

**Morphogenetic Landscapes:
Potential Microhabitats in the Namib Desert**

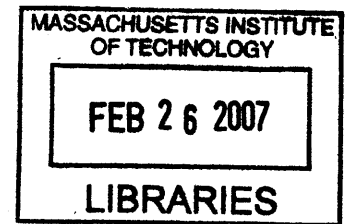
by

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B.Des. Architecture
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Morphogenetic Landscapes: Potential Microhabitats in the Namib Desert

by

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ABSTRACT

This thesis is concerned with the creation of systems that respond to selective environmental conditions in extreme environments resulting in varying levels of habitation. The development of these morphogenetic landscapes was arrived at through two parts. The first was a rigorous analysis of the role that biology, ecology, genetics and evolutionary development play in current architectural discourse. The second part consisted of discarding this current trend and developing a new methodology that instead of taking architecture as a given and applying a biological thread, attempted to work within current biological research and find the architectural thread.

This methodology begins with a fundamental shift in the perception of the relationship between organism and environment. In traditional Darwinian evolution, the environment presents problems and the organism attempts to answer them by adaptation. However, the organism is no longer thought to be a simple set of closed physiological systems that simply buffer the external environment to maintain life and thus maximize the chance at reproduction. Rather, the organism and it's constructed environment form an immediate and co-evolutionary continuum that is based on fluctuating, but specific, information flows. This phenomenon is best exhibited in extreme habitats where a few harsh climactic parameters take precedence. In such situations, many phylogenetically diverse species utilize the same climate conditions which make the entire ecosystem interdependent on many scales.

One example of such a habitat is the Namib Desert in southwest Africa. It is not only one of the hottest and driest places on Earth, it is also the geologically oldest desert in the world at 55 million years. These parameters converge to create one of the most evolutionarily excited environments in the world. Thus, the goal is to develop an architecture within this specific continuum of environmental flows that could foster scientific study in the relation between organism and its effective environment. The environmental parameters consist of extreme heat, high wind levels and the Namib's unique moisture rich fog.

Through this biological and ecological analysis, the thesis became the creation of an architectural organism that selectively utilizes natural parameters to construct its own environmental continuum. Thus, the intervention was conceived as fostering and supporting [human] habitation while at the same time creating multiple microhabitats by its very existence. It is simultaneously a vehicle for study and an object of study.

**Thesis Supervisor: Mark Goulthorpe
Title: Associate Professor of Architecture**

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I would like to thank Mark Goulthorpe for continually challenging my process and keeping me oriented on the goal of the thesis.

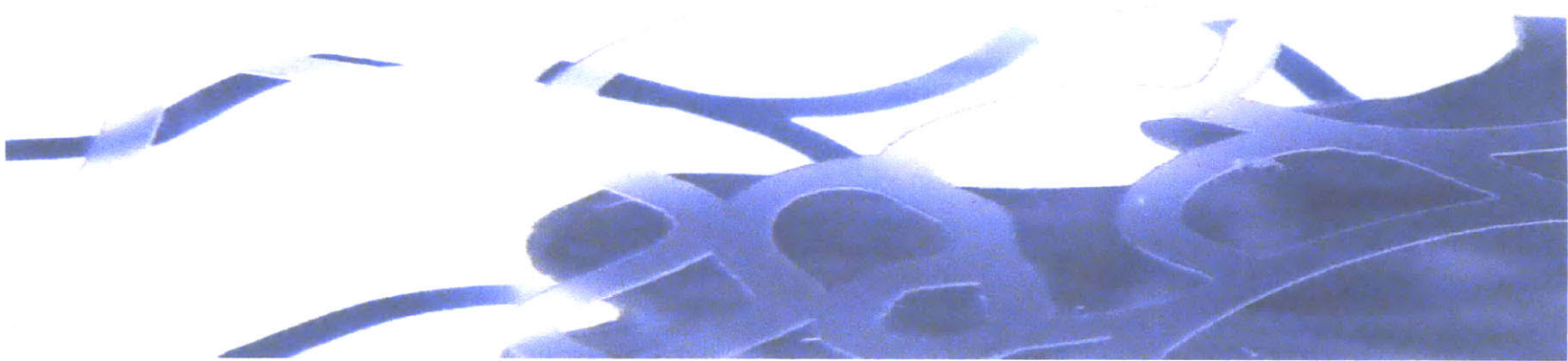
I would also like to thank Sanford Kwinter without whom I would never have undertaken such an endeavor. The invaluable conversations we had always left me with the realization that I could craft an entire career from these investigations. You always emphasized that this was a beginning and I am incredibly indebted to you for helping me find it.

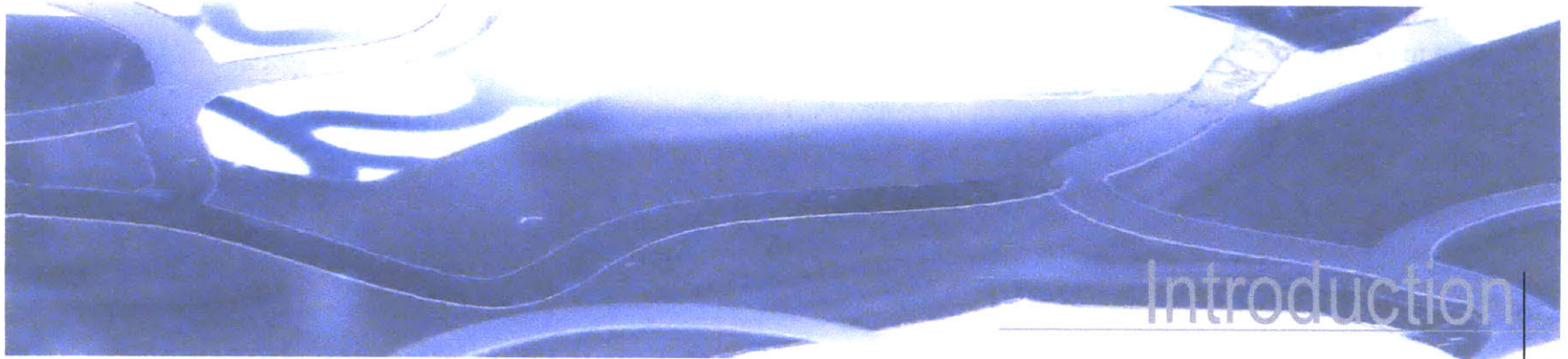
I am also largely indebted to Neri Oxman. If Sanford was the catalyst you were the continual support. You were instrumental in helping me pull a thesis out of the quagmire of my research. I am utterly humbled that you would devote so much time and effort. What success I had was largely because of you.

The greatest amount of thanks go to my wife Lauren and our daughter Sophia. No matter how frustrated or downtrodden I was, you always made me feel better by your sheer presence. You kept me going when nothing else would. You supported me even when my time with you had to suffer. I love you both more than words could ever express.

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Introduction

Introduction

This thesis began with an assignment in a seminar taught by Sanford Kwinter. The subject was an investigation into the evolutionary developmental biology of the family hominidae, specifically the development of bipedal locomotion, brain cavity progression and skeletal adaptations. This analysis led to a distinct interest in the relationship between biology and architecture.

In the past decade, spurred by recent advancements in the disciplines, an interest in biology, genetics, and evolution and their various [attempted] overlaps with architecture has emerged. Architectural discourse in the subject has thus incorporated inspiration ranging from biomimetic engineering to the Human Genome Project. Biological processes [or more accurately the semblance of these processes] have become a major area of study for the development of an architectural evolution. Unfortunately, most examples of this fall within two problematic categories.

The problems I found were concerned with two current trends in the architectural discourse when incorporating the biological sciences. The first treats the subject in a purely metaphorical way. The 'natural' form is applied to the building much the same way decorative elements like Corinthian or Doric column capitals are applied. Other than the biological rhetoric of establishing the natural precedent, there is no deeper understanding of the forces which gave rise to that form. The second approach concerns the problematic use of rhetoric to establish a connection with the biological sciences. And the final critique is on the fascination with tools and techniques that are developed for biological sciences and then hijacked. These processes are used in design with little understanding of the original role they played or the way these certain programs or tools were created.

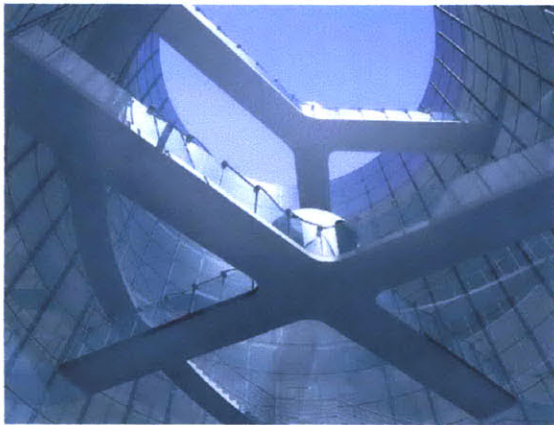


Fig. 1 & 2.
The Institute for Nanobiomedical Technology and Membrane Biology in Chengdu, China -(exterior rendering) The building is designed based on the formal inspiration of a cell. from the article "Three at MIT conceive cell-shaped building", image sources: <http://web.mit.edu/newsoffice/2006/cellbuilding.html>

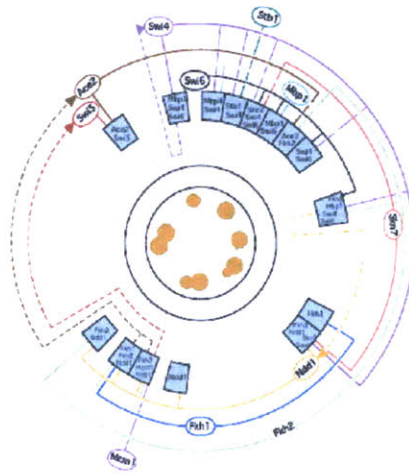


Fig. 3.
The complex internal cell cycle network. image source: <http://www.cs.cmu.edu/~zivbj/compBio/compBio.html>

An example: Formal Misunderstandings

A glaring problem arises when an architectural work is instantiated directly from a bird's wing, a human's spinal cord or a living cell. While there may be some metaphorical connection with these natural catalysts, the removal of these biological systems from a context [like the body] destroys the interdependence of the systems in which they came from. A bird's wing is not simply a form, but a highly refined biological system at the intersection of numerous purposes like aerodynamics [shape], physiology [cooling of body temperature by flapping] and reproduction [attracting potential mates]. The spinal cord is the main structure of the body, but also is the central pathway for the nervous system and is the production center of red blood cells for the circulatory system. The cell is a node of a much larger network that receives, process and transmits information to initiate large scale processes like hormonal activation or small scale processes like cell division, not to mention the complexity of intercellular processes.

Another Example:
Misunderstandings of Language

Just as an exercise of the cell as built form is an error, likewise the use of biological and ecological rhetoric in support of architecture is a problem. For instance, the Genetic Architectures program at Universitat Internacional de Catalunya founded by Alberto T. Estevez is arguably a direct response to the current practices and discoveries made in evolutionary biology, while redefining what ecology means for architecture.¹

...I come to the core of my subject: proclaiming that the new ecologic-environmental architectural design does not imply creating in nature but creating with nature... (Estevez pg. 9)

Mr. Estevez seems to give architecture a little too much credit. The term ecologic-environmental architecture is never defined. In fact, the whole concept of a universal nature or environment seems in

error. In the book "The Triple Helix: Gene, Organism and Environment," Richard Lewontin states, "the organism is the nexus of a very large number of weakly determining forces, no one of which is dominant." Therefore, how can nature be generalized to such an extent for the aims of mere architectural fascination?

...What is more, the new architect creates nature... (Estevez pg. 9)

To restate the issue, there are an almost incalculable number of influences and forces within a habitat. There are relationships imbedded within larger systems that can have a serious effect on flora and fauna, yet are latent unless certain precursors emerge.² This is why even within the same ecozone, there are vastly different flora and fauna in the Kalahari Desert as in the Namib Desert. Biologists and ecologists are only now coming to terms with these systems, so it is naive to think we can.

One Last Example: Technical Misunderstandings

This final discussion centers on an almost ubiquitous tactic of borrowing the newest tool or technique for the benefit of architectural computation. The program uses a variety of tools like scripting, genetic algorithms and emerging systems to offer “a fresh look at ecology, the environment and digital media in architecture”.³ While interdisciplinary work is no doubt important to the reinvigoration of computation within architecture, the methodology behind it seems to be flawed. The reason is that the nature this program seems to be creating with is nothing more than the current iteration of computational biology analysis and simulation tools. These techniques are often used despite their intended purposes and seldom understood.

The problem lies in the fact that computational biology is not biology; it is an interpretation of it. As was mentioned in the previous section, the Genetic Architectures

program puts great faith into the nature of these computational tools. But the tools that are now finding their way into the architectural process, such as genetic algorithms, population analysis and complex sequencing, are used because they are simple abstractions of vastly complicated systems. They are not nature. They are beneficial optimization techniques that are applied to very specific and limited problems of their respective type.

For instance, Dennis Dollens, a visiting professor at the Genetic Architectures program, is concerned not with the creation of a generative organic process, but actually using an already existing system of growing architecture itself utilizing a botanical growing software called Xfrog.⁴ He states in the essay *Toward Biomimetic Architecture*, “there is this quality of a kit of parts to my work, there’s still a fiction, an unknown, of what the forms are going to be.” There is an

assumption that because this software was created to showcase the growth patterns of plants, using it to grow architectural forms automatically legitimizes it as some sort of bio-architecture.

First of all, this software was designed based on certain algorithms that simulate plant growth. Soil content, local impact of other plant material, faunal interaction and climate patterns are not addressed. Everything that contributes to a plants success in a given location is disregarded, in other words, the plants environment. The software merely represents the geometrical unfolding of a typical plant species. The process is an abstraction of a complex system that is no longer natural. It is merely a useful interpretation. Thus any architectural process incorporating this software is merely a formal exercise in applying a plant-like ornament. I even hesitate to use the term plant-like.

Furthermore, because the environment is completely absent from this simulation, the fundamental mistake that Dollens makes is in the application of the forms. The tumble weed is uniquely adapted within a field of influence that results in form, reproduction, physiology etc. Dollens often analyzes these precedents and then applies them to any context he sees fit. In biological terms, transplantation of any organism often results in death or a rampage of unchecked dominance and subsequent destruction of the habitat.

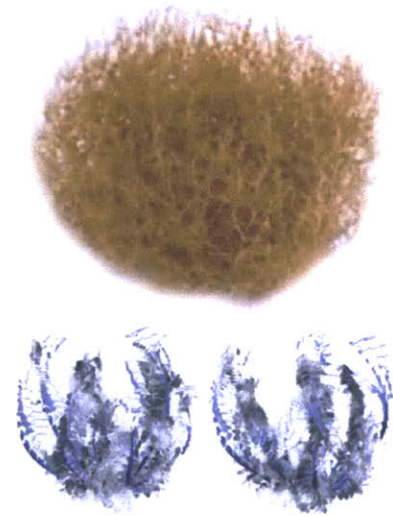


Fig. 4.
Top: Tumble Weed (*Salsola tragus*)
(Dollens, www.tumbletruss.com).

Fig. 5.
Bottom: Xfrog grown truss
-based on tumbleweed (Dollens,
www.tumbletruss.com).

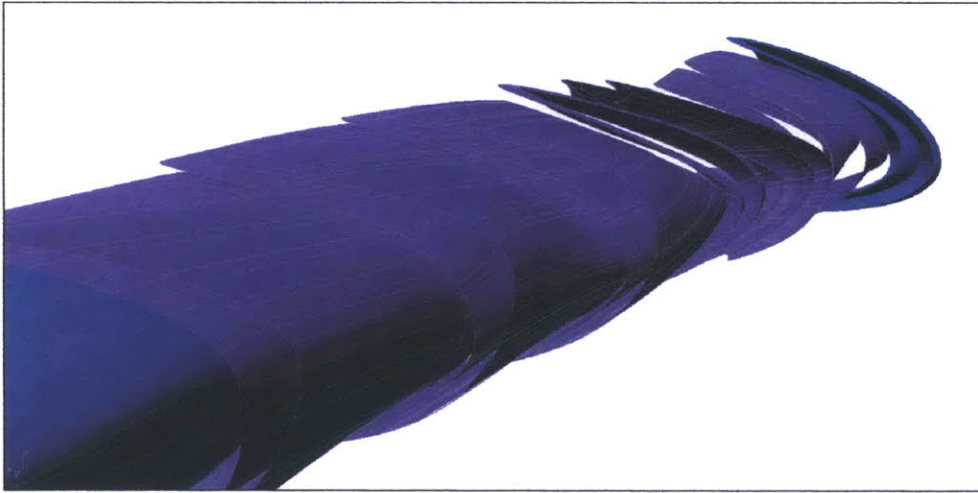


Fig. 6.
View along openings of shells

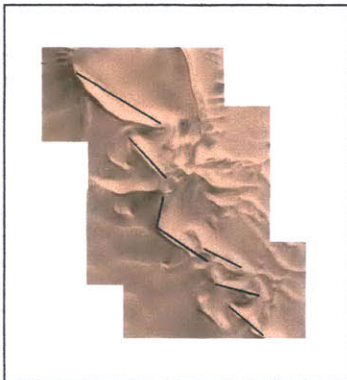


Fig. 9.
Sand Dune Pattern



Fig. 7.
Exterior of overlapping shells



Fig. 8.
Interior of overlapping shells

These images represent my first attempt to create a synthesis of form and an incredibly complex habitat. This tubular structure was derived by analyzing the wind direction and pattern emergence in the sand habitat of the Namib Desert. The attempt was to create a shell like structure similar to the indigenous beetles that harvest fog.

This work failed because it was based on a singular instance of a continuously changing pattern. It did not analyze the forces that created that pattern much less the larger context of related forces with the habitat. It is a singular formal exercise that has nothing to do with the intricate field of interactions between the beetle and its environment. This procedure is guilty of the misunderstandings of language and the technical.

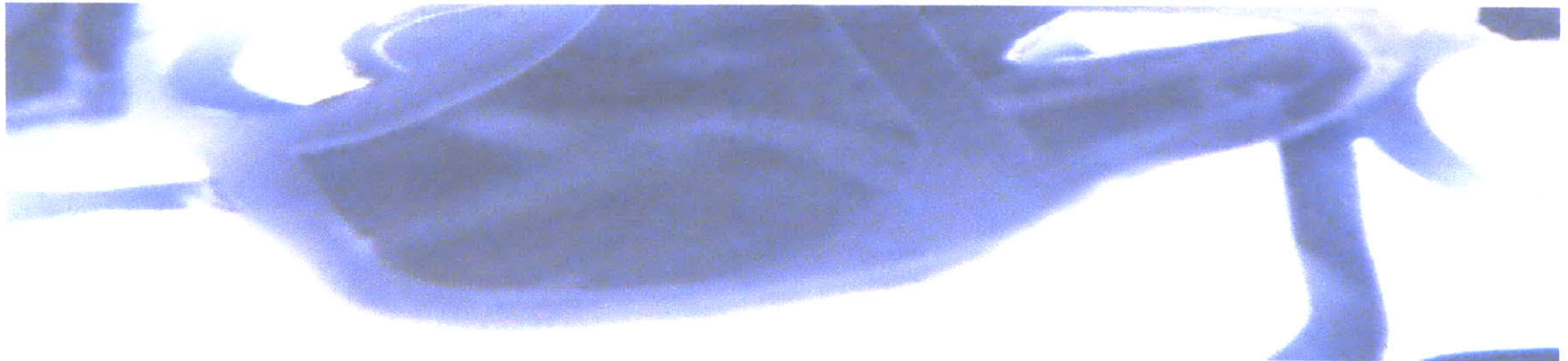


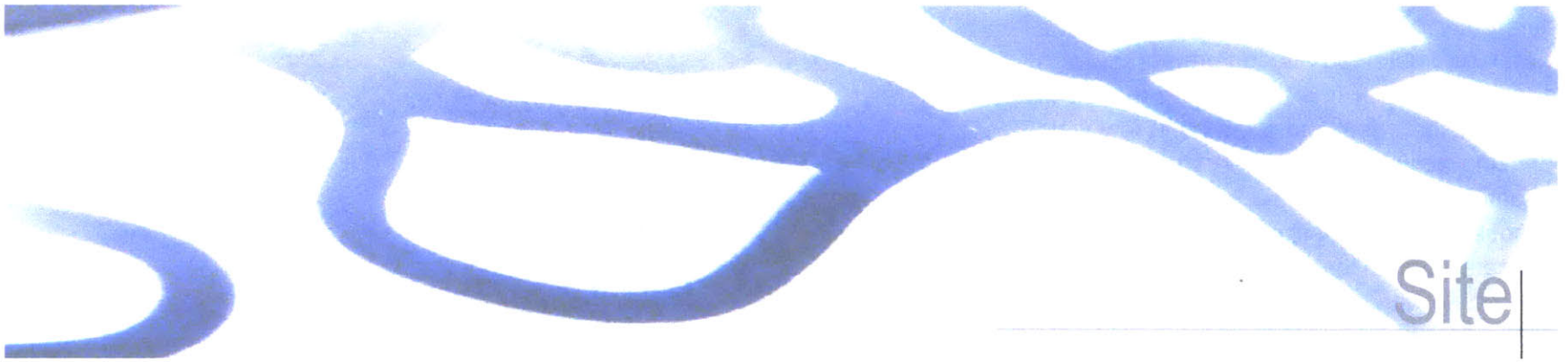
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Site |

Site

It is obvious that different species can utilize some of the same elements. Yet, the ways in which that utilization is carried out are based on each species unique physiology, metabolism, behavior, reproduction and so on. However, in most habitats it is impossible to single out a particular element that is shared by more than one species.

For instance, it seems easy to assume that all species in a given habitat require water, almost every species has a different territory with a corresponding variation of watering holes. These holes could be as simple as a different patch of riverbank, yet have different soil content and nutrient distribution. Therefore, the metabolism of each individual will process the moisture differently. Also, the manner in which the water is obtained is different between species, whether it is the lapping motion of the tiger that results in a long and low yield drinking activity, or the short squirt of large quantities of water by the elephant's trunk. It is not simply an aspect of the habitat, but the intricate relationship of the organism when interacting with it.

This relationship is evident in extreme climates where differing species converge to utilize the same elements. The few available resources become dense nodes of overlapping environments. Here is where the organism/environment relationship that is the foundation of biological thought becomes manifest.



Fig. 11.
Drinking behavior of African elephant
Image source: http://gallery.hd.org/_c/natural-science/_more2003/_more09/elephant-drinking-water-in-Addo-Park-Eastern-Cape-South-Africa-WL.jpg.html



Fig. 12.
Adolescent lion's drinking behavior
Image source: <http://www.liv.ac.uk/~sdb/Safari-2005/index.html>



Fig. 13.

Extreme Habitat - Ice Desert - Antarctica

Image source: http://en.wikipedia.org/wiki/Image:Fryxellsee_Opt.jpg



Fig. 14.

Extreme Habitat - Rainforest - Amazon Rainforest

Image source: http://en.wikipedia.org/wiki/Image:Amazon_57.53278W_2.71207S.jpg

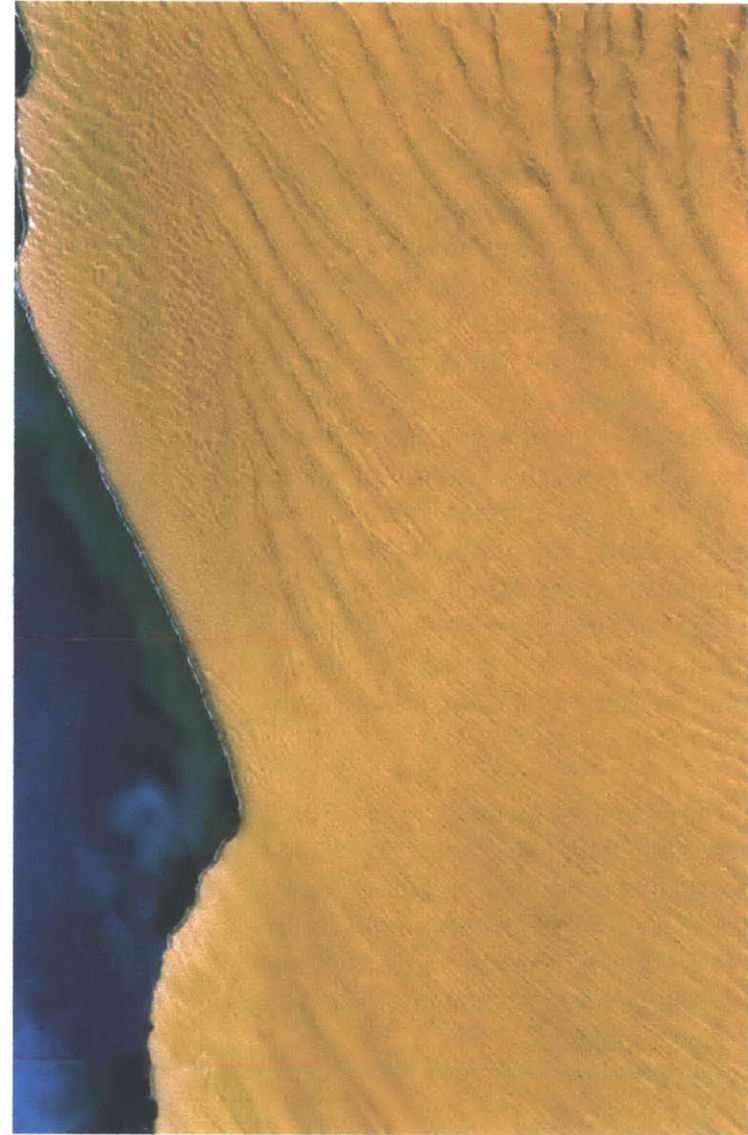


Fig. 15.

Extreme Habitat - Desert - Amazon Rainforest

Image source: http://en.wikipedia.org/wiki/Image:ConceptionBay_Namibia_ISS011-E-9756.jpg

To further this aim the site I have chosen is the Namib Desert in Southern Africa. This unique environment has limited resources that force the environment of species to converge. It is a habitat that, due to the severity of the climate, forces the continuum of organism/environment to manifest itself. Different species converge on a few distinct microhabitats that have a limited number of components. These include moisture, temperature and wind. Every organism in the Namib has a distinct relationship with these elements. Thus, it is possible to design an architectural physiology, behavior and metabolism based on this continuum.

The Namib is located on the Southwest coast of Africa. Because it has such a unique location and is the oldest desert (approximately 80 million years old), organisms have created extraordinary environments to sustain life in the exact habitat that should be the most desolate.



Fig. 16.
Namib Desert montage (modified image)
Original image source: NASA's globe software, Whirl Wind

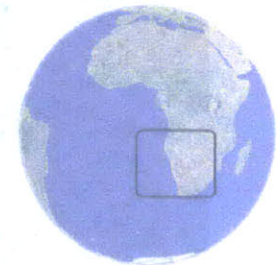


Fig. 17.
Namib Desert Location (modified image)
Original image source: GoogleEarth

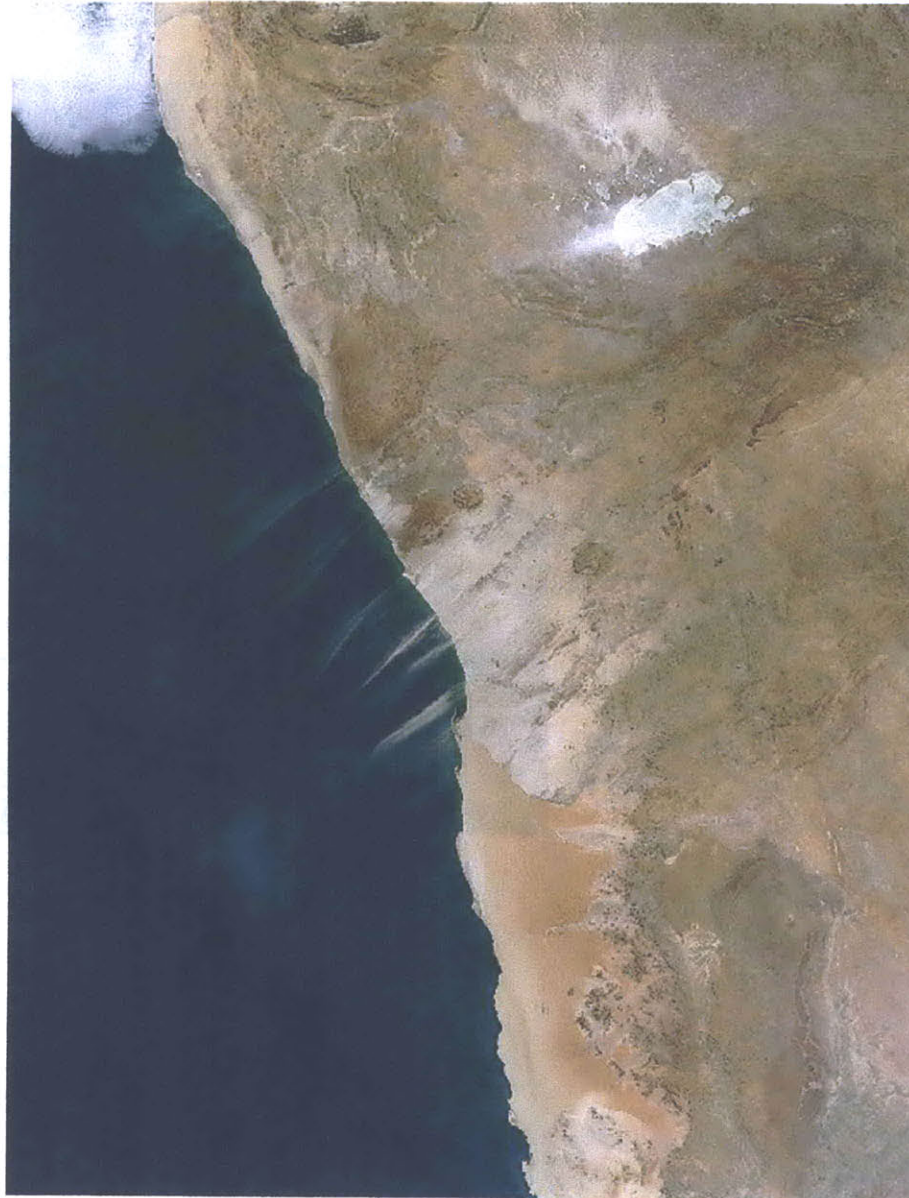


Fig. 18.
Sand being blown off of the Namib
image source: [http://members.shaw.ca/hbooyens/
Namib_space.htm](http://members.shaw.ca/hbooyens/Namib_space.htm)

The analysis of the site began by framing it in a larger context. By positioning the Namib Desert relative to other extreme climates, a clearer picture began to emerge of the particular conditions that produce it in the first place. The habitats I studied besides the Namib Desert were Antarctica and the Amazon Rainforest.

In the book *Ecozones of the World* (of which this figure is adapted from), Jurgen Schultz provides ample evidence of the relationships between habitats. At the macroscale, these locations are iterations of the same parameters at different levels. Both the Namib and Antarctica are deserts. Yet, Antarctica is a cold desert and its sole source of precipitation is snow or ice. Due to the consistency of climate, the Amazon Rainforest actually has a higher average temperature annually than the Namib Desert.

While the habitats are comparable on this scale, they quickly deviate when local microhabitats are considered (fig. 20, 21, 22). The distribution of local conditions take precedent at these scales producing varied conditions within the larger habitat.



Fig. 19.

Fog over the Namib Desert

-This is a unique condition of the habitat that supports a wide range of organisms. Image source: <http://pubs.usgs.gov/gip/deserts/types/>

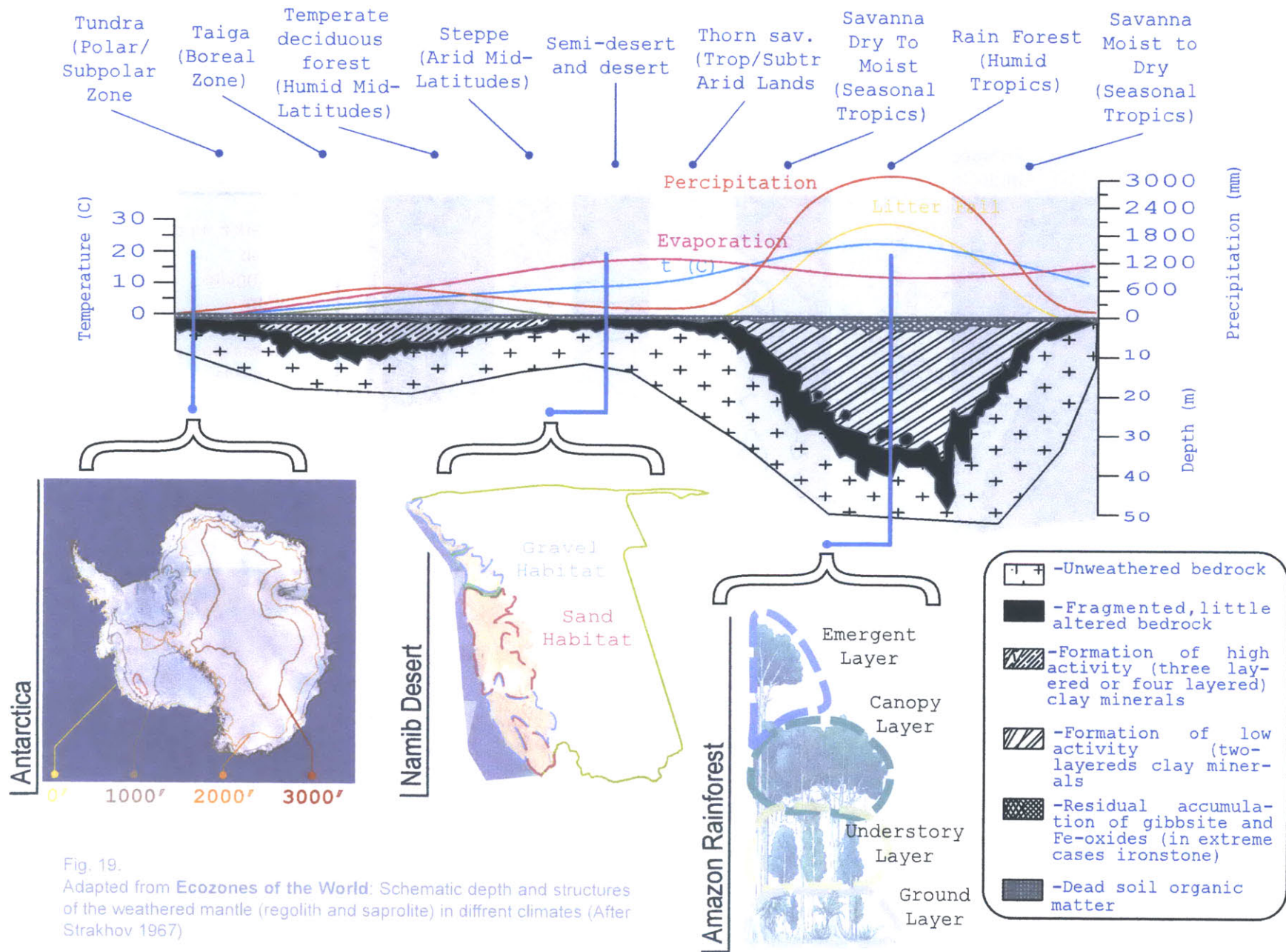
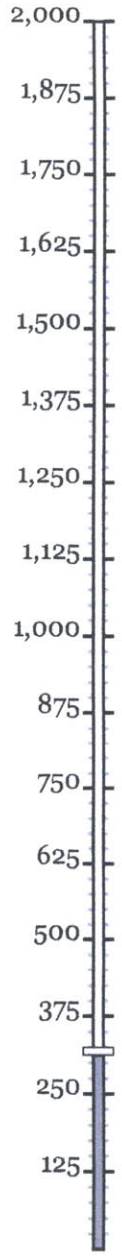


Fig. 19. Adapted from *Ecozones of the World*; Schematic depth and structures of the weathered mantle (regolith and saprolite) in different climates (After Strakhov 1967)

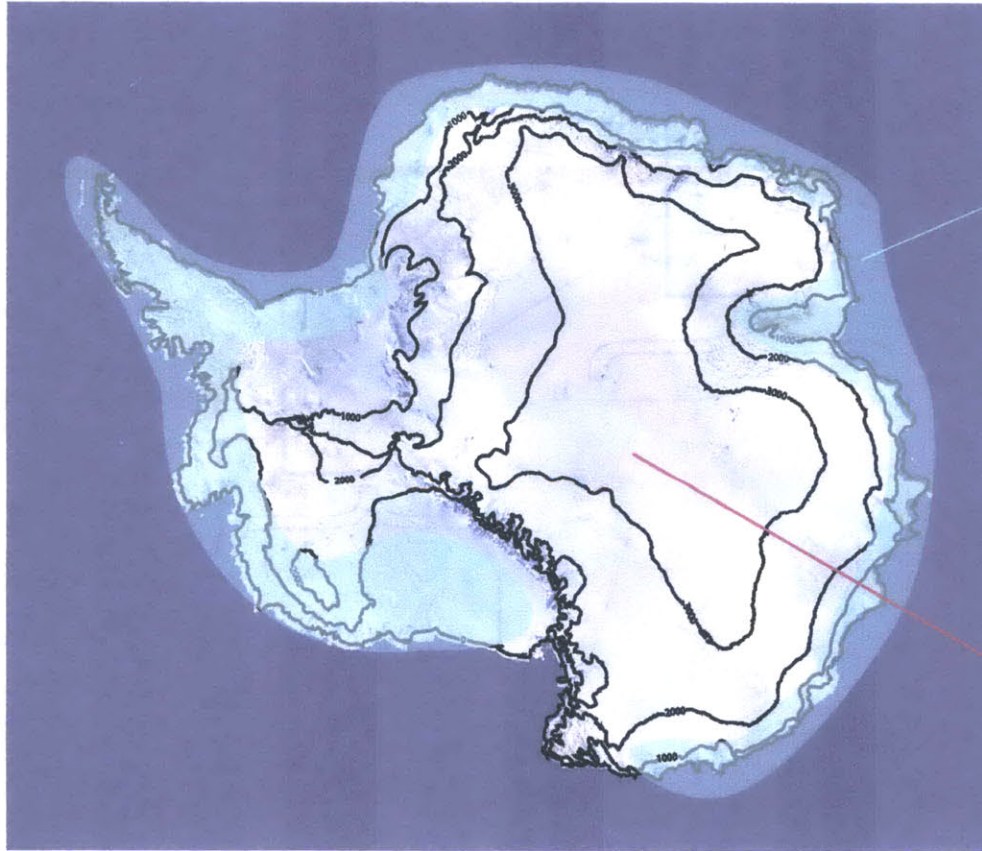


Antarctica

Approximate Biodiversity (terrestrial)

Flora:
 supports- 250 species (Lichens, moss, algae)
 2 species (flowering plants)

Fauna:
 arthropods- 38 species
 birds- 15 species



Coast
 population support
 -seals
 -penguins
 -flora
 only two flowering plants grow on peninsula
 high winds and frequent storms are common

Interior
 population support (almost none)
 -lichen
 -moss
 -invertebrates
 largest desert- less than 2" of rain/year
 much colder than coast

Fig. 21.
 Antarctic analysis
 -Scale represents amount of biodiversity endemic to the habitat

Namib Desert

Approximate Biodiversity

Flora:

- supports- 210 species
- endemic- at least 2 species

Fauna:

- mammals- 20 species
- birds- 180 species
- reptiles- 70 species
- arthropods & insects- 620 species

Riverbed Habitat
 population support
 -ungulates
 -baboon
 -hyenas
 ephemeral riverflow
 due to inland rain
 predators include
 cheetah, brown &
 spotted hyenas,
 bat-eared foxes

Sand Desert
 population support
 -insect
 -reptiles
 intervals of years
 between rainfall
 costal fog moving
 eastward is major
 water source

Gravel Desert
 population support
 -reptiles
 -insects
 -plants (grasses)
 sporadic rain sparks
 ephemeral grasses
 & plants
 subsequent dead
 plant material
 supports fungus
 and insects

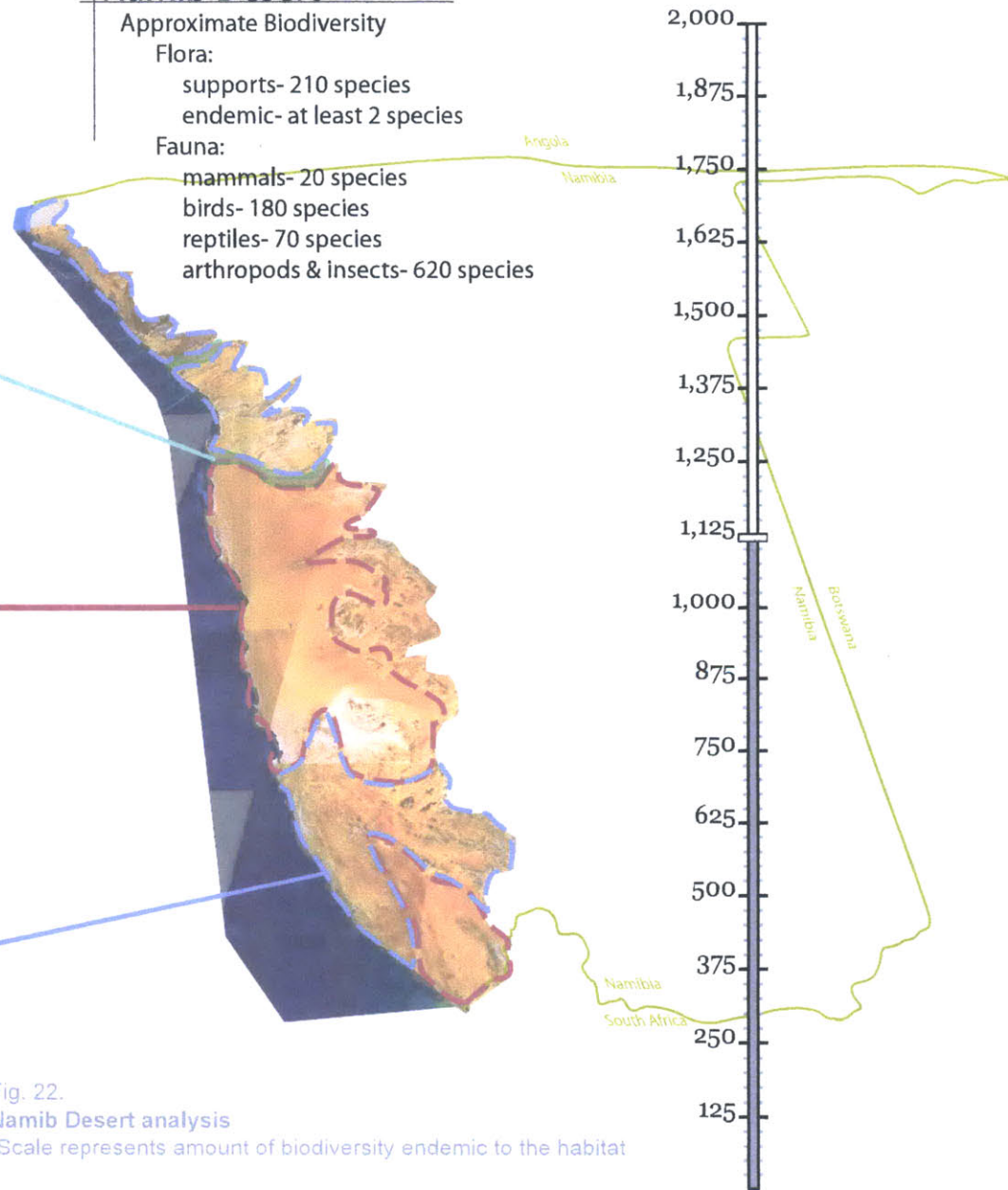


Fig. 22.
 Namib Desert analysis
 -Scale represents amount of biodiversity endemic to the habitat

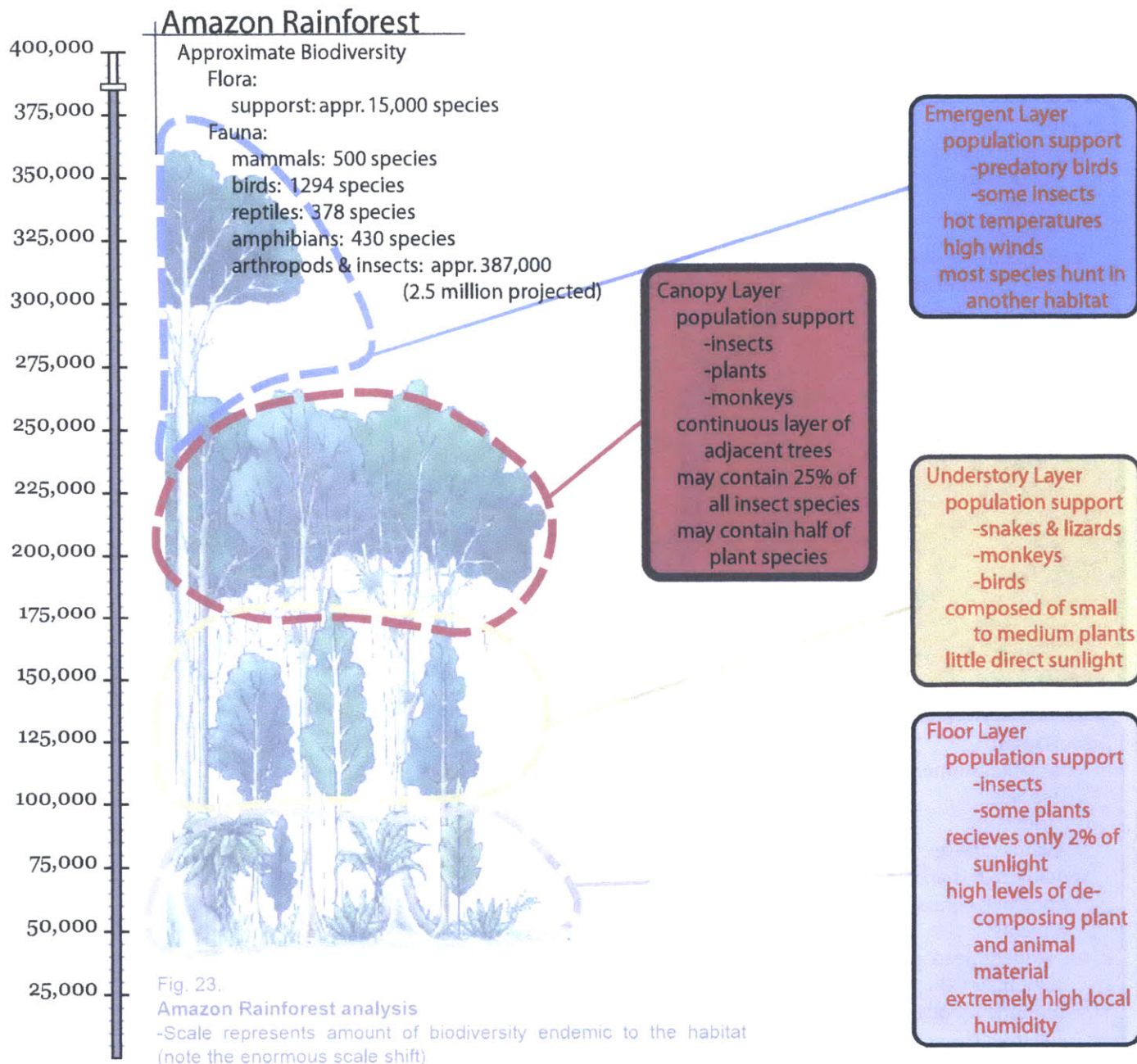




Fig. 24.

Namib Desert Biodiversity

-The tenebroid beetle climbs a dune and angles its shell toward the incoming fog. The surface of the shell produces condensation that is the only moisture this insect receives.

Image source: <http://www.orusovo.com/guidebook/content6.htm>



Fig. 25.

Antarctica Biodiversity

-There are only two species of penguin native to Antarctica. However, there is a wide variety of seal species that are endemic to the region.

Image source: http://www.ptialaska.net/~rbtbrsrd/html/body_10.html

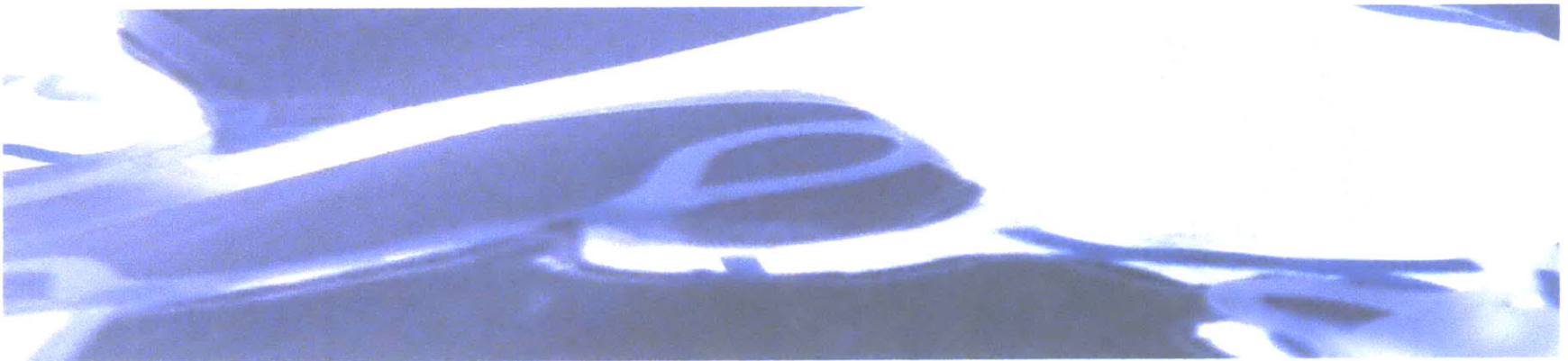


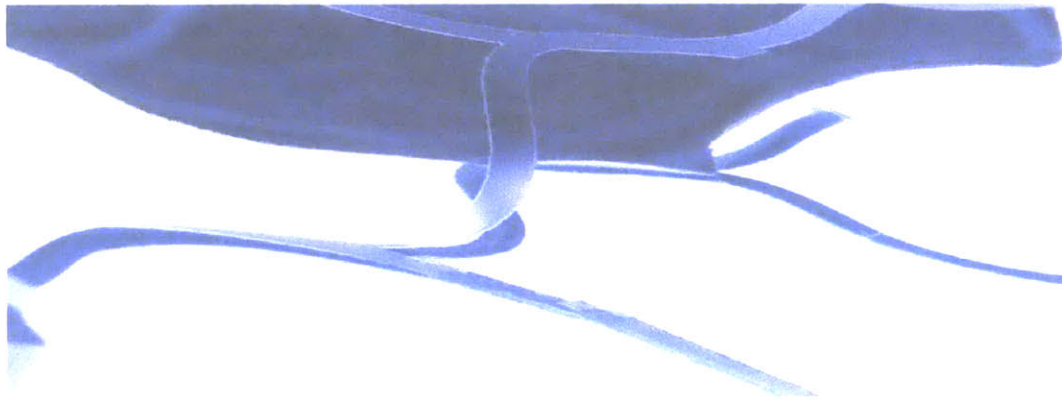
Fig. 26.

Amazon Rainforest Biodiversity

-There are an estimated 12.5 million species of insects in the Amazon. Of which only a small fraction has been identified.

Image source: <http://www.lostworldadventures.com/countries/ecuador/regions/amazon.htm>





Project |

As was mentioned in the introduction section, the first attempt to construct something out of this analysis was not successful. It relied on too many premises that were later proved incorrect. Also, it was an architectural response to the climate as a negative force in the Namib Desert. The more research I did into the organisms of the habitat, the more and more it became clear that the habitat is neither positive nor negative. Since the organism constructs its own environment, there is a prerequisite to choose those conditions that are beneficial to it.

To understand this point, I developed a map to place this first attempt as well as a digital surface model. This allowed me to orient this project based on its behavior and factors of the habitat that it was utilizing (fig. 28). This map was a crucial step in realizing that the goal was not to produce a formal reaction, but to produce effects.

Therefore, every subsequent iteration was designed through the effects it should create rather than an actual program.

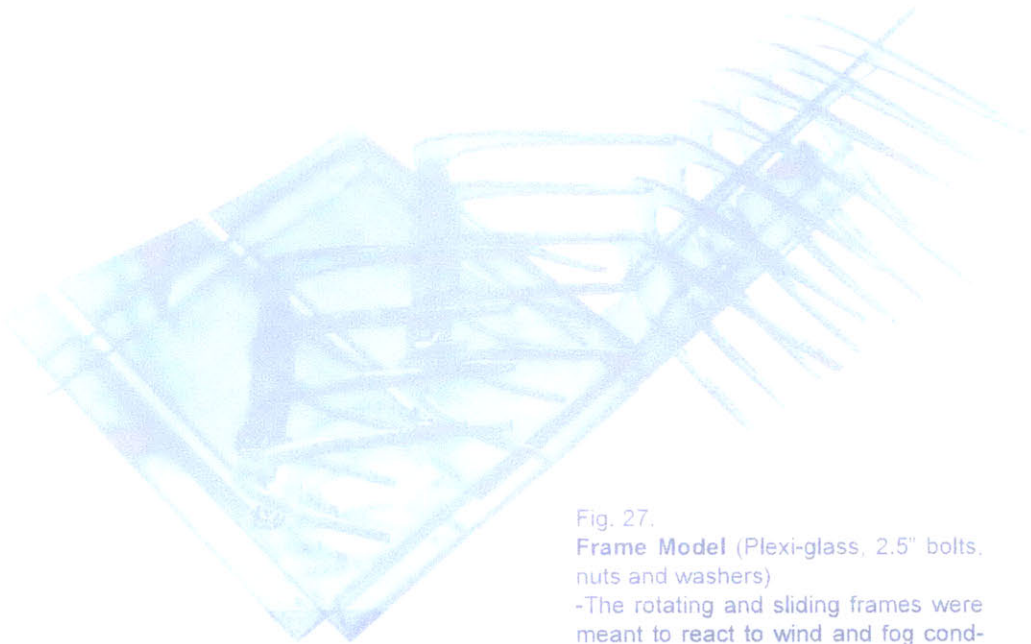
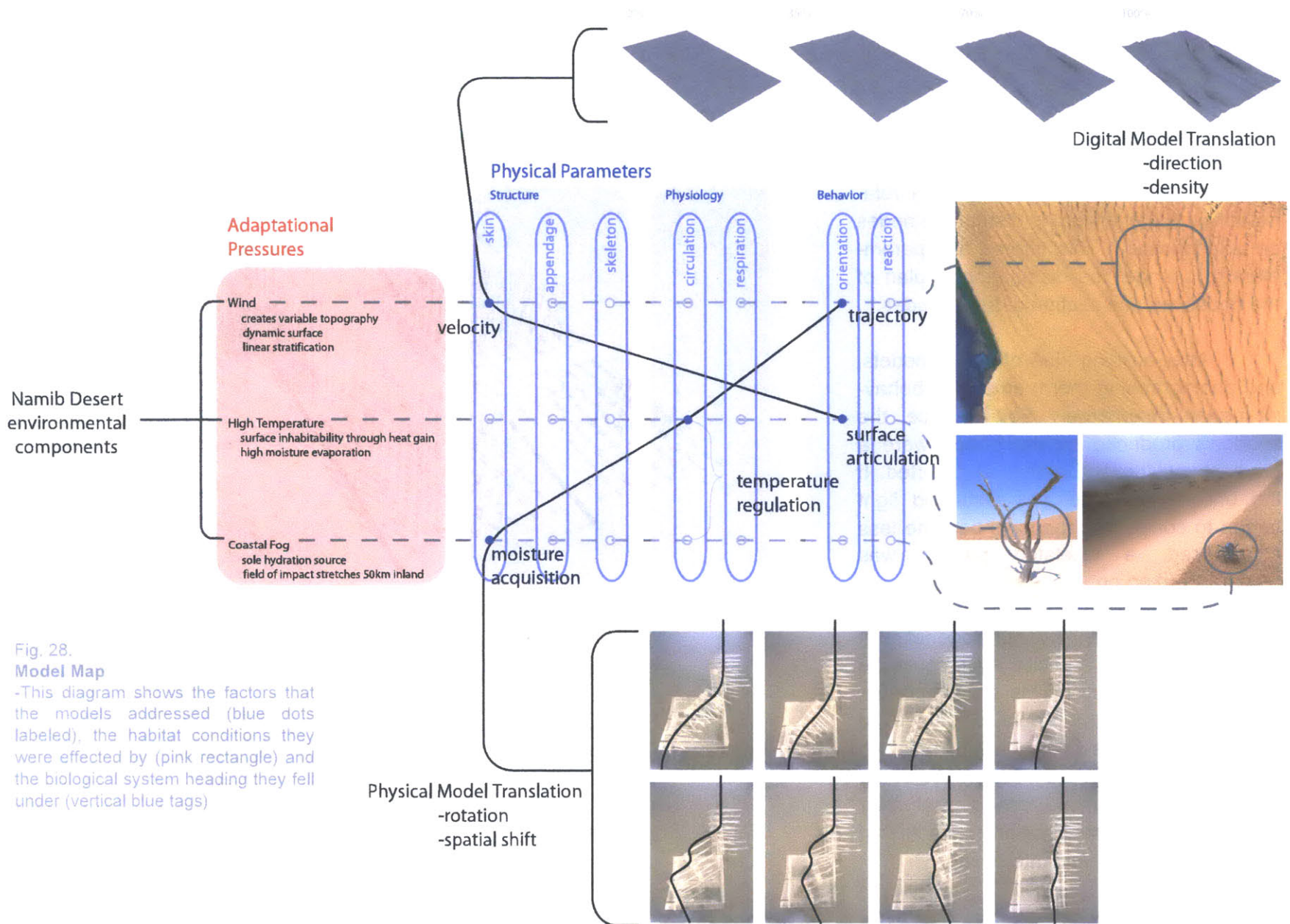


Fig. 27.
 Frame Model (Plexi-glass, 2.5" bolts, nuts and washers)
 -The rotating and sliding frames were meant to react to wind and fog conditions by regulating the porosity of the shell.



The next step was to design models that would produce a range of effects. To keep this from becoming complex, I relegated the entire system to distributed nodes on a landscape. This offered two parameters to change; the distribution in plan of the nodes and the section of those nodes.

After building nine of these models, and photographing them, emergent behavior began to emerge. For instance, the shadows produced by the nodes were a gradient until the landscape was distorted. If the underlying plane was disturbed light began to condense, shadows became less pronounced, a pixelated pattern was revealed and so on.

Furthermore, by phylogenetically arranging them, a specific trait could be mapped to behavior. This was important because the system could be tuned to produce certain effects by adjusting only two parameters. Despite the crude nature of the models, the underlying control that they offered as well as the variation in effects that they produced was very interesting.

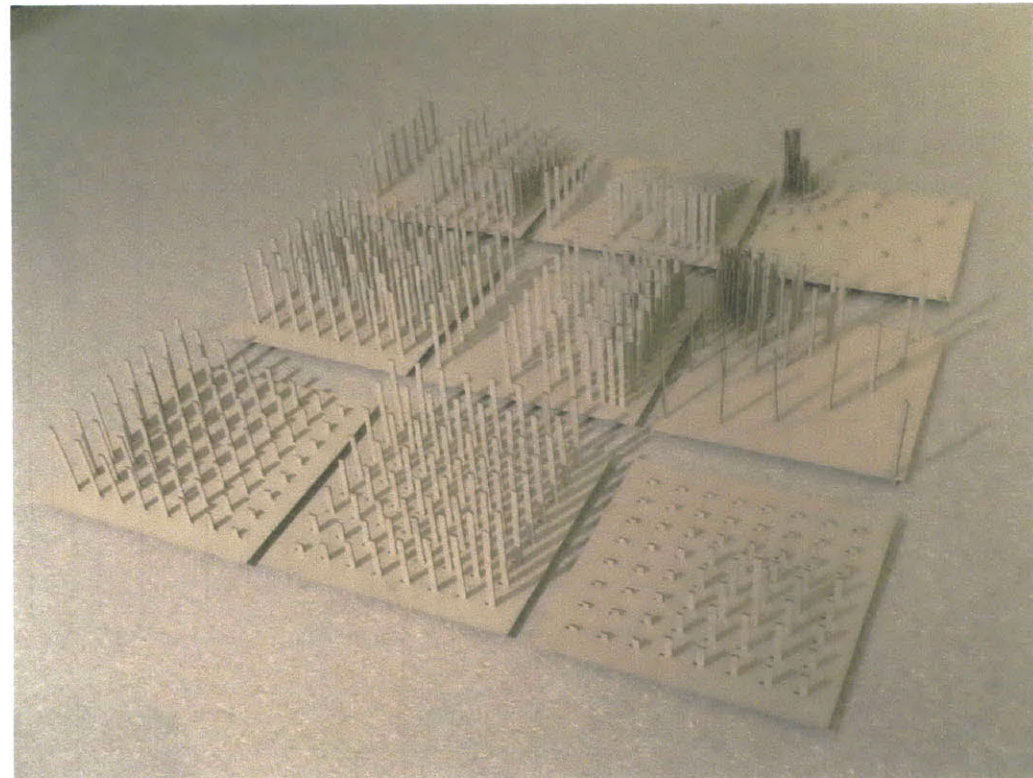


Fig. 29.

Landscape Models

-These models varied in plan and/or section in 1 direction and/or 2 directions.

Taxonomy of Plan

Uniform Plan Species

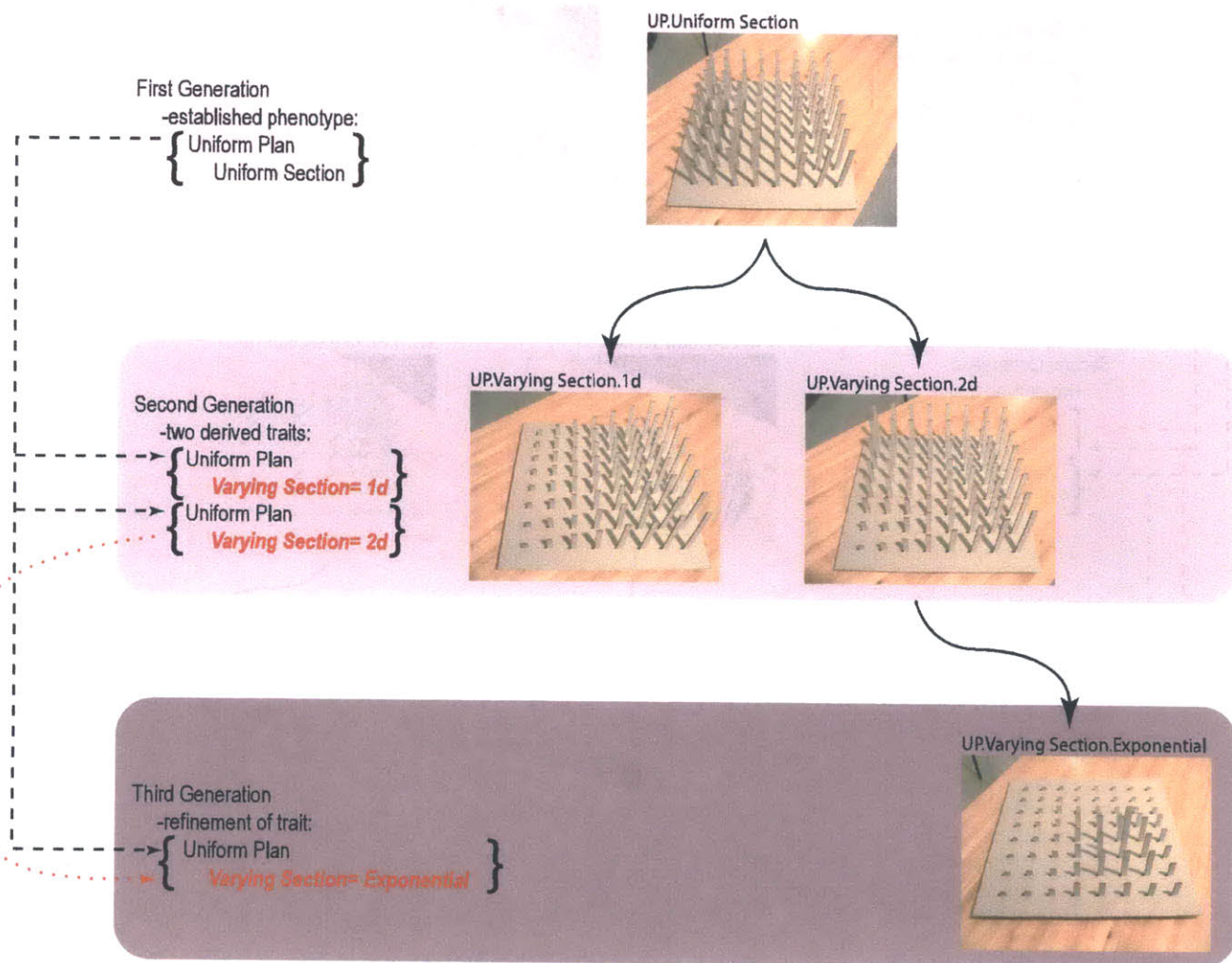


Fig. 29.
Taxonomy of Plan
 -This categorization establishes the uniform plan as static and all other traits are derived (in red).

Taxonomy of Plan

Varying Plan Species

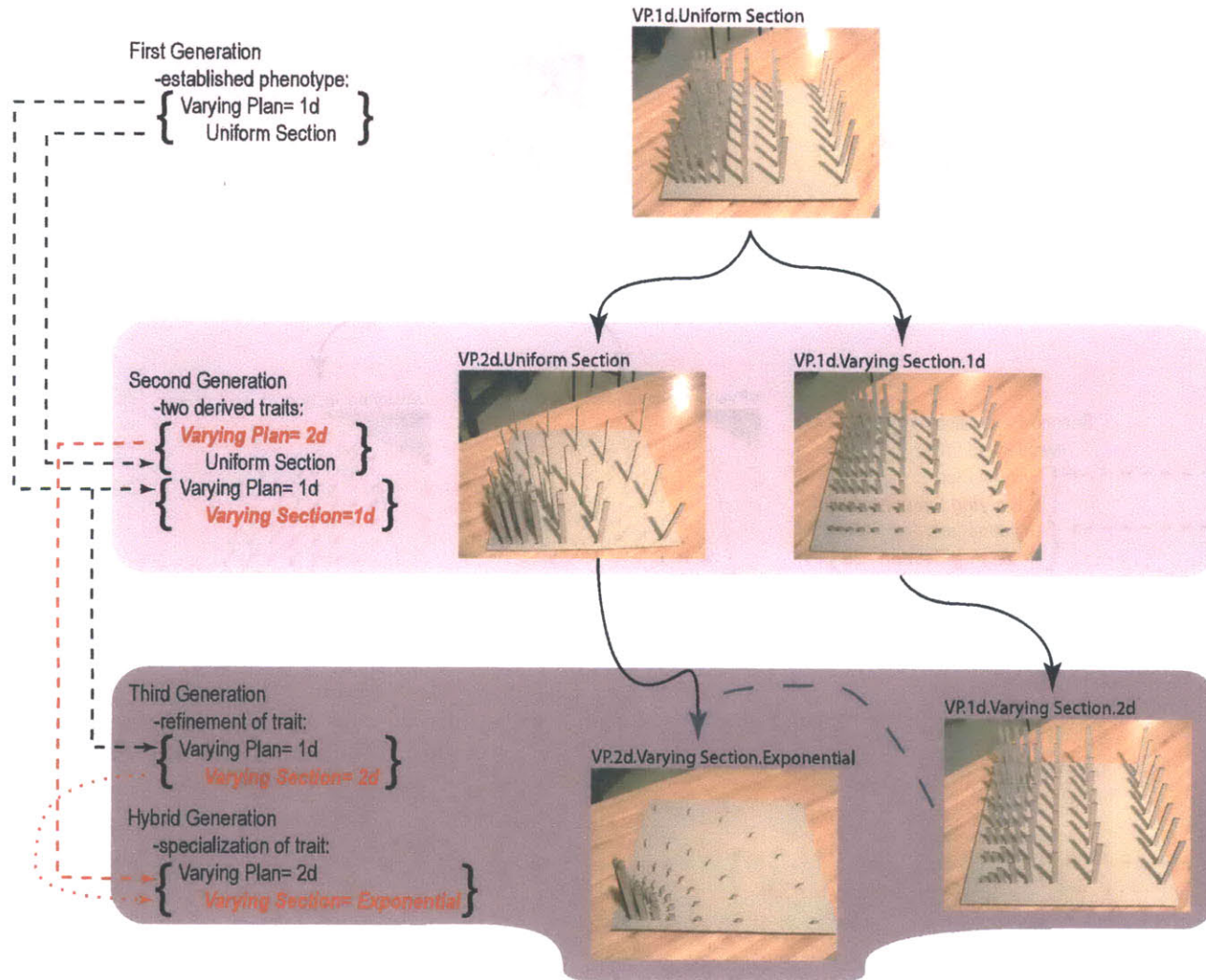


Fig. 30.
Taxonomy of Plan
 -This categorization establishes the a varying plan as static and all other traits are derived (in red).

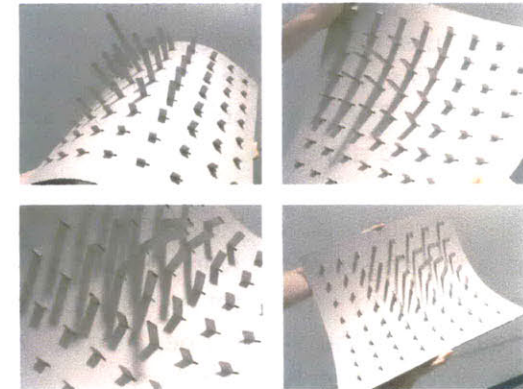
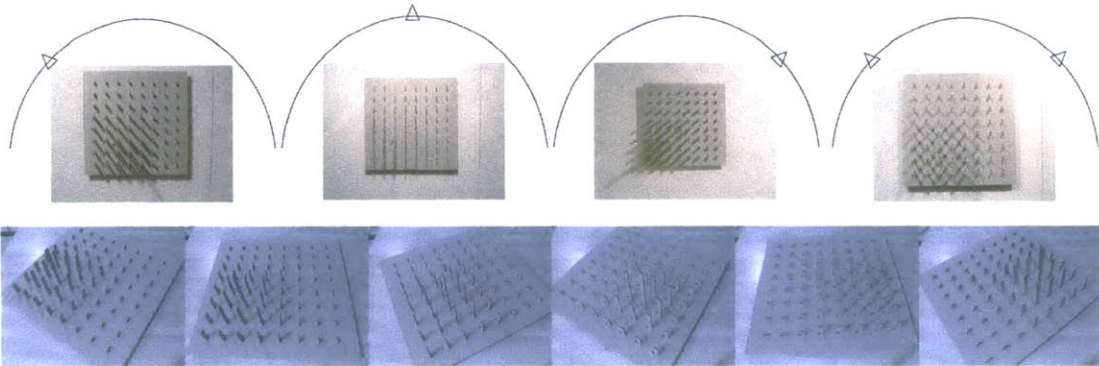
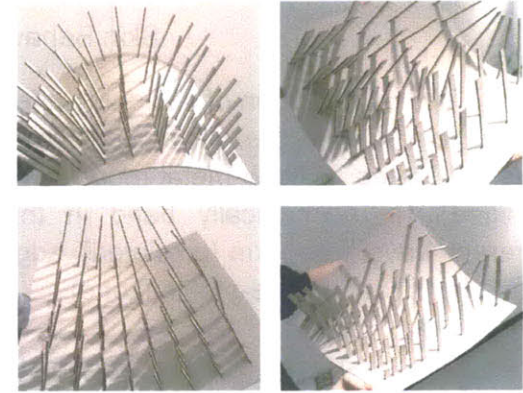
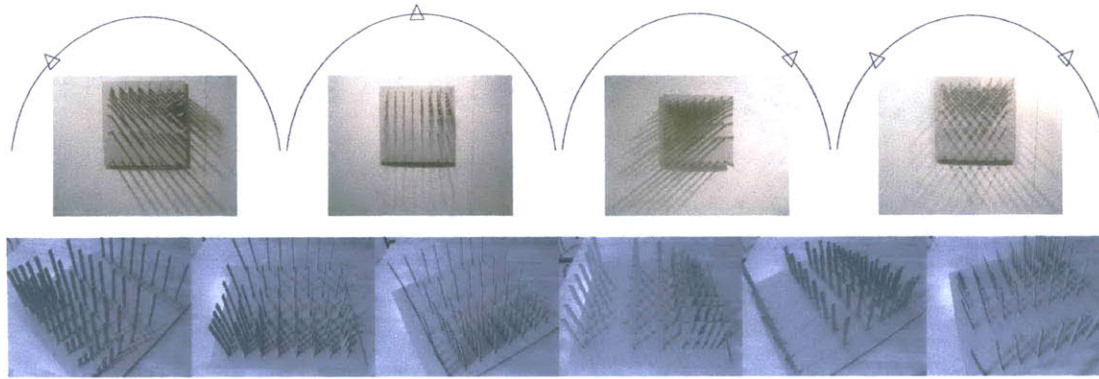


Fig. 31.
Shadow and Bending Behavior of landscape models.

Skin Behavior

The continuation of designing effects led me to a study of the way a skin reacts to external forces. These metal models were designed to mechanically bend in three different ways: free-form [pixelated], edge-frame [strip] and shape-profile [zone].

The first site specific parameters were applied to these skins as if they had evolved from the same progenitors but had found themselves in different microhabitats and forced to adapt.

The circle pattern was established so at a future date a component could be added to filter and absorb certain aspects of the habitat. The skin would therefore act as the controlling armature.

Through all of these studies there was a missing aspect. None of the models ever produced emergent or non-uniform behavior like the landscape models had done. That aspect had to return.

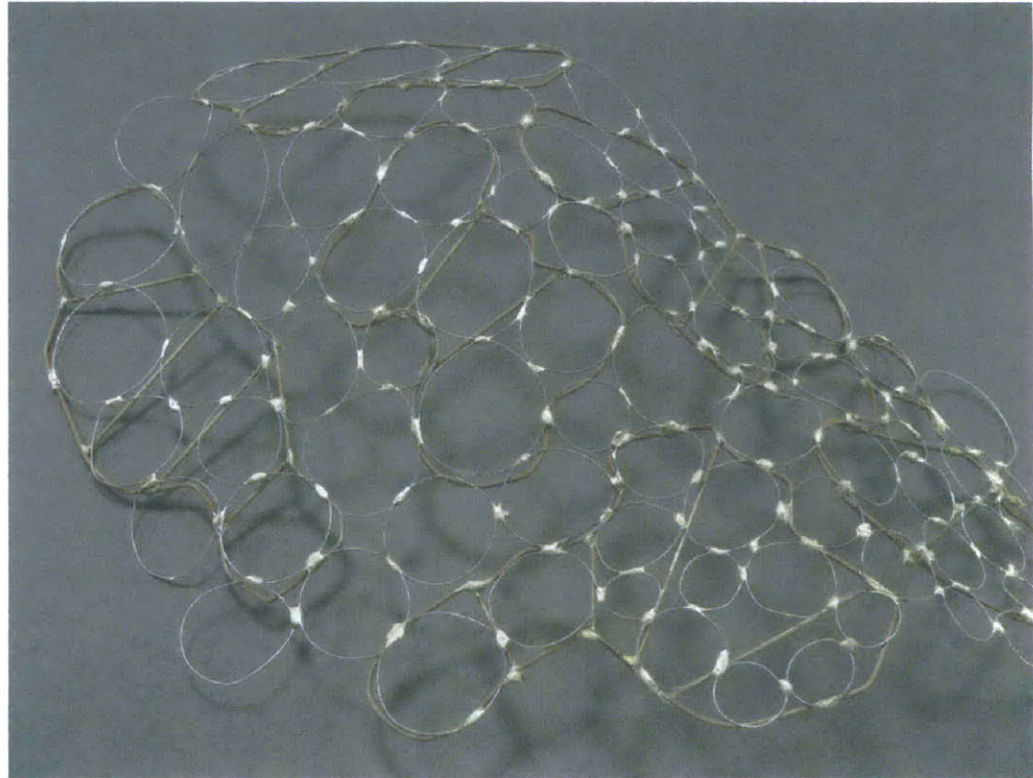


Fig. 32.

Zone skin

-This model is made up of soldered rings with an underlying profile armature.

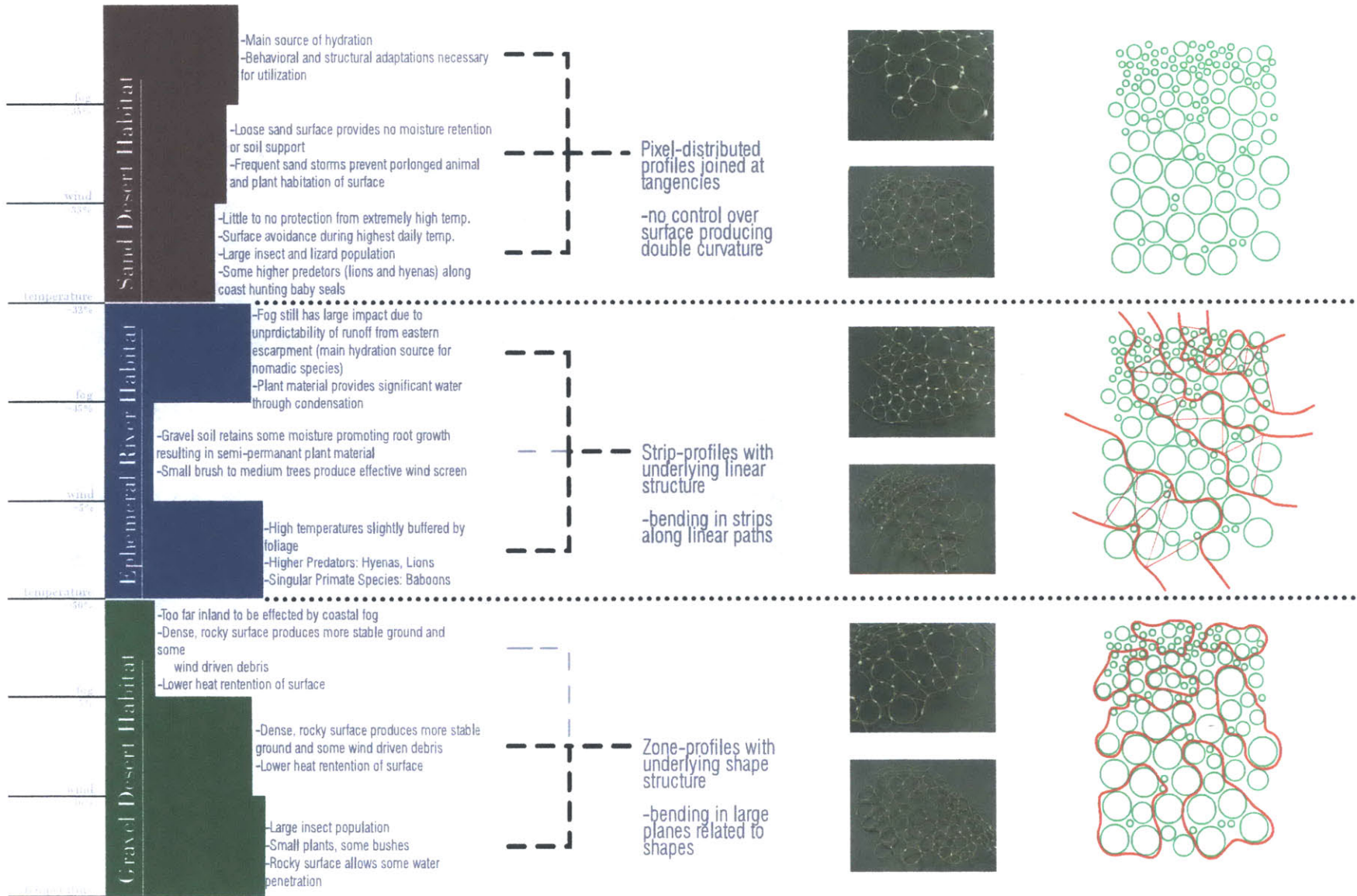


Fig. 33.
Skin categorization based on microhabitats

Non-uniform Deformation

The previous models relied too greatly on the actual material used and the way they were constructed. Almost all the behavior that they exhibited was a result of uncontrollable factors like the soldered joints, the twist of the metal, fatigue in the metal and errors in the construction. As a result, there was no emergent behavior other than uncontrollable noise in the process.

However, I began to analyze the process of the circle maps and started creating lattices that were the tangential result of these patterns. The two shown here are a rectangular footprint and a T footprint. Once they were laser cut, they became nondirectional lattices that could be folded on themselves creating greater levels of complexity.

When they were assembled, the behavior they exhibited was based specifically on the density of the pattern. Yet, every action produced non-uniform deformation which is exactly the behavior that would occur with non-uniform environmental forces acting on a membrane.

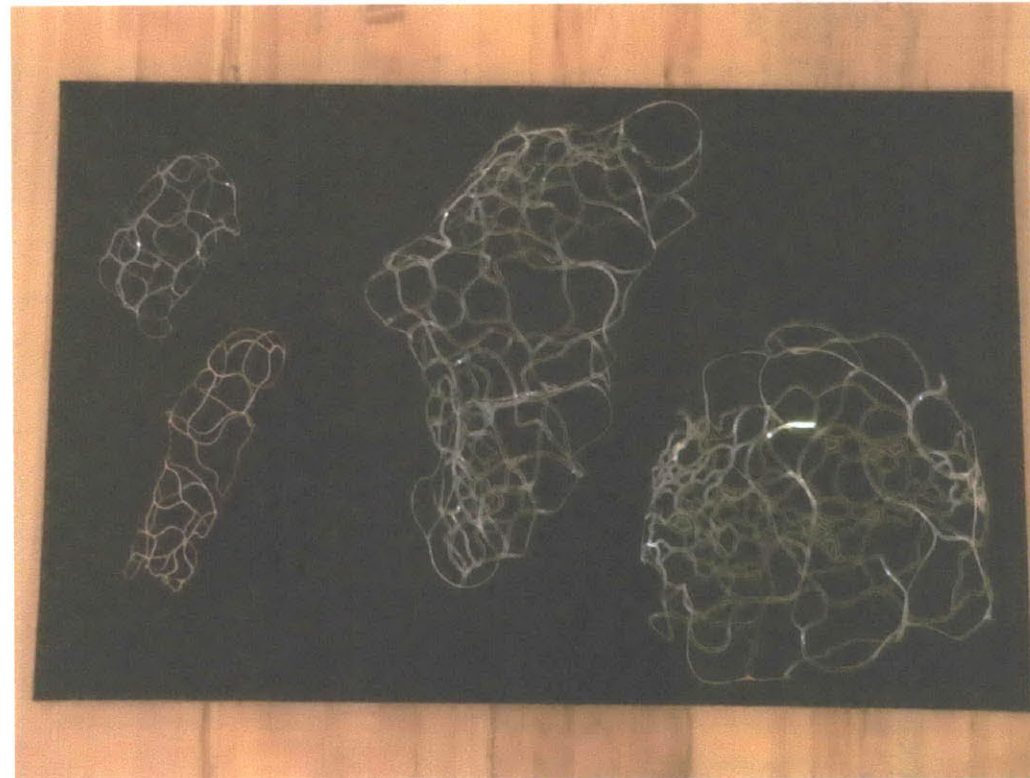


Fig. 34.

Non-D Models

- The two smaller models on the left are made from the rectangular pattern but assembled in opposite directions (longitudinal and latitudinal)
- The two larger models on the right are made from the T pattern and also are assembled in opposite directions (longitudinal and latitudinal)

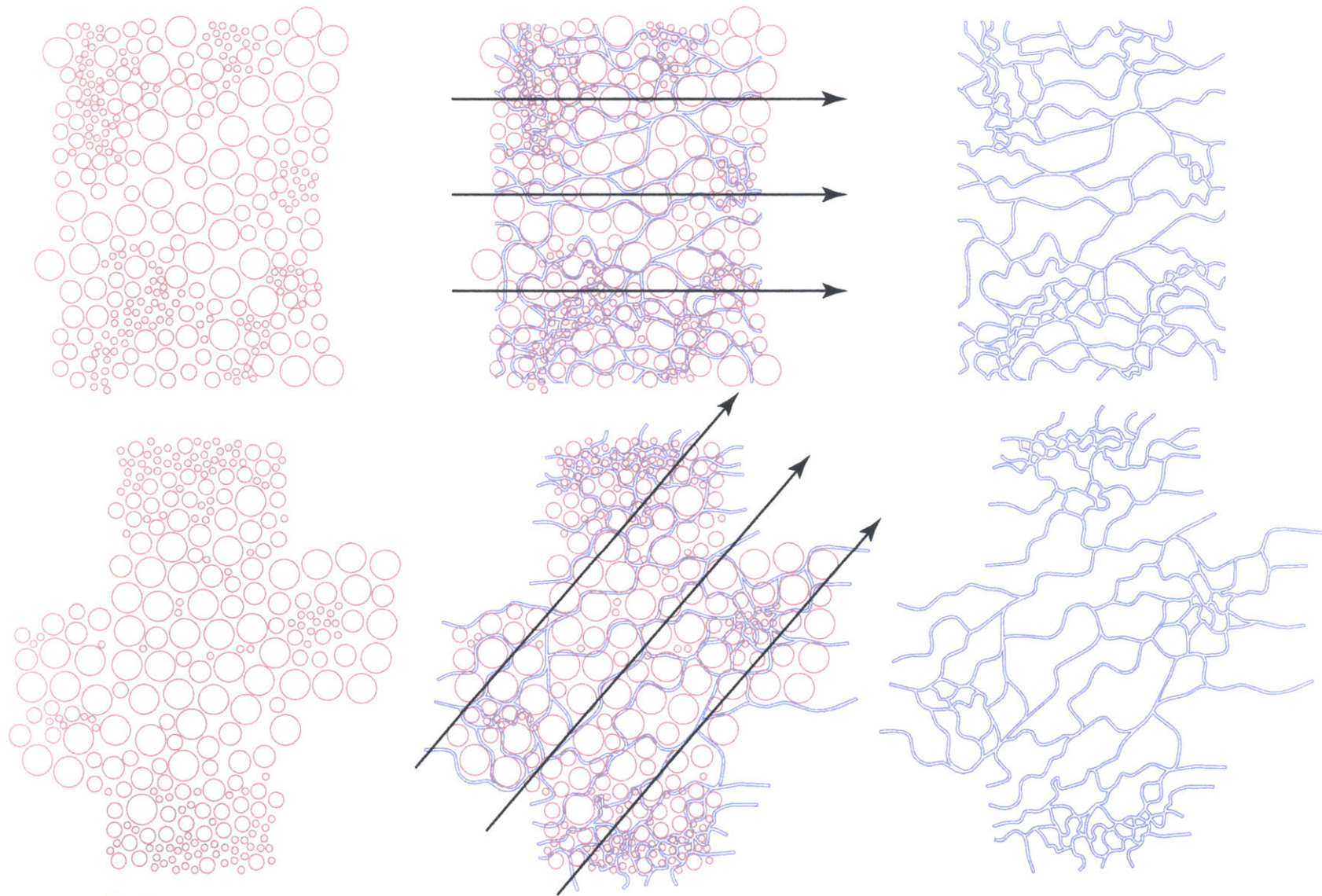


Fig. 34.

Non-D Models

-Derivation of patterns. At the middle stage, the tangential lines are drawn with a direction (shown).

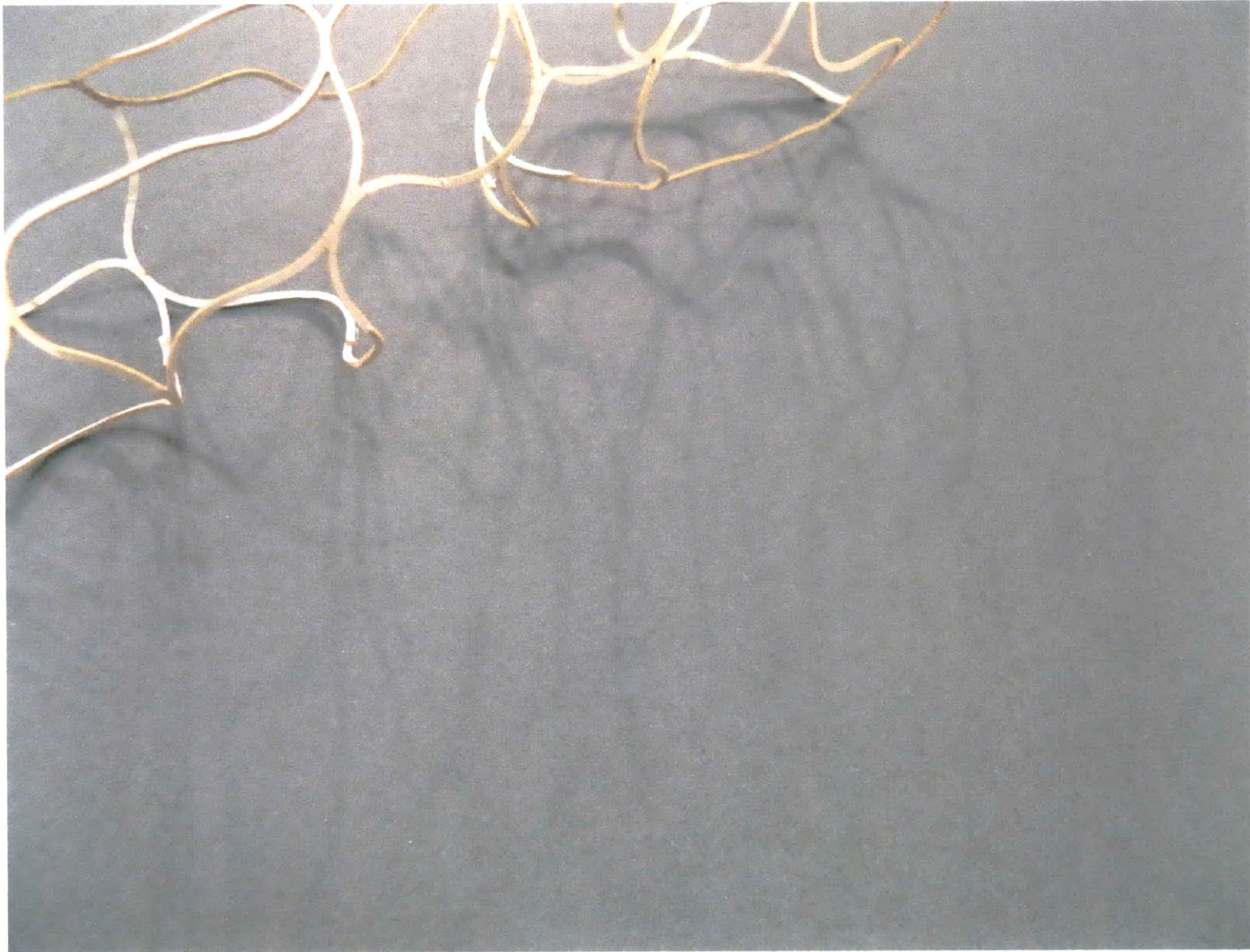


Fig. 35.

Non-D Model

-Smaller rectangular chip-board model. Even the shadow patterns created emergent patterns.

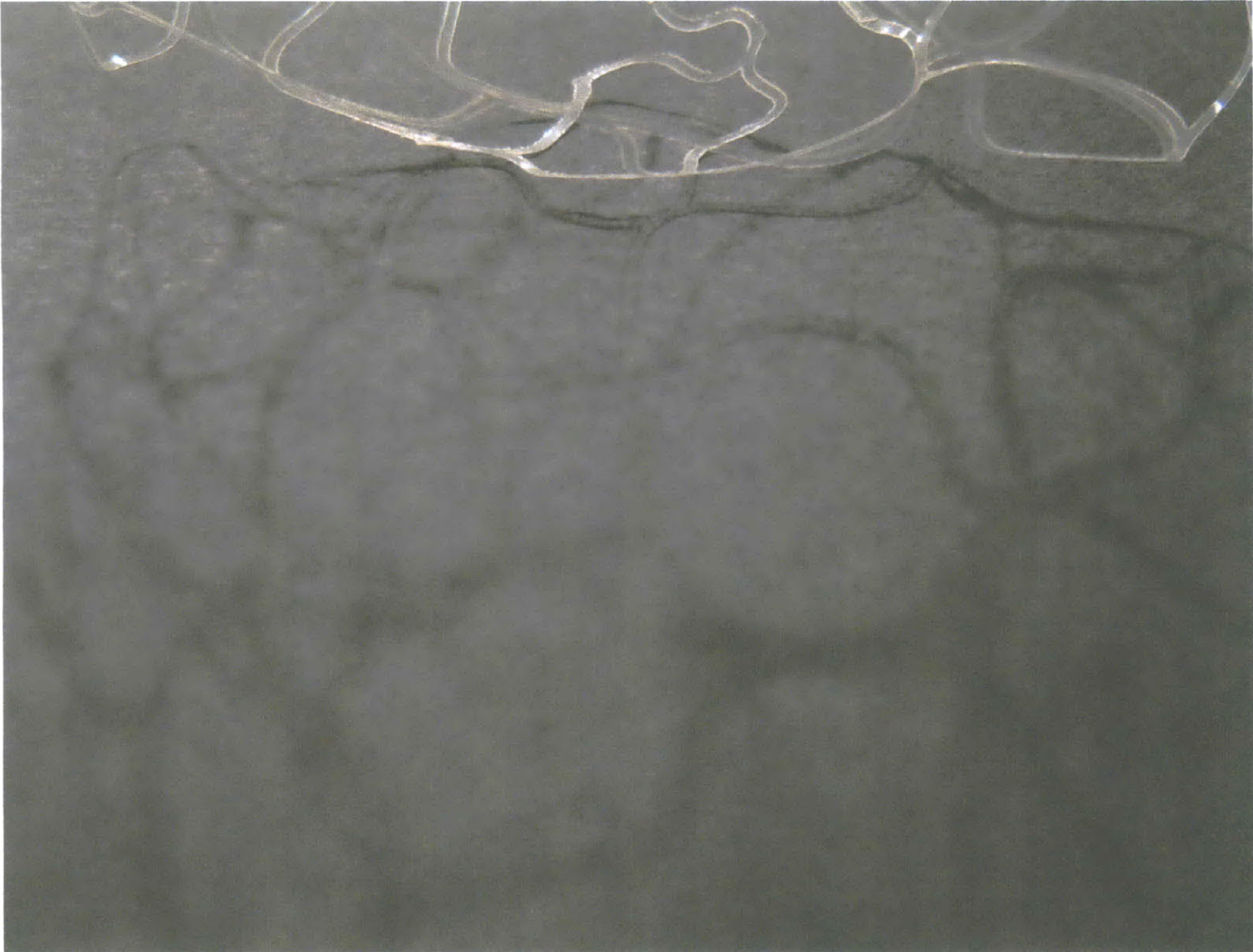


Fig. 36.
Non-D Model
-Smaller rectangular acetate model.



Fig. 37.
Non-D Model
-Planar Lattices that are systematically pushed and pulled to create deformed spacial configurations

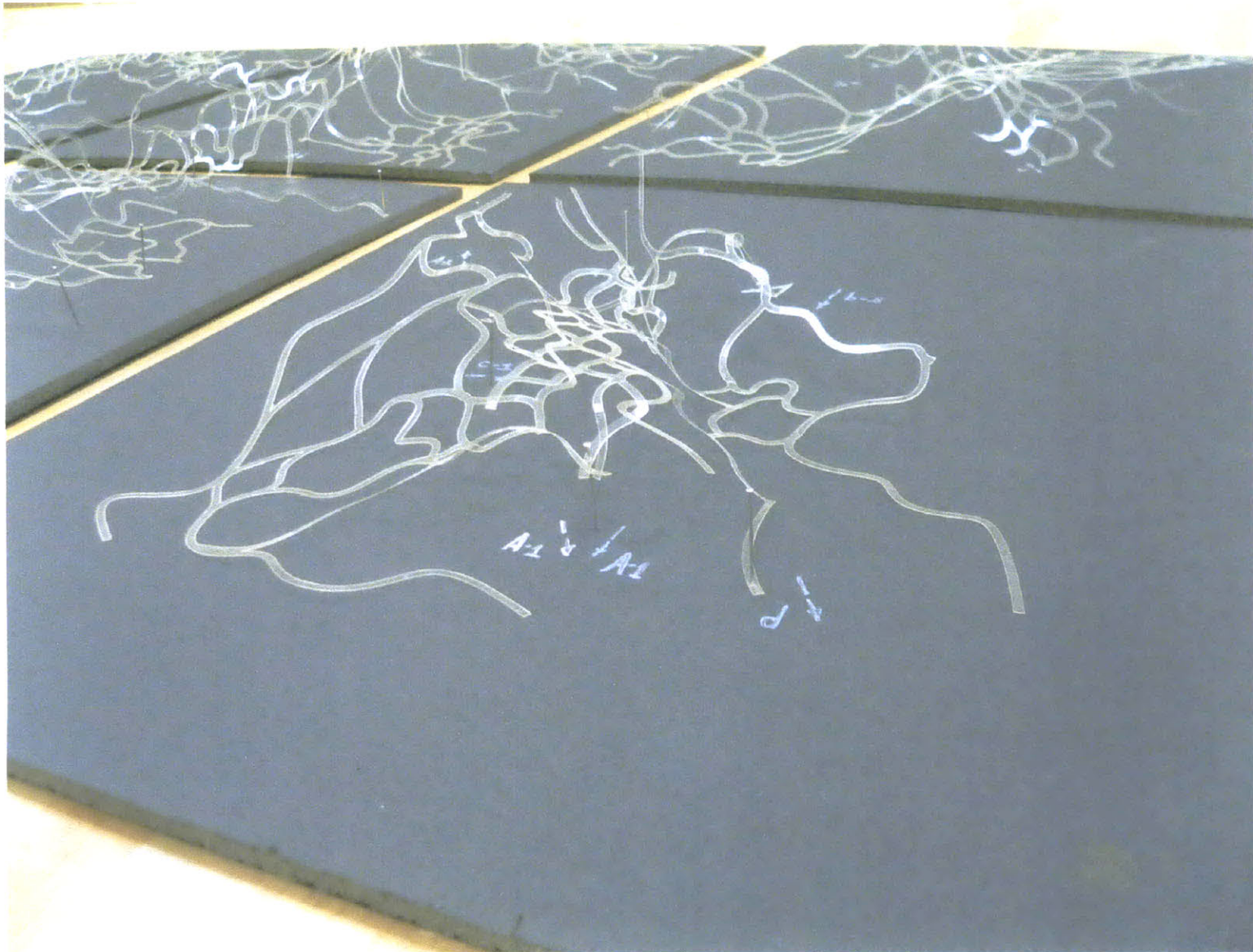
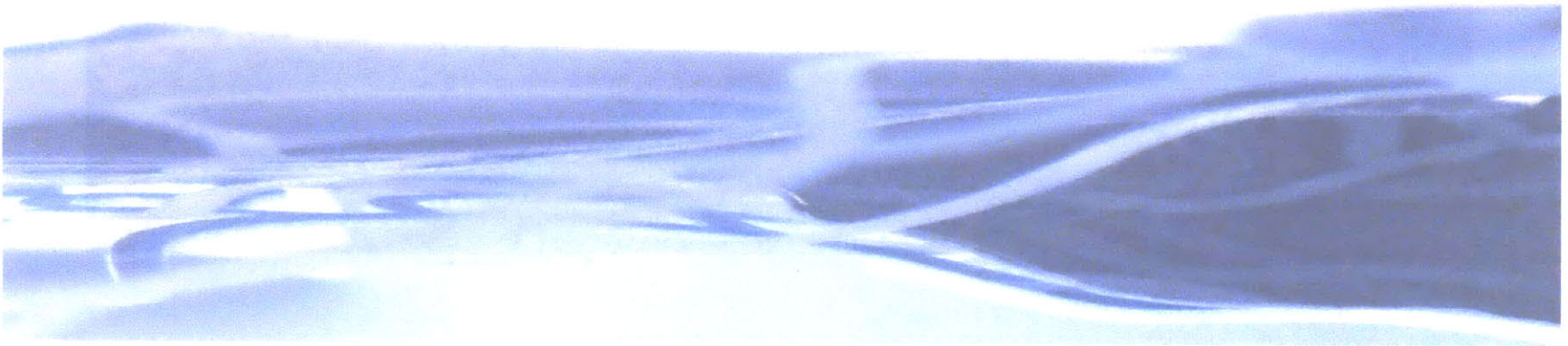


Fig. 38.
Non-D Model
-Detail of push pull key. Each operation was done sequentially (A,B,C...) and symmetrically.





Final

Microhabitats of the Namib Desert

While these lattices were beginning to show non-uniform deformation as well as exhibit dynamic equilibrium by constantly deflecting and deforming to a changing context, they were disengaged from the analysis of the site. I was succeeding in designing behavior, but I had to reintegrate it into the site analysis.

The Namib Desert has three of the most distinct microhabitats of any desert in the world (fig. 33). The sand desert, ephemeral river desert and the gravel desert are all controlled by the three parameters of temperature, moisture and wind. These combine with topography and geology to create the opportunity for organisms to create very unique environments.

I chose three locations that corresponded to each microhabitat (fig. ??). The goal was to analyze these locations in the hopes that an intervention could be designed such that it created a continuum of interactions and concurrent reactions similar to that exhibited by organisms in their constructed environments. These locations are a mere 1.8 miles apart and yet are incredibly varied.

The sand desert is not only dominated by the high temperatures, but also has access to moisture rich fog and is buffeted by strong winds that swirl the sand like an orange ocean. Because the early morning fog is the regions sole source of moisture, many organisms have adopted extraordinary behaviors and forms to utilize it.

The ephemeral river habitat is fed by rain that falls at certain periods in central Namibia. The habitat supports enough drought tolerant flora year round to act as an effective wind screen. This maintains a diffinitive line between the sand and ephemeral river desert by holding at bay large quantities of sand. However, the area still recieves fog that condenses on plant material. This not only benefits the plant, but many animals depend on sucking the moisture from leaves.

The gravel desert is at a somewhat higher elevation so is exposed to the wind. This microhabitat is the rocky beginning to the central escarpement. Therefore, few large plants can take root with the exception of the welwitschia (fig. 10).

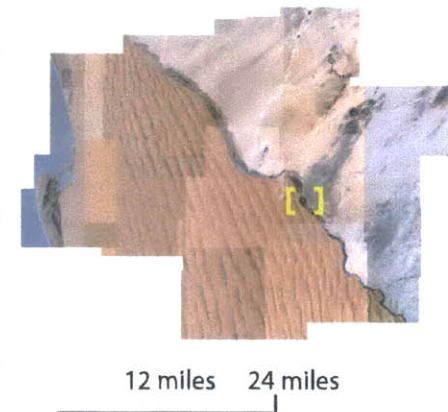


Fig. 39. (Top)
Namibia Map
-The image highlights the central area between the sand and gravel divide.
Image source: NASA's World Wind Software

Fig. 40 (Bottom)
Namib Desert Detail
-The three microhabitats are within the bracketed area.
Image source: Google Earth collage

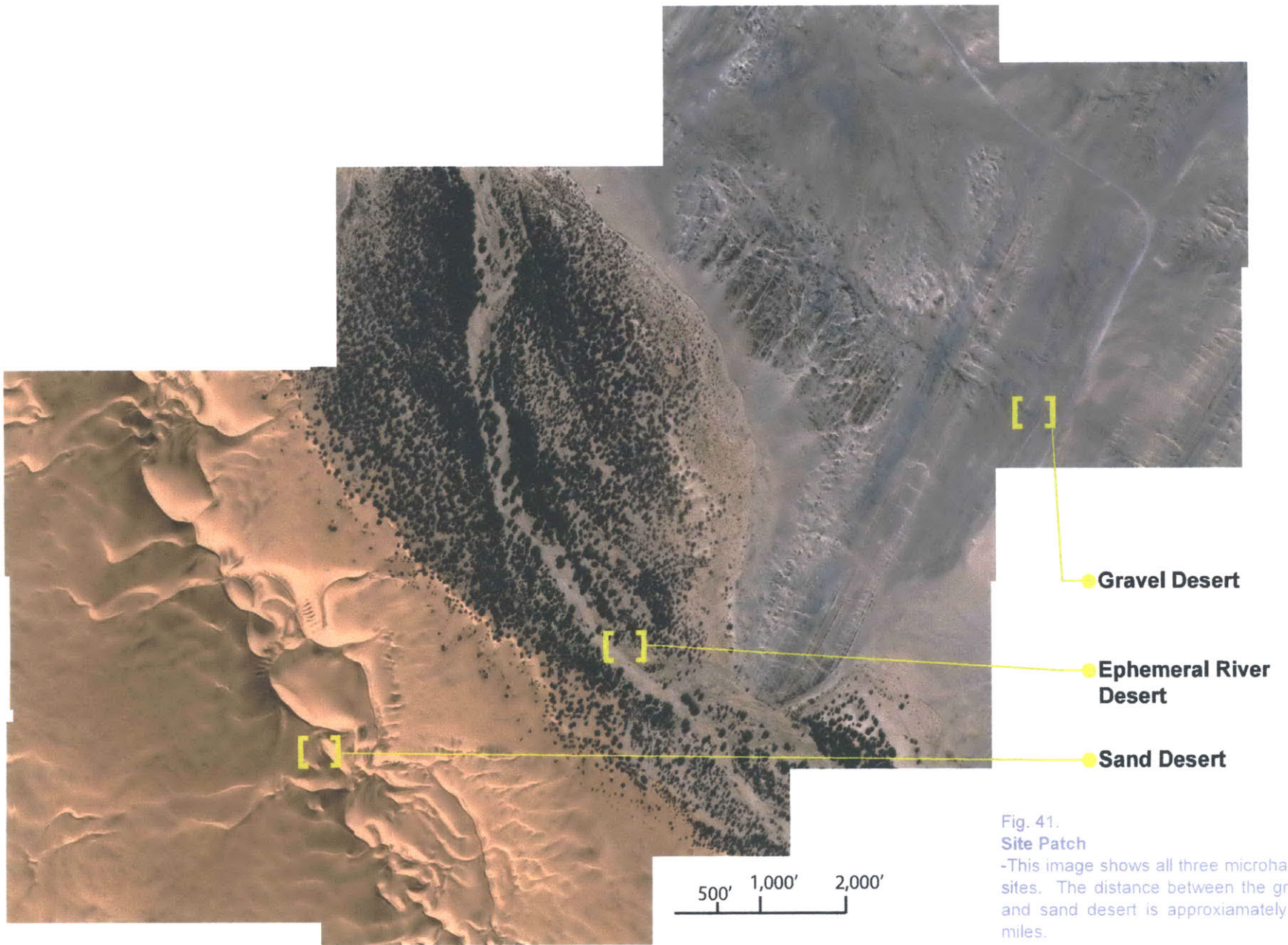


Fig. 41.
Site Patch
-This image shows all three microhabitat sites. The distance between the gravel and sand desert is approximately 1.8 miles.

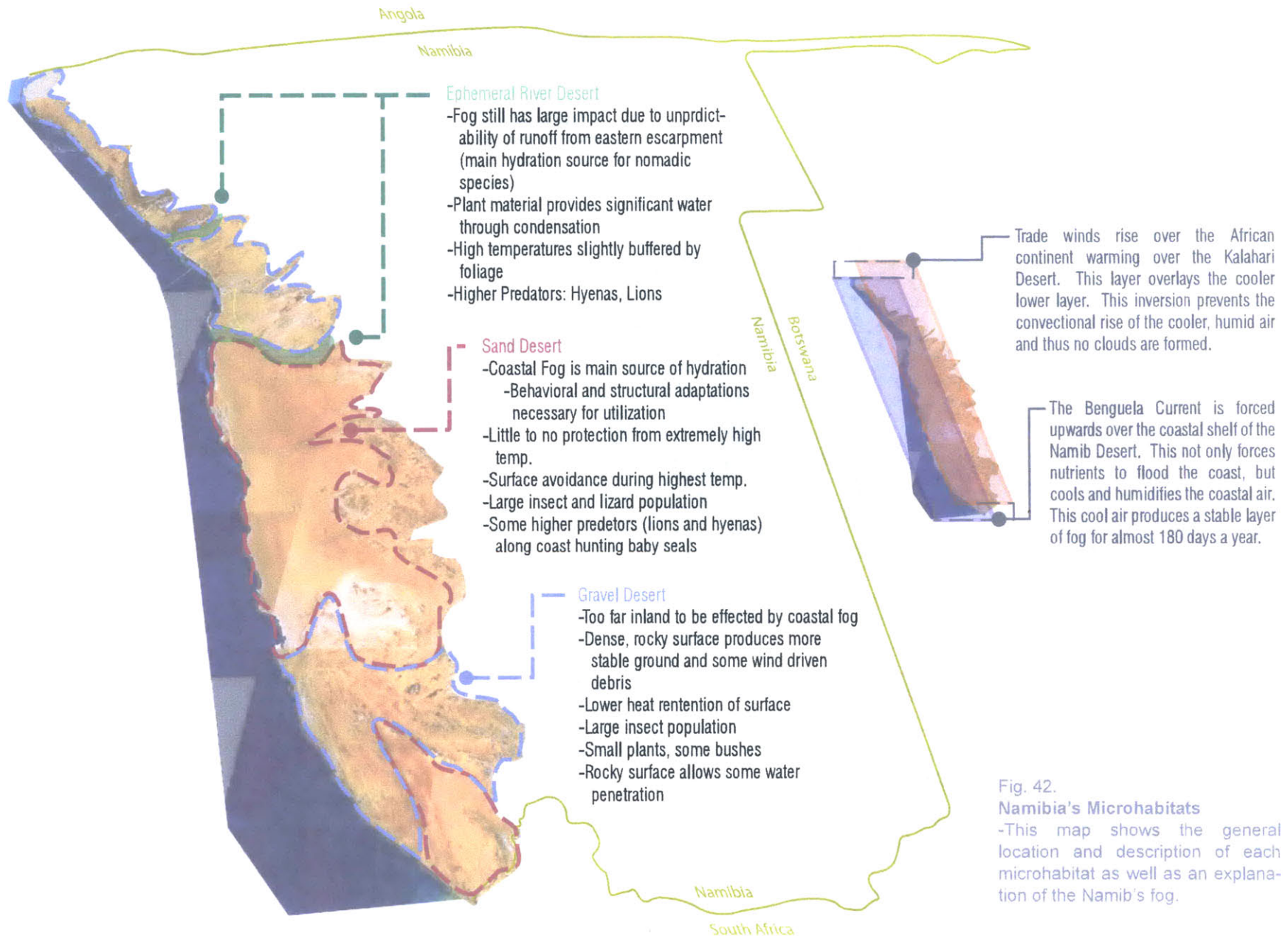


Fig. 42.
Namibia's Microhabitats
 -This map shows the general location and description of each microhabitat as well as an explanation of the Namib's fog.



Fig. 43.

Namib Beetle

-The beetle's shell has a textured surface that alternates between bumps that attract (hydrophilic) water droplets until they get too large and slide into valleys that repel (hydrophobic) the water toward the beetles mouth.

Image source: <http://theenchilada.tripod.com/id25.html>



Fig. 44.

Desert Elephants

-Usually drinking every third or fourth day, desert elephants still are able to expend massive amounts of energy in their long search for grazing. These elephants only graze on grasses during the rainy season and allow the large woody plants to recover before switching in the dry season, thereby sustaining their own food source.

Image source: http://www.wildland.com/trips/details/177/namibia_itin.aspx



Fig. 45.

Lithops or Stone Plant

-Because of the high temperatures in the desert, most plants lose a lot of water by evaporation through the leaves. These plants produce two large fleshy leaves that conceal the sensitive photosynthetic cells. The leaves remain closed until the temperature cools or the plant is ready to bloom.

Image source: http://www.beevo.com/Site_Map.htm

Morphogenetic Landscapes

The title of the thesis refers to the membranes I produced when I combined the lattice process with the analysis of the microhabitats.

Each microhabitat was mapped based on topography, local climate conditions, and organism distribution. The layering of these diagrams were the foundation for the circle pattern. However, the circles were now able to represent flows and forces between organisms and climate.

The tangential line procedure produced these rebuilt landscapes with embedded information of the organism/environment continuum. They are a deformable field that is initially a 2d diagram, but when placed in its context and operated on by forces, immediately becomes a three dimensional matrix of latent forces operating within the habitat.

This strategy allowed me to pursue the resolution of the sand habitat as an intervention designed by the effects it produces within its environment.

Fig. 46.
Sand Desert

-due to large topographic shifts in surface, microhabitats are dense and varied
-fog, wind and temperature vary greatly in short distances

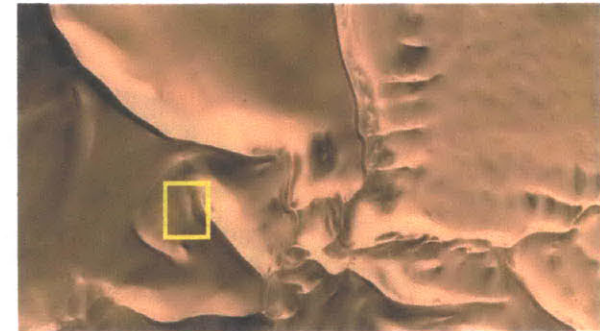


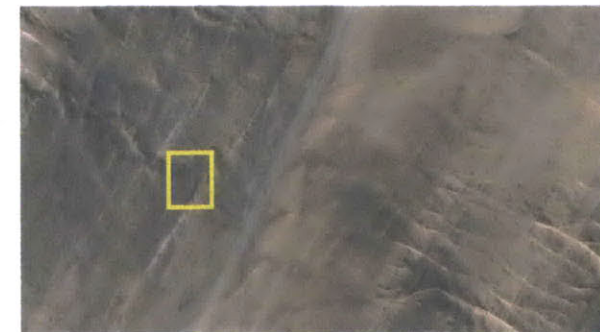
Fig. 47.
Ephemeral River Desert

- Less dense dispersion
-greatly effected by foliage wind screen and fluctuations of river



Fig. 48.
Gravel Desert

-Least dense
-effected primarily by topography and wind



400' 800'
200'

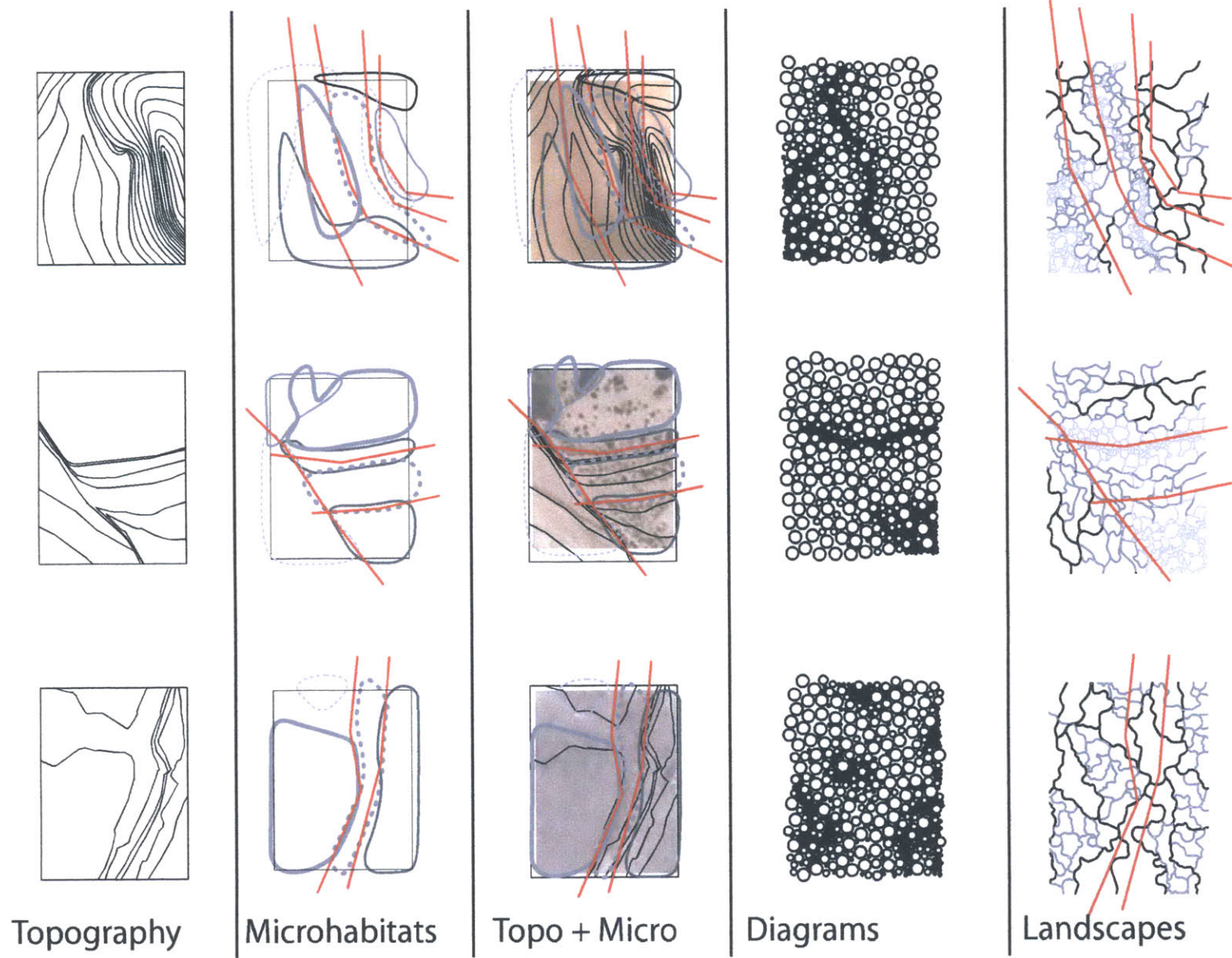


Fig. 49.
Morphogenetic Landscape Derivation

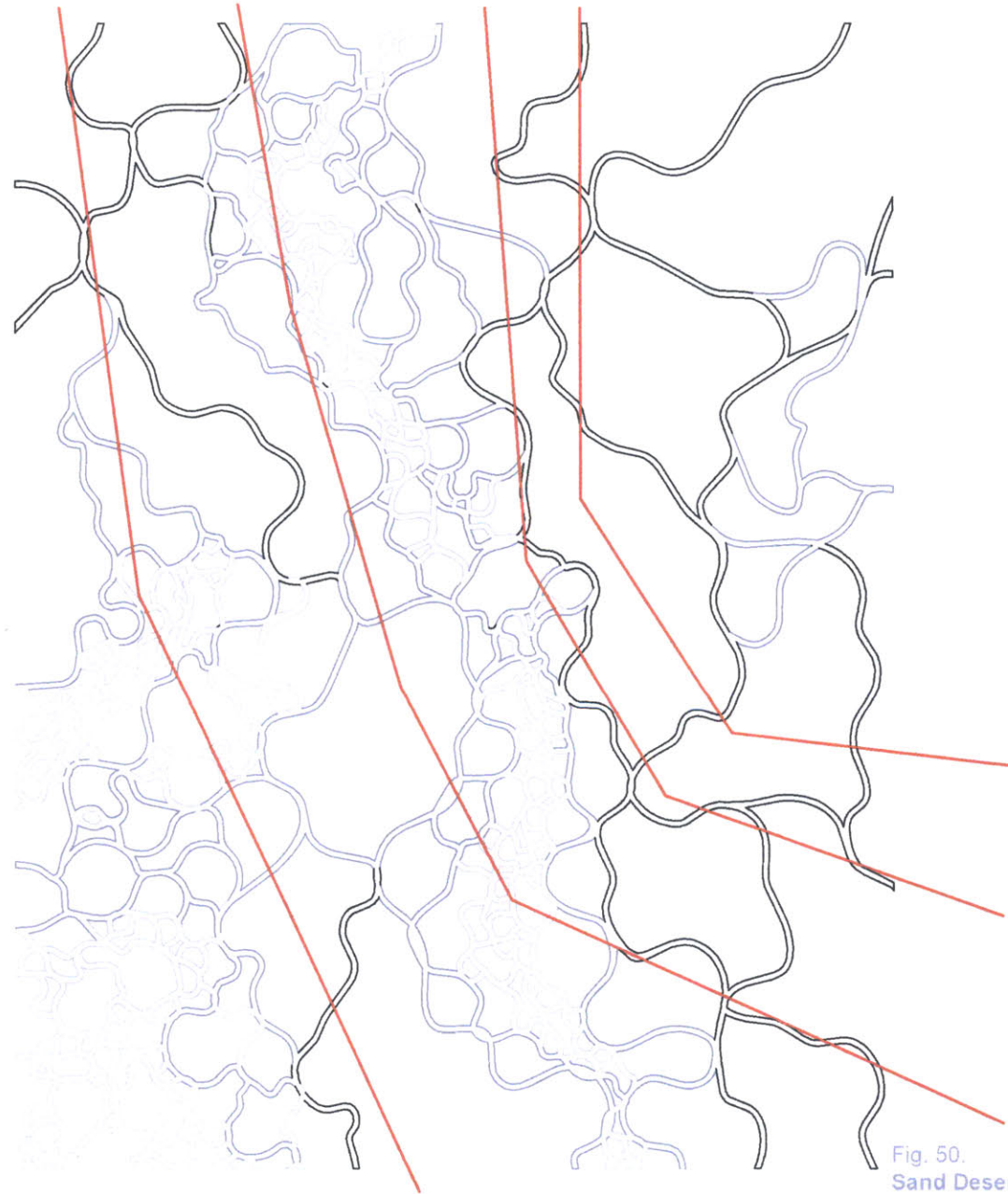


Fig. 50.
Sand Desert Landscape

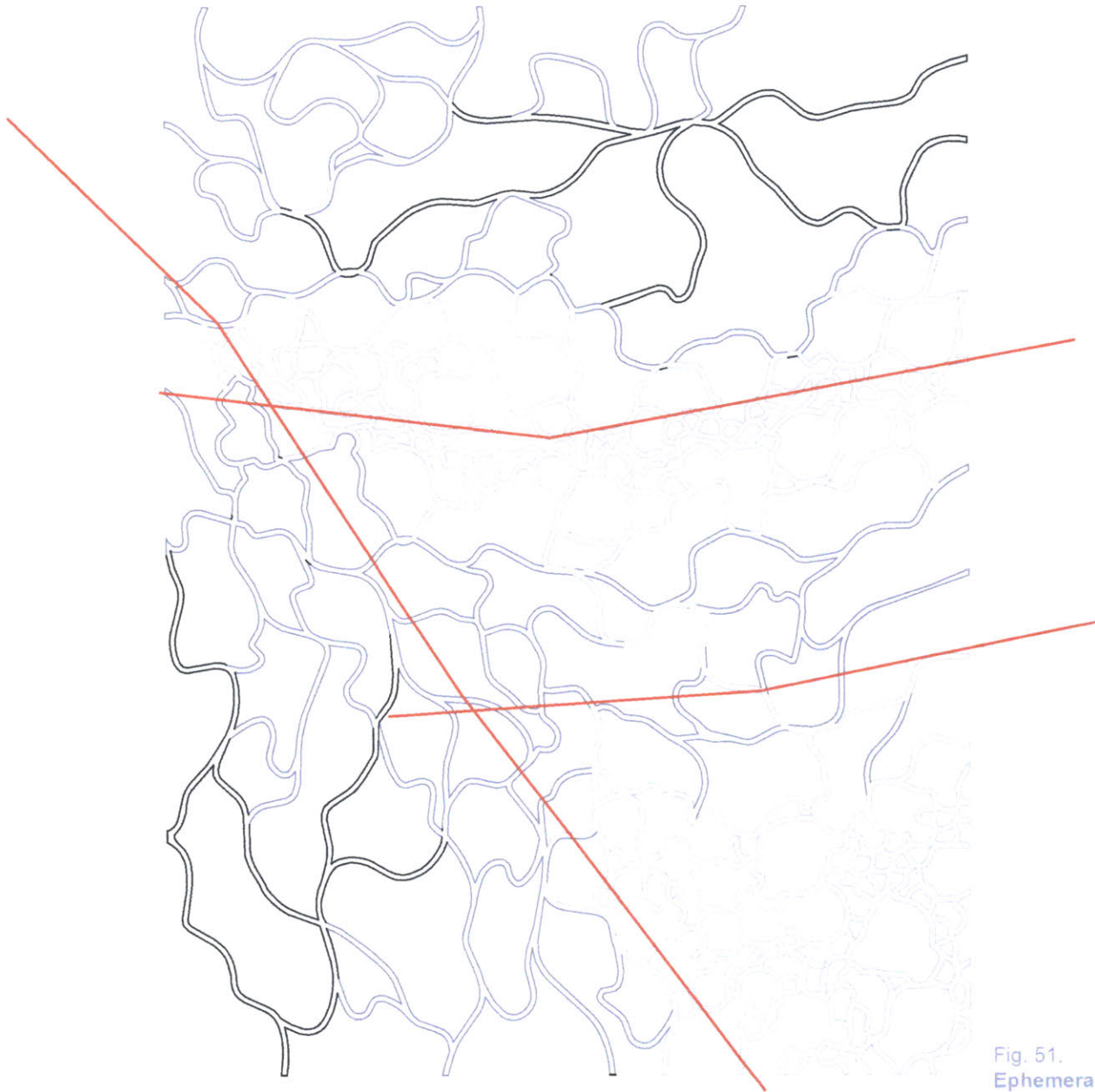


Fig. 51.
Ephemeral River Desert Landscape

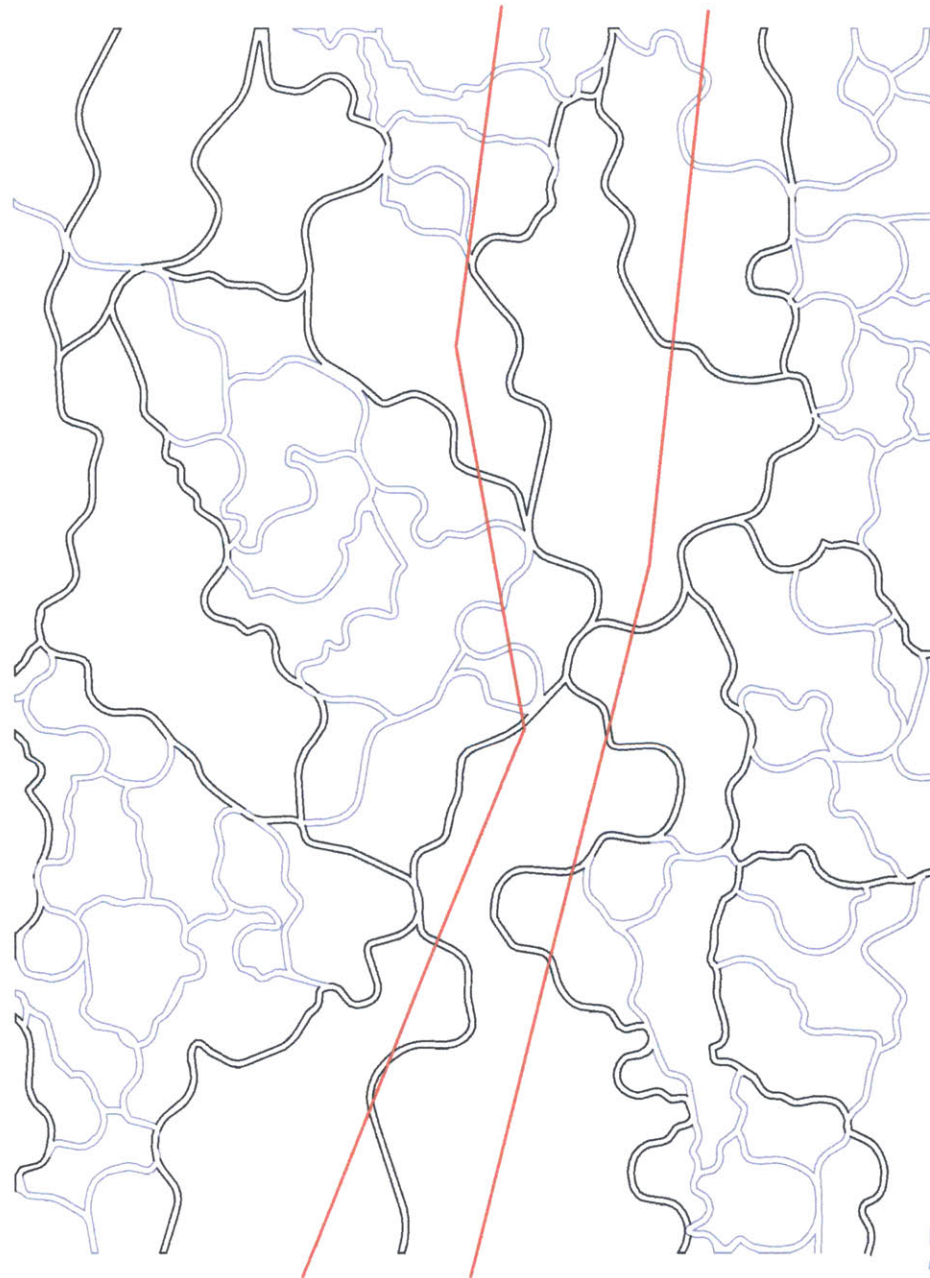


Fig. 52.
Gravel Desert Landscape

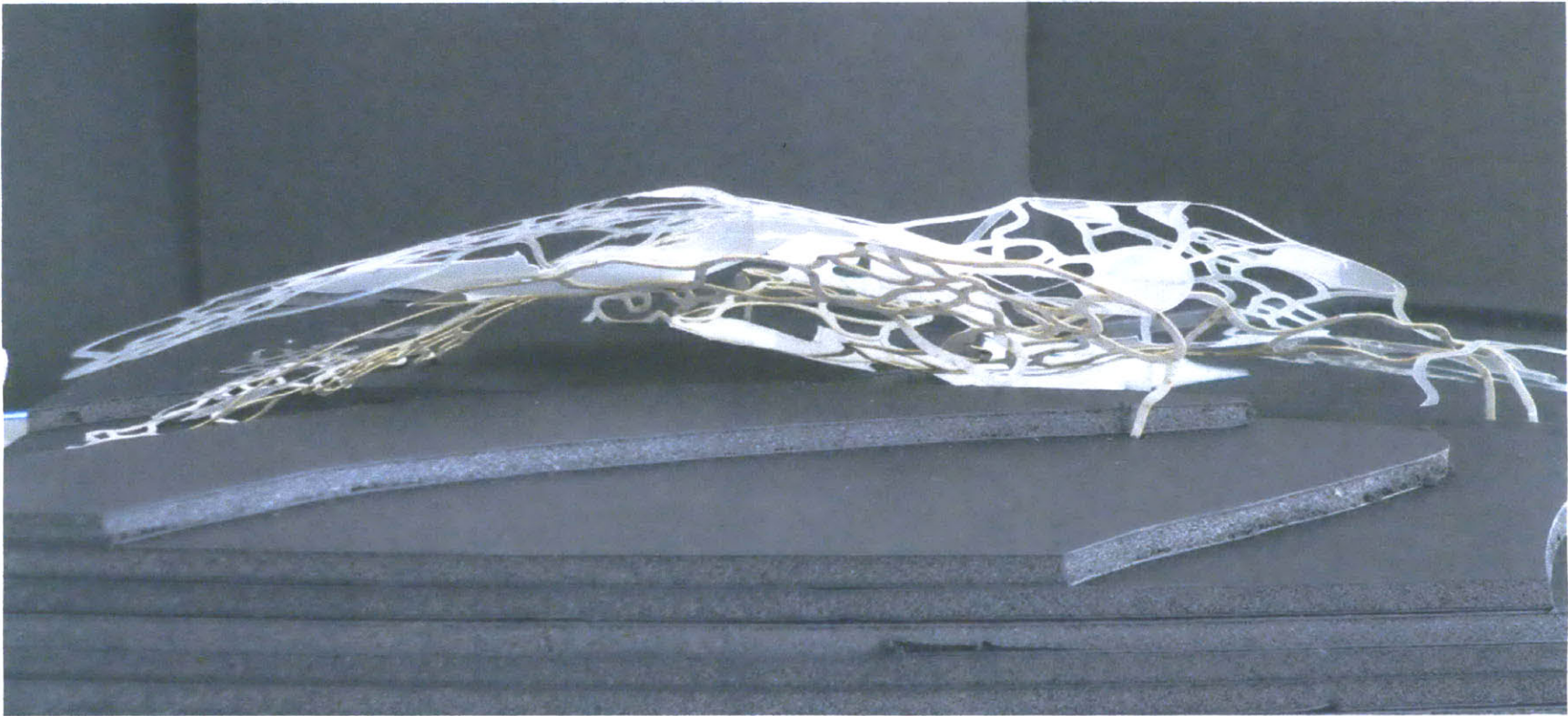


Fig. 53.
First intervention based on Morphogenetic Landscapes
-This model achieved mitigation and effect by layer materials over and within the lattice.

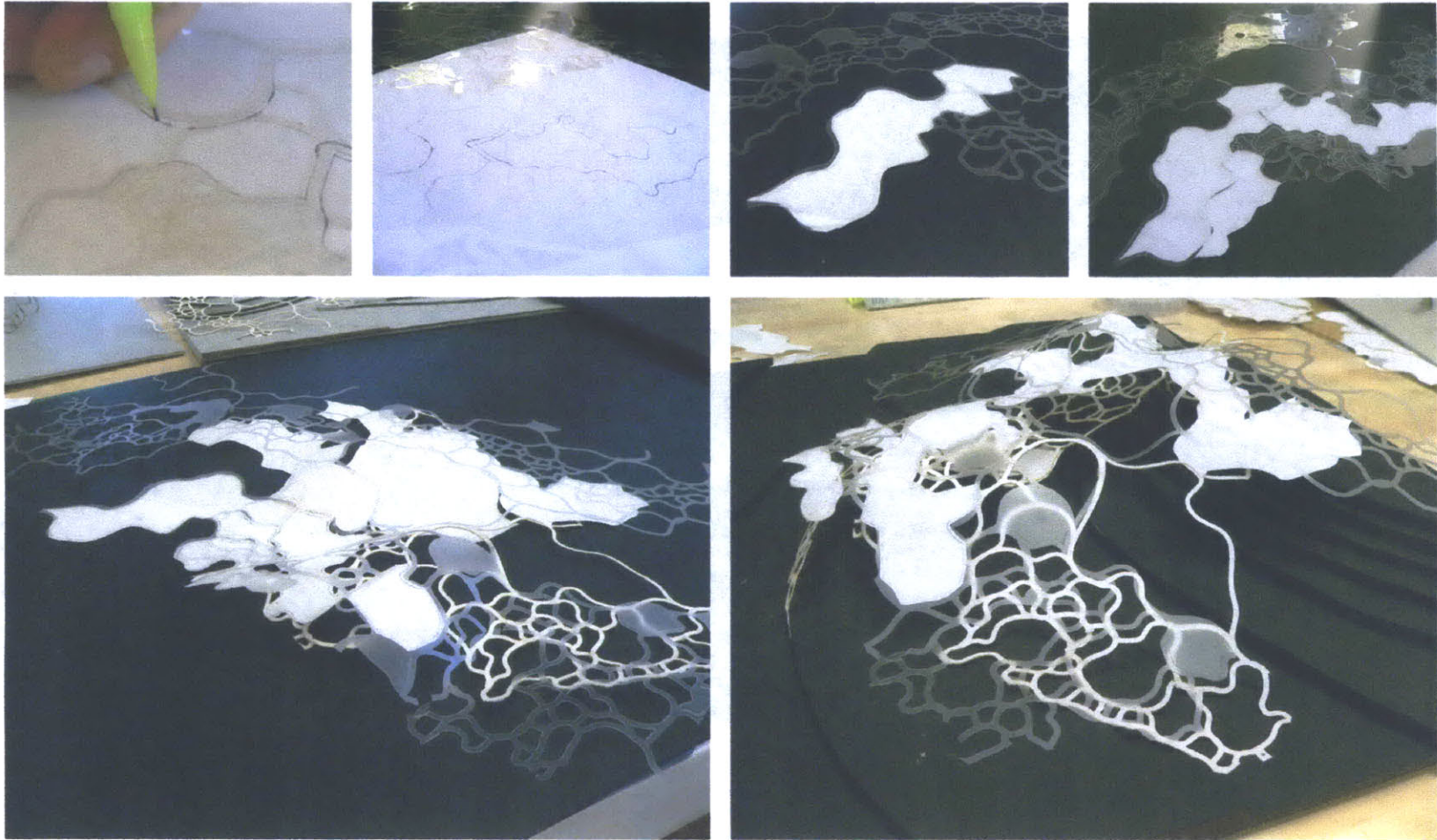


Fig. 54.

Process of Construction

-The images along the top show the making of the fitted membranes. The bottom left image shows the landscape at rest (blanket-like form). The bottom right image shows the landscape deployed.

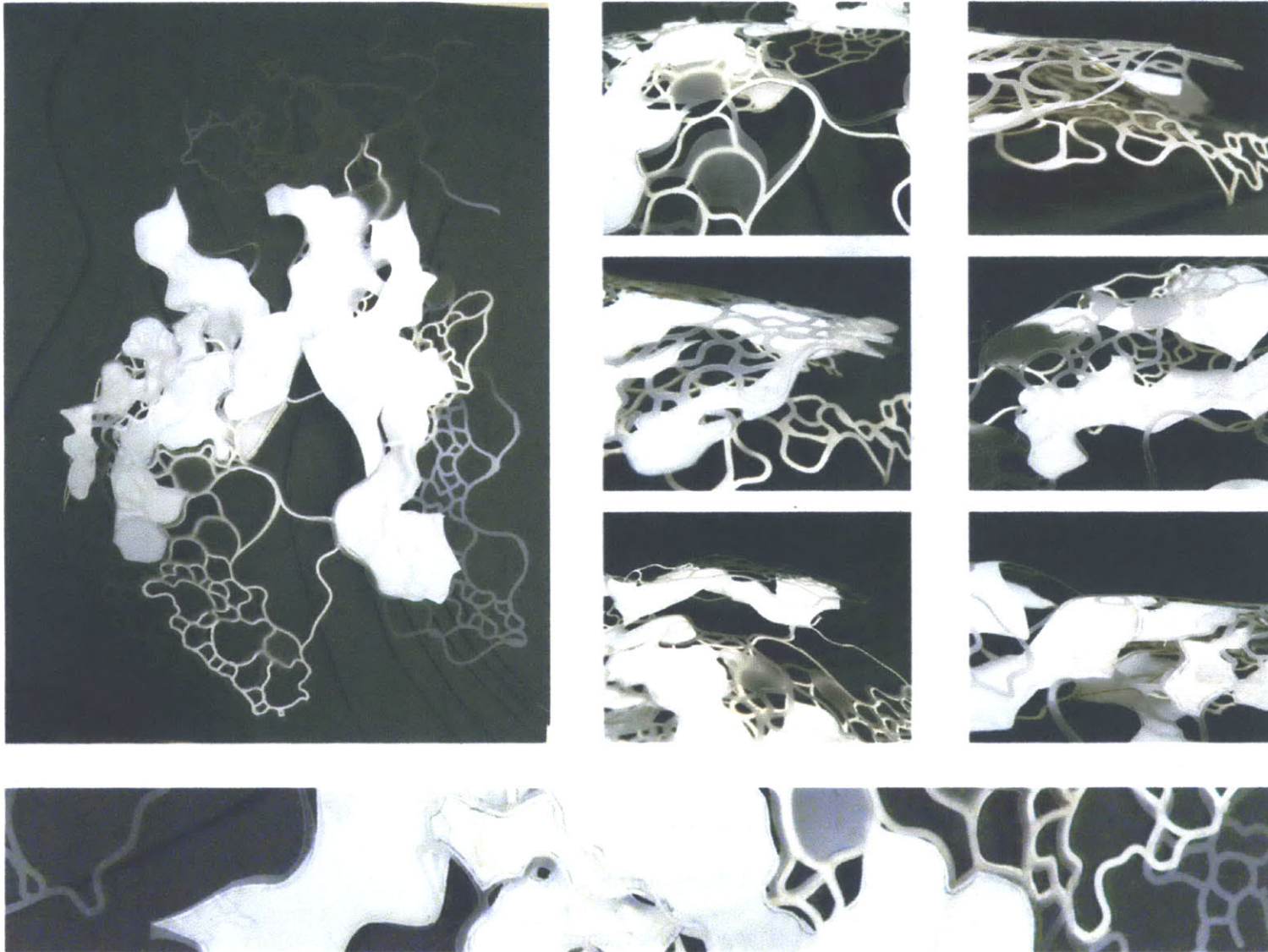
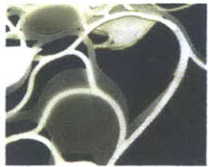


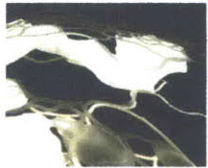
Fig. 55.
Various views of the model.



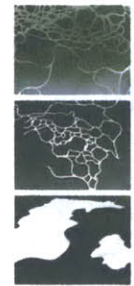
Coloration- transparency, translucency, opaqueness



Responds to:
light conditions
wind pressure



Material Composition- structural lattice, translucent lattice, structural planes



-Distributes dynamic equilibrium non-uniformly over structure
-More rigid, static structure
-Mitigates between translucent and structural lattice



Bifurcation- plane transitions from structural to translucent lattice

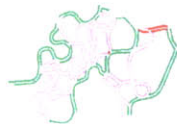


Provides directionality to flow wind/sand/fog

Demarcates space of within and without



Porosity- lattice density



Responds to:
dilatation and filtration
topographic change due to sand movement

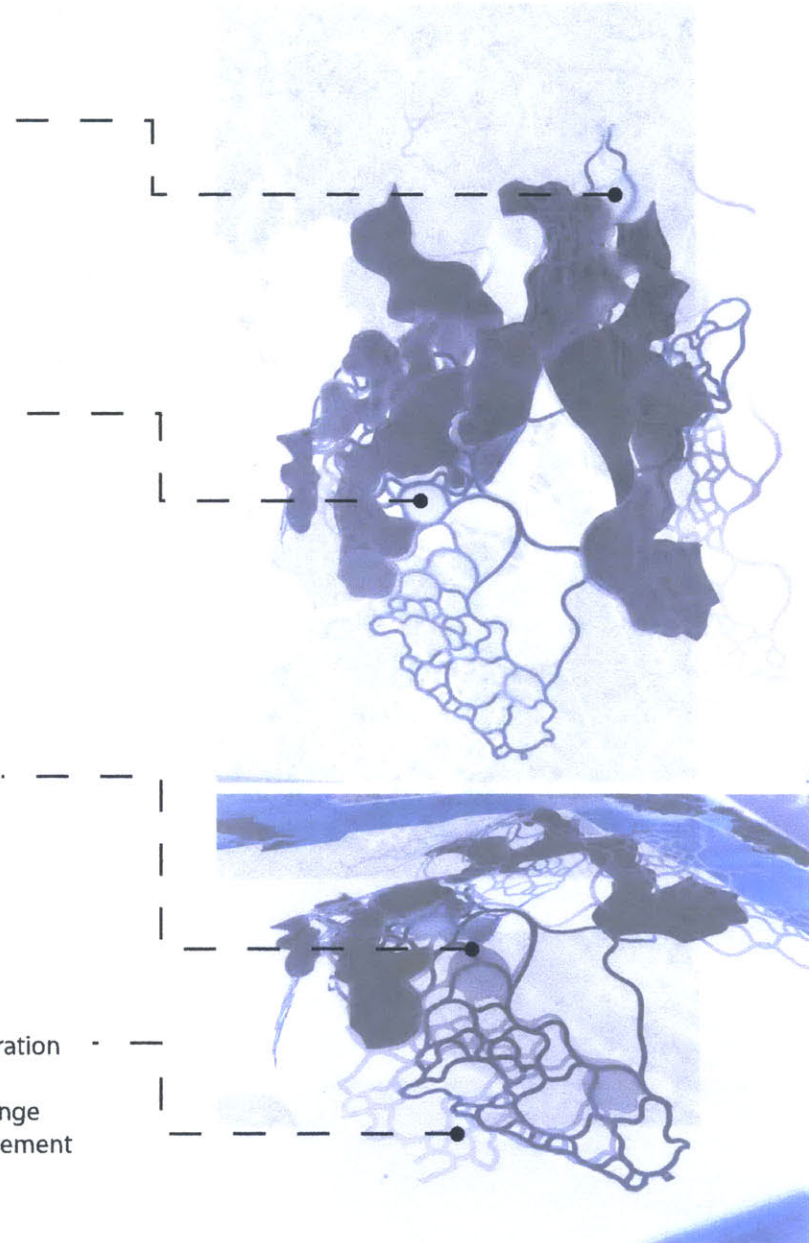


Fig. 56.

Diagram of material versus effects

-This diagram catalogues how the material mitigates certain elements.

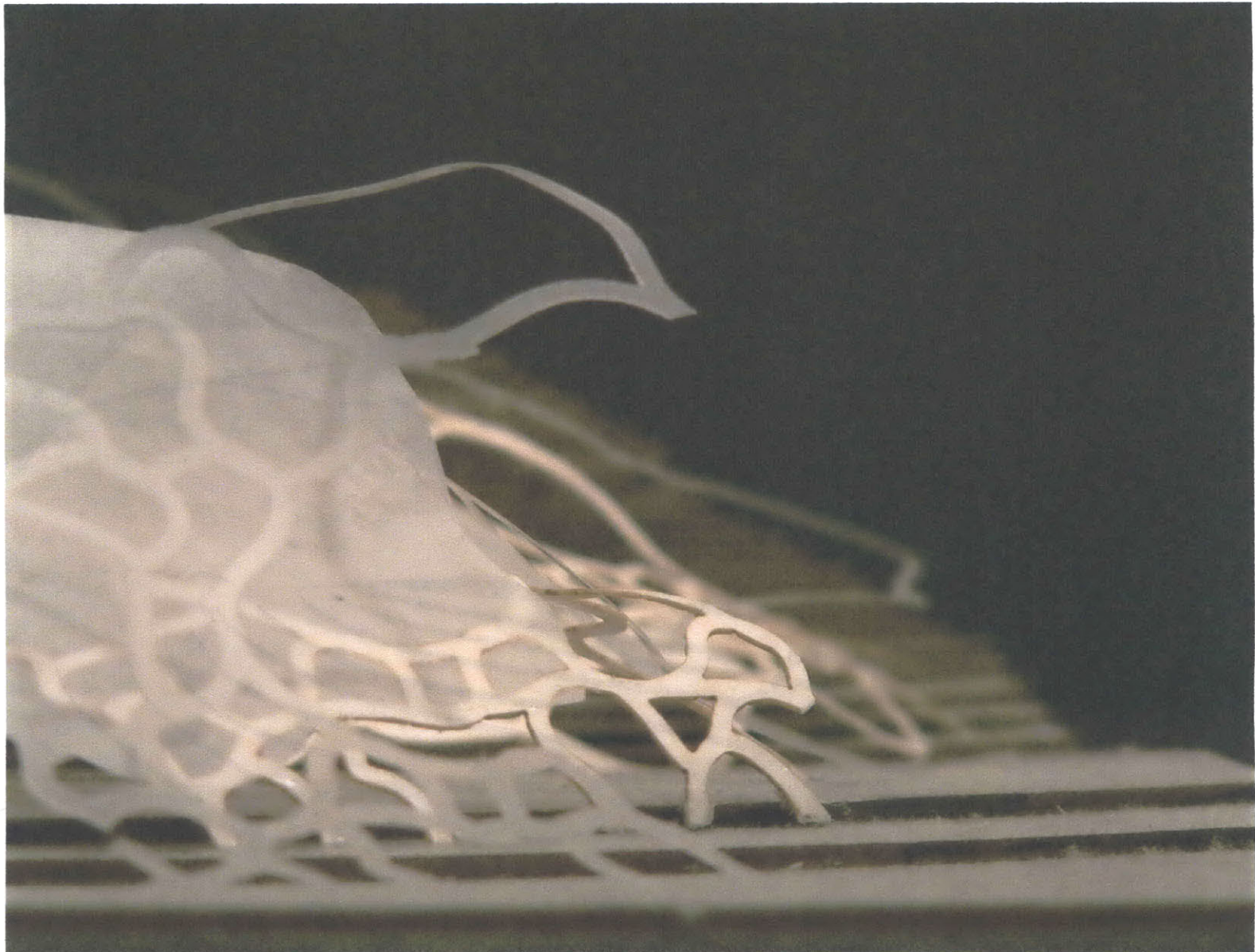


Fig. 57.
Close up of final model

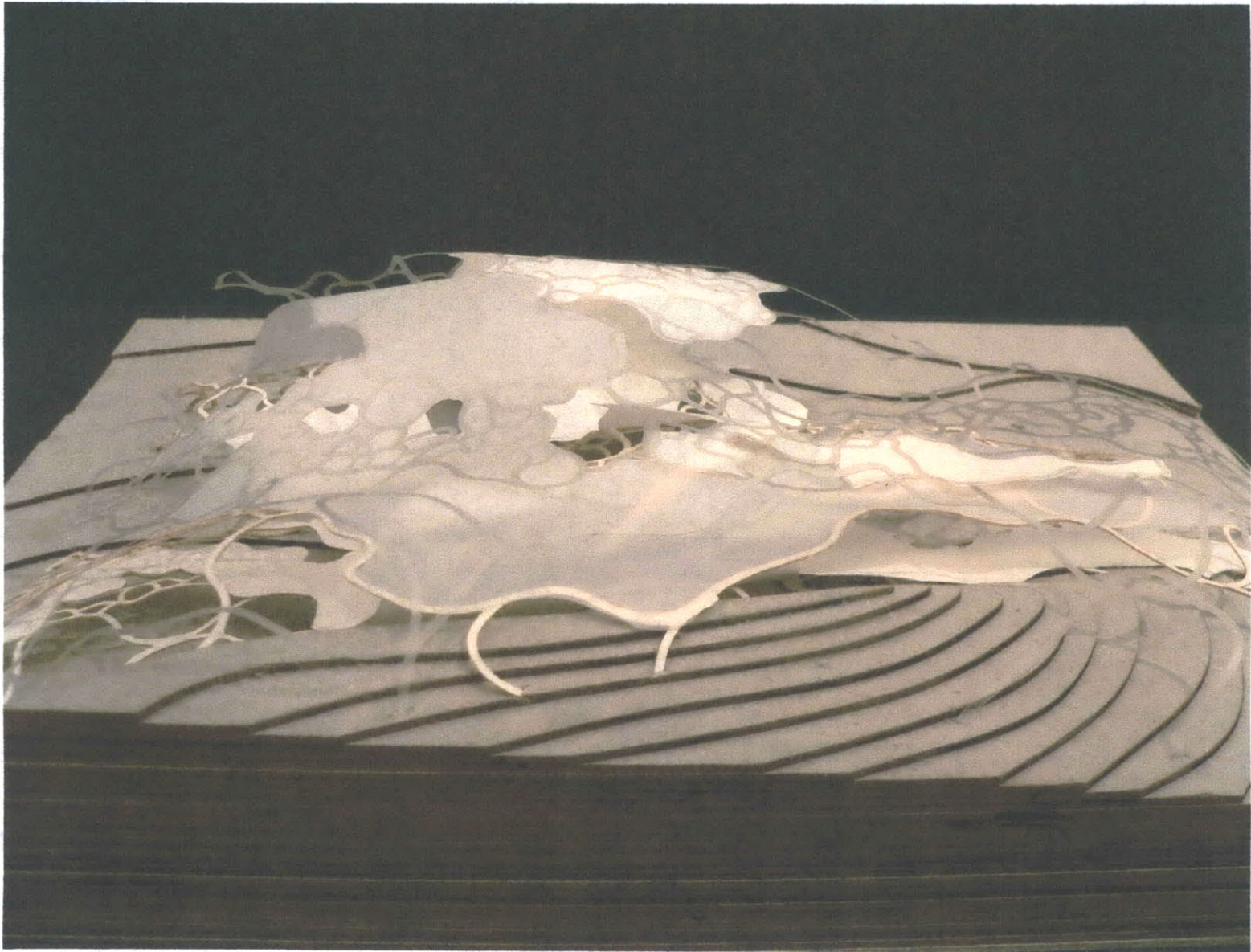


Fig. 58.
Looking over Western Dune



Fig. 59.
Plan Image

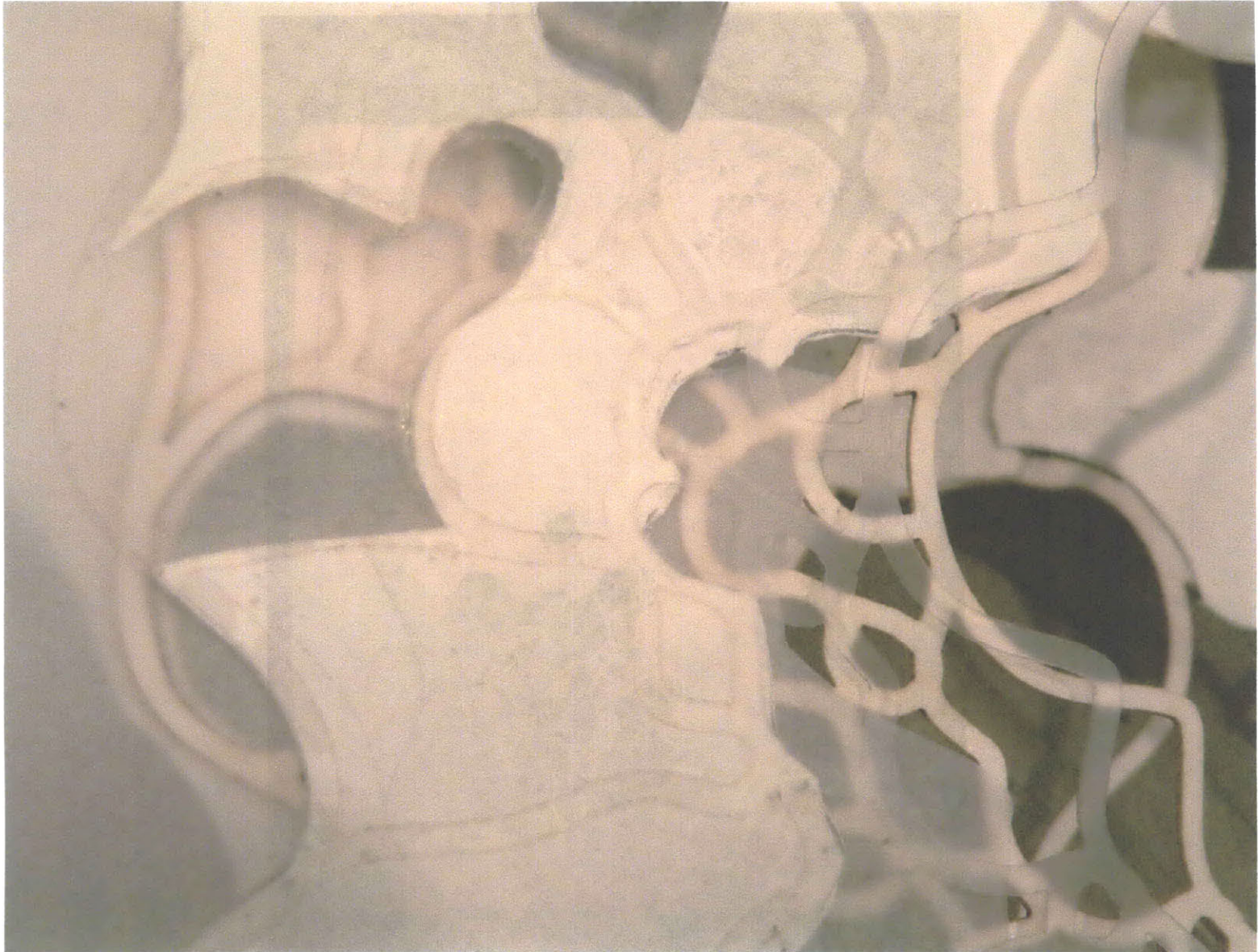


Fig. 60.
Membrane Detail

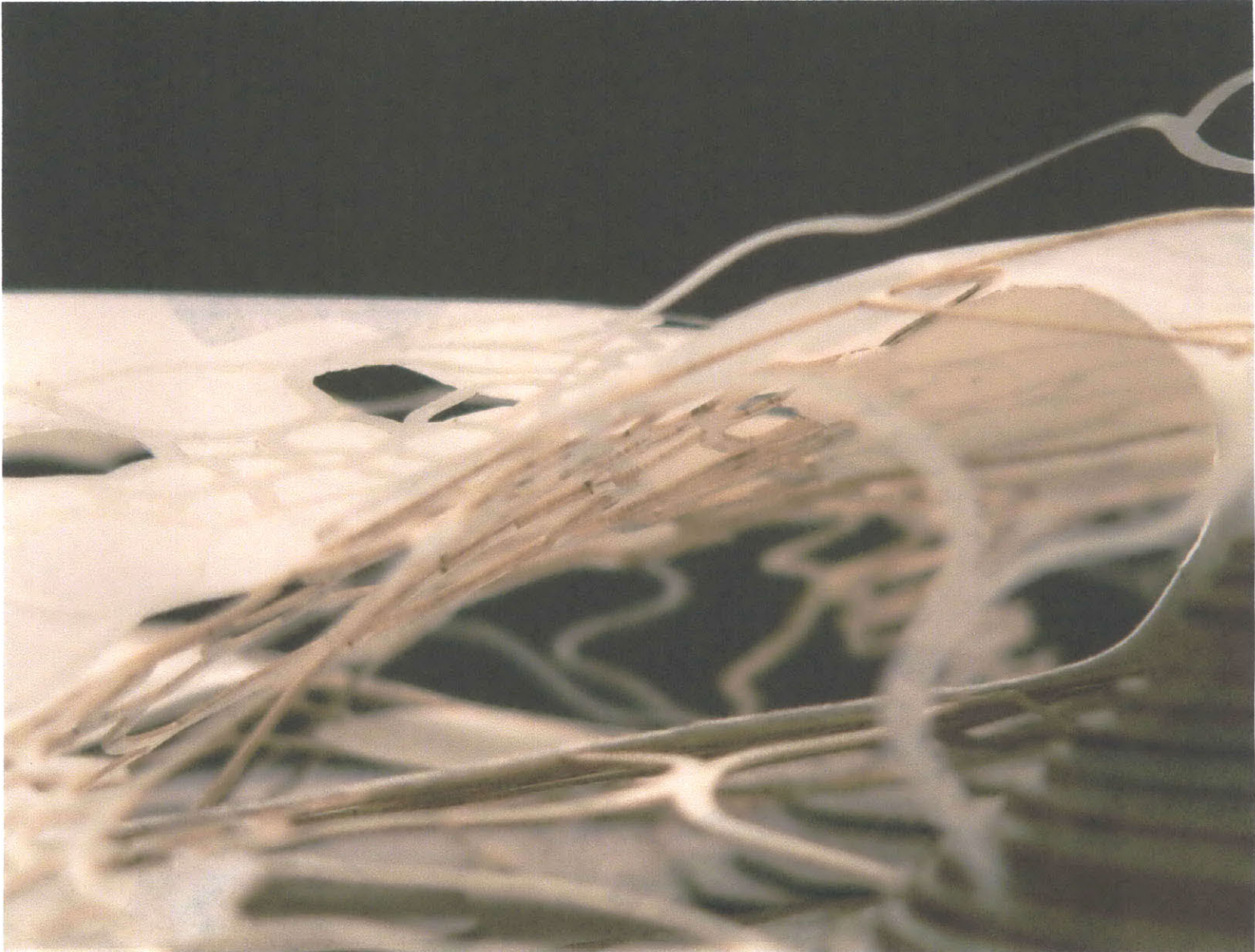


Fig. 61.
View of Membrane Depth



Fig. 62.
Membrane Detail

Spatial Habitat

Dry/Static/Warm
Wet/Dynamic/Cool

Dry/Dynamic/Cool
Wet/Static/Warm

Dry/Dynamic/Warm
Wet/Static/Cool

Dry/Static/Warm
Wet/Dynamic/Cool

Wet/Static/Cool
Dry/Dynamic/Warm

Activities:

Eating

Sleeping

Observation

Researching

Excreting

Fog
Wind
Temp.

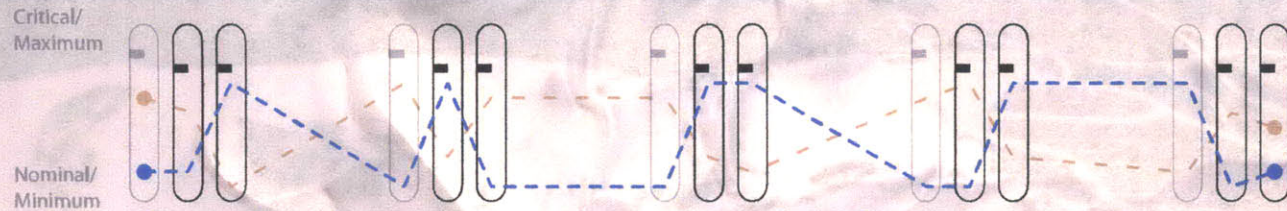
Fog
Wind
Temp.

Fog
Wind
Temp.

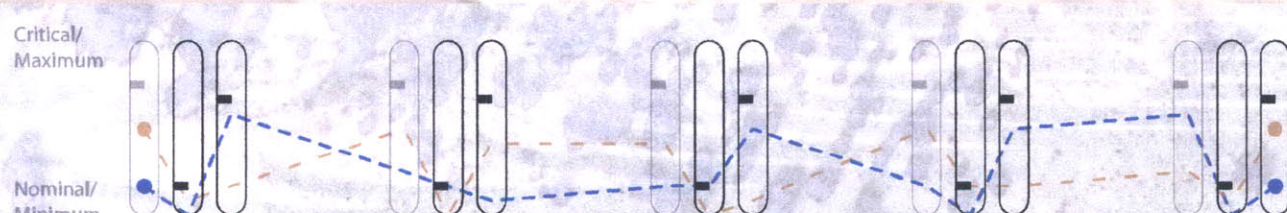
Fog
Wind
Temp.

Fog
Wind
Temp.

Sand Habitat:



River Habitat:



Gravel Habitat:

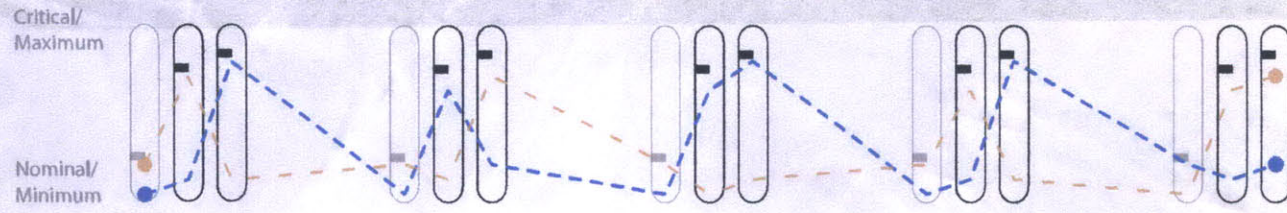
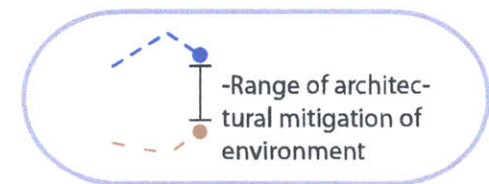


Fig. 63.

Environment + Activities

-Habitation is no longer thought of as rooms for particular uses. Rather, program is now a series of spaces dictated by the environment and the system which mitigates, enhances or blocks it.



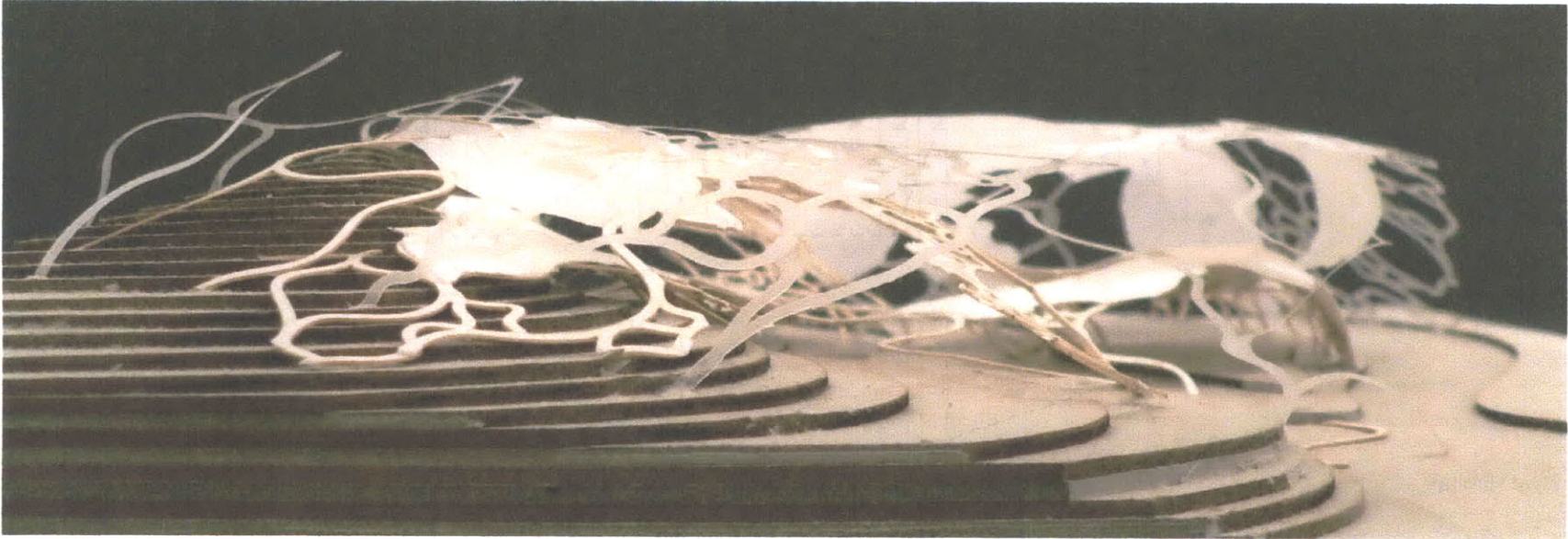


Fig. 64.
North Elevation

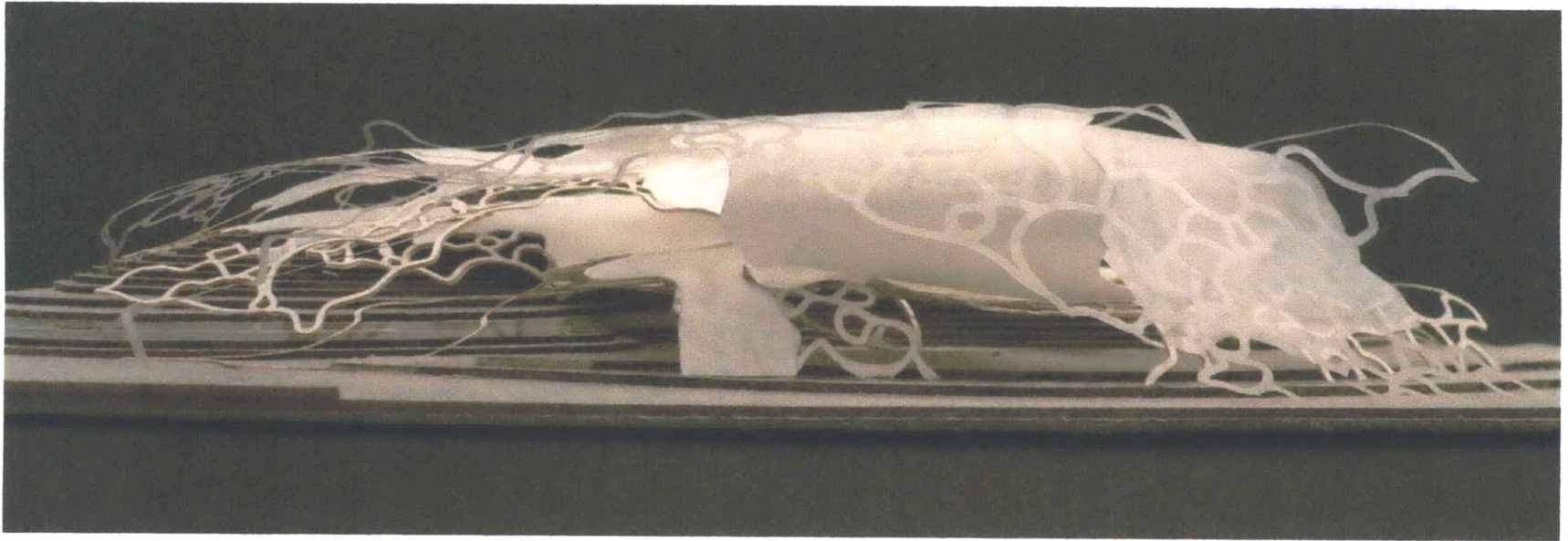


Fig. 65.
West Elevation

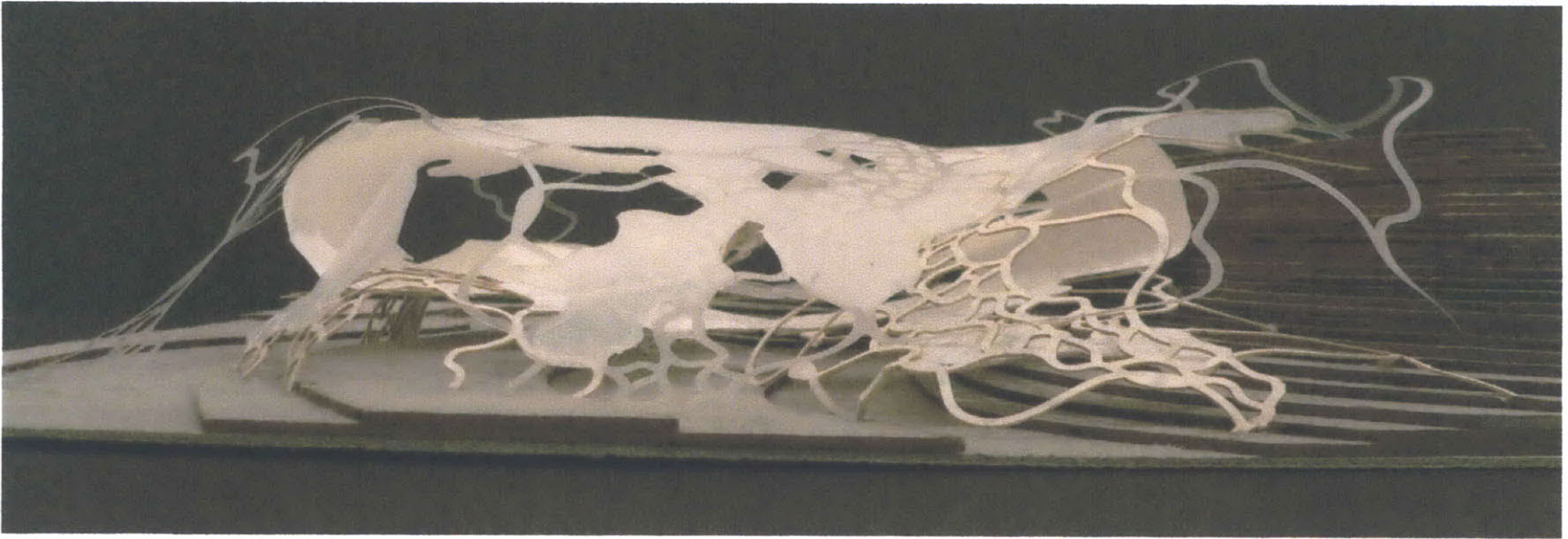


Fig. 66.
South Elevation

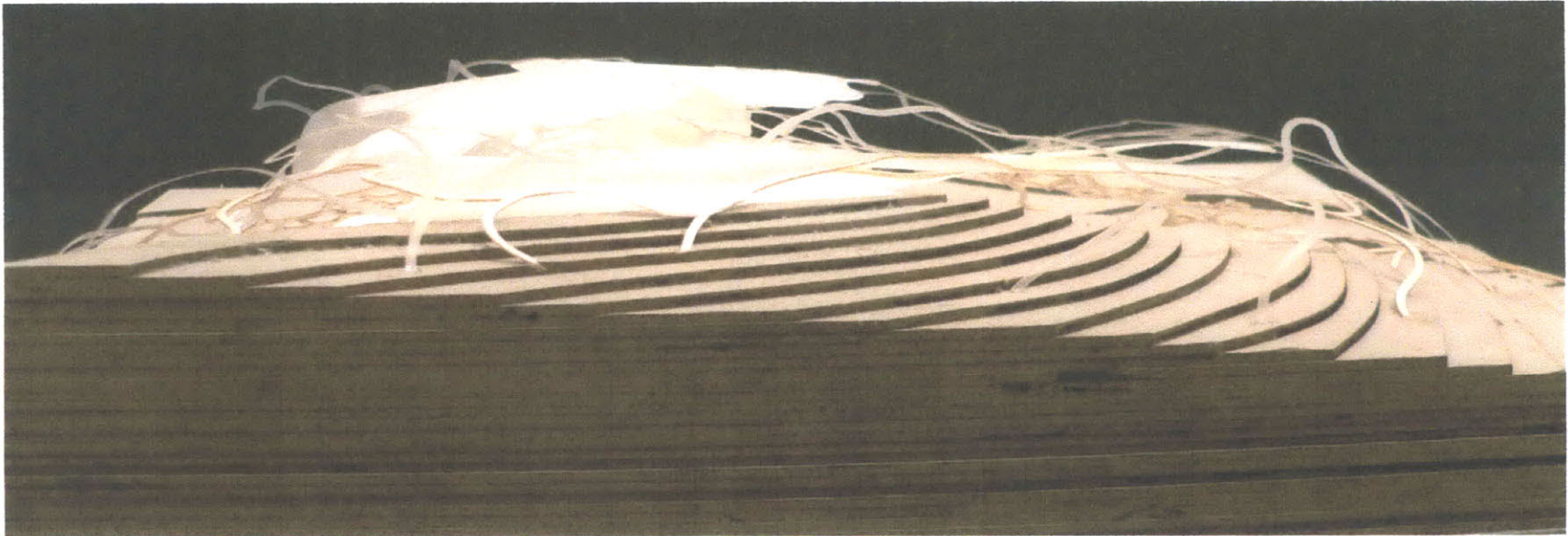


Fig. 67.
East Elevation

Conclusion

This thesis was a lesson in how to keep my thoughts straight. It seemed at every moment I was being led astray by research or some other current bit of work.

The only two problems that I disliked about this project, was the fact that I did not get to the other two microhabitats and that I feel that I am only now beginning. The only other thing I would mention is the amount of time I have to work on this subject matter. I really could see myself continuing on to research this further.

One critique that was brought up by the committee was the problem with making a diagram into a building. My answer would be for someone to describe diagram to me. I do not have a problem with this at all. In fact, I wish I could go back now and run simulations on the final model.

The next step has to be material studies. There is a lack of material information in this investigation and how it is coupled with activities.

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