Complex Curvilinear Surfaces in Composite Materials

by

Nancy Han Liao, 2001

B.S. Architecture
Ohio State University, 1997

SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARCHITECTURE
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FEBRUARY 2001

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Department of Architecture
January 19, 2001

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William J. Mitchell
Dean, Department of Architecture
and Planning
Thesis Supervisor

Accepted by: _____

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Principal Research Scientist in Architecture
Department Committee on Graduate Students Chairman

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Certified by: _____

Terry Knight, Associate Professor
Design and Computation

Certified by: _____

Edward Levine, Professor
Visual Arts

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ABSTRACT |

The thesis will propose a method of architectural design that applies the use of continuous and curvilinear surfaces. It will explore a method of engaging the continuous surface as an expression and response to the dynamic form-giving forces of the 1. functional / programmatic needs, 2. environmental and 3. metaphoric, all of which will be further elaborated in the Introduction. This thesis will be conducted with the understanding that these shaping forces, as well as materiality, are critical and complex design issues that can be communicated through the form-giving process by an exploration and application of a continuous and curvilinear surface constructed with composite materials in an urban site condition.

Thesis Supervisor: William J. Mitchell
Title: Dean, School of Architecture and Planning

To those whose priveledge to love is gratefully mine
and who love me still:

My warmest thank you to my Dearest Mama, Dad and brother, Sean,
for your unquestionable confidence and pride in me.
Your loving encouragement is with me always.

To Richard Truby, for sharing my hardest disappointments and quietest joys.
For bravely guiding me through my tentative steps into adulthood.
My rock star.

Lastly, to my grandfather, whose esteem for the architect inspires me still.

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Abstract |
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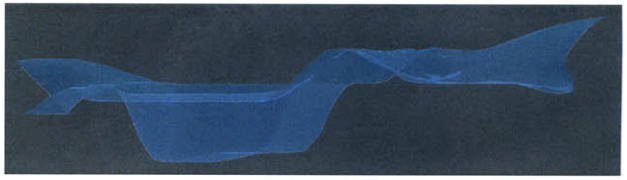


fig. 1: view of complex surface incorporating formal needs of program

Issue.One: the typology of curvilinear and continuous surfaces

Issue.Two: external and internal shaping forces that will directly influence the continuous surface into articulating the relationship among these forces

Issue Three: the historical context and significance of the exploration of surface

Issue Four: the set of design guidelines that will motivate the design process

Issue Five: the specific site and program to test the proposed design method

Issue Six: fiber reinforced polymers (composites) as the surface material

Issue Seven: the architectural outcome and product

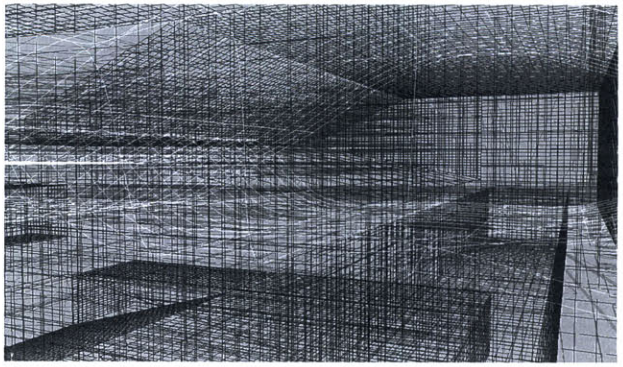


fig. 2: wireframe view of iteration 2

Introduction |
This proposal stems from the interest in continuous architectural surfaces and the complex set of physical and architectural forces that influence that surface as an expression of shelter, enclosure, forces and flows. Within the context of this thesis, "shaping forces" will be understood as (1) programmatic constraints and requirements, (2) environmental concerns of the site such as wind loads and natural lighting considerations and (3) "metaphoric" forces, among them, aesthetic, ritualistic-or the usage of the space over time, political, particularly spatially political issues of ownership and degrees of desired public sociability within the space.

There are many programmatic constraints to every architectural design endeavor that, unlike other creative fields, this pragmatic of design is an intrinsic part of the creative process. Square-footage requirements, suitable internal circulation and spatial organization of inter-functional parts is critical in creating an architecture that responds to its logistical and functional needs. Environmental forces are concerns that physically link the building to its site and landscape. To list a few are, building directionality and the possible need for natural light as a spatial articulator, boundary and enclosure, which is a particularly challenging issue with the use of curvilinear surfaces, dynamic loads such as wind and seismic issues, contextual issues of pre-existing building structure and architectural intent, and ventilation needs among them. Metaphoric issues are more complex than either programmatic / functional or environmental.

The program :

1 | A small/medium flexible auditorium space

2 | A viewing theatre for MIT-affiliated media arts

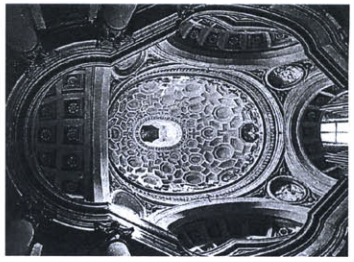
3 | A daycare center operated by the community

4 | MIT-maintained study carrols

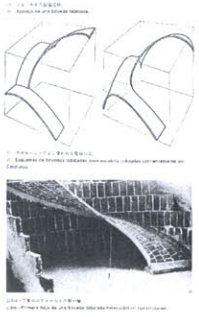
These issues consider the highly personal nature of design, in that every designer, even implementing curvilinear logics in the same site and landscape and with the same methodology to be clarified below, will interpret and generate those shaping forces in a highly variant way. The design motivations are complex and include an internal logic that often eludes further clarification or definition. Personal, aesthetic and intellectual motivations are among the metaphoric forces that shape, compress and stretch this initial surface into an element that responds to the complex issues of program, function and environment.

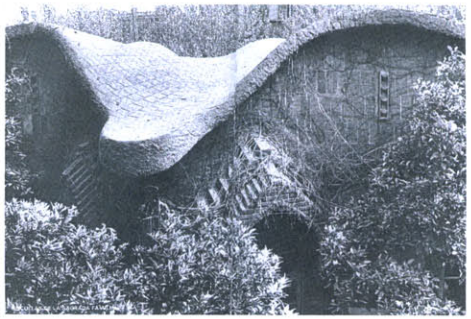
Historical Context of Exploration |
Until very recently, notions of surface have been limited to the Modernist sensibilities of either horizontal or vertical elements that express, perform and celebrate the singularity of function as expression. Surface was the "clarifier" of dynamic and variant experiences manifested as a clean sheet of transparency. LeCorbusier and a host of supporting thinkers such as Colin Rowe, then pushed the contemporary reading of surface to include complex plays on thickness, poché as well as and in relation to transparency that have extended the three-dimensional reading and experience of surface. Those including Frei Otto have challenged the normative concept of surface by creating surface as fabric, thereby fundamentally challenging the way contemporary architecture perceives surface, making it a fluid, buoyant, even kinetic component to an architectural event. As a direct result of architects and designers such as Heinz Eisler and Felix Candela of the 1950s and 60s, surface now has critical concepts of movement embedded into its form-making process and architectural considerations. With Deconstructivism, the formal interest was in the direct and literal expression of the fractured free elements of contradiction and conflict that collide and spar to form architectural spaces. I propose the curvilinear and continuous surface as the organizer and articulator for spatial organizations that are not necessarily non-hierarchical but that serve as arbitrage among a multiplicity of governing motives and needs.

Precedent studies



1659 | San Carlo alla Quattro Fontane, Rome
Interpreting forces on the sie to influence interior patiality and form; form is no longer an object in the round. It is an expression of its placement in the city fabric, directionality and axiality.





1909 | Escuelas de la Sagrada Familia, Barcelona
A bombardment of texture and movement in Catalan bricks and mortar is synonomous with Gaudi and Barcelona. It was his way of utilizing small components to create expressionistic surfaces that creates the highly individualistic. "neo-Gothic" aspect of his formalism.

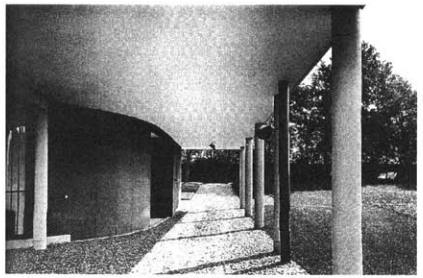
Technique of Form Generation |
To articulate surface as the organizer and expression of a "multiplicity of governing motives and needs," a new method of design must be proposed to engage curvilinear logics. A new terminology will be introduced to help define the actions upon the initial surface and may be elucidated as follows in a non-chronological order:

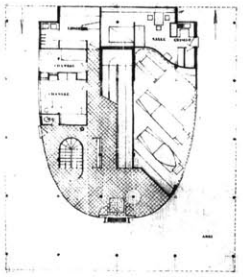
(1) initial surface: the surface in the site prior to "shaping."
(2) "lift": to bend the surface upward.
(3) "fold": to create a crease upon the surface.
(4) "slide": to shift laterally or vertically the areas articulated by the crease.
(5) "notch": similar to slot, but along an edge
(6) "punch": create an opening in the surface
(7) "push": to compress the surface on an edge
(8) "extend": to expand the boundary of the initial surface

...and so on. This terminology should lend a visual imprint of how the surface is to engage those shaping forces as form. Through this proposed relationship between shaping forces and curvilinear surface forms, a large-scale physical prototype will be constructed to demonstrate the quality of space a curvilinear surface may offer.

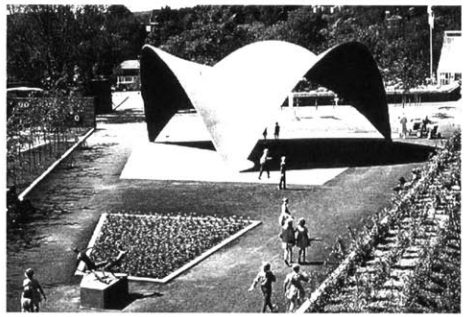
How a continuous and curvilinear surface is conceptualized is inextricably linked to how the designer approaches and engages the architectural design question. This proposal will suggest a new reading of surface that reacts to these dynamic and interrelating shaping forces as a **continuous yet heterogeneous system of needs**. In other words, the proposed surface engages curvilinear sensibilities that argue for "an active involvement with external events in the folding, bending and curving of form." (Lynn, Folds, Bodies and Blobs, Collected Essays, 1998)

Precedent studies (cont'd)





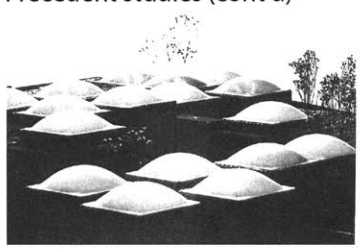
1928 | La Villa Savoye, outside Paris
Corb's use of a single sweeping curvilinear surface to articulate the "phenomenological transparency" of the experience of plan reinforces his Modernist arguement for piloti, which then makes possible the use of the ground floor as a garage for automobiles. The wrapping surface creates an object in the field of piloti



1958 | Los Manantiales, Xochimilco, Mexico
Modern thin-shell concrete architect, Candela implemented the hyperbolic parabaloid to express structure as form, not mass.

Normative processes of design and design methodology intrinsically edit and reduce the influences that engage the architectural process of form generation. To address the complex nature of how designers might begin to elucidate these numerous and seemingly disparate forces as communicative and inter-connected, I will implement the proposed design technique to generate a continuous and curvilinear surface as an alternative response to environments, contextual, expressive and functional needs. Designers need not remain tethered and restricted to what we can visualize through conventional means and discrete mathematical formulae. It is possible to systematically explore the curved surface in and as architecture through complexly-curved and continuous surfaces to communicate the interior functions, exterior forces and design motives into a dynamic architectural form.

Precedent studies (cont'd)



1957 | (left) Experimental House with transluscent pneumatic domes
These playful structures are the first to implement literal transluscency as structural skin into architectural experience using new materials.

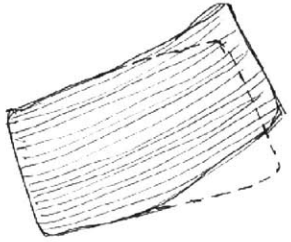
1959 | (right) American National Exhibition in Moscow
transluscent umbrella pavilions. Both by George Nelson

Demonstrating possible transformation conditions as a series of manipulations on an "initial surface."

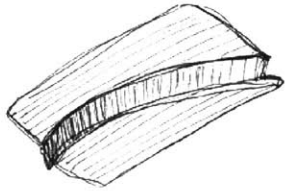
These manipulations will be logged to express the process by which a curvilinear surface could be generated.

Intuitive as well as performative issues can motivate the formal system of initial surface transformation.

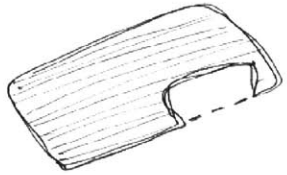
The surface(s) need not be considered wall or roof structures exclusively.



"lift"

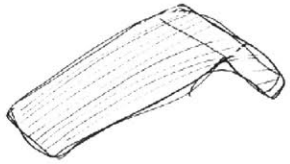


"crease"

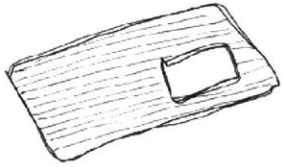


"notch"

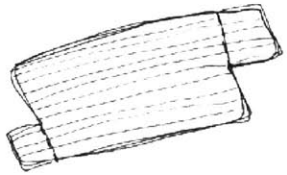
"push"



"extend"



"perforate"



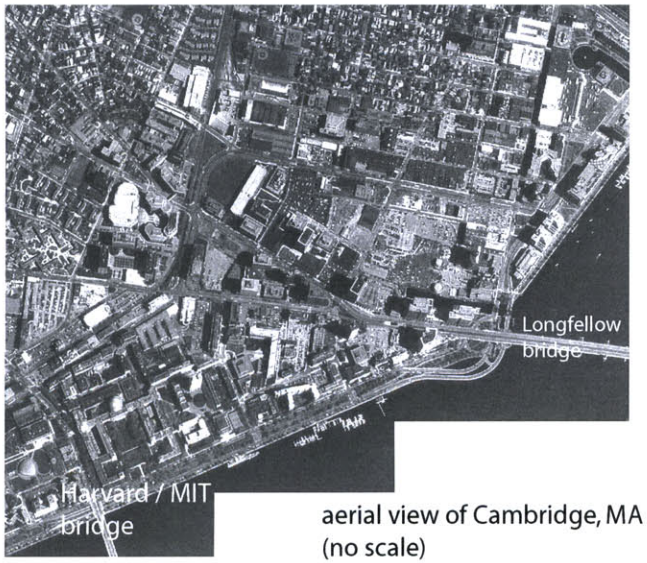
"slide"

Site and Program | **Technology Square, Cambridge, MA**

In order to test this new methodology of "incorporating" shaping forces through curvilinear logics, a site and program will be determined for its multiplicities of need and function and the variant flows through it. The program will be a multi-programmatic urban garden space in the Boston area yet to be determined. It will be considered a small urban insertion into a pre-existing fabric. The interior space designed must accommodate (1) individual and small group study rooms, (2) service and support program, (3) a reservable small to medium flexible auditorium space/ conference area serving nearby offices and businesses. The selection of program substantiates issues of programmatic interaction, pedestrian flow, cycles of spatial usage and traffic and arrival and passage. These programs articulate the multiplicity of flows and disparate elements and needs that cohabit as a complex system of urban intensification and local connectiveness. **How can we understand this small urban insertion as a complex set of motivations and influences through the use of curvilinear surfaces?**

pre-existing site condition: small-capacity carpark, facing west

view of the site facing east



aerial view of Cambridge, MA (no scale)

aerial view (no scale) of Technology Square and the main thoroughfares flanking it:

- Main St (south)
- Portland Ave (west)
- Cambridge St (north)
- train tracks (east)

Presently, Technology Square stands as a vast office park landscape that ensure security and parking for associates of relocated technology-oriented companies: Akamai, Forrester Group, as well as members of the Laboratory of Computer Science and Draper Laboratory, both MIT departments or affiliations. It is also undergoing a new urban design initiative from Sasaki and Associates of Boston

Site motivations |
The concept for Technology Square as a test site of curvilinear surfaces is its positioning between two zones: (1) an "old campus" spatiality and sensibility with MIT's traditional west campus.

Technology Square : the third zone

1

2

3

4

These views are of the site and its vicinity. There is a low-income, medium density housing community directly to the east of the site (image 1). Draper Lab's program calls for a secure office park (image 2) dominated by its corporate landscaping and spacious loading zone (image 3). A multi-level carpark is situated west of the main entrace to Draper Lab (image 4). The office park becomes the playing ground of local Cambridge children. Image 5 is an image of Forrester Group's new headquarters directly south of the multi-level carpark.

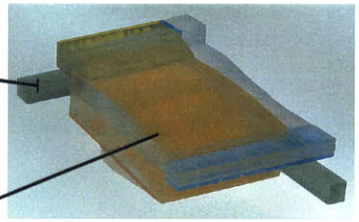
5

The buildings are situated around a Green and the interior space is organized around the "Infinite Corridor." Zone 2 is a largely undeveloped area MIT. New independent research and technology-service companies are slowly building and moving into these once empty lots.

Zone 3 is where Technology Square is located. It is wedged between these two zones as a volatile area undergoing extensive urban planning reorganization and a changeover of ownership.

To create an intervention that encourages visual exchanges, the child care facility will be a narrow "finger" of program protruding into the residual spaces of the site. The program model demonstrates an interlocking of programmatic elements.

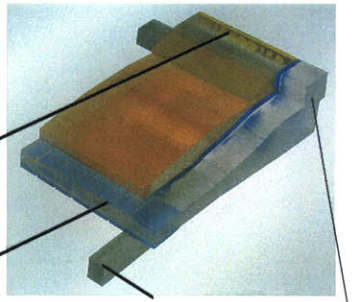
(1) child care facility and community space



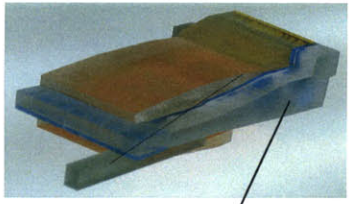
northeast view

southwest view

(2) auditorium space



axonometric view



northwest view

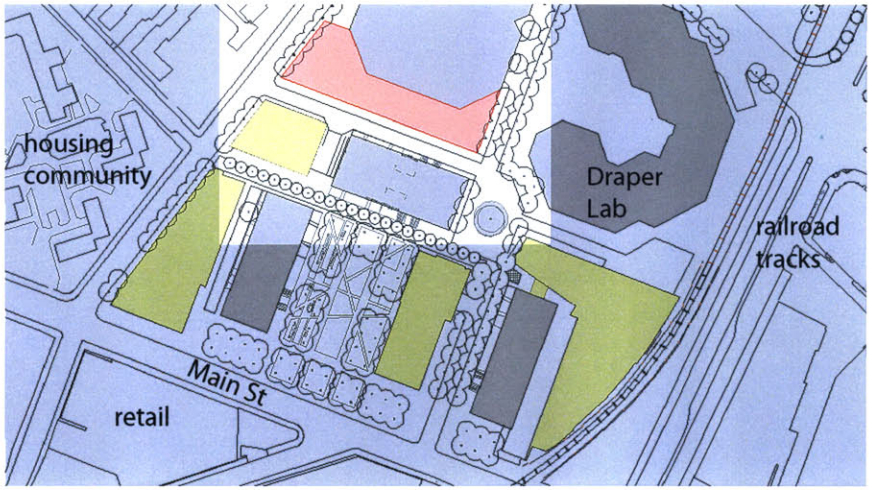
(3) media arts viewing box

additional shared circulation space maintained by MIT

(4) study carrols/rooms

double-height gallery support program for exhibition material

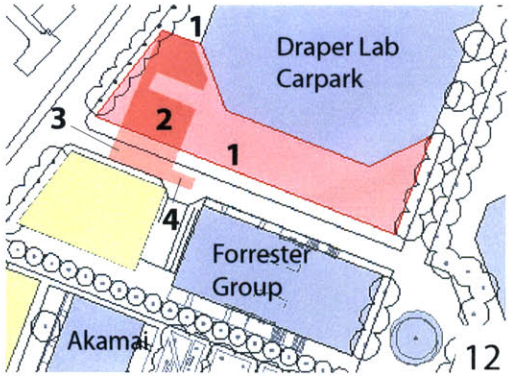
circulation space connecting to open-program community space



the test site

pre-existing

under construction



Method |
Design decisions are directly motivated by spatial needs -- for solid, compact yet flexible spaces of the study carrols and their interaction with the more public and overlapping spaces of gather. These needs will be articulated through the formal logics of a curvilinear condition. Issues of boundary and enclosure of the curvilinear surface will also drive the design response of this continuous yet heterogeneous system of interacting and connected elements.

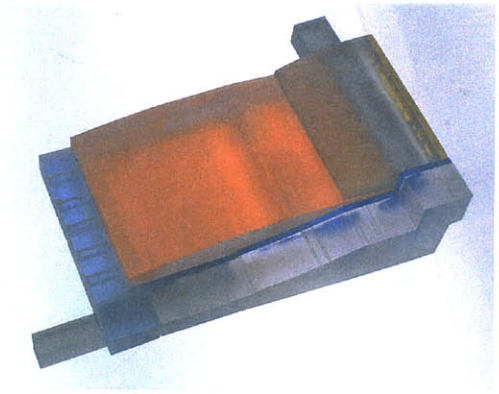
A crucial aspect to the design is the **differentiated ownership of individual, architectural programs**:

(1) MIT | the study carrols, Public circulation space, the new media viewing box

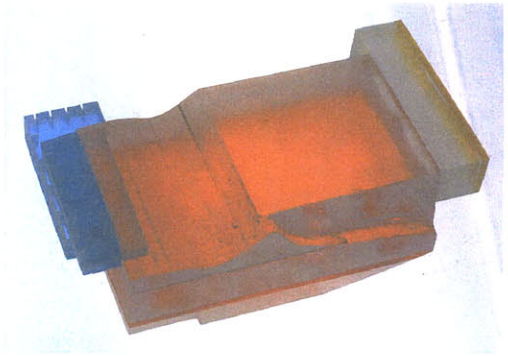
(2) City of Cambridge | day care facility and the un-programmed community space

(3) Collectively | the small-medium flexible auditorium space equipped with a secure digital server space

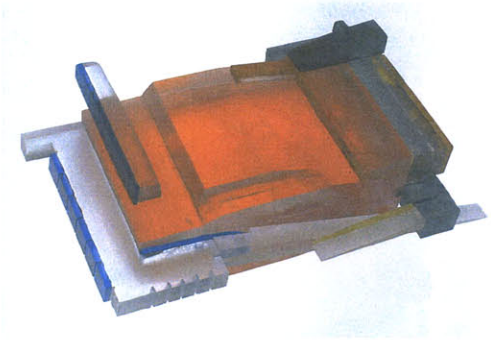
The theory for the thesis is to use curvilinear surfaces and interlocking program to create a more interactive social space, even if the interaction is merely through visual means., as with the proposed elevated day care facility.



iteration 1 | original program model

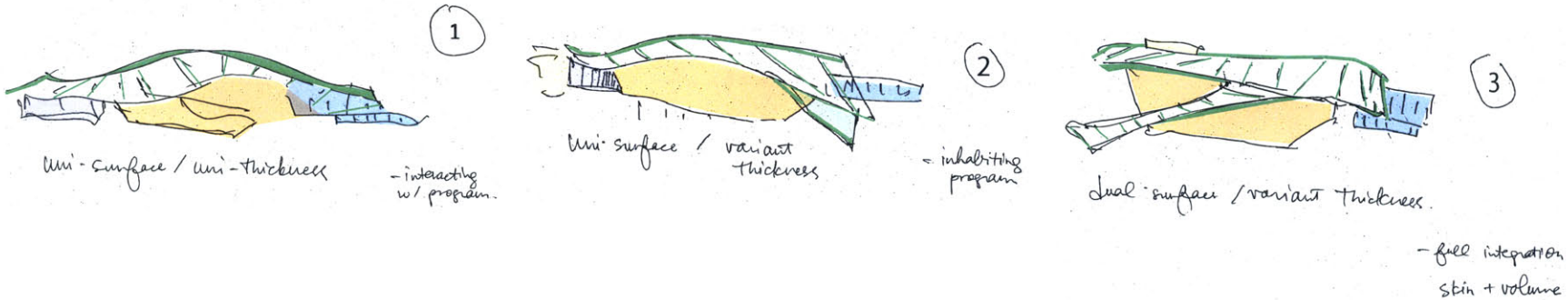


iteration 2 | modified program model



iteration 3 | modified program model

The method for testing complex curvilinear surfaces will involve three theories of architectural curvilinearity:
(1) One surface with uniform thickness (2) One surface with variant thickness to imply the volumetric needs of program (3) Two or more surfaces with thickness as more of a concept than a literal.

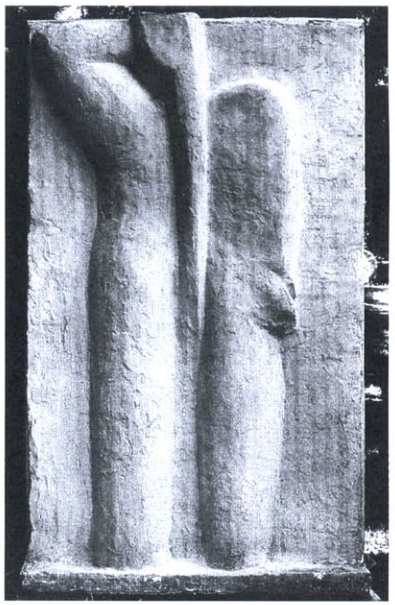


The theoretical concept of refinement and prioritizing the formal developments of the curvilinear surface(s) is inspired by this Matisse series, Back I-IV, 1908. The first piece is an initial gesture. The following panels begin the editing process, distilling his initial pass into an abstract and elemental expression of physicality.

I.

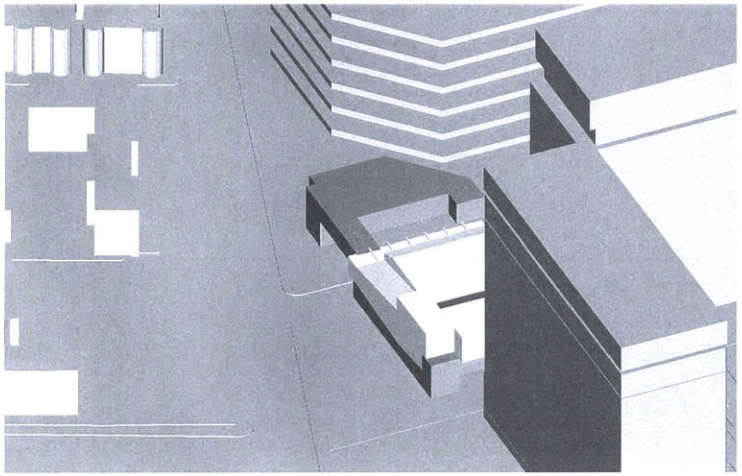
II.

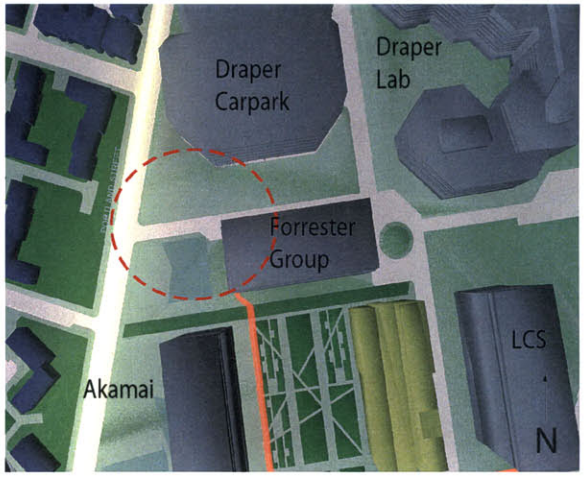
III.



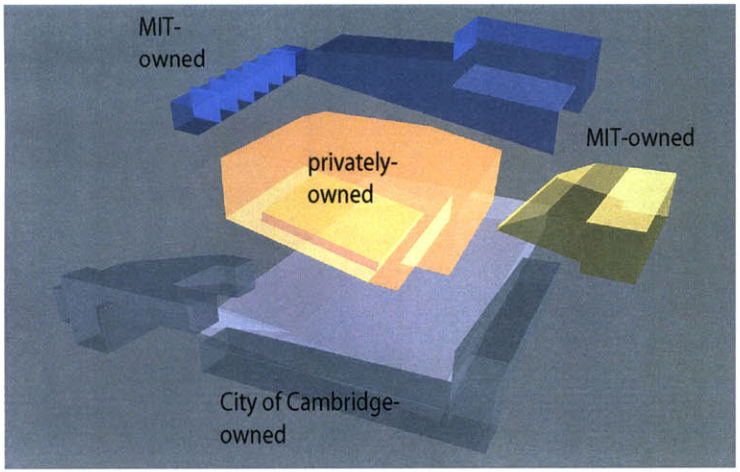
IV.

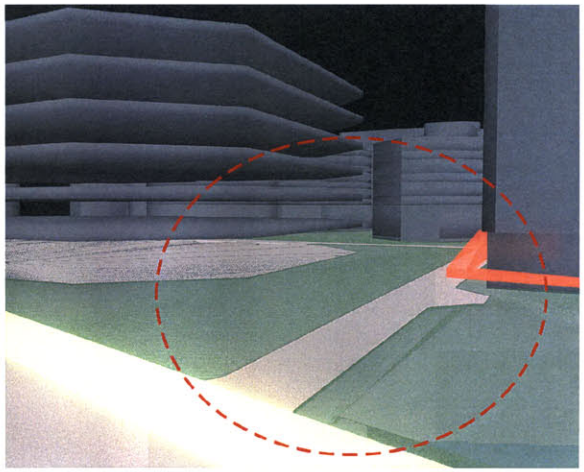
The site is replicated in a digital environment using Alias | Wavefront Maya Unlimited 3.0. The digital environment was chosen specifically because of its abilities to visualize and orbit freely about the design using "hotkeys" set for personal ease. Also, Maya is NURBS-friendly (non-uniform, rational b-splines), allowing the designer a flexible environment for building, editing, rebuilding and visualizing the design of curvilinear surfaces that would otherwise be difficult to design.





southwest view of the program model within the site



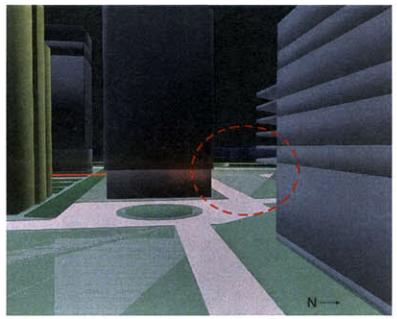


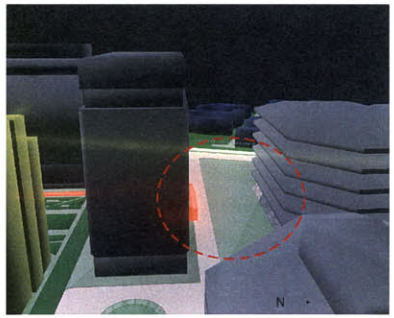
major car path

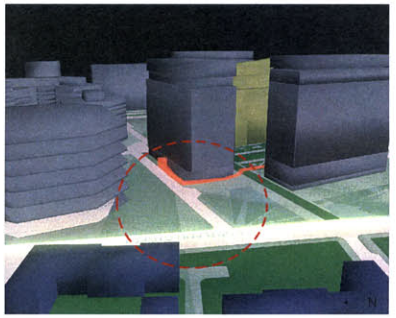
major pedestrian path

diagram of "active surfaces" upon which the environment applies "activator surfaces" that influence the formation of curvilinearity

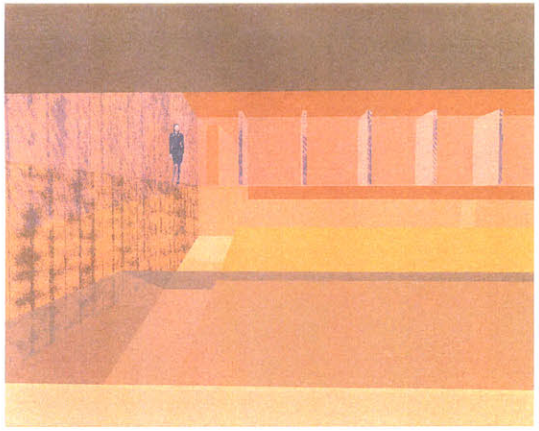
Additional views of the site in the digital environment



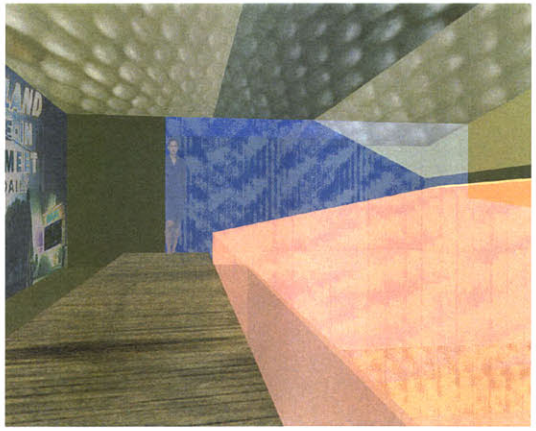




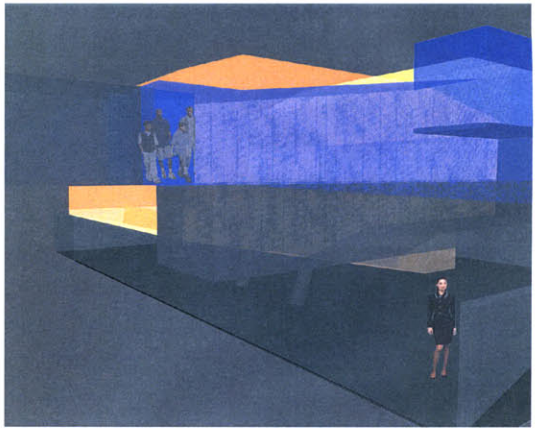
Pre-design views of the initial program model comprised of "activated surfaces," or "prgram volumes."



interior view of auditorium space, study carrols and shared, double-height circulation space



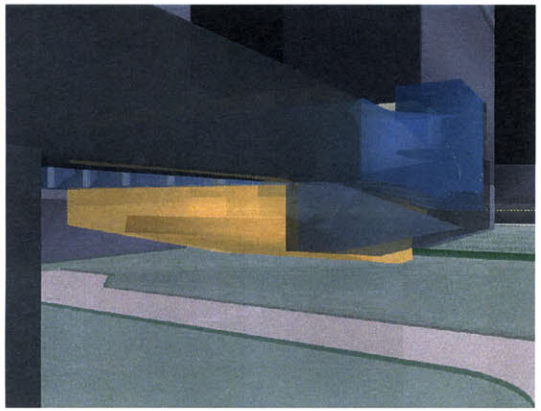
interior view of new media viewing box and the double-height gallery space



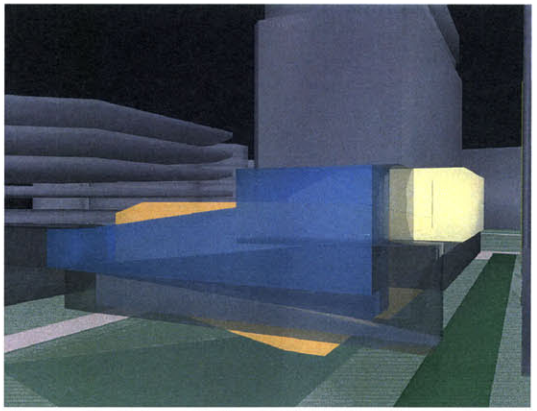
exterior view of sloped ground plane and shared, double-height circulation space

Pre-design views of the initial program model comprised of "activated surfaces," or "program volumes," in the digital environment.

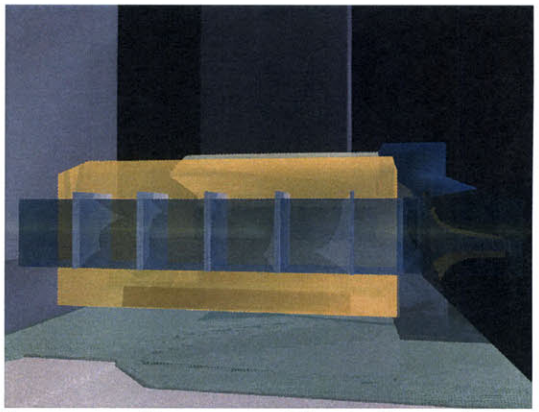
exteror views of intial program model



view of the circulation bar connecting gallery space and community space

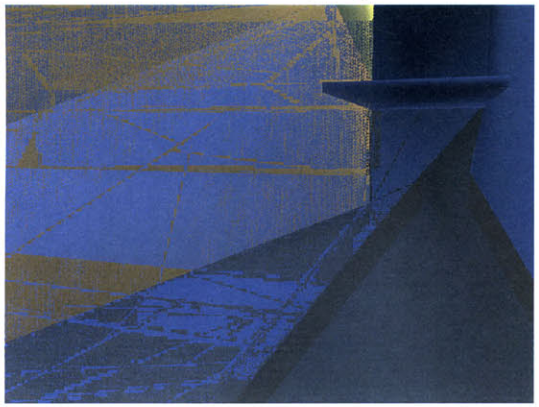


view of the shared circulation space

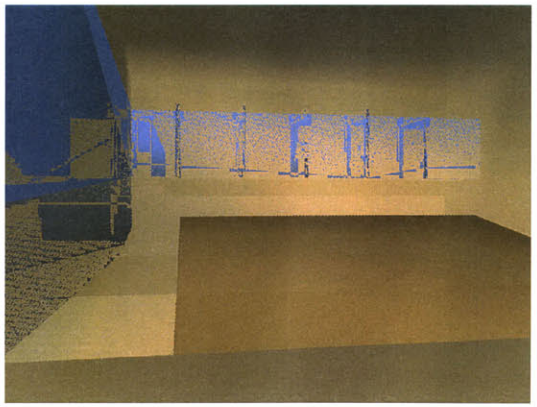


the community space and the study carrols share a view of ground level circulation space below

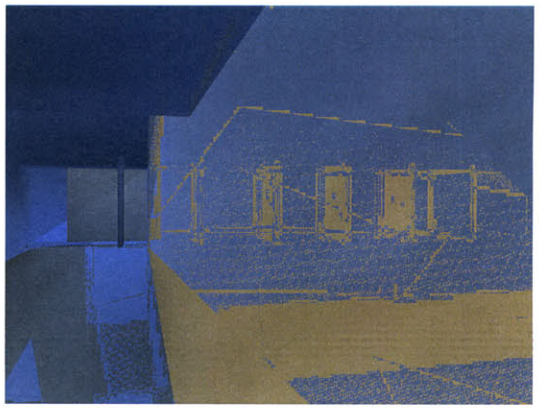
interior views of initial program model



interior view of circulation space, gallery above

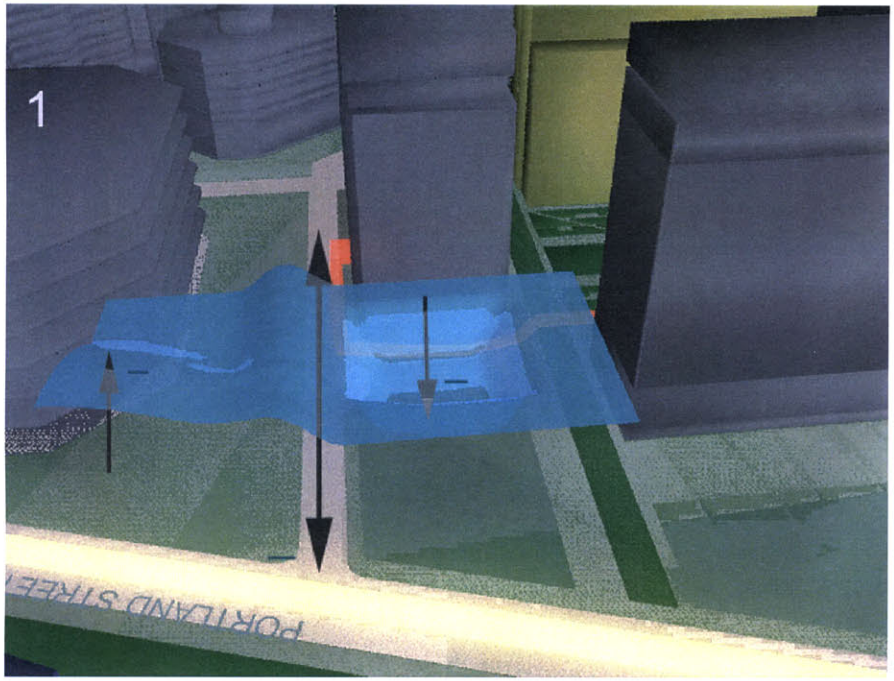


view of auditorium space



shared circulation space leading to study carrols

Design Phase | Iteration 1

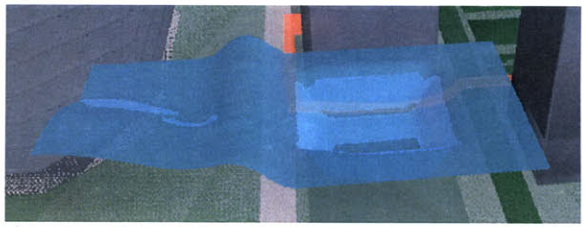


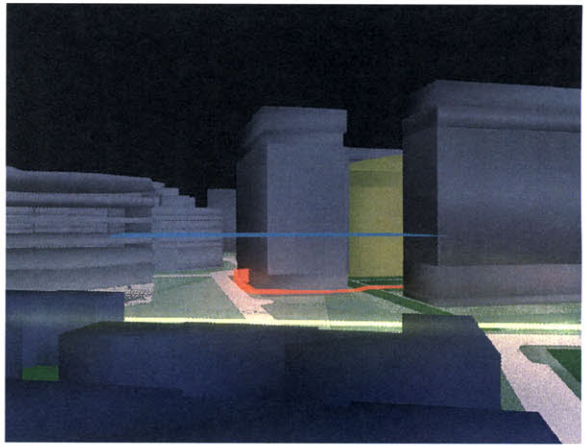
Design decision #1:
negative charge on the context surfaces

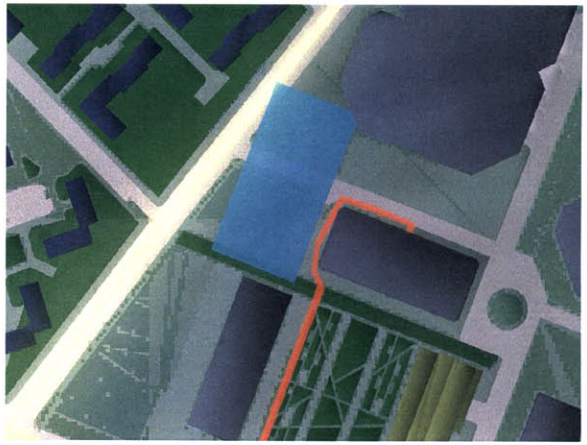
Design decision #2 :
"lift" of northwest corner to negotiate around the Draper Carpark footprint

Design decision #3 :
depress surface to imply auditorium volume

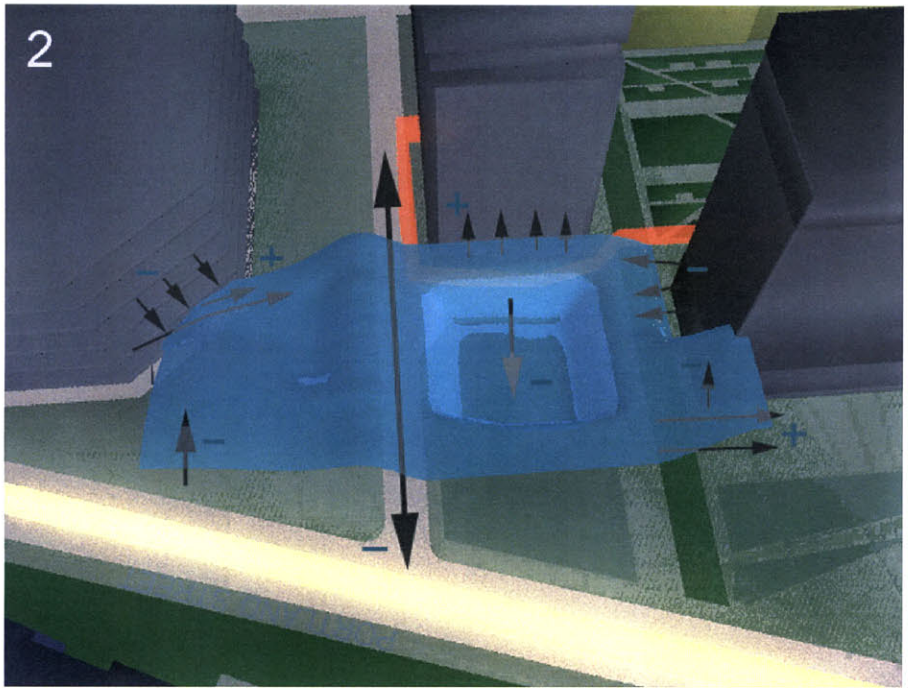
Design decision #4 :
funnel-like articulation of automobile/pedestrian path through site


close-up of the first three design moves


the initial flat surface @ 48' elevation


top view of the initial flat surface

Design Phase | Iteration 1 (cont'd)

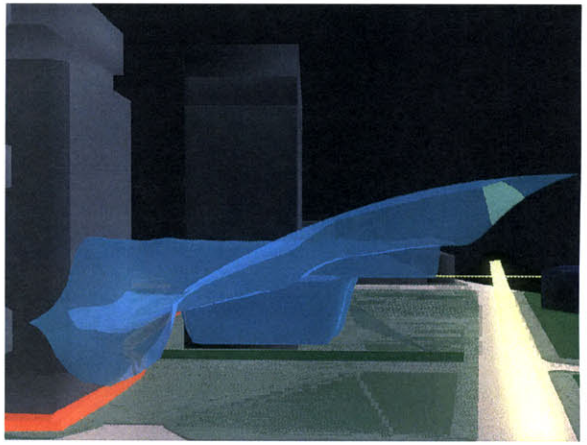


Design decision #5:

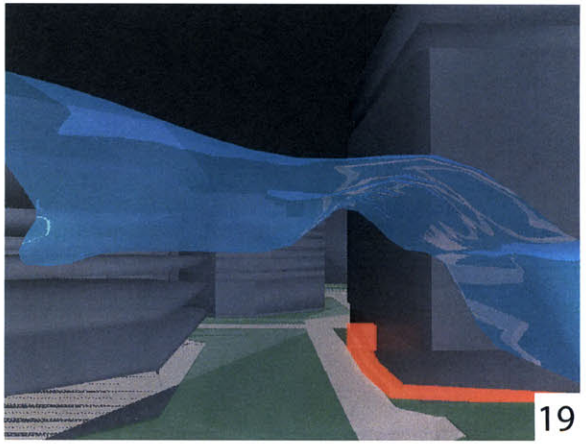
positive charge on additional moves to refine the footprint of the complex surface

In the first iterations, the concept was to now consider the complex surface seperate from the program model and to interpret this phase of the design process starting with a flat initial surface upon the site @ 48' elevation (top of the tallest surface, the auditorium space).

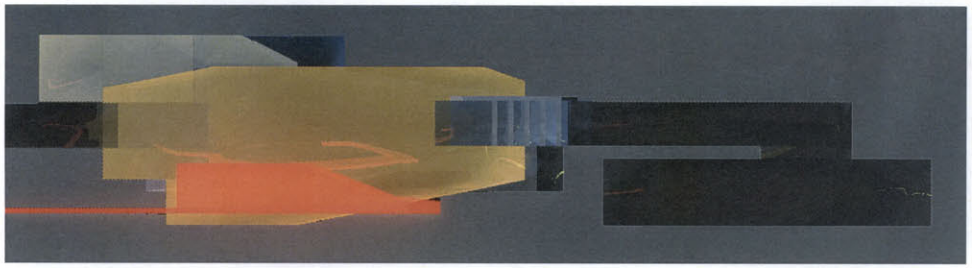
close-up of the subsequent design moves



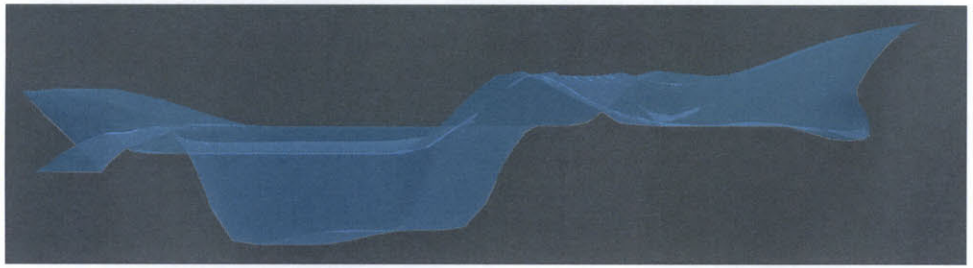
complex surface #1 after the initial design moves



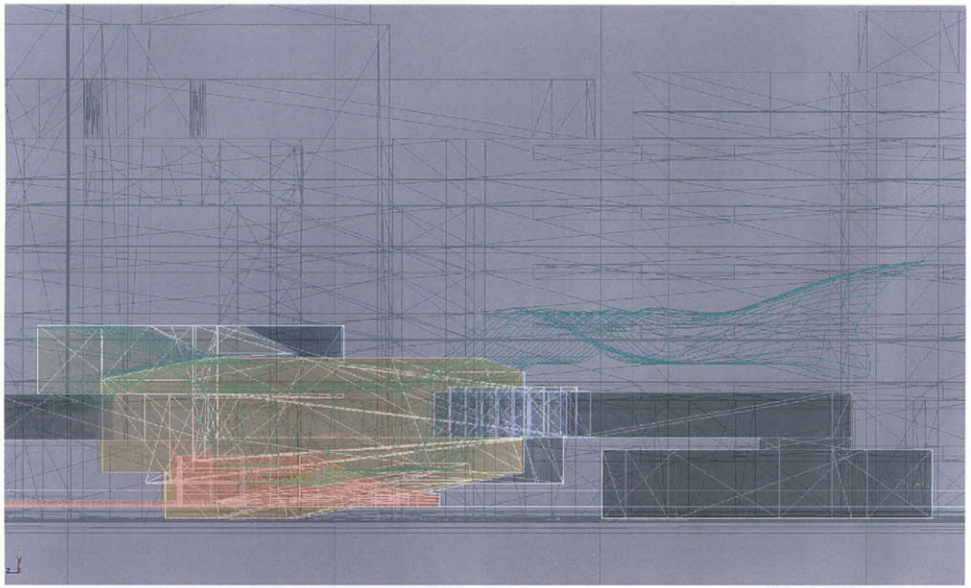
Design Phase | Iteration 1 (cont'd 2)



initial program model with pedestrian site path articulated in red



iteration 1 of complex curvilinear surfaces



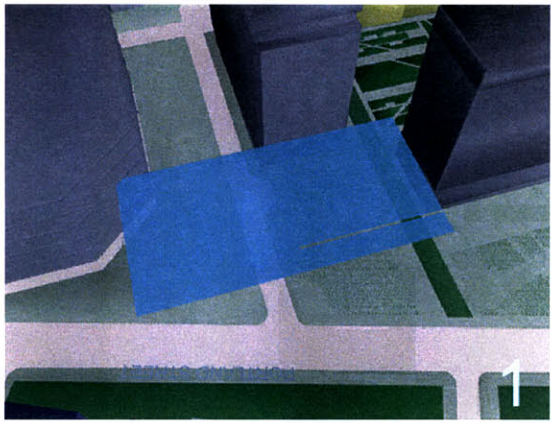
superimposition of iteration 1 and the initial program model

Iteration 1 was generated within the digital environment with the initial program model/ "activated surfaces" placed within the environment. All design decisions simultaneously considered the site and its "activator surfaces" and the initial program model/ "activator surfaces."

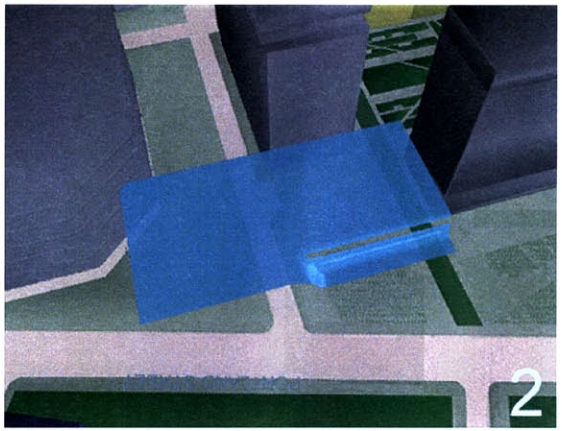
trial 3d print model

second 3d print attempt
of iteration 2

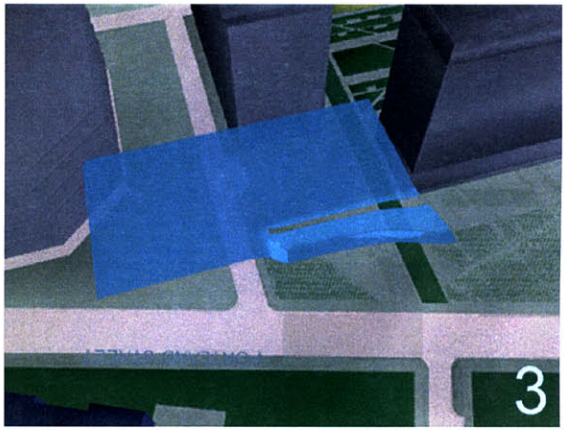
Design Phase | Iteration 2



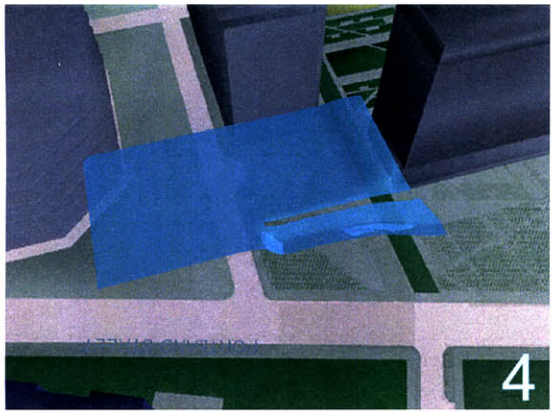
"slot" to indicate the axiality of the site and the footprint of Akamai



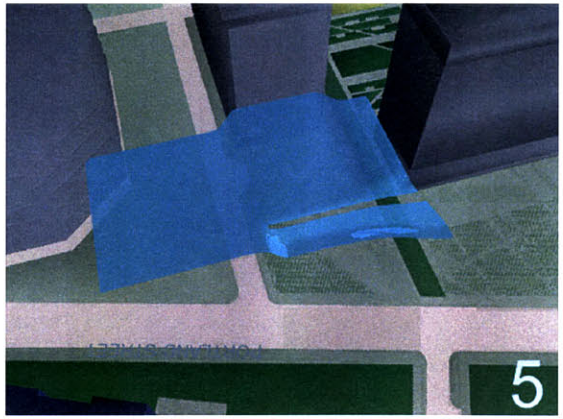
"depress" to create a walkable surface in preparation for the next step



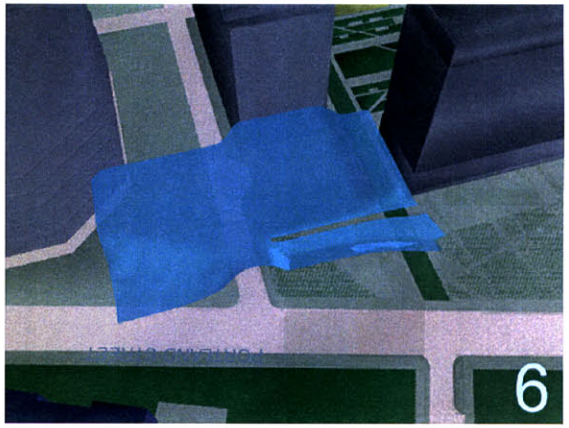
"stetch" and "lengthen" disproportionately to create a linear circulation space



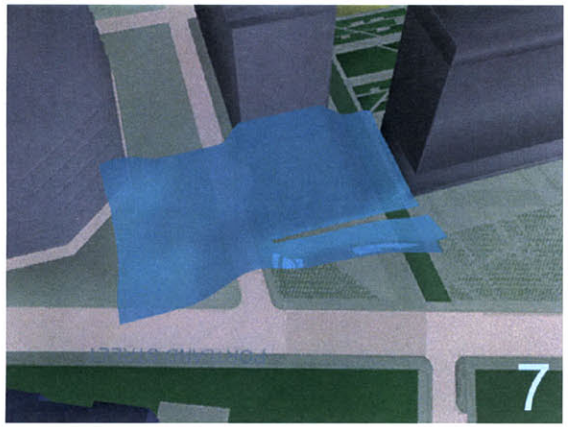
"punctuate" lifts the membrane to allocate space to the auditorium space, which is the least flexible of programmatic volumes



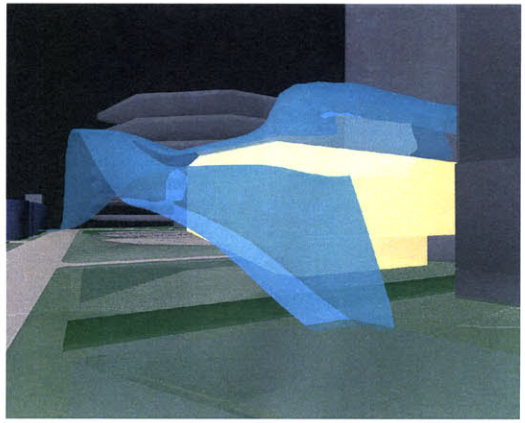
"tab" extends the surface to attach to the adjacent building (Forrester Group) to allow for multiple entries and exits

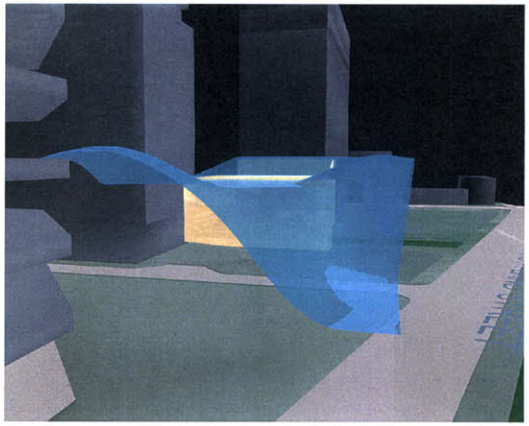


"depress" once again allows for a sectional differentiation of community space to privately-owned space of the auditorium

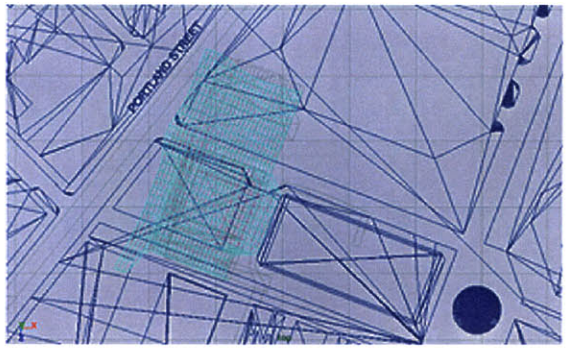


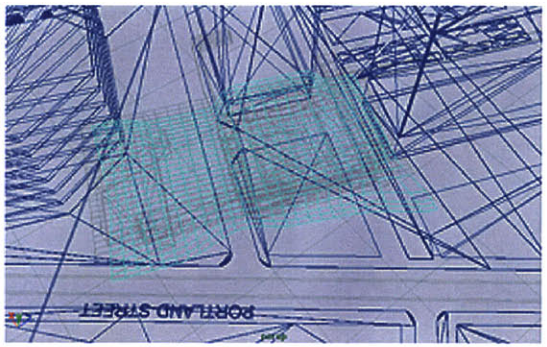
the final step in the development of iteration 2

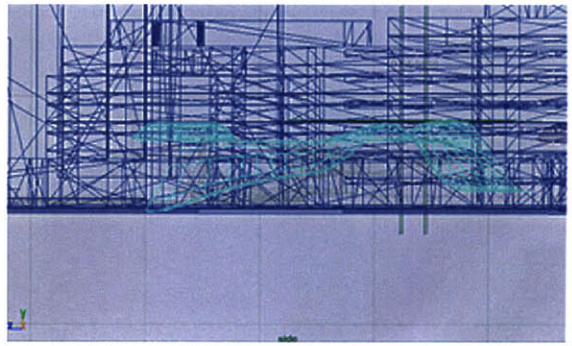




these images are including the auditorium space to give a sense of development for the interstitial space, the space inbetween the complex surface and the auditorium volume



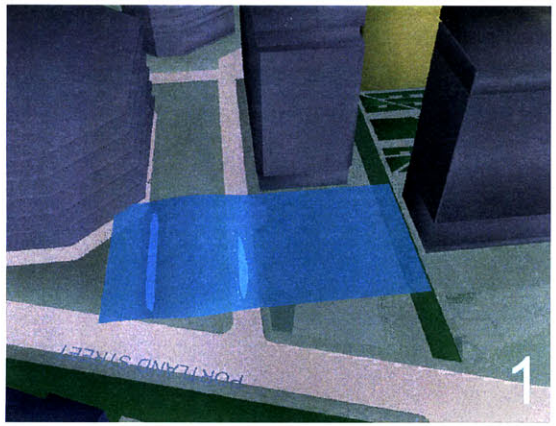




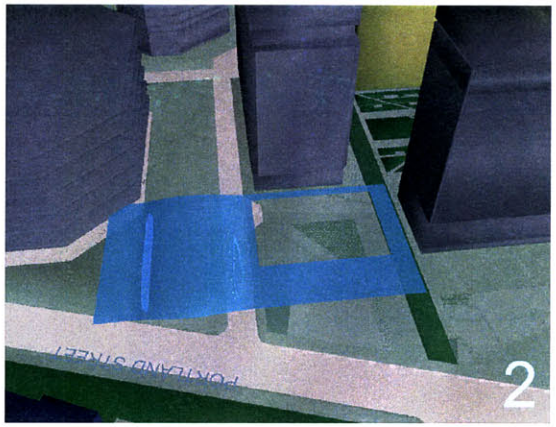
screen shots of the surface activated in the design environment

In iteration 2, the focus was on linearity or circulation and a "lifted" area to indicate the auditorium space rather than an indented one as in the previous iteration. The numerically organized screen shoots begin to narrate a log of design events.

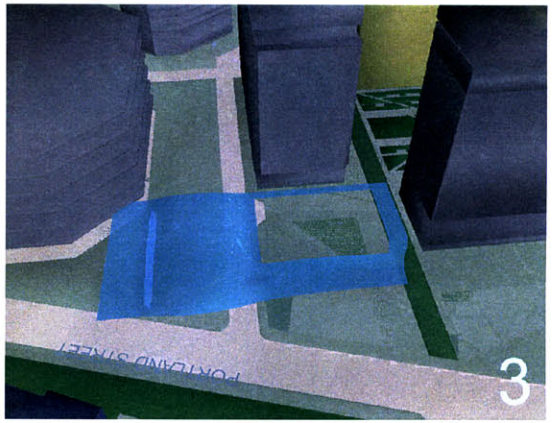
Design Phase | Iteration 3



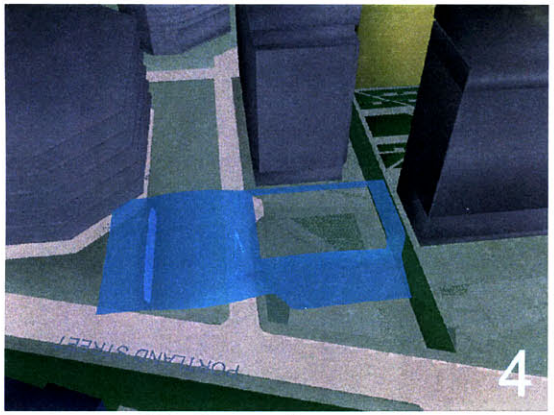
"punctuate" articulates the significance of the community space as a volume that relates in proportion to the auditorium space



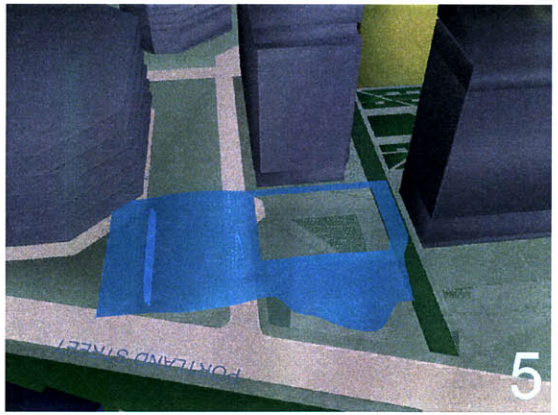
"punctuate" allows for the auditorium volume to be preserved while the surface continuous around it



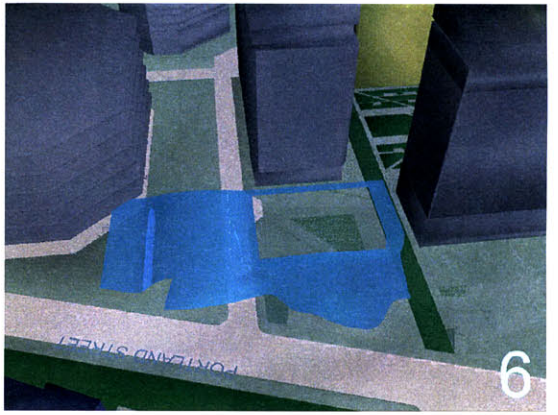
"stretch" indicates inhabitable space underneath the surface



"punctuate" lifts the membrane to allocate space to the auditorium space, which is the least flexible of programmatic volumes

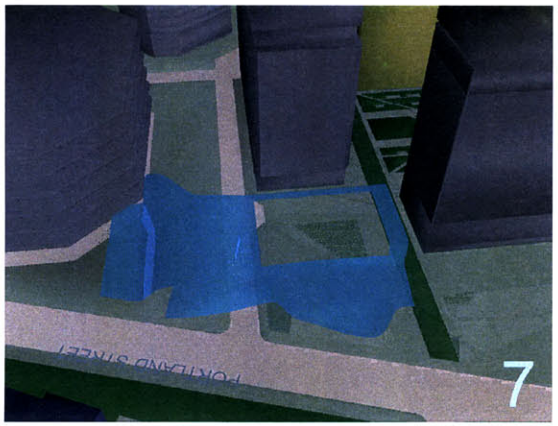


"tab" extends the surface to attach to the adjacent building (Forrester Group) to allow for multiple entries and exits

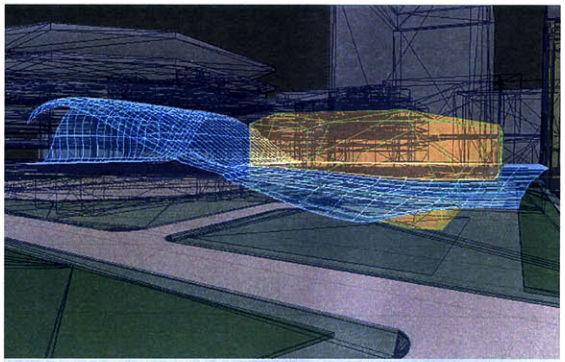


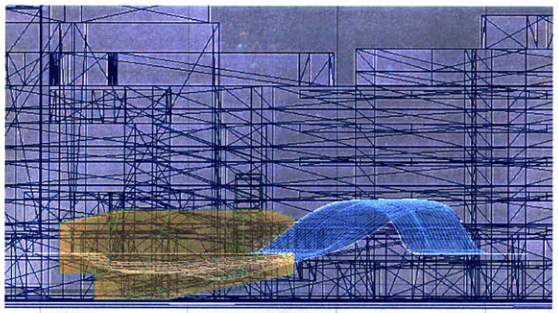
"depress" once again allows for a sectional differentiation of community space to privately-owned space of the auditorium

Design Phase | Iteration 3 (cont'd)

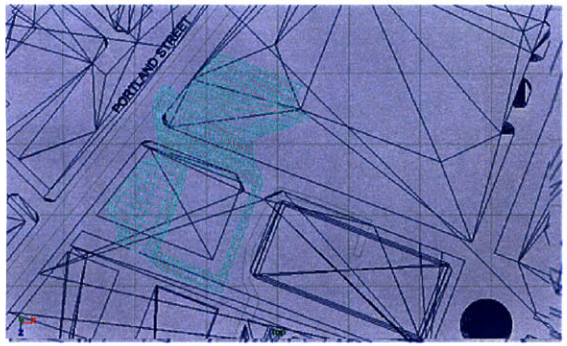


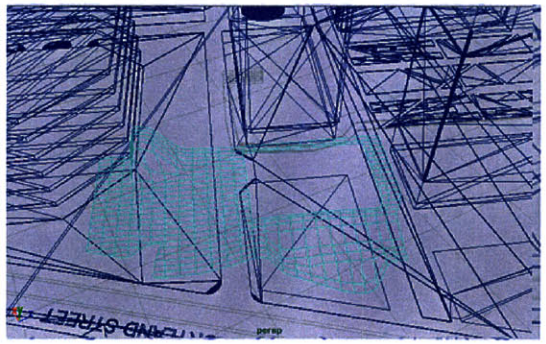
the final step in the development of iteration 2

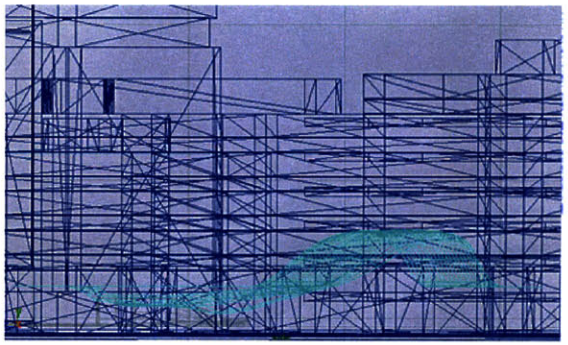




these images are as the previous ones. They include the auditorium space to better clarify the design decisions to puncture the surface in iteration 3



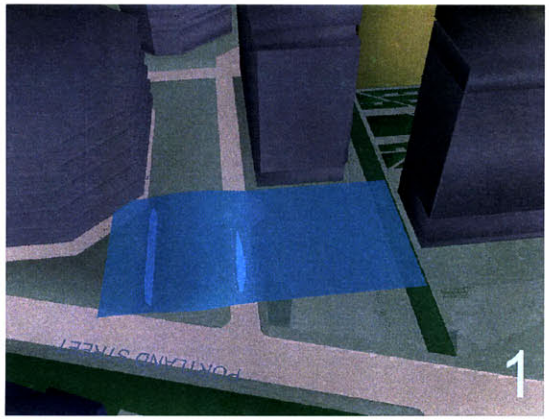




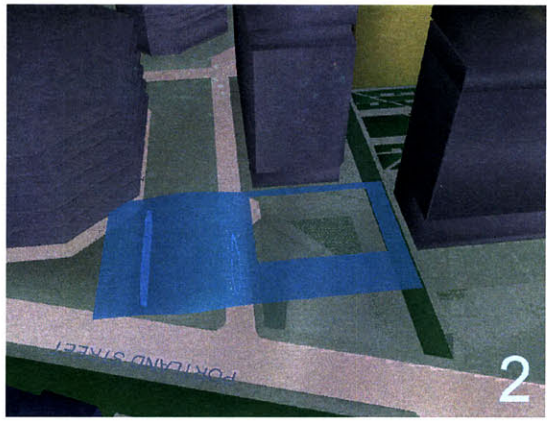
screen shots of the third surface iteration activated in the design environment

In iteration 3, the focus was on the volumetric accomodation of the auditorium space and how to create spaces neither interior or exterior, just as the surface is neither roof structure or wall structure exclusively. The idea was to architecturally communicate this subtle yet specific spatial integrity.

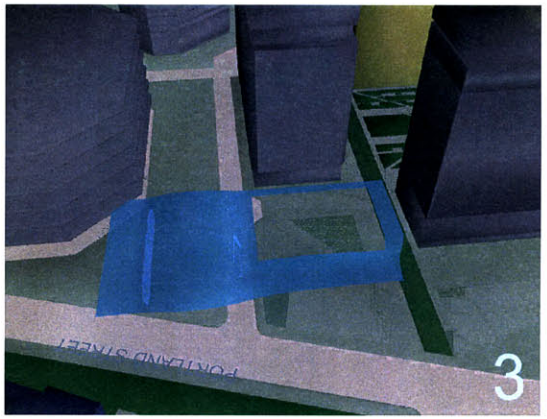
Design Phase | Iteration 4



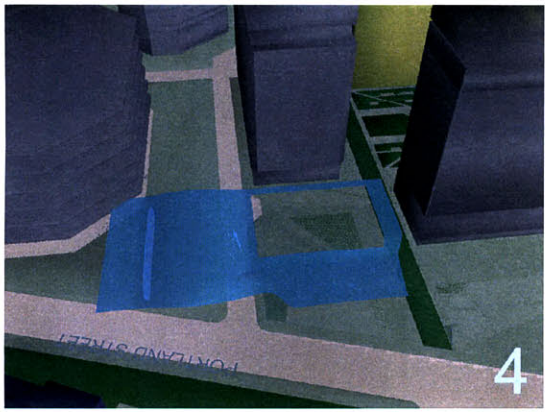
"punctuate" articulates the significance of the community space as a volume that relates in proportion to the auditorium space



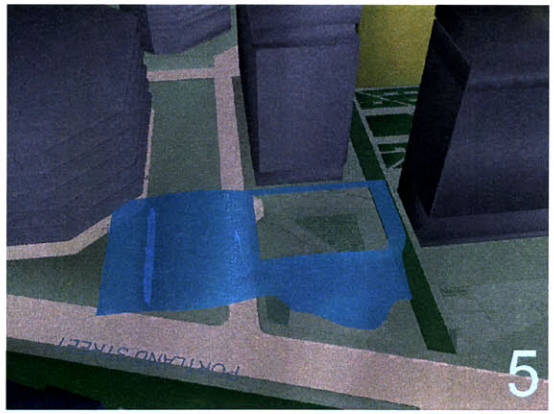
"punctuate" allows for the auditorium volume to be preserved while the surface continuous around it



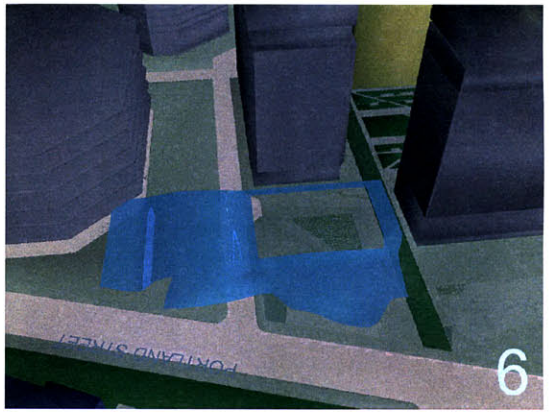
"stretch" indicates inhabitable space underneath the surface



"punctuate" lifts the membrane to allocate space to the auditorium space, which is the least flexible of programmatic volumes

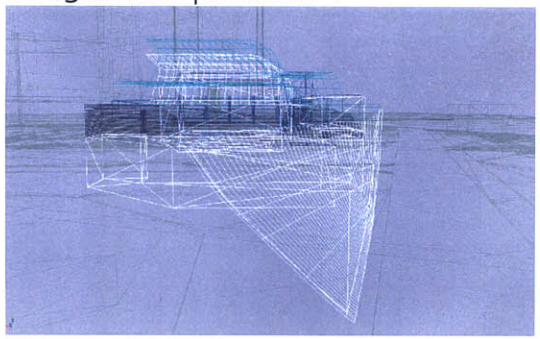


"tab" extends the surface to attach to the adjacent building (Forrester Group) to allow for multiple entries and exits

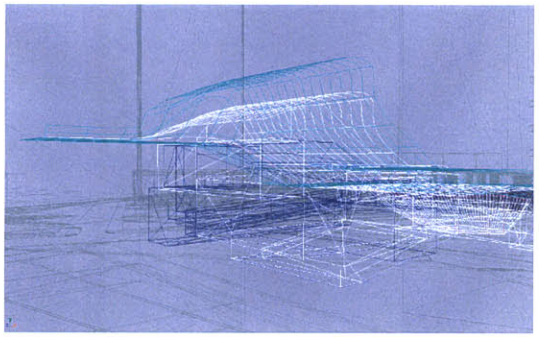


"depress" once again allows for a sectional differentiation of community space to privately-owned space of the auditorium

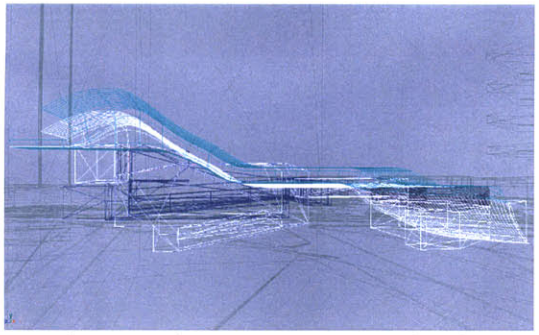
Design Phase | Iteration 4



looking south along Portland Street

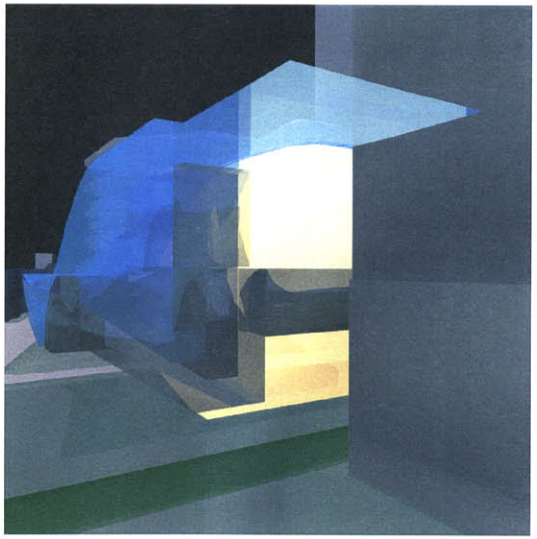


view of the dual surface interactions for the cinema box



east elevation showing interaction of surfaces and program volumes

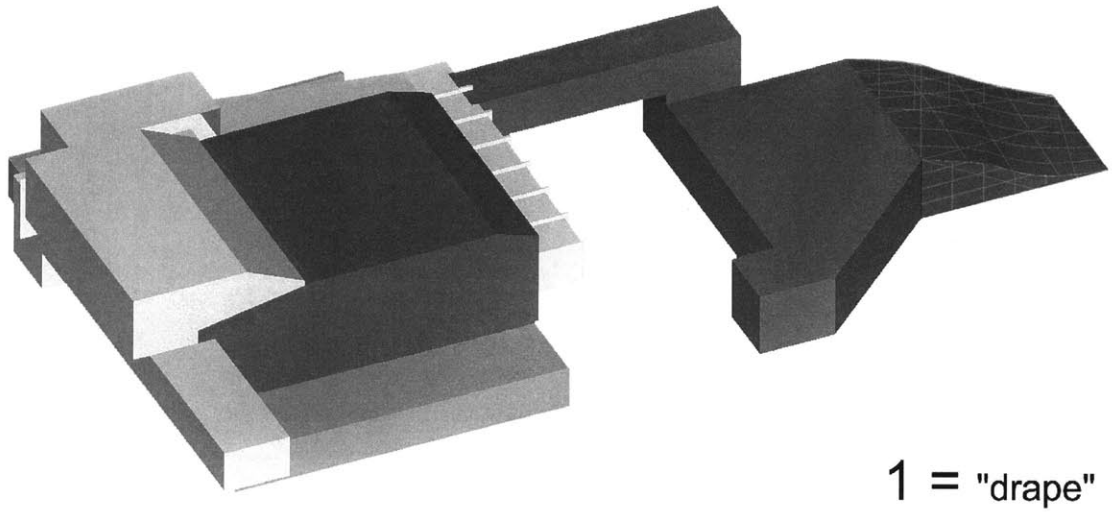
aerial view of the surface and program volumes interacting

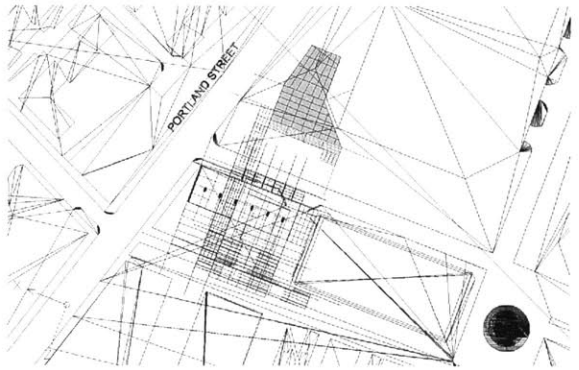


southwest view of the cinema box and childcare facility

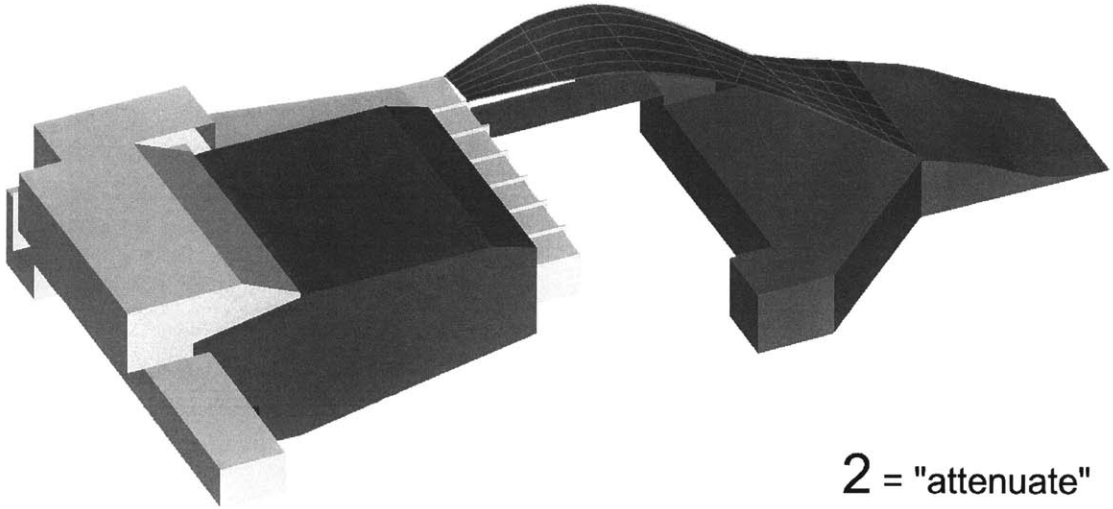
The final iteration attempts to inscribe the surfaces into the earth, creating a continuous movement from ground plane to roof surface. The program volumes are permitted to puncture through the surface, as well, creating another level of interaction between inside and outside spaces or interior and exterior conditions. These complexities are the motivations for using curves in the design process.

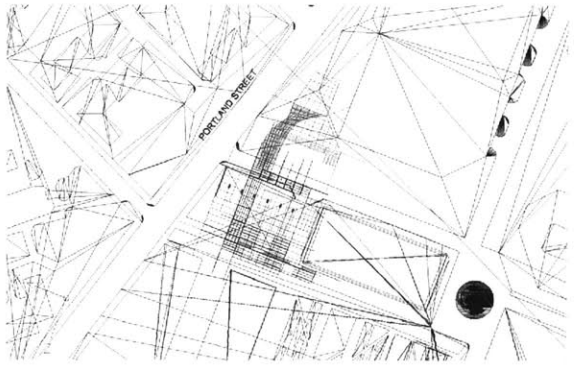
They may allow for complex spatial configurations with the self-referential programmatic volumes interracting with the surfaces and modifying their forms.



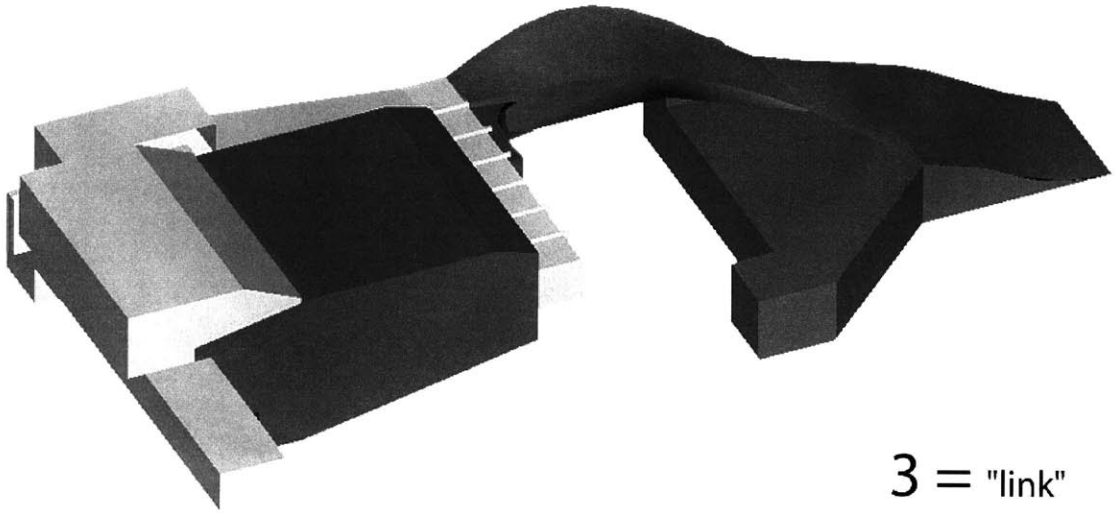


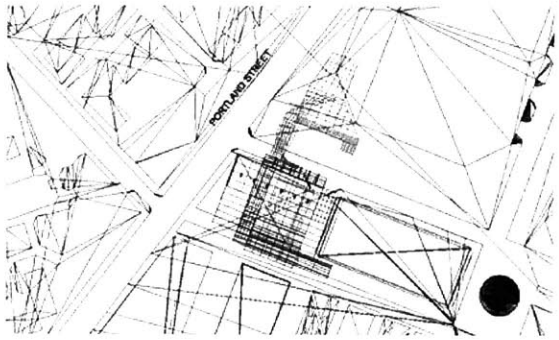
1 = "drape"



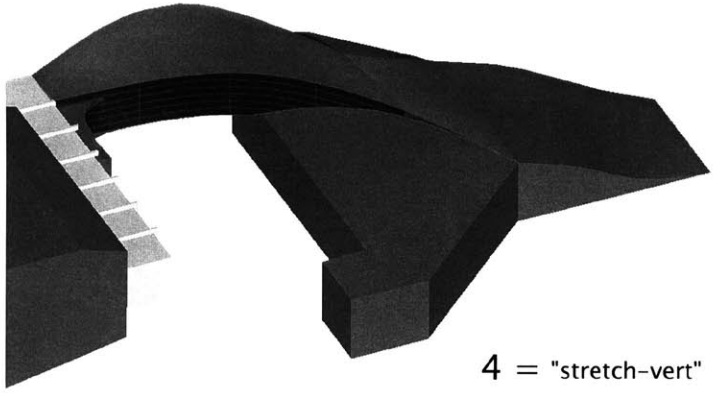


2 = "attenuate"

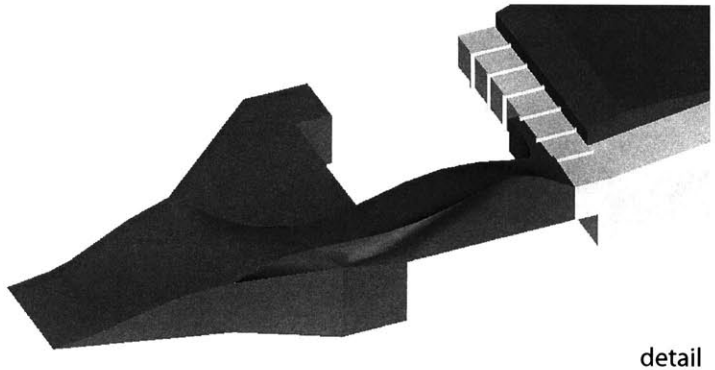




3 = "link"

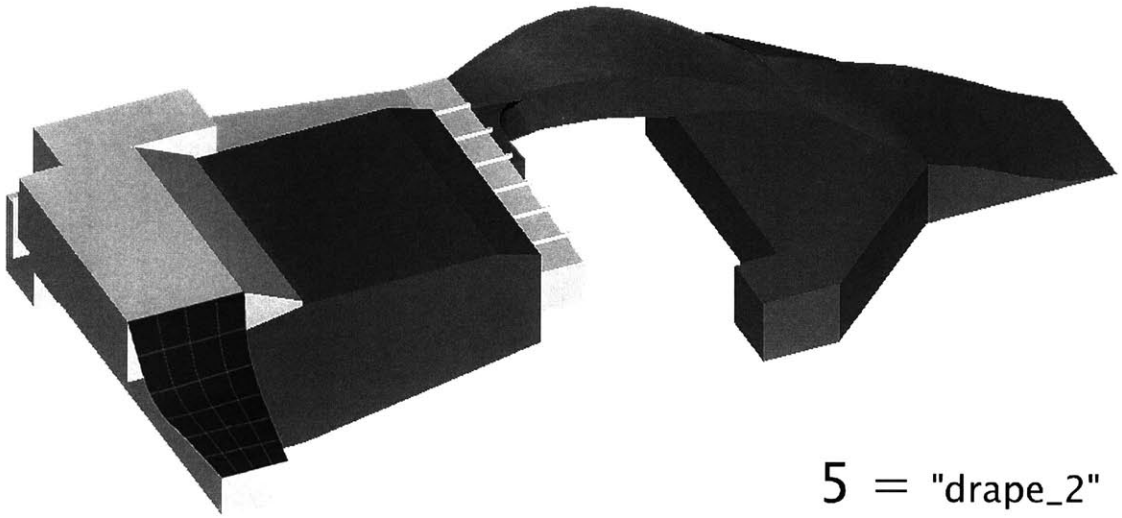


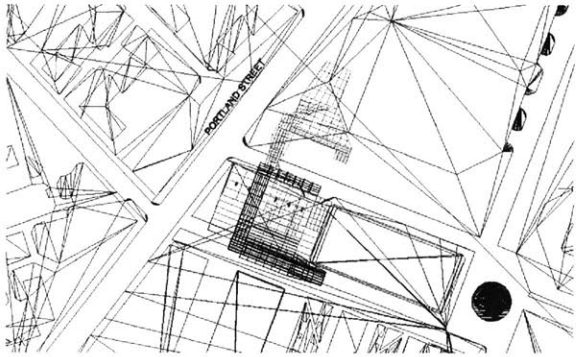
4 = "stretch-vert"



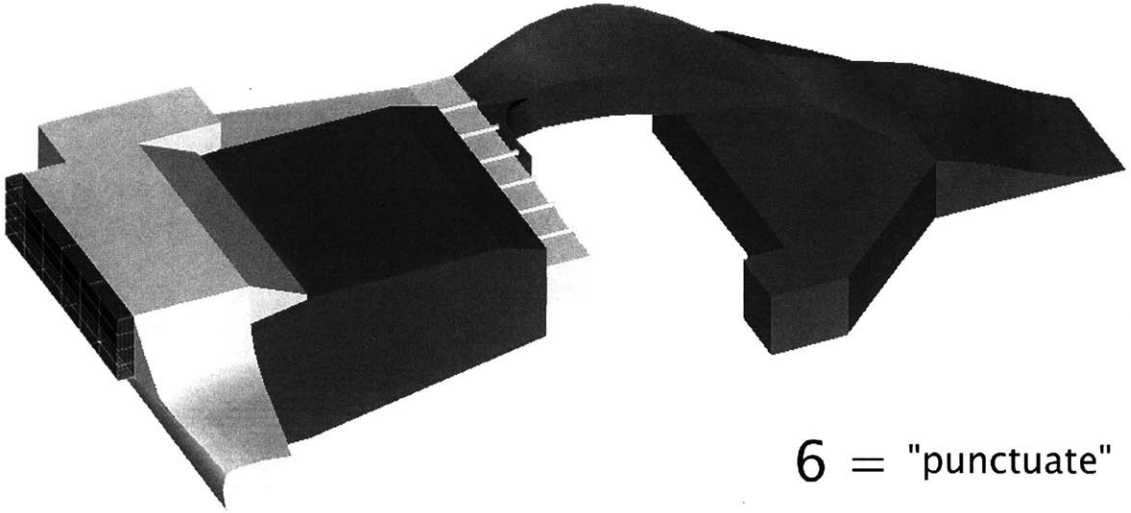
detail

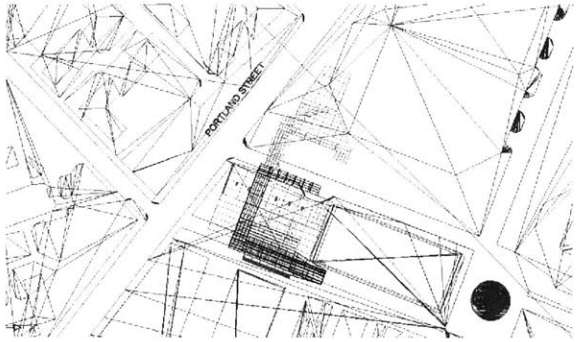
To promote continuous curvilinearity, the link has a generous form that sweeps from the base of the community center to the entrance of the MIT-owned study carrols.



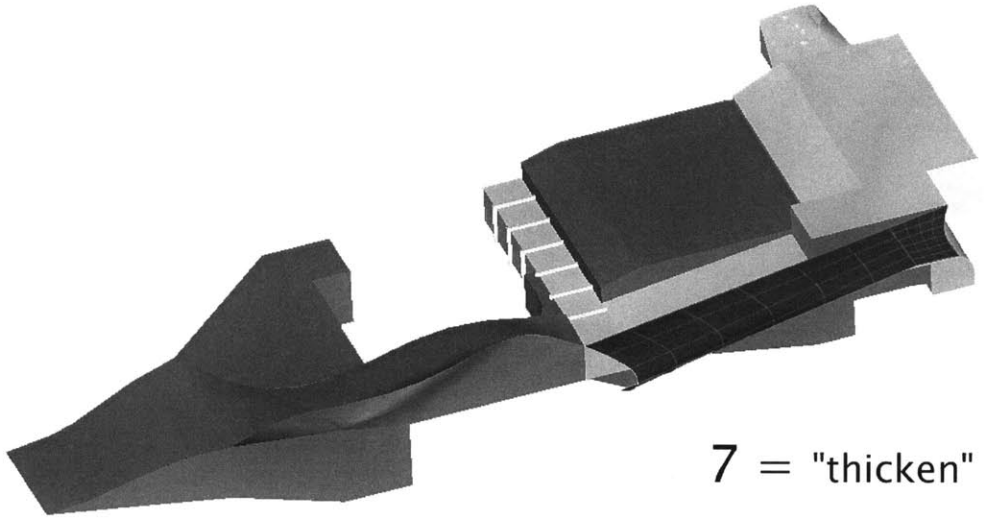


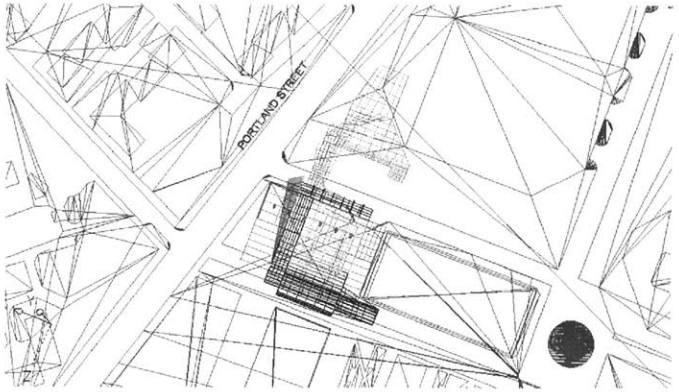
5 = "drape_2"



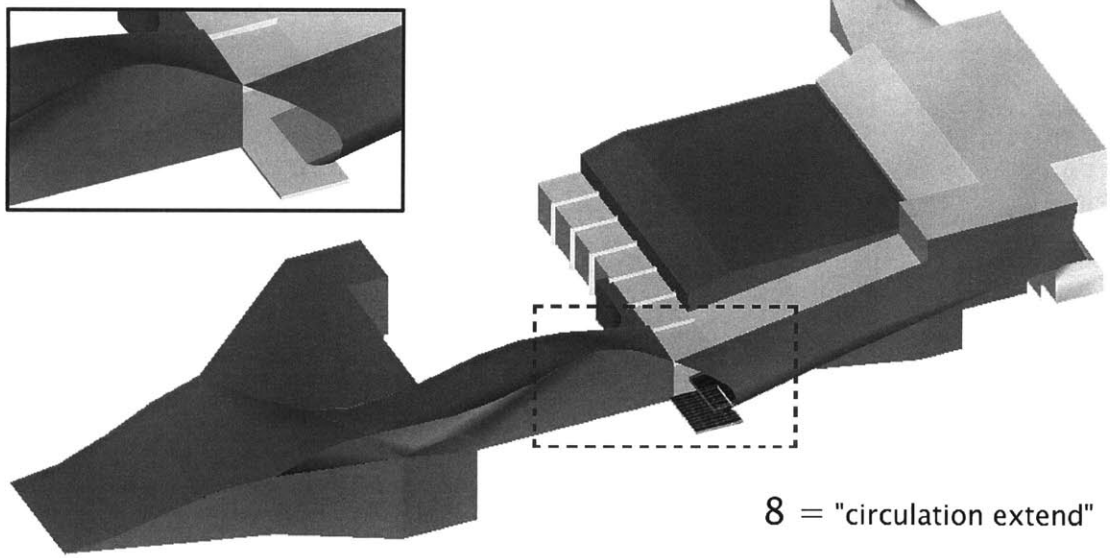


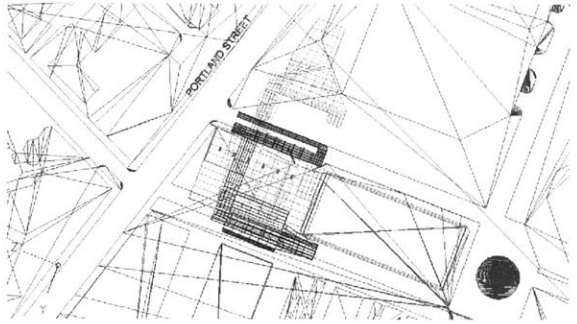
6 = "punctuate"



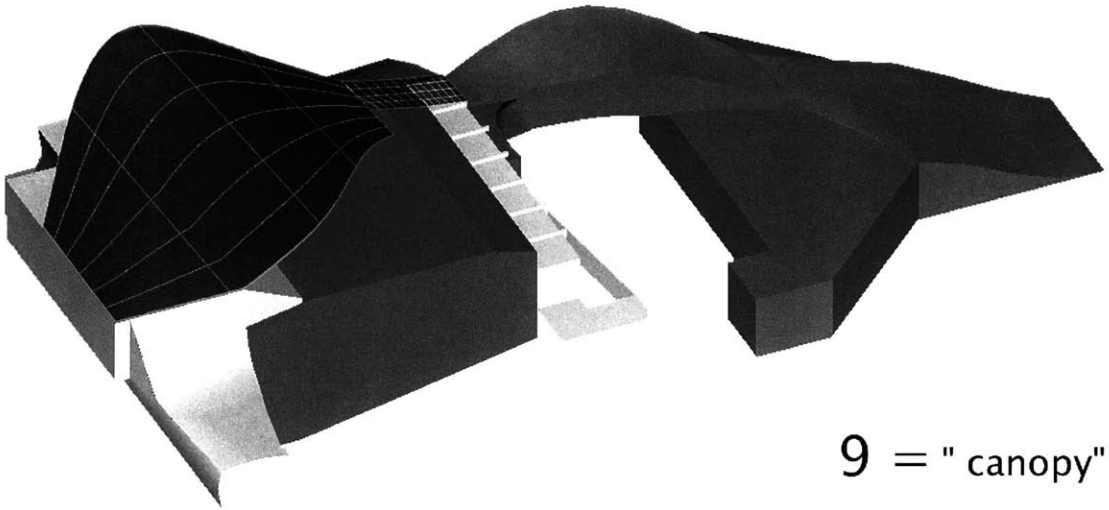


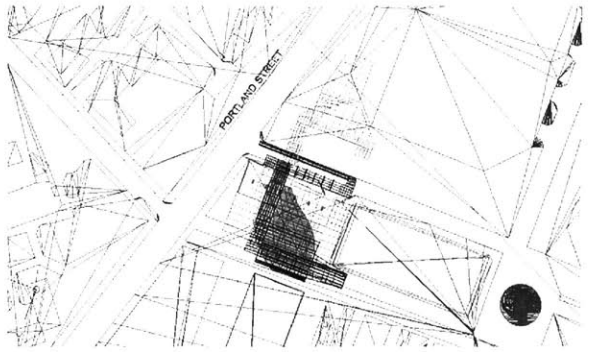
7 = "thicken"



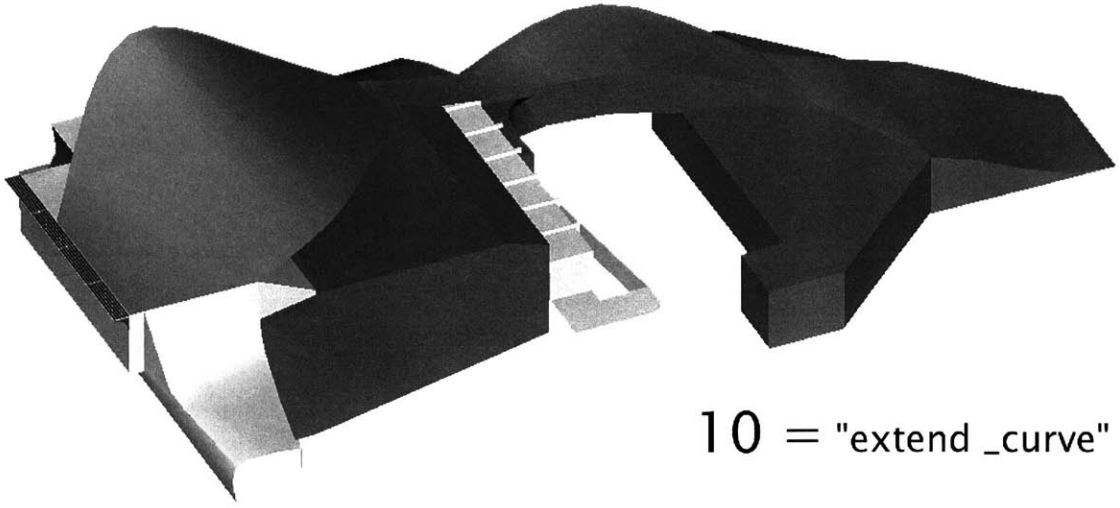


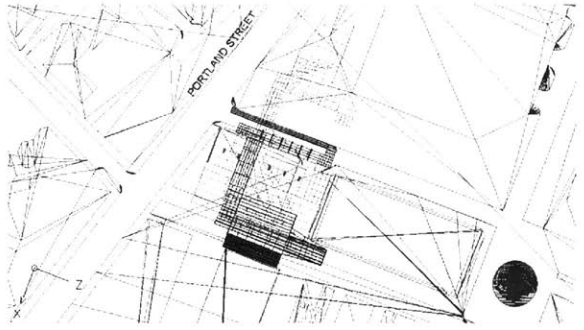
8 = "circulation extend"





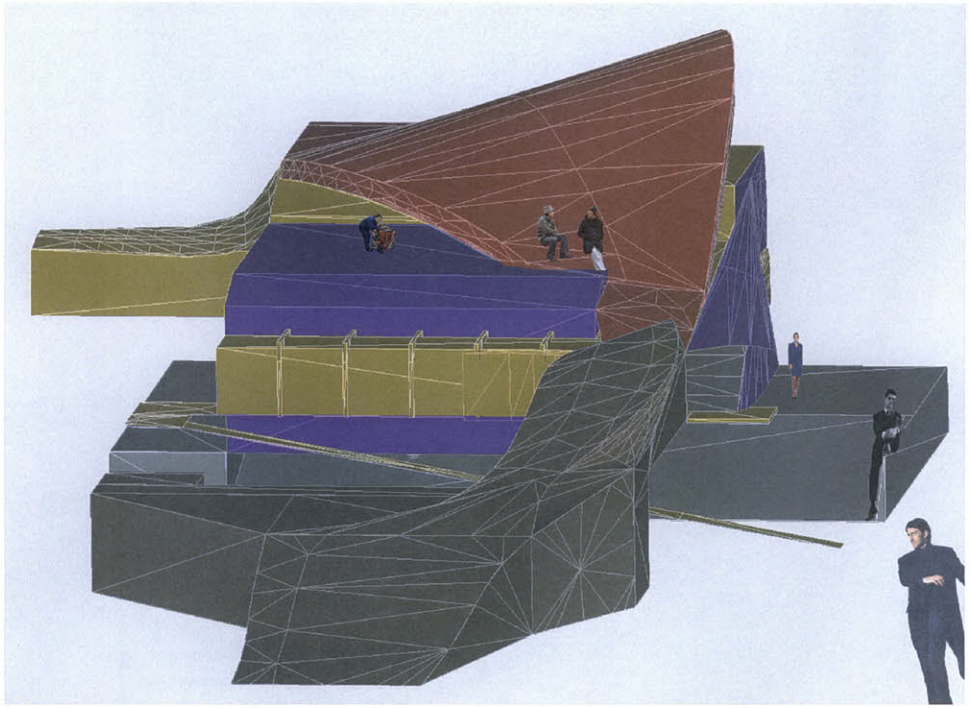
9 = " canopy"



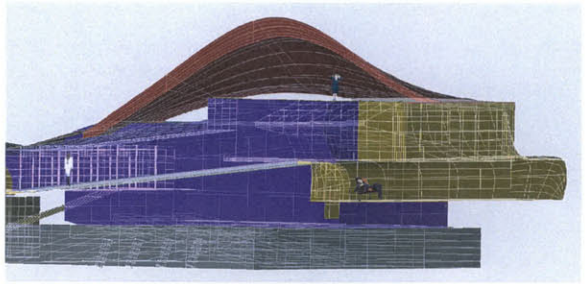


10 = "extend _curve"

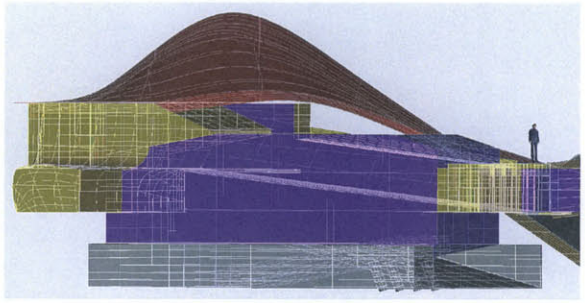
Final Design Phase | Visualization



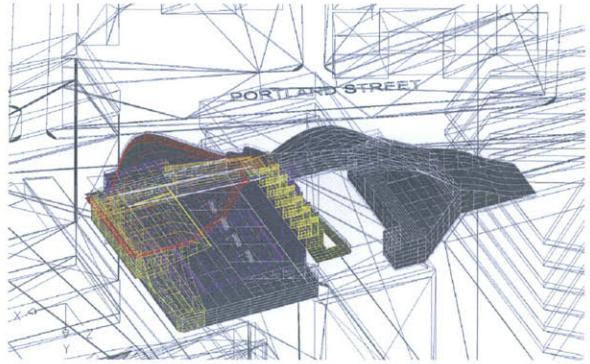
The design log documents the design decisions made to produce the final design.



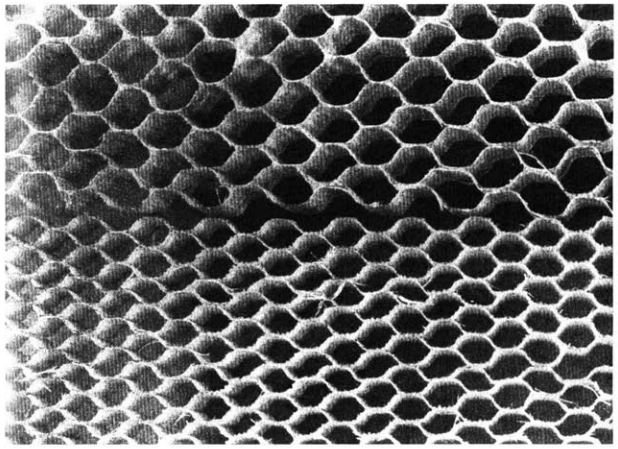
west elevation (facing Portland St.)

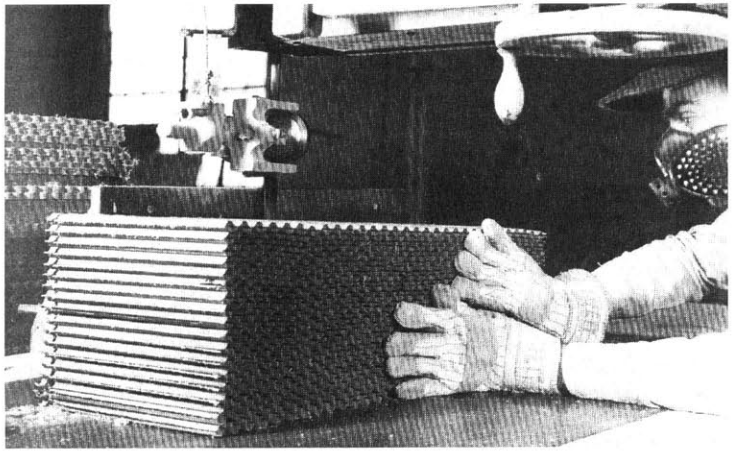


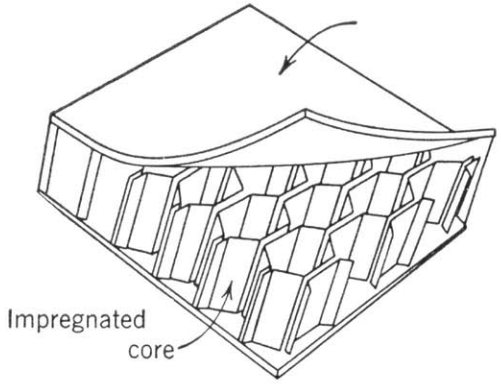
east elevation (facing Akamai)



axonometric wireframe of final design

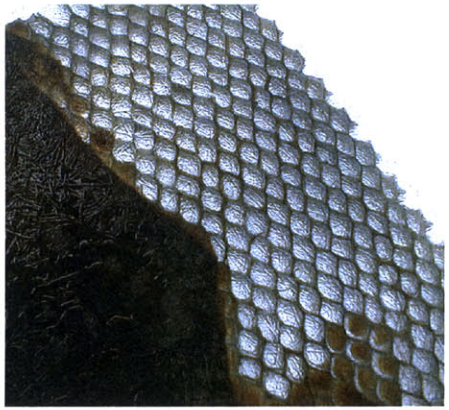


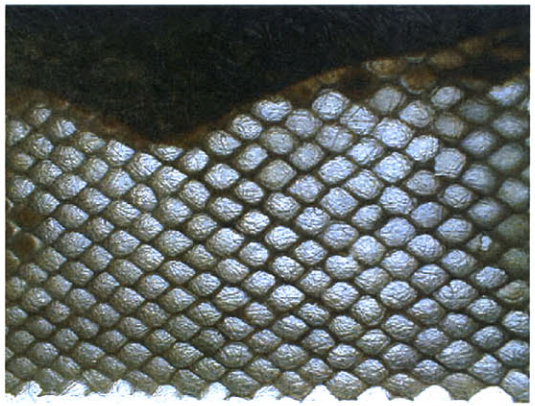




Honeycomb Sandwich Construction.

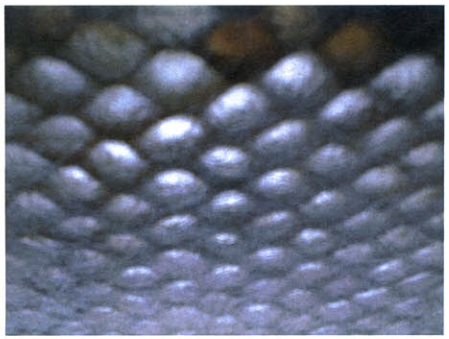
For many years after WWII, honeycomb, polymer-reinforced composites and other high performance or ultra-light materials began their years of development, eventually becoming normative choices for materiality in which frequent replacement or repair was procedural. Naval ship doors, space exploration transport devices, propeller blades are only a few applications of such materials. Although architecture remains a field with little use of the high performance aspect of these materials, their ultra-light properties, quick fabrication and relative ease of maintenance and transluscent/transparent properties make them alluring alternatives to poured concrete.





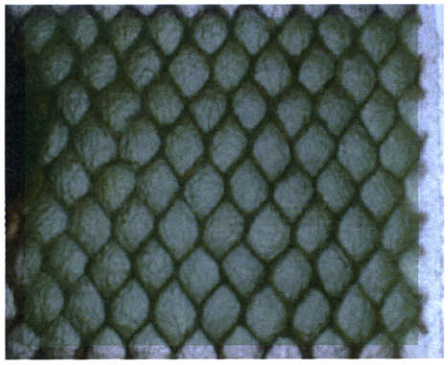
The composite surfaces would be constructed in panels, the dimensions of which would be limited to the bed size of the manufacturing machinery. This apparent limitation would make repairs and upkeep a relatively simple procedure. The individual panels can simply be manurfactured again and reinstalled.

Transluscency
Ventilation
Ease of installation
Ultra light and thin properties



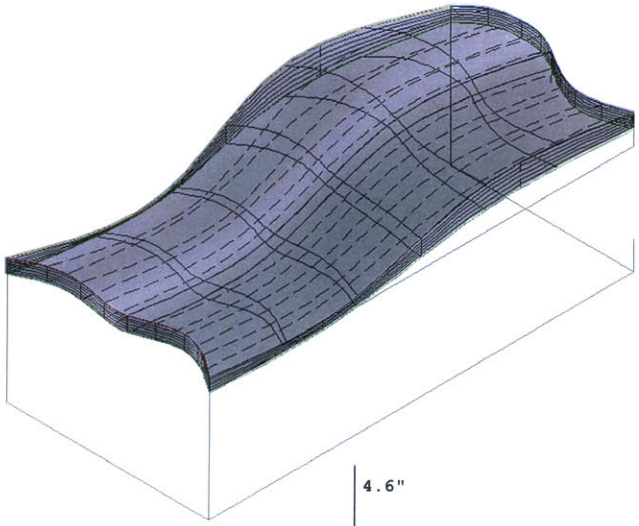
are attributes to using composite materials in architectural structures. Aviation, naval and car manufacturers consider composite materials an almost normative possibility in their respective research fields.

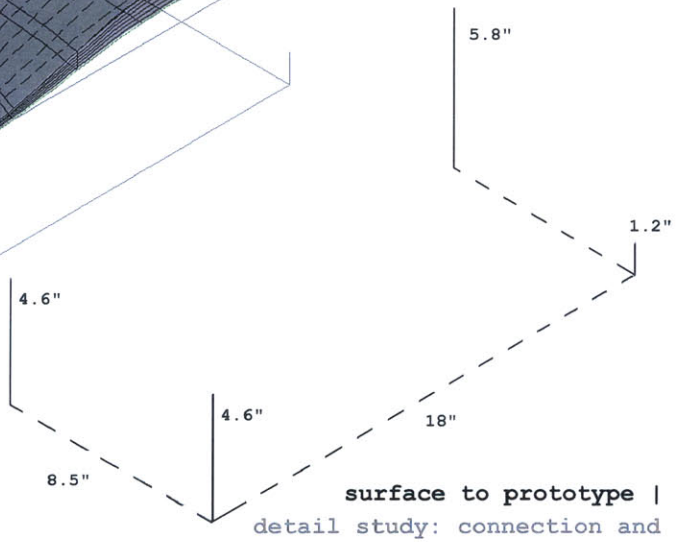
This study uses fiberglass matting and epoxy resin to approximate the possible transparency of composite materials in application as a building surface. The honeycomb material would be prototyped with a mounted router to

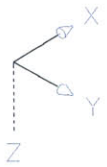


have complex curvilinear qualities--top and bottom. Structural integrity relies on the walls of the honeycomb surface to remain perpendicular to the ground plane. Composite strips would be applied directly to the honeycomb thus eliminating the need for formwork.

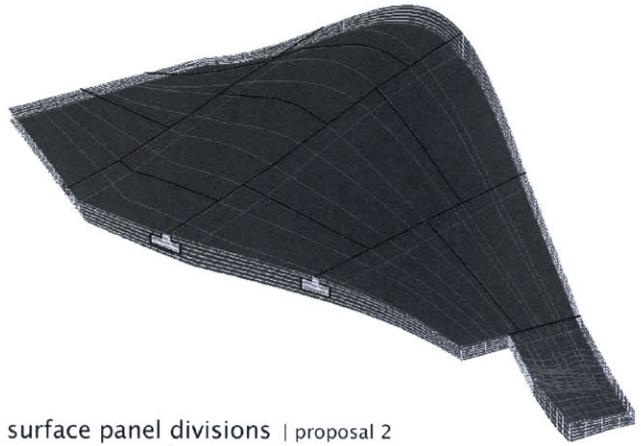
Materiality (cont'd_2) |







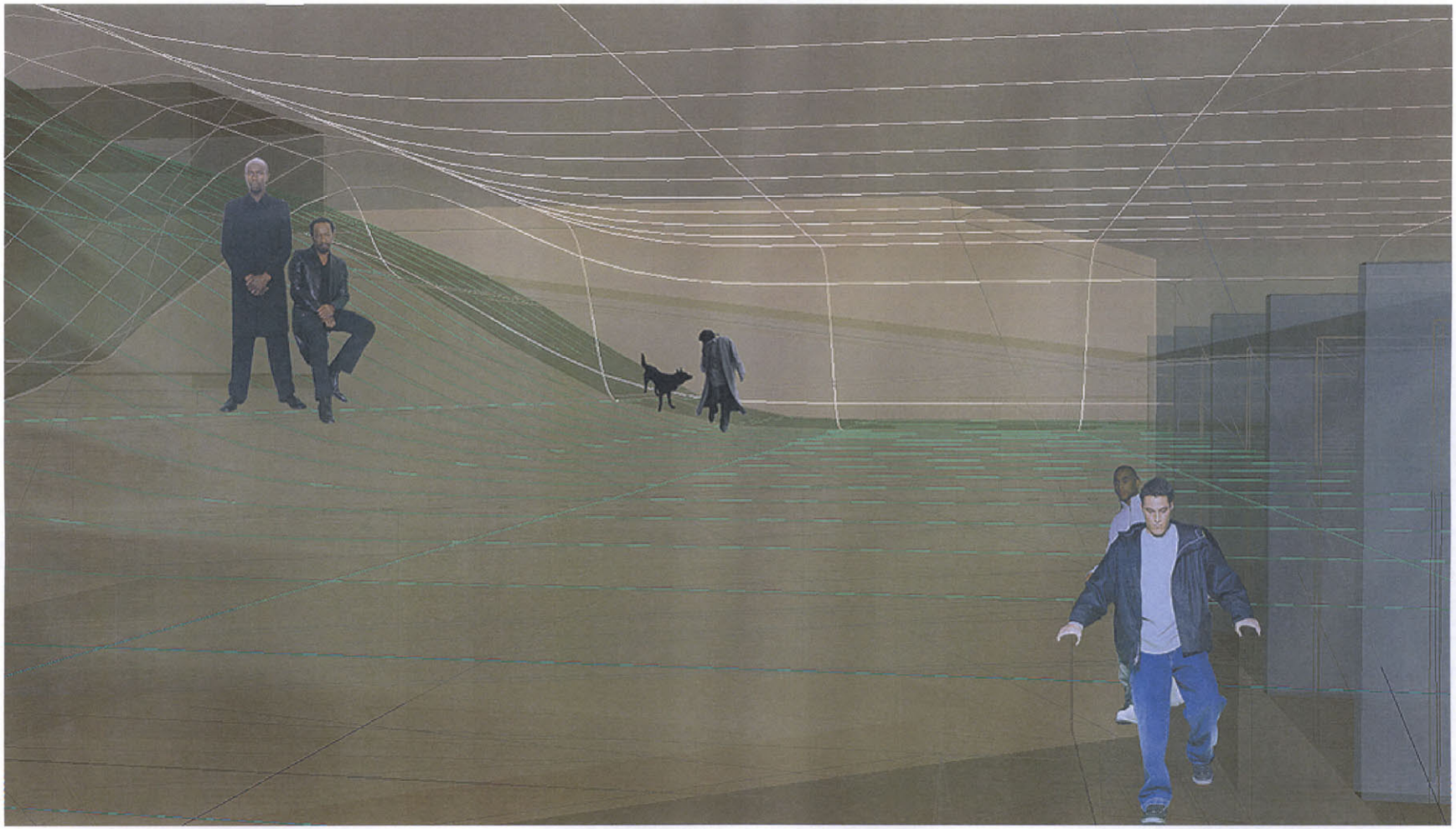
surface to prototype |
detail study: connection and section



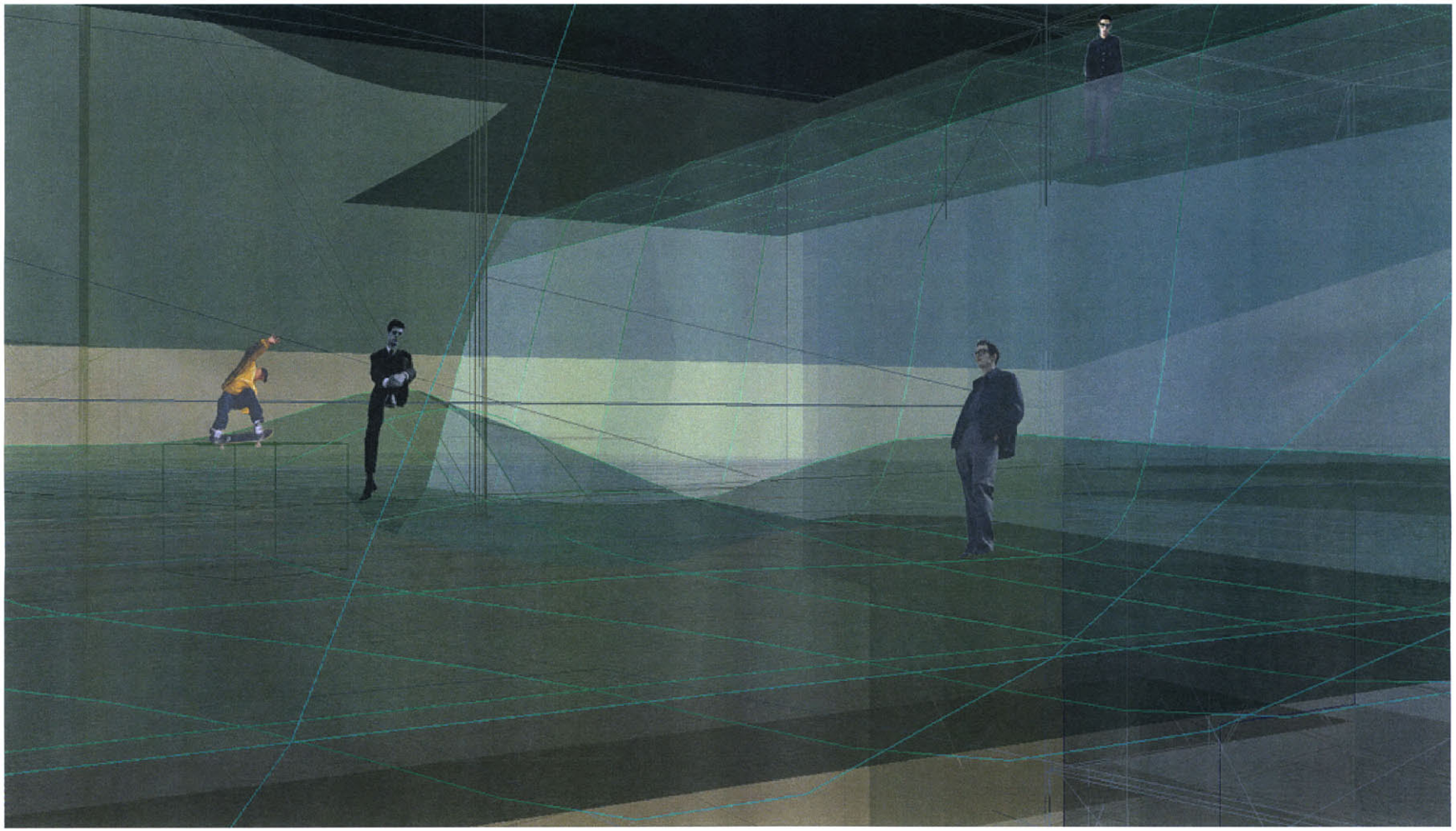
surface panel divisions | proposal 2

Detailing the surface becomes an issue of of connecting the panels by as seamless of a design as possible to create a walkable or inhabitable surface. A complex curvilinear surface was designed and scaled for a router bed to be shaped out of a block of cardboard honeycomb.

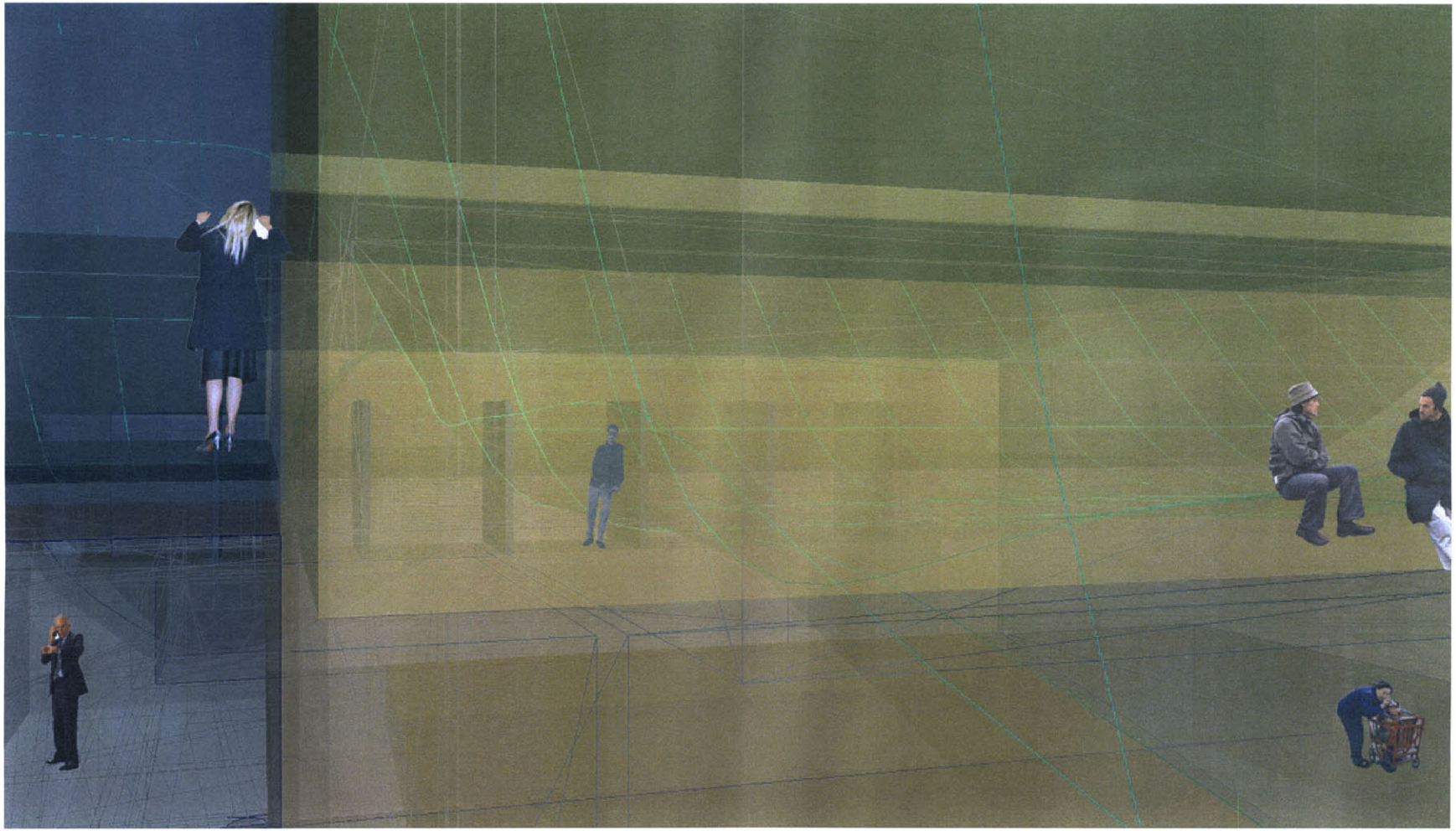
The model is missing, but the concept for construction remains. Honeycomb would be routered to the shape specified by the digital file. Composite fibers would be "layed up" upon the honeycomb surface on both sides. The honeycomb would act as formwork as well as the seperating material between the two composite surfaces.



imagery of inhabiting curvilinear surfaces that encourage the ambiguity between inside and outside spaces

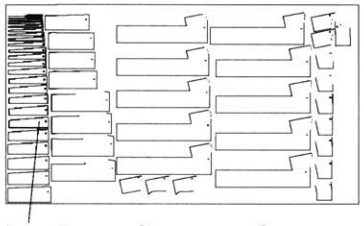


additional imagery of inhabiting curvilinear surfaces

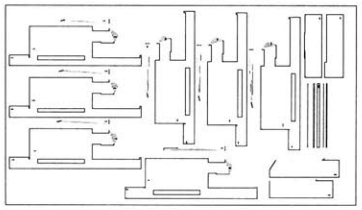


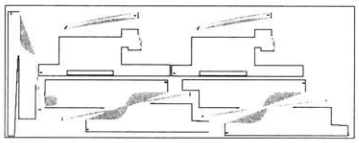
additional imagery of inhabiting curvilinear surfaces_2

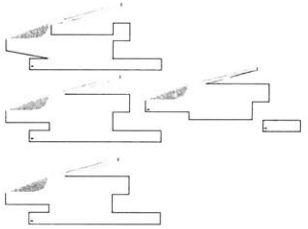
The final "proposed" design for the Technology Square intervention | To the laser cutter



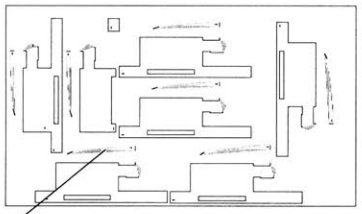
interior reading space for
the community



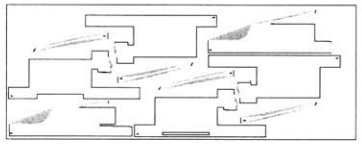


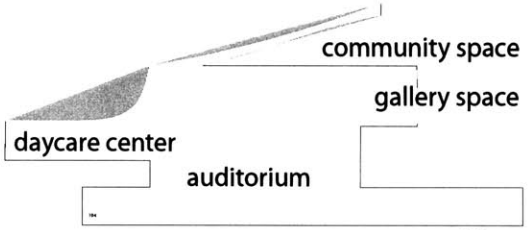


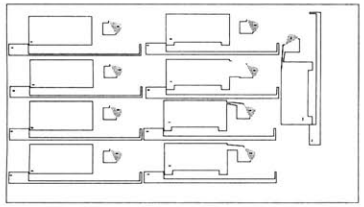
study carrols and
public reading space

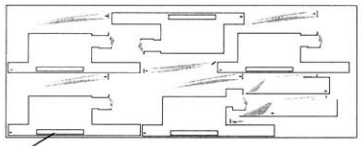


canopy form begins

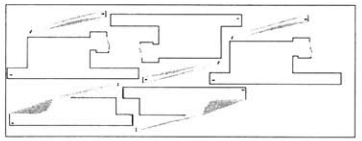


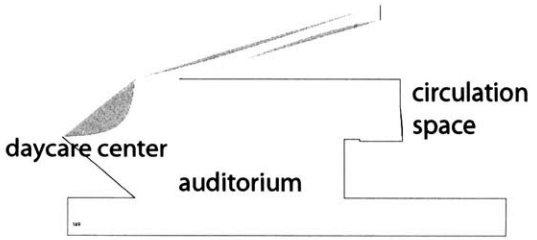


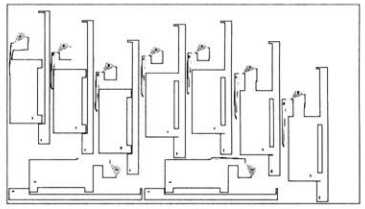


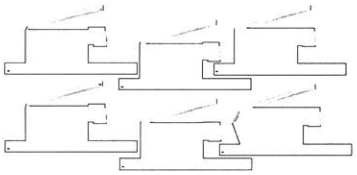


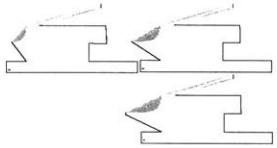
seating area for auditorium

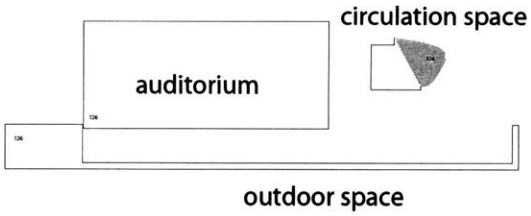






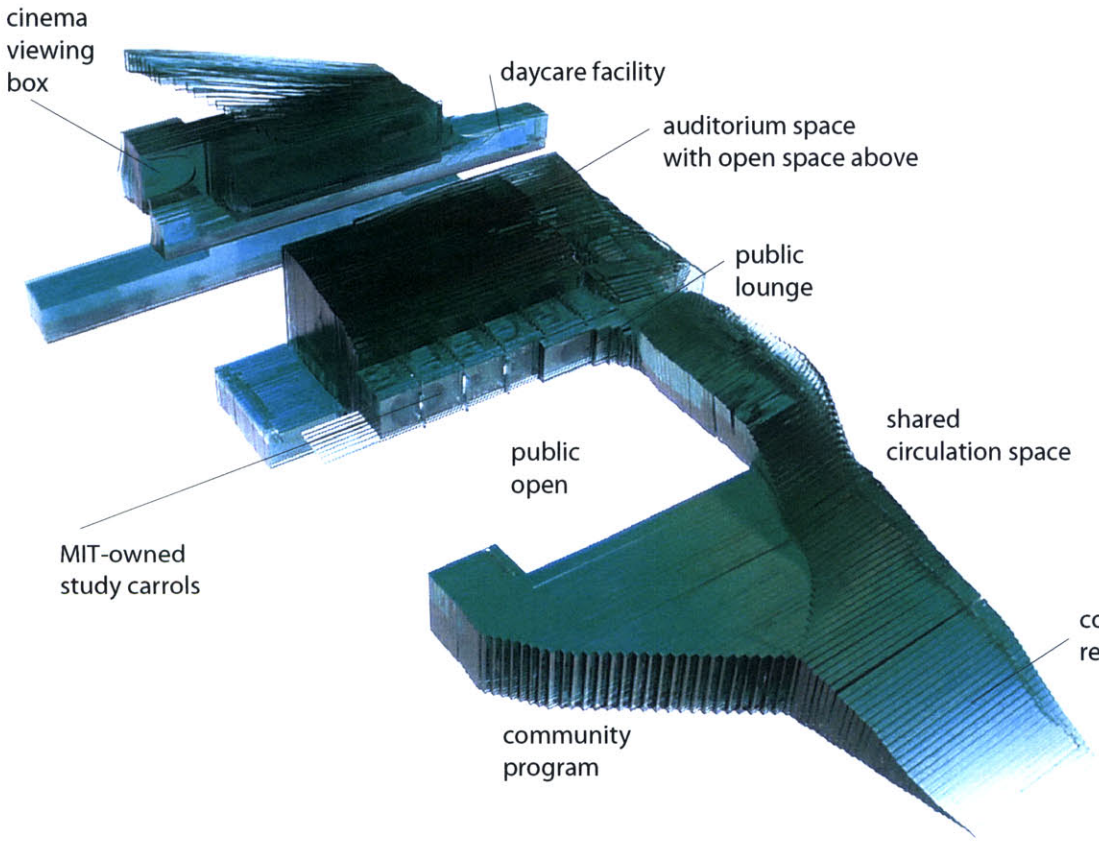




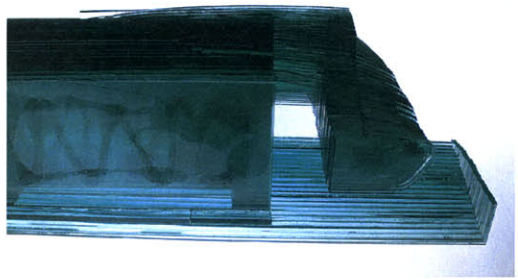


Slicing the final design creates a series of diagrammatic sections that reveal the interractions between curvilinear surfaces and the program model. There are two ways of narrating the sequence of events in generating a curvilinear design. One way is to create terminologies for its generation. Another is to slice the final design and interpret the results through its reconstruction into 3d form.

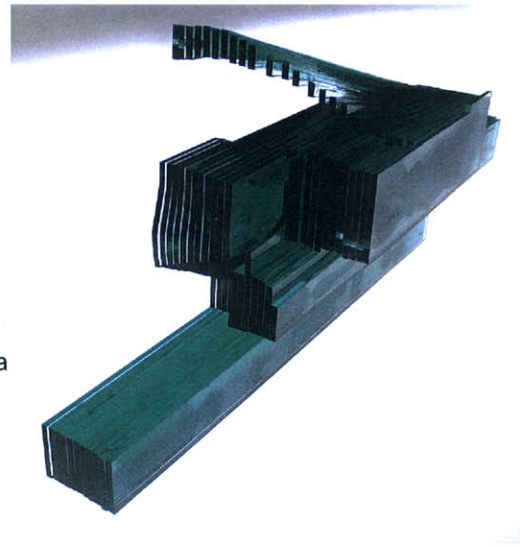
The final "proposed" design plexiglass model for the Technology Square intervention



The final model (incomplete).

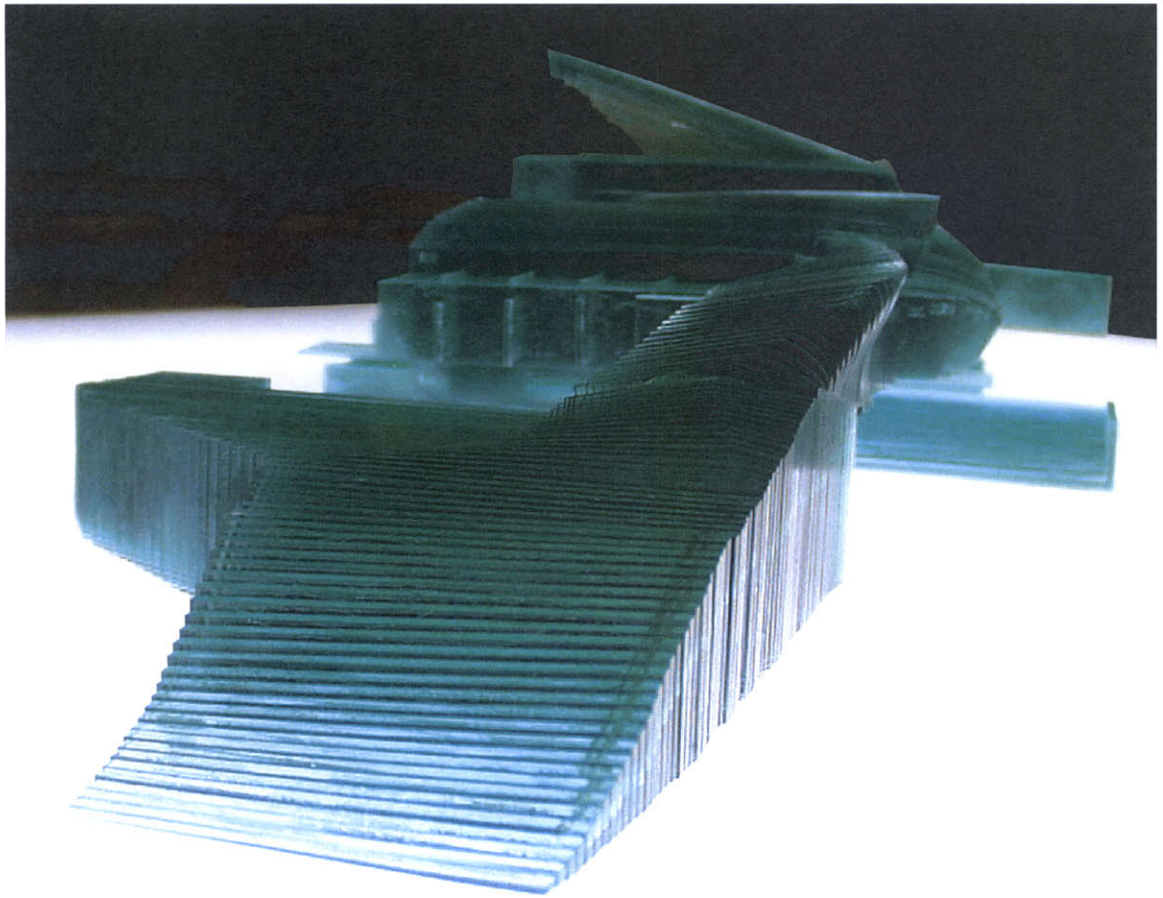


the individual sections are laminated together

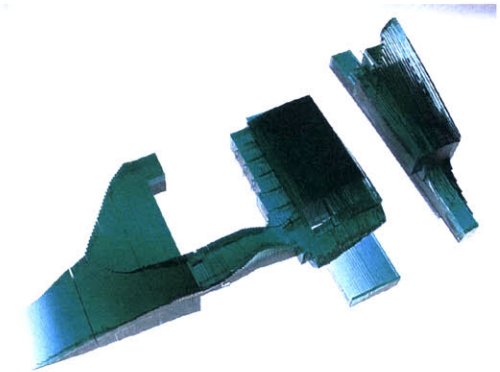


an oblique view of a section of the laminated model

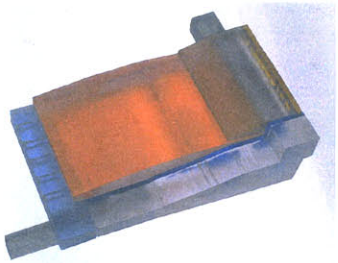
The final "proposed" design plexiglass model for the Technology Square intervention_2



North elevation | detail view of the community reading center. The top surface is also inhabitable during warm weather



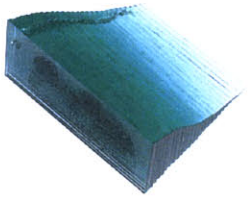
aerial view of design



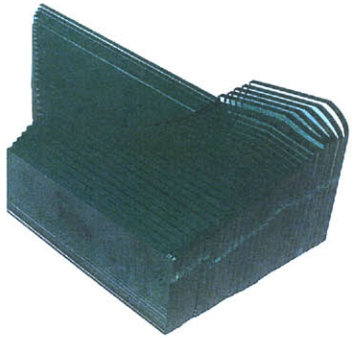
original program model without the community center attachment

The sectional compoenets of the final model |

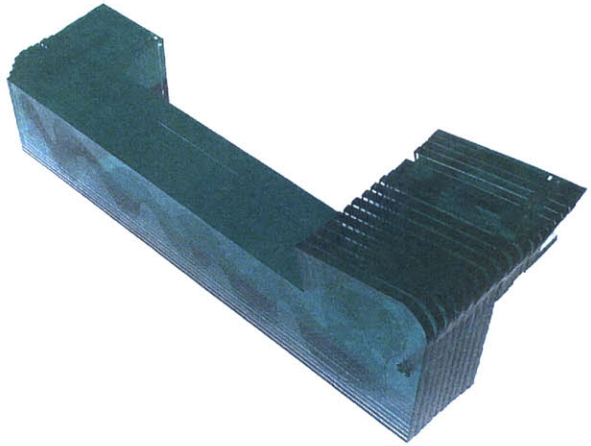
community reading area



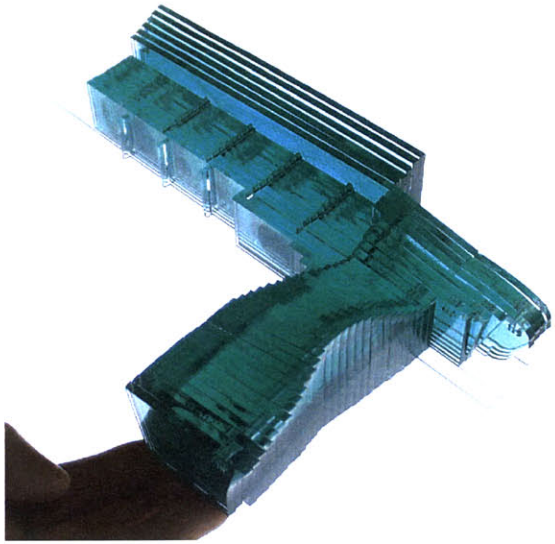
community area / circulation space



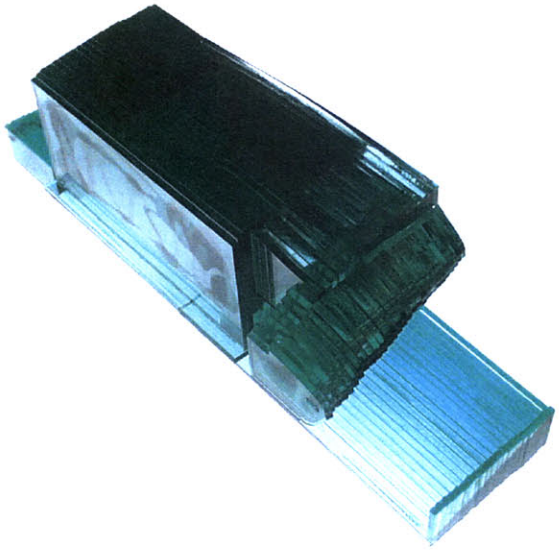
auditorium / circulation space



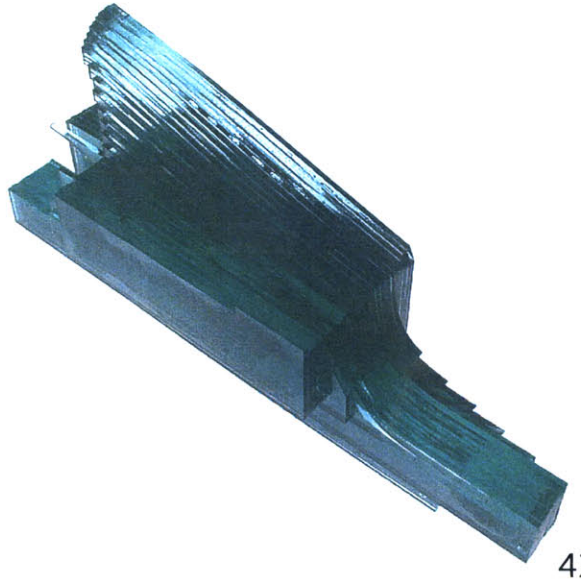
circulation space / study carrols



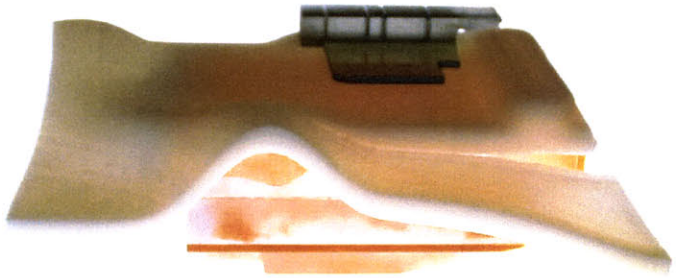
auditorium / circulation space / open space



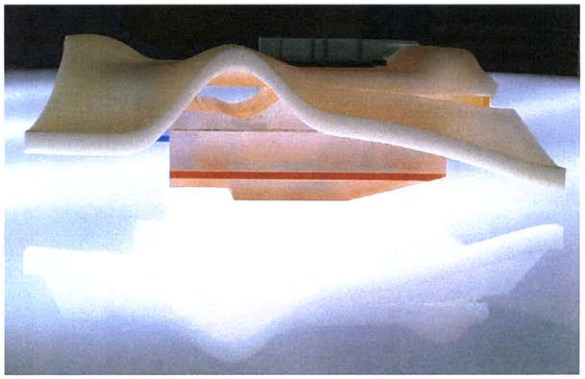
auditorium / canopied space / daycare facility



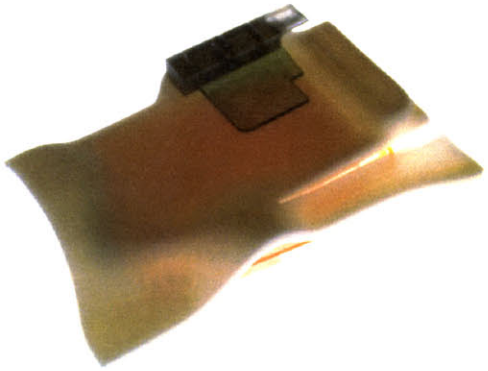
Additional images of iteration 2 |



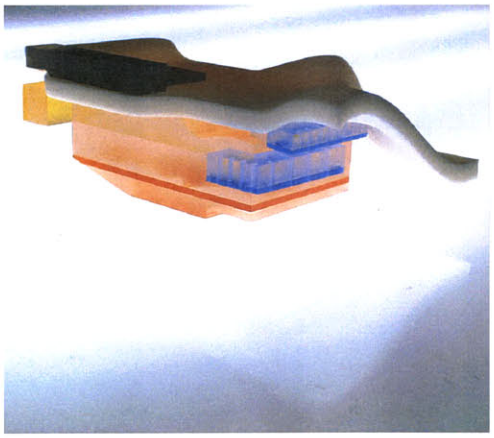
view of ramp connecting a pre-existing pedestrian path and the top of the curvilinear surface

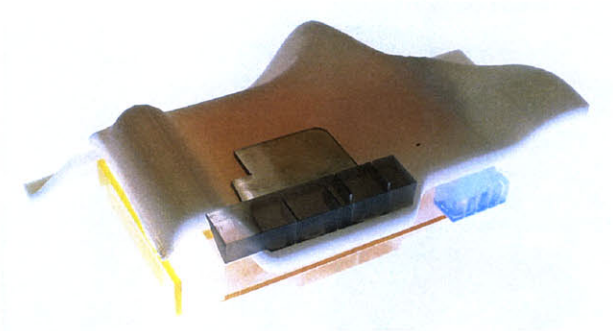


view of interstitial space below the surface



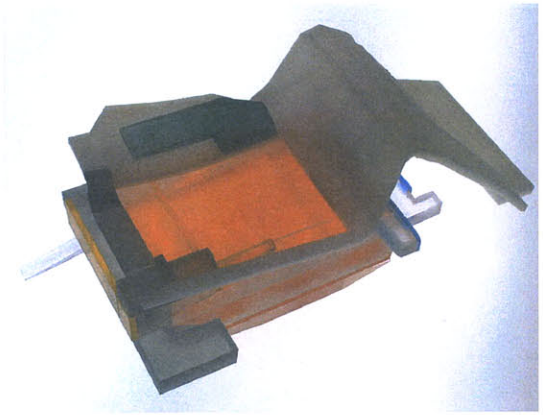
green space is located on top of the surface and is a part of the childcare facility. The video box is located below.



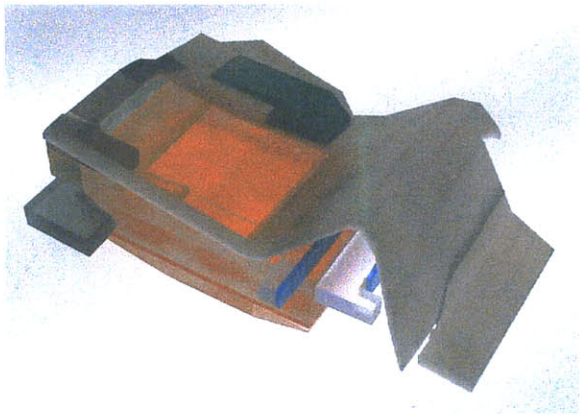


the childcare facility is located on top of the surface

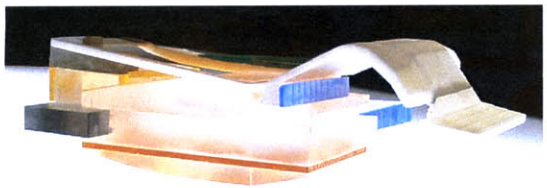
Additional images of iteration 3 |



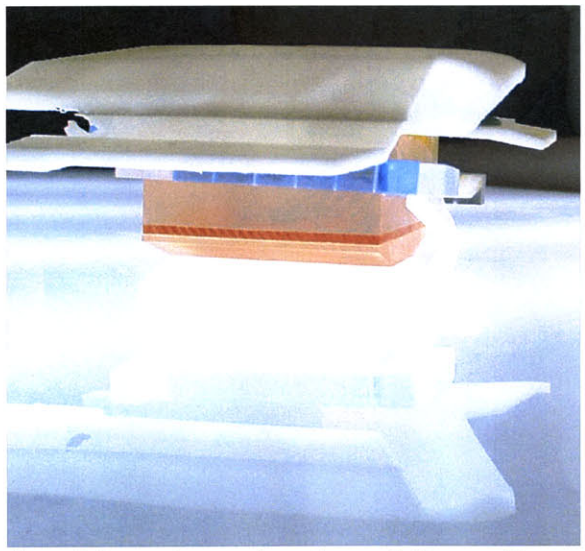
small green space above



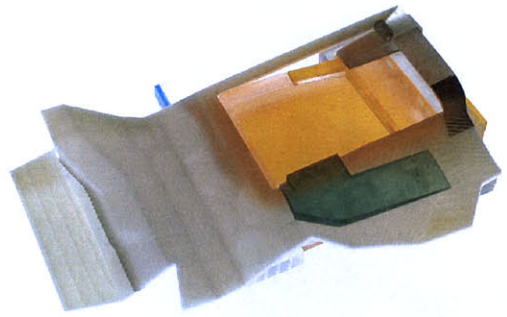
northeast aerial view



a view of the interstitial space between the study carrols and the curvilinear surface



view of the study carrols underneath the curvilinear surface



the space on top is inhabitable and is where children from the daycare facility would play safely above ground