Ficca*}

fig.0161 van interior ~ looking forward.jpg

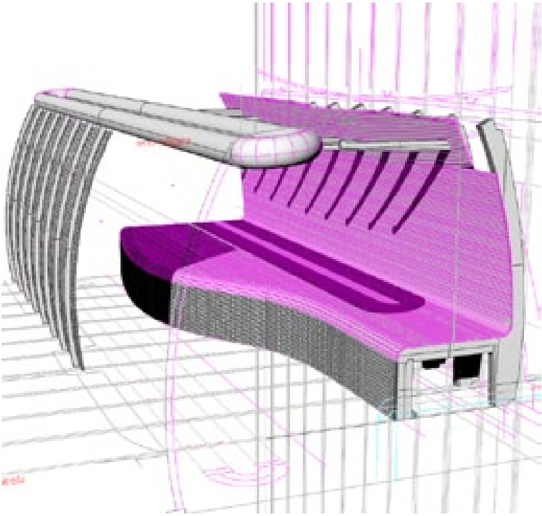

fig.0162 rhino model.tif

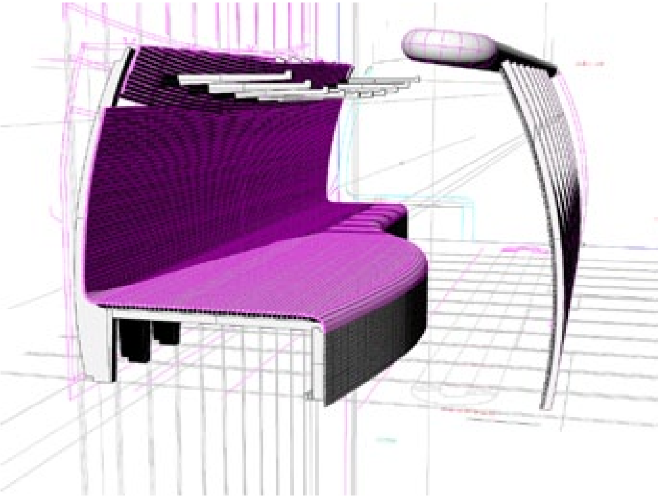

fig.0163 rhinomodel.tif

Materials :: 1 Ford E-250 cargo van, 3 sheets of Spanish Birch Ply, Approx. 125 board feet of Poplar, PVC, Copper Pipe and Silver Solder, Steel for Swivel Base, Piano Hinges and One Old Window Unit Air Conditioner.

Program: Accommodate one full-time resident. A double berth, easily cleaned and safe culinary facilities. Air conditioning, screening and cross ventilation. An open gathering space near starboard doors. A swiveling passenger seat. House lighting and AC power, showering facilities and sink. All storage on the interior to avoid roof racks (therefore achieving better gas mileage). Storage to include space for two bicycles and five surfboards. All construction shall be lightweight (again to save gas mileage), and all storage compartments must be breathable to hinder odor accumulation.

Time Frame: Approximately four weeks, nights/weekends.

A week was spent on the computer designing the construction system and plan arrangement. The design was based primarily on the ergonomic considerations of living in an extremely small space with complex programmatic requirements. After generating the tool-paths , the structural frames were cut on the school's CNC machine. Their installation was guided by one computer splied and two pre-measured battens fixed to the steel shell of the van. Each frame is a laminate of two 3/4" birch plywood pieces laid 1'- 0" on center at each station point in the van, equating to 10.5" spans for the poplar- a reasonable distance to keep the strips small and lightweight. A window unit air conditioner was dismantled and suspended within the skeleton of the insertion, with the condenser outside underneath the van and the evaporator inside to cool the van during stationary use. An auxiliary DC house-battery bank and inverted AC receptacles was also installed.

After all the mechanical and electrical work was finished, the skin was laid. Consisting of poplar strips 3/8" x 5/8" in section, it is held in place by approx. 10 lbs. of fasteners. The fasteners are countersunk to accommodate plugs at a later date. The strips have had no problems resisting point loads. The poplar will remain untreated and un-surfaced so as to darken with age and wear. The water system functions independently. The stoves were concieved as pods built in the same language and materials as the sink, housed under the skin of the main insertion. The swivel base allows the passenger seat to rotate, capturing the space while providing a comfortable chair to sit in. Water is stored in a series of standard 4" PVC pipes connected to make a container. Pipe connections are achieved with miscellaneous "Y" and "U" section fittings to allow for

fig.0164 underside.JPG

fig.0165 strip planking.jpg

fig.0166 planking detail.jpg

fig.0167 detail.jpg

smooth water transition in the gravity fed system. The container is easily filled with a standard garden hose and can hold 22.5 gallons of water. One showers outside through an attachable fitting either behind or beside the van. The system vent is directed to the sink, which drains overboard, allowing it to double as the plumbing system overflow.

The skin lifts on a piano hinge against the portside wall, exposing the electrical and mechanical infrastructure (batteries and air conditioner) for easy service. Primary storage space is found aft. The skin also opens at intervals for faster access. Future clothes storage to be constructed in the port wall will create 6" of insulation. The roof is left bare to later accommodate sky lighting and additional ventilation. The overhead storage arms change in height along the length of the van to accommodate the camber of a longboard so as to minimize the spatial impact below. The rack comfortably holds three longboards in its arms, and an additional three shortboards can be strapped to the starboard wall forward of the berth.


fig.0168 sink.jpg


fig.0169 stoves ~ storage.jpg


fig.0170 lid open.jpg


fig.0171 stoves and air conditioner.jpg

fig.0172 interior looking aft.jpg