

Topological Inversions

An Honors Thesis (HONR 499)

by

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Abstract

Architecture is stagnant. Once a design is implemented, executed, and constructed, the building or structure is inherently immovable and non-reactionary to its environment. Patterns are stagnant. Patterns are applied to a surface and become motionless and unchanging. We live in a world where technology and our environment is ever-changing. People react to their surroundings and, therefore, architecture must also become a field that reflects the environment.

The thesis is as a critique and a reevaluation on the stagnancy of architectural design that we see today. The following experiments begin to manifest an ideology of architectural design and patterns that are generated from existing conditions. The form of a design is further investigated by exploring the latency of a singular pattern into a design that reflects that of its environmental constraints, inevitably creating an architectural and morphological language that results in reactionary interstitial spaces.

Acknowledgements

“Topological Inversions” was explored with Assistant Professor of Architecture Sean Burns. He has been a supporting mentor throughout my undergraduate career and has continued to push my views in architectural design theories, therefore helping me evolve into the designer that I am today.

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Process Analysis Statement

“Variable practices also operate according to this numerical model of time, but in addition, they regard themselves as momentary configurations that transform over time. Their shapes, forms and organization change as they reinvent themselves and their techniques in response to shifting contexts”

- Ali Rahim, *The Architecture of Variation*

The thesis theorized and critiqued the ideology behind the current stagnation of architectural design. Both architecture and patterns rarely reflect movement or evolution. But what were to happen if architectural forms started to generate a language that reflected existing conditions towards exploring its latent potential? How can architectural design evolve to embrace transition as part of a reactionary process? What were to happen if a design was to begin to respond to its context, essentially reinventing itself and manifesting inversions of its original state?

Through a series of operations that analyzed the latency of a form and the evolvability of movement to the environment, the ideology of a reactionary architecture was explored. For the purpose of this thesis, the following terms are defined:

- *form*: a design element that acknowledges and responds to the presence of existing conditions
- *object*: a stagnant design element that does not react to existing conditions
- *simulation*: the process of a form reacting in response to an object
- *animation*: a series of key frames

“Topological Inversions” formulated as a critique which was a response to stationary contemporary architectural examples seen today; stagnant structures that do not react to the environment. Buildings are oftentimes inserted within an environment without any transitional state between the existing conditions and the new. “Topological Inversions” explored the ideology behind introducing a new form that could react to a set of existing conditions, analyzing performance patterns in relation to depth, interstitial spaces, and latent potentials.

Initial research influenced the design process for this thesis: How can one design an architectural language or form that critiques the present idea of stagnancy? How can a form begin to incorporate existing conditions? The design for this thesis involved a series of operations involving animation in architectural and gaming softwares. Certain softwares - such as Revit, SketchUp, AutoCAD, etc. - are rooted in objects; or elements that do not move or reflect existing conditions. However, using processes generated in gaming softwares - such as Maya - that are rooted in animation, allows designers to simulate a form that can reflect conditions in key frames, therefore, allowing the designer to analyze step by step movements of a form and its reaction.

Similar to the critique on forms, can patterns also incorporate the existing conditions as well? What is the evolutionary process when a form is applied with a pattern? The application of patterns provides an alternative method of analysis, focusing on the form’s overall structure and reaction to existing conditions.

Iterations of the design process used operations to explore a multitude of elements: evolutions, elasticity, latency, reactions, inversions, and moments of performance of the form and the patterns that were applied. Architectural theorist and critic Sanford Kwinter’s

terminology of the object and the form were considered for this process; the object acts as a stagnant element, while the form is a reactionary element to existing conditions.

The experimentation of animation is also a relatively new introduction to the field of architecture. As forms are generated for a structure, designers rarely explore the architecture potentials of animation; forms are typically manipulated using polygonal softwares; however, the designers are the ones dictating the placement of the form and not necessarily the form itself. In other words, "Topological Inversions" experimented with the form reacting by itself to a set of existing conditions manipulated by the designer post-process (after the form itself explores a series of design discoveries).

Originating with an object, a primitive pattern of grids was studied and analyzed with the aid of a simulation software. From here, operations were constructed to promote the latency of the object through the manipulation of obstacles or an applied force.

The entirety of the thesis was driven by the personal design philosophy of establishing not what things are, but what they might be. I am interested in observing and analyzing the process of the form rather than the beginning or the end result. "Topological Inversions" is a thesis devoted to the personal exploration into the process and evolution of reactionary architectural design.

The Application of Patterns

"In fact, the relationship between patterns and architecture hasn't been addressed in 30 years. So why the silence on patterns? There are a number of reasons: first, dissatisfaction with previous architectural conceptions of them; second, their everyday association with superficiality and

planned obsolescence; third, the ambiguity of the term pattern; and fourth, the uncritical and one-dimensional use of them in design.”

- Anderson & Salomon, *The Architecture of Patterns*

Like architecture, patterns are also known to be stagnant - or, as Andersen and Salomon state, are “uncritical and one-dimensional” (Andersen, Salomon 42). Oftentimes, patterns are applied to a single surface that does not react to its environment, inevitably producing a series of patterns that are also stagnant or frozen in space. But what were to happen when an unmoving and stationary pattern is applied to a transformative, evolving, reactionary form? How does the form and the applied impression of patterns begin to react to one another? Can the application of patterns breed a new way of viewing the architectural evolution of a form?

Throughout the studies involved in “Topological Inversions,” patterns were applied to a surface. However, the surface is reactionary, weaving, inverting, morphing, transforming, and contorting in relation to existing conditions.

The intent of the application of patterns onto a moving and transformative form was to determine whether or not the patterns would undergo significant losses in their original and pure aesthetic identity. What were to happen if the pattern begins to invert on itself? What happens to the legibility of the pattern? In what ways does the form ultimately relate or respond to the presence of a pattern?

The application of patterns on a form evolves into an interdependent and symbiotic relationship. Both the form and the pattern benefit from one another’s presence and performance; the pattern whether twisted, stretched, contorted, or transformed from its original state to an

alternative latent potential, and the form has the ability to express unforeseen moments that could not be seen without the influence of the applied pattern (i.e. a stretch in the fabric, an inversion of the fabric folding in on itself, etc.).

Primitive patterns were of particular interest throughout the iterational studies and design operations of the thesis, such as patterns that generate grids, lines, or points. The primitive and simplistic nature of the patterns (such as a grid) allows us to view areas of densities or moments of inversions throughout a form and the generation of an animation over time. While the form is in its early stages in the animation a pattern is still present; but what were to happen to the pattern when the form reacts to a boundary or constraint - such as an object as earlier stated - over time? What happens to the legibility of the pattern? Is the pattern damaged? Is the pattern merely informative to the form, or simply reactionary to the form's manipulation?

Pattern performances also allow the form to display a certain structure; not only does the presence of a pattern better display the form's reactions and design discoveries, while interacting with the object, but it also displays a better understanding of the areas densification of the form. Areas that display high densities could inform design solutions in regards to the form's structure.

The depths of the form are also highlighted with the application of a pattern. There is a certain diversification in the design results; as the form is manipulated by the object, so too is the pattern. As the object changes, both the form along with the applied pattern react, creating a series of adaptive and reactionary iterations.

In *The Architecture of Patterns*, Andersen and Salomon argue that all designs begin with the formulation of a pattern:

“There are two equally relevant (if seemingly paradoxical) ways to take advantage of patterns' multi-functional capabilities: begin a design project with a chosen pattern and

adapt it to meet certain goals, or identify patterns native to the problem at hand and use them as diagrams for design. In either case, design begins with patterns. Instead of form following function, patterns produce performances” (Andersen, Salomon 33).

The thesis analyzes both of these ways to take advantage of a pattern’s multi-functional capabilities defined by Andersen and Salomon. Throughout the design operations in “Topological Inversions,” a chosen pattern was adapted to a set of existing conditions, while simultaneously being analyzed to inform its architectural language and its overall design performance.

Constraints and Boundaries

“The formless may be referred to as the replacement of direct manipulation of geometry with an aprocedural design process, in which the designer does not look for a single formal solution but instead reimagines the design as the current state of an evolving system of constraints, working through design discoveries made within this dynamic system”

- Axel Killian, “Finding the Formless”

Before proceeding with the series of design operations and iterations, various constraints and boundaries integrated within the thesis must be explored. A form is only successful if it is exposed to a set of existing conditions (since a form must be *reactionary*). An existing condition can be defined as an element of design that is already present for a form to react to or originate from; existing conditions include environments, landscapes, structural systems, floor plates, columns, etc. - as long as they provide a shape to allow the form to react to over time.

Constraints, boundaries, and existing conditions are necessary throughout the series of design

iterations as they inevitably determine the overall performance, evolvability, and morphology of the new form.

Constraints and boundaries are influential forces that allow a form to not only react to the existing conditions, but also allow a form to morph from its original state to something new or unpredictable. It is predictable that the form will somehow react to its environment; however, it is not predictable how the form will morph, nor is it determined what the exact outcome and performance will be. As the form is in its original state, it begins to transform and evolve into a new morphological design language that would not be present without the existence of the constraints. There becomes an interdependent relation between the existing and the new; the new – or, according to Kwinter, the “form” – could not be explored without the presence of the existing conditions– or the “object.”

Evolvability is a process explored throughout the thesis as well. The form begins to evolve from the existing conditions, therefore allowing the injection of a new form to encompass a set of the existing conditions; there becomes a relation between existing elements now that the form is a single entity that reacts to a series of constraints.

According to architectural design critic and theorist Axel Killian, constraints and boundaries allow the form to explore a space through design discoveries (Killian 127). The form becomes reactionary in the sense that it is identifying and reflecting moves in reaction to the existing conditions. The form evolves into an intuitive state, transforming, stretching, inverting, and contorting to morph around the existing conditions and obstacles.

In other terms, the constraints and boundaries present in this thesis act as constants, and therefore, the forms are variables. Within the design operations and iterations of this thesis, the

controlled constraints include simplistic elements of gravity and boxed conditions, better displaying the fluidity of the form that reacts in an unpredictable response to primitive objects.

Conclusions

“Nothing - no function, no object - can remain isolated; everything is involved in a continuous process of transformation; everything is necessarily opened up and leaking away. Such ‘liquid’ architecture is not about nice, pleasing or sculptural forms; since form is action and action is form, there is always a certain risk involved. This includes the risk of form being swallowed up in the abyss of the formless, and without this risk, the act of architecture seems utterly pointless.”

- Lars Spuybroek *The Architecture of Continuity*

The theories and philosophies that encompass the field of architecture have evolved substantially in an effort to critique the way that we view design today. One of the criticisms that was personally posed throughout this thesis is in relation to the stagnancy of design. How can a designer break the boundary of unresponsive architecture? Several conclusions and ideas were manifested during the process of “Topological Inversions,” including theories behind object and form, relationships and interdependencies, pattern performances, and the transitory blending and blurring states of a form between the existing design and the evolving design.

Related to the argument by Spuybroek, architecture is about taking risks; architecture is not about accepting the conditions and copying what has worked in the past, but rather generating ways to critique what has already done. The execution of this thesis experimented with the opportunity of pursuing variational methods in which a form could begin to display characteristics and qualities associated with a new vision of architectural and reactionary design.

By introducing a new form into a set of existing conditions - and viewing and analyzing the performance of the form's response to such conditions - it provided an alternative view of a reactionary architecture and progressive type of topology rather than the present state of stagnancy in design.

One of the most notable findings from this thesis was the exploration into the philosophy and process behind simulations as well as the experimentation of animation software. Many designers today produce standard buildings that act as an object - according to architectural theorists like Greg Lynn and Sanford Kwinter - without the presence of a dynamic and reactionary form. But the exploration into the animation software provided opportunities to experiment with the properties of the introduction of an architectural form, manifesting ideas behind resiliency, latency, and morphology in reaction to existing conditions.

Sanford Kwinter described the two entities of the object and the form in *Architectures of Time* as separate in nature. However, from the design operations utilized in this thesis, they are more dependent on one another than when I first started researching the theories and philosophies between the two. If it were not for the object, the form could not be generated, whether that object be an existing structure, a landscape, or even gravity. What makes a form successful is that it must react to an object - something that is negatively viewed by designers and critics as stagnant or unmoving in space.

The light, coloration, and texture studies strengthened the concepts related to reactions: the response of the form to the object allowed the application of the pattern to react as well. The inclusion of colored lighting to the simulation displayed areas among the form as it began to distort or invert, thus the reaction of the form would not be as prominent had it not been for the application of a pattern.

Architectural theorist and University of Pennsylvania Professor, Ferda Kolatan, stated in a lecture that “Architecture is not about the mere feasibility of a structure. It is about assigning a set of boundaries, and strategically breaking through [those boundaries]” (“Fleeting Morphologies”). From the series of operations resulting in the form’s reaction to an object, the morphological language became a byproduct of the design response and discoveries. Every response and reaction to the object, or the set of existing conditions, was due to the presence of an object.

The morphological language of the form and the pattern became more critical in the simulation in comparison to the mere presence of a stationary object - a design philosophy that many critics, such as Kolatan and Kwinter, are beginning to view in terms of existing conditions. The entirety of “Topological Inversions” was driven by a personal desire to address a design philosophy of establishing not what things are, but what they might be - a critique on escaping from the stagnancy in design and evolve into a new reactionary and responsive architectural language.

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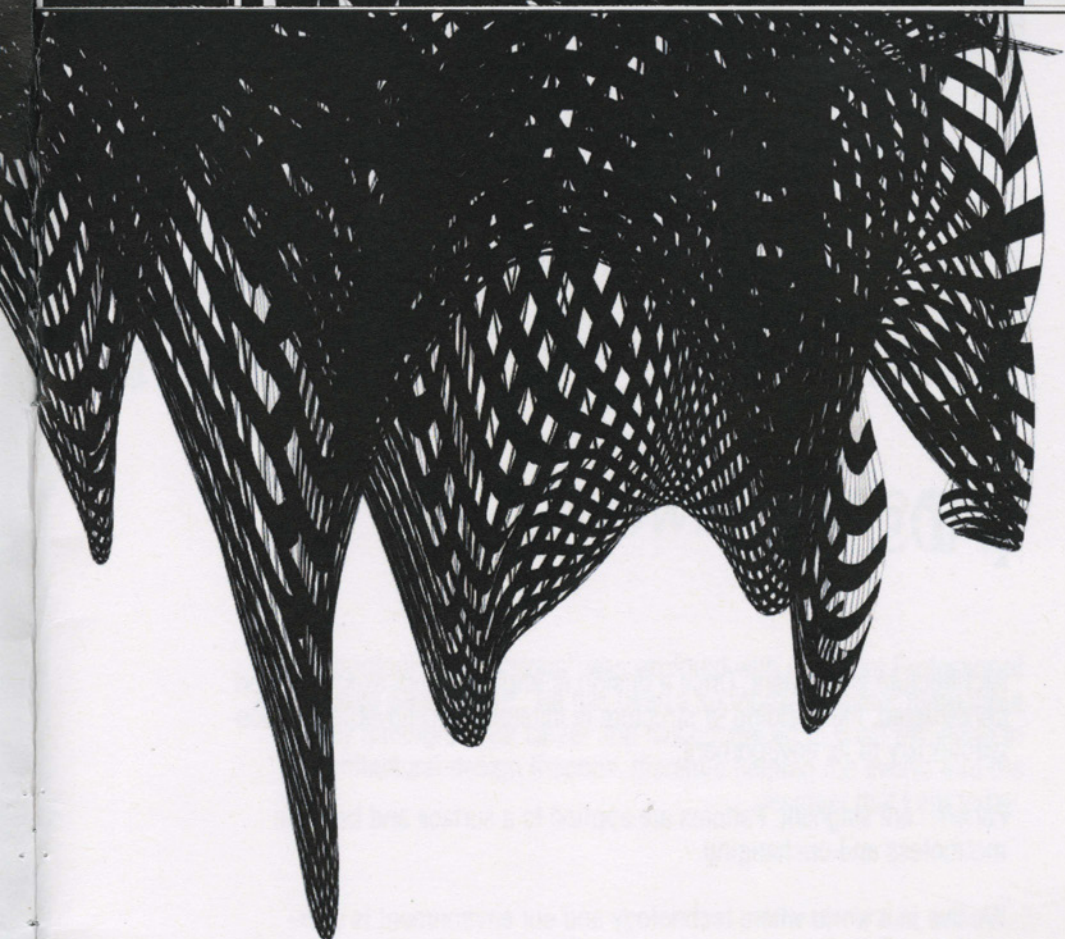
TOPO- LOGI- CAL INVER- SIONS

Megan A. York
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[Abstract]

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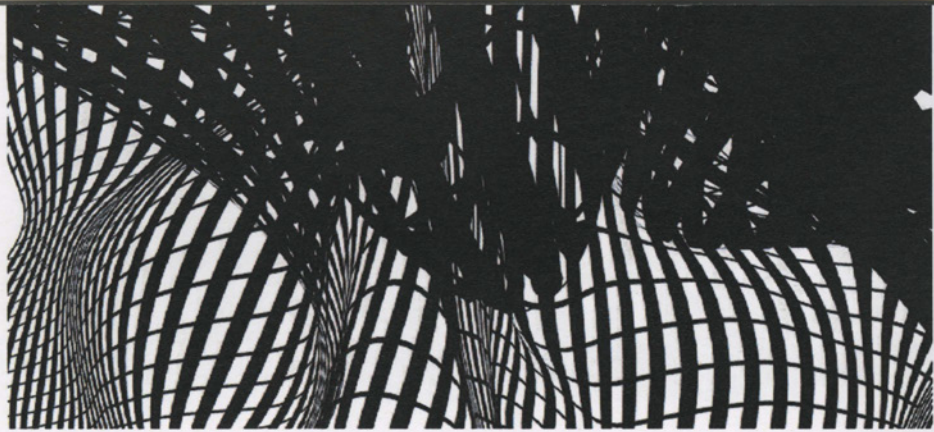
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- *form*: a design element that acknowledges and responds to the presence of existing conditions
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ideology behind introducing a new form that could react to a set of existing conditions, analyzing performance patterns in relation to depth, interstitial spaces, and latent potentials.

Initial research influenced the design process for this thesis: How can one design an architectural language or form that critiques the present idea of stagnancy? How can a form begin to incorporate existing conditions? The design for this thesis involved a series of operations involving animation in architectural and gaming softwares. Certain softwares - such as Revit, SketchUp, AutoCAD, etc. - are rooted in objects; or elements that do not move or reflect existing conditions. However, using processes generated in gaming softwares - such as Maya - that are rooted in animation, allows designers to simulate a form that can reflect conditions in key frames, therefore, allowing the designer to analyze step by step movements of a form and its reaction.

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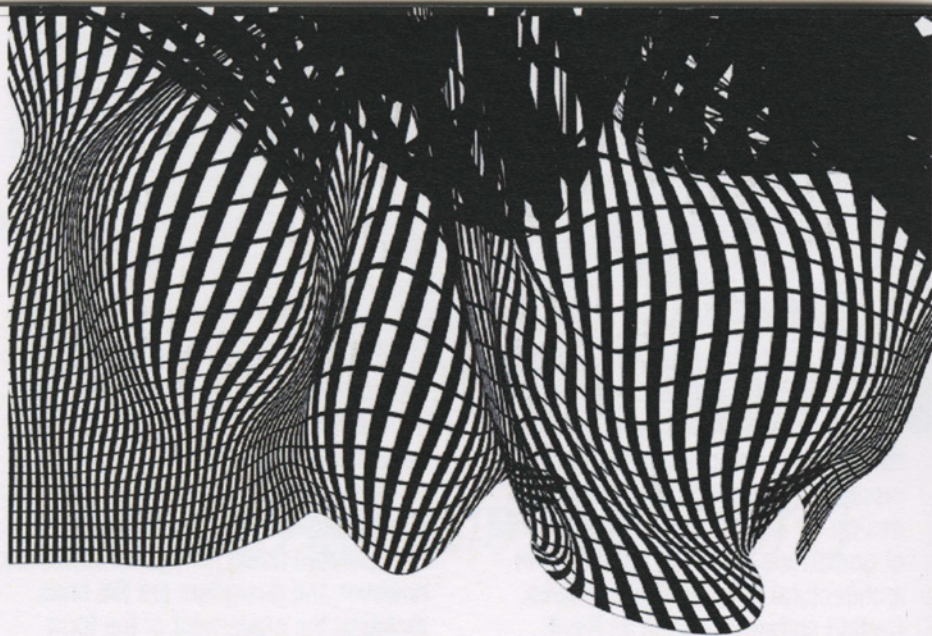
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theorist and critic Sanford Kwinter's terminology of the object and the form were considered for this process; the object acts as a stagnant element, while the form is a reactionary element to existing conditions.

The experimentation of animation is also a relatively new introduction to the field of architecture. As forms are generated for a structure, designers rarely explore the architecture potentials of animation; forms are typically manipulated using polygonal softwares; however, the designers are the ones dictating the placement of the form and not necessarily the form itself. In other words, "Topological Inversions" experimented with the form reacting by itself to a set of existing conditions manipulated by the designer post-process (after the form itself explores a series of design discoveries).

Originating with an object, a primitive pattern of grids was studied and analyzed with the aid of a simulation software. From here, operations were constructed to promote the latency of the object through the manipulation of obstacles or an applied force of gravity.

The entirety of the thesis was driven by the personal design philosophy of *establishing not what things are, but what they might be*. I am interested in observing and analyzing the process of the form rather than the beginning or the end result. "Topological Inversions" is a thesis devoted to the personal exploration into the process and evolution of reactionary architectural design.



[Application of Patterns]

"In fact, the relationship between patterns and architecture hasn't been addressed in 30 years. So why the silence on patterns? There are a number of reasons: first, dissatisfaction with previous architectural conceptions of them; second, their everyday association with superficiality and planned obsolescence; third, the ambiguity of the term pattern; and fourth, the uncritical and one-dimensional use of them in design."

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Like architecture, patterns are also known to be stagnant - or, as Andersen and Salomon state, are "uncritical and one-dimensional" (Andersen, Salomon 42). Oftentimes, patterns are applied to a single surface that does not react to its environment, inevitably producing a series of patterns that are also stagnant or frozen in space. But what were to happen when an unmoving and

stationary pattern is applied to a transformative, evolving, reactionary form? How does the form and the applied impression of patterns begin to react to one another? Can the application of patterns breed a new way of viewing the architectural evolution of a form?

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The application of patterns on a form evolves into an interdependent and symbiotic relationship. Both the form and the pattern benefit from one another's presence and performance; the pattern whether twisted, stretched, contorted, or transformed from its original state to an alternative latent potential, and the form has the ability to express unforeseen moments that could not be seen without the influence of the applied pattern (i.e. a stretch in the fabric, an inversion of the fabric folding in on itself, etc.).

Primitive patterns were of particular interest throughout the iterational studies and design operations of the thesis, such as patterns that generate grids, lines, or points. The primitive and simplistic nature of the patterns (such as a grid) allows us to view areas of densities or moments of inversions throughout a form and the generation of an animation over time. While the form is in its early stages in the animation a pattern is still present; but what were to happen to the pattern when the form reacts to a boundary or constraint - such as an object as earlier stated - over time? What happens to the legibility of the pattern? Is the pattern damaged? Is the pattern merely informative to the form, or simply reactionary to the form's manipulation?

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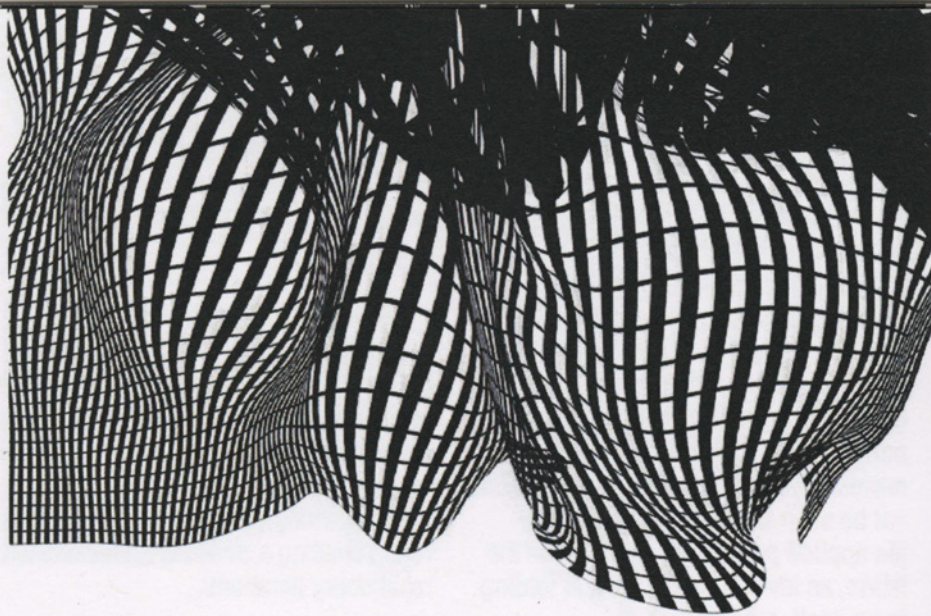
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The thesis analyzes both of these ways to take advantage of a pattern's multi-functional capabilities defined by Andersen and Salomon. Throughout the design operations in "Topological Inversions," a chosen pattern was adapted to a set of existing conditions, while simultaneously being analyzed to inform its architectural language and its overall design performance.



[Constraints & Boundaries]

"The formless may be referred to as the replacement of direct manipulation of geometry with an aprocudural design process, in which the designer does not look for a single formal solution but instead reimagines the design as the current state of an evolving system of constraints, working through design discoveries made within this dynamic system"

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columns, etc. - as long as they provide a shape to allow the form to react to over time. Constraints, boundaries, and existing conditions are necessary throughout the series of design iterations as they inevitably determine the overall performance, evolvability, and morphology of the new form.

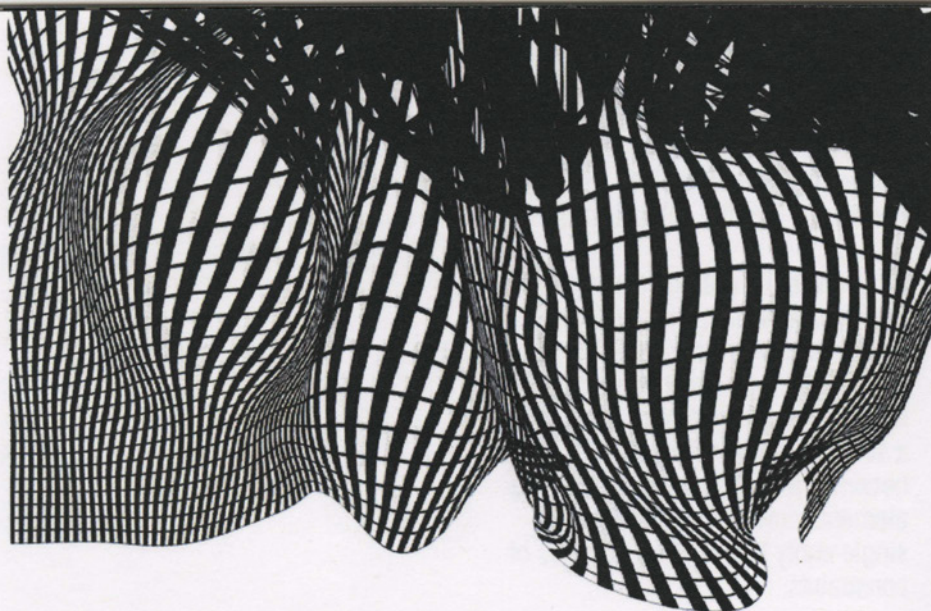
Constraints and boundaries are influential forces that allow a form to not only react to the existing conditions, but also allow a form to morph from its original state to something new or unpredictable. It is predictable that the form will somehow react to its environment; however, it is not predictable how the form will morph, nor is it determined what the exact outcome and performance will be. As the form is in its original state, it begins to transform and evolve into a new morphological design language that would not be present without the existence of the constraints. There becomes an *interdependent* relation between the existing and the new; the

new – or, according to Kwinter, the “form” – could not be explored without the presence of the existing conditions – or the “object.”

Evolvability is a process explored throughout the thesis as well. The form begins to evolve from the existing conditions, therefore allowing the injection of a new form to encompass a set of the existing conditions; there becomes a relation between existing elements now that the form is a single entity that reacts to a series of constraints.

According to architectural design critic and theorist Axel Killian, constraints and boundaries allow the form to explore a space through design discoveries (Killian 127). The form becomes reactionary in the sense that it is identifying and reflecting moves in reaction to the existing conditions. The form evolves into an intuitive state, transforming, stretching, inverting, and contorting to morph around the existing conditions and obstacles.

In other terms, the constraints and boundaries present in this thesis act as constants, and therefore, the forms are variables. Within the design operations and iterations of this thesis, the controlled constraints include simplistic elements of gravity and boxed conditions, better displaying the fluidity of the form that reacts in an unpredictable response to primitive objects.



[Design Operations]

Deviating from the ideology of Sanford Kwinter, Paul Andersen, David Salomon, and Axel Killian, this thesis originated by exploring a series of forces that were applied to a form in reaction to an object. Pattern applications, lighting conditions, coloration, inversions, depths of interstitial spaces, and latent potentials were all explored throughout the design operations as well, experimenting with the different performance patterns of a form in relation to a set of existing conditions.

Initial studies explored the relationship between the form and the object. Originating with a primitive box (the object) and creating a planar surface with the materiality and properties of a fabric (the form), an animation was generated. In the software Autodesk Maya, a combination of boundaries, the box and gravity, were introduced in addition to the fabric. Assigning the form the properties of a

“fabric” allowed it to be pliable and, therefore, reactionary to the environmental forces while displaying properties of elasticity, resiliency, and latency. The fabric was allowed to stretch, contort, and distort itself as it responds to the boundary of the box. The box’s properties in the software were generated into a “passive collider,” or in other terms, a stationary object that remained stagnant in its movement capabilities throughout the simulation of the animation.

In this study, the two boundaries of the box with the inclusion of gravity allowed the form to react with a generated morphic design language. The form progressively morphed and molded itself in response to its introduced obstacles through a series of design trials and discoveries, an architectural theory and philosophy similar to the ideas of Axel Killian (Pages: 14-17). The form kept its resiliency as a plane, while simultaneously displaying properties that started to address the object; an

outline of the box is present on the surface of the form as it is folding itself around the obstacle. This observation proved that the presence of a form both displayed latent potential in its morphological language, while also displaying traits of its original state of design and addressing a set of existing conditions, a codependence between object and form.

Within the first few frames of the animation (Frames: 58 - 124), the shape and evolution of the form was predictable. Since it was a fabric, it began to mold or morph in reaction to the object. It stretched until the moment where its resiliency was distorted to its maximum potential, therefore attempting to return to a state that does not have to morph to an object. Seen in the last few key frames of the animation (Frames: 182 - 246 Pages: 14-15), the form attempted to resist the object; interestingly, even though the form had transformed itself from its object through a series of design discoveries, the form continued to have the presence of the outline of the box on the surface of the fabric, similar to an imprint. The form displayed both the characteristics of a fabric in its resiliency and morphology of a new aesthetic, as well as displayed characteristics of the original object due to its reaction to the set of existing conditions.

Further studies began to address the application of a primitive grid pattern in relation to an animated notion of time. As presented by architectural theorists and critics Paul Andersen and David Salomon, the presence of patterns "foreground the sensual while shaping matter and behavior by stealth" (*The*

Architecture of Patterns 14). The application of a pattern further helped to analyze the performance of the form through alternative methods. The patterns applied to the fabric in Maya have the ability to stretch, contort, invert, and mold itself in relation to the object, similar to the properties as the resiliency of the fabric of the form. A primitive pattern of a grid overlay was applied to the fabric in order to view the form's hyper-densities and morphological evolution over time throughout the animations and series of iterations.

Once generated, gravitational forces along with the constraint of the box began to distort the pattern of the grid at particular moments along the animation. These particular key frames and moments showed the inversion of the pattern on the form, producing an overlay of reactionary and transitory performance patterns in relation to interstitial space. Throughout the series of key frames, there was a presence of relationships between the grid patterns and the molds of the form. The legibility of the pattern was oftentimes lost in certain moments (Frames: 96-168 Pages 16-17). This loss of legibility of the grid frame reflected that the properties of the pattern are not necessarily being broken or damaged, but rather they are being manipulated in a way due to the constraints of gravity and the box.

In Sanford Kwinter's *Architectures of Time*, he critiqued the theory behind a primitive object morphing into a transitional state that begins to dissipate, only to result in a form take the place and reemerge and transcend



058 : 320



072 : 320



142 : 320



168 : 320



096 : 320



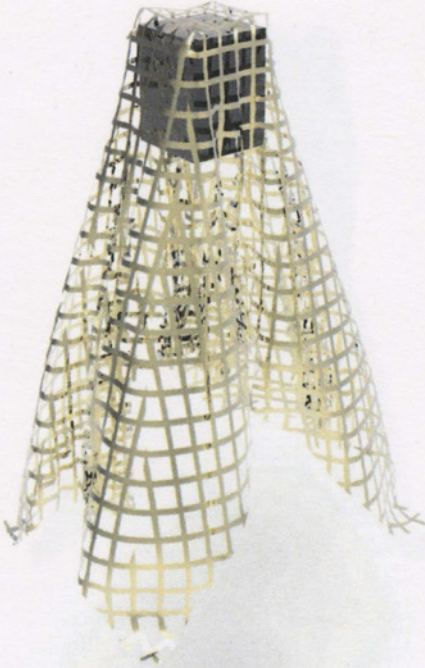
124 : 320



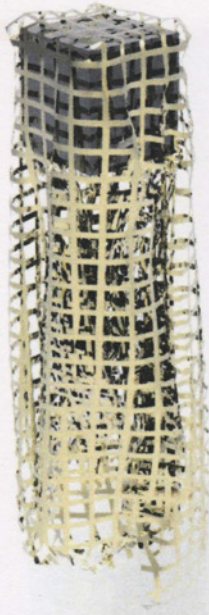
204 : 320



246 : 320



058 : 320



072 : 320



142 : 320



168 : 320



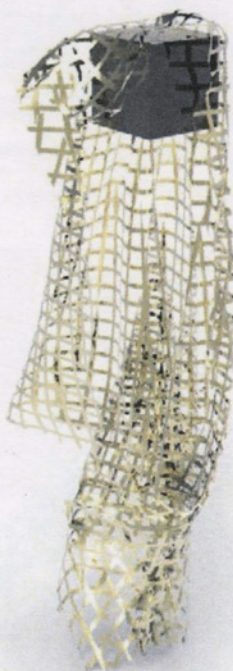
096 : 320



124 : 320



204 : 320



246 : 320

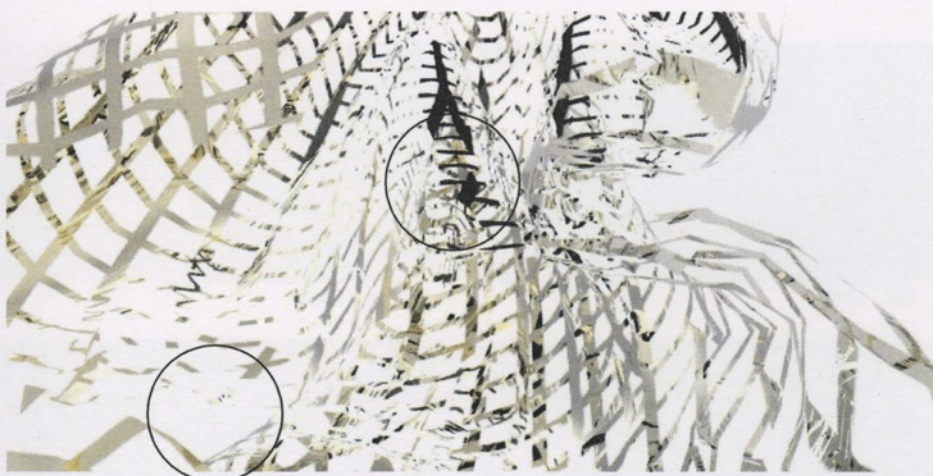
as a result of a force over time, inevitably generating forms that "... vanish and reemerge into the chaotic flux of unstable aggregates and events" (Kwinter 36). Extracting theories from Kwinter, the simulations in relation to the form and the applied patterns presented similar properties of reemergence and chaotic flux. The introduction of glossy textures onto the applied patterns weakened the legibility of the form, providing moments where the form seems to disappear and later reemerge throughout the generation of the simulation.

Individual frames and interior moments within the form were further explored; areas of lost legibility and distortion of the pattern were of particular interest; these moments were further analyzed (Frames: 620-1080 Page: 19). As the simulation progressed, the pattern and form was no longer read as its pure planar surface; this was due to the presence of the object and the reaction of the form and pattern. Additionally, there were moments throughout the simulation when the form began to invert on itself or began to interact with its own surface, reflecting and contorting to its own reactions with the object of the box. The moments of inversion were further studied due to their unpredictability; could such inversions begin to reflect program or structure within a space? How could the depth and distortion of the interstitial space begin to inform architectural performance?

To further understand the relationship between the object, the form, the pattern, the reaction and

architectural design, coloration and light placement within the simulation was also explored throughout various design iterations. Two colored lights were introduced to the animated model. In the first study, gold lighting was applied in addition to a white lighting (Frames: 620, 840, and 1080). The areas of interest were circled in the frames, where there were moments of inversion due to the contortion of the form, the obstacle, and the lighting, thus strengthening the loss of legibility of the form and pattern in response to its surroundings.

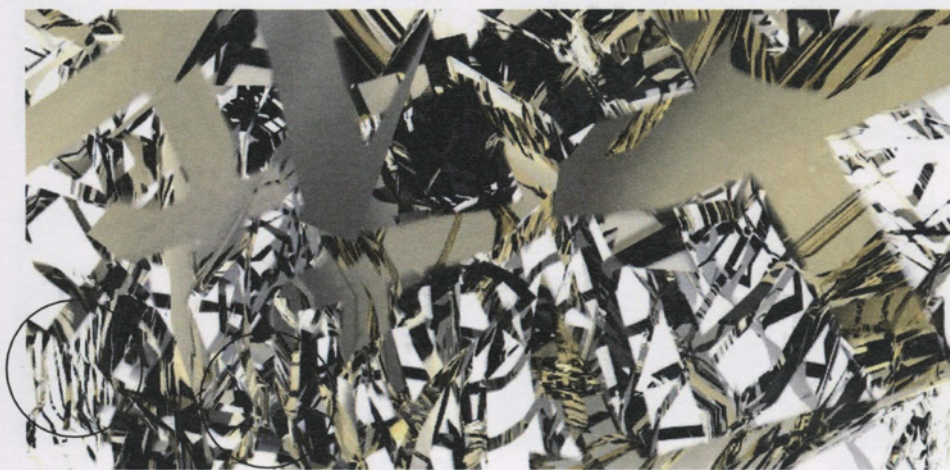
Another study incorporated with the placement of violet lighting, applied in addition to a white lighting. The white light highlighted the intensity of the sharp contrasting shadows, while the gold and violet light was incorporated in order to better acknowledge the transformation of layers. In the first series of key frames of the simulation (Frames: 240-620 Pages: 20-21), the colored light began to interact with the white light, displaying a few overlapping layers. The applied force, along with the stagnant obstacle of the box, allowed the form to proceed through a series of design discoveries. As the force progressed within the simulation, coloration in light began to become more apparent as the layers inverted on one another; the white light, produced contrasting shadows to the gold light, provided the analysis of the interstitial space and overall depth of the form. The wider the variation in contrasting shadows of the gold and violet light coloration, the pattern became more manipulated in layering and inverting on itself.



620 : 1280



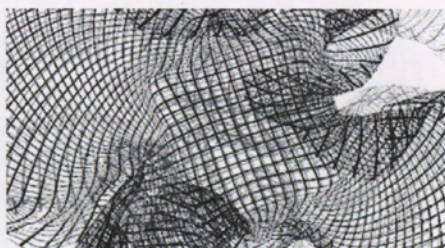
840 : 1280



1080 : 1280



240 : 1200



240-260 : 1200



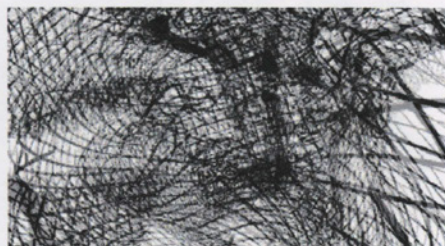
620 : 1200



620-640 : 1200



760 : 1200



760-780 : 1200



980 : 1200



980-1000 : 1200



1120 : 1200



1120-1140 : 1200



240 : 1200



240-260 : 1200



620 : 1200



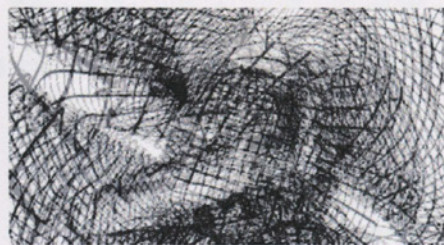
620-640 : 1200



760 : 1200



760-780 : 1200



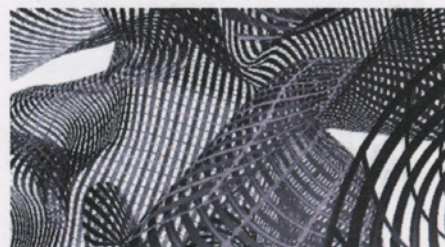
980 : 1200



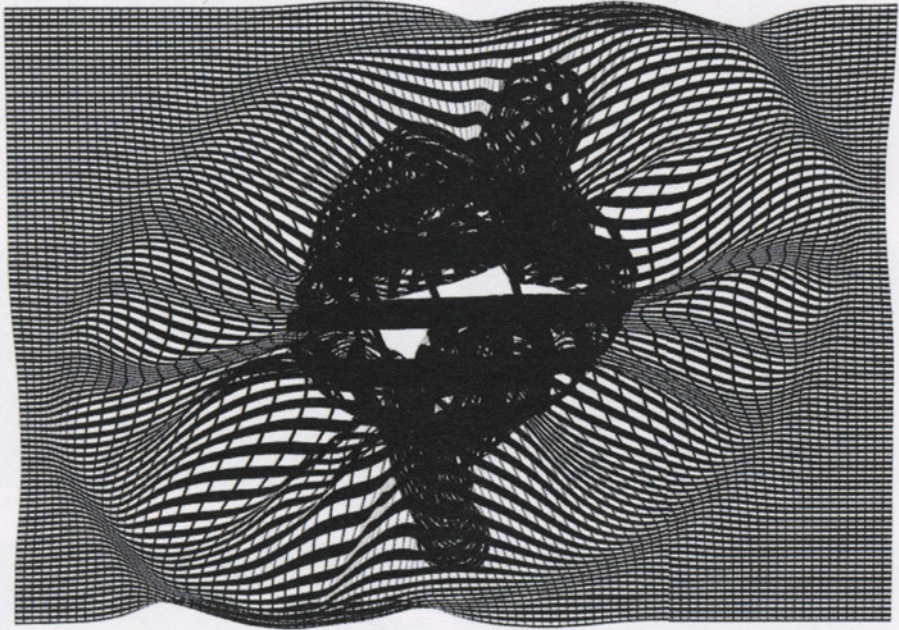
980-1000 : 1200



1120 : 1200



1120-1140 : 1200



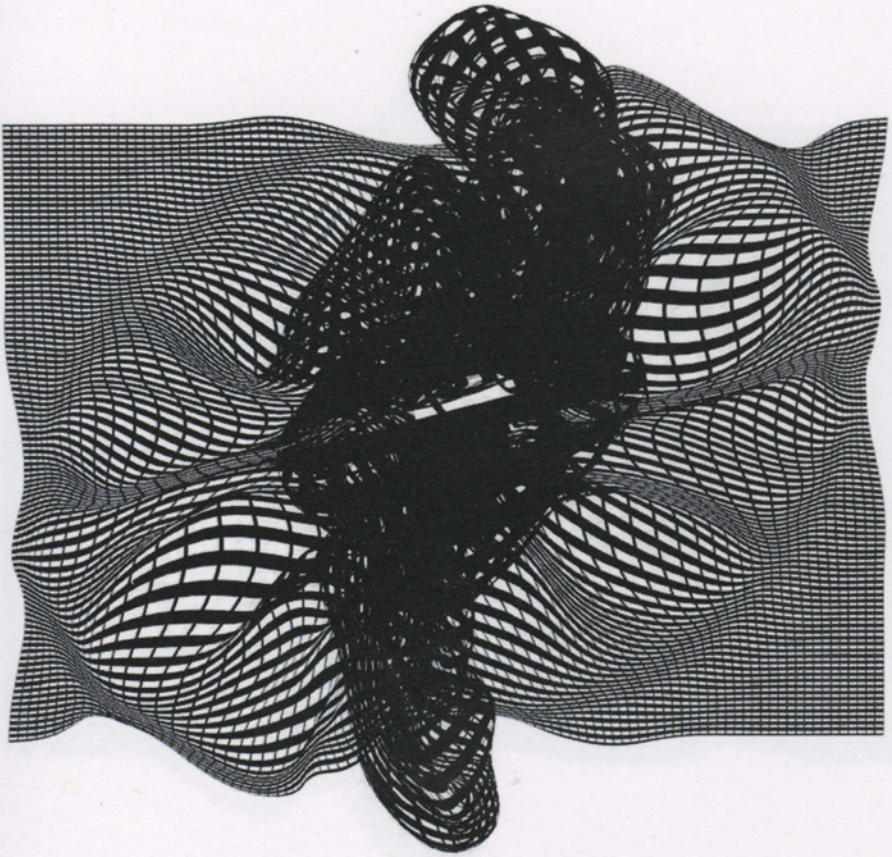
Following the iterative experimentation of color and light, the exploration of lines was analyzed, particularly with respect to the relationships of the structure of the vectored line (the wire-frame line work) and its interaction with different depths of the pattern. The series of key frames on the preceding pages (Frames:240-1120 Pages: 20-21) explored the interrelations between the overall depth of the form and overlapping architectural components such as points, lines, and planes (in this instance, the applied primitive grid pattern acts as the plane).

In *Animate Form*, architectural

theorist Greg Lynn critiqued the way in which animation is utilized in the field of architecture, in terms of analyzing vectored geometries while generating a reactionary form:

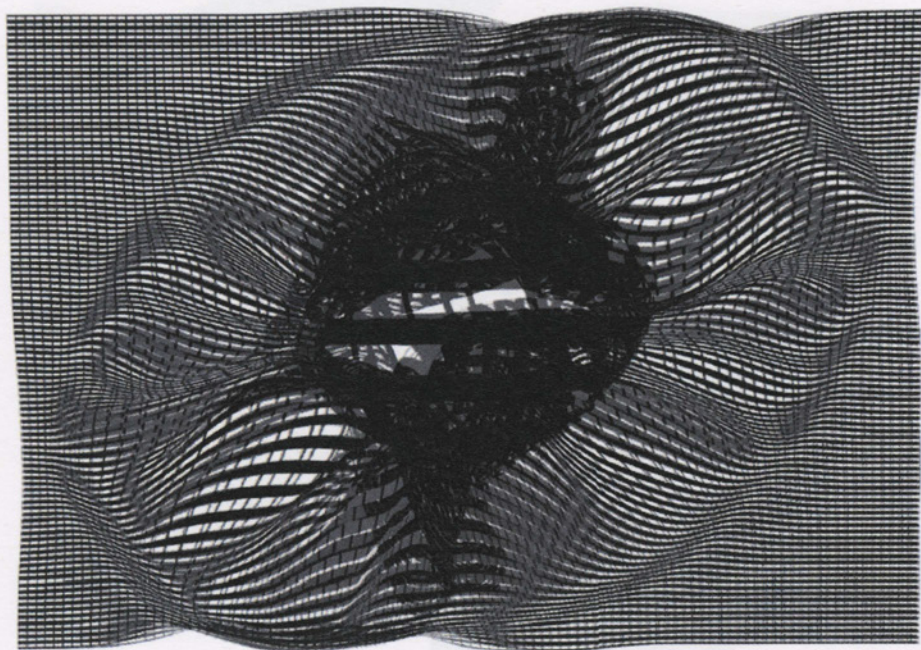
“Force is an initial condition, the cause of both motion and the particular inflections of a form. For example, in what is called inverse kinematic animation, the motion and shape of a form is defined by multiple interacting vectors that unfold in time perpetually and openly” (Lynn 11).

In addition to analyzing coloration, lighting, and reflection, the latency and evolvability in terms of the form’s vector



and lines were studied. Lynn reviewed the method in which a form's lines are manipulated throughout a simulation, stating that all forms evolve form vectors (Lynn 11). The lines of the patterns were further analyzed, with particular interests given to the moments of inversion where the form began to react to the object of the box by going in on itself in an attempt to escape from the constraint of the box (Pages: 22-25). When analyzing the linework, there were certain moments among the key frames where the form's patterns began to interlock and inverse in high irregularities, thus creating impenetrable areas of hyper-densities (or areas that had multiple high intensity

of activity, where lines intersected at a rate of high frequency). Similar to the reaction of the form to the object of the box, the linework and vectors displayed characteristics and properties of both its latent potential and its outline of the mold to the original object. In the initial key frames (Frames: 240 and 620 Pages: 24-25), there was the presence of the original grid pattern in the center background, due to the boundary and constraint of the box. Further in the simulation, when the form began its resistance to the object, the vectors of the pattern started to lose the original legibility of the grid.

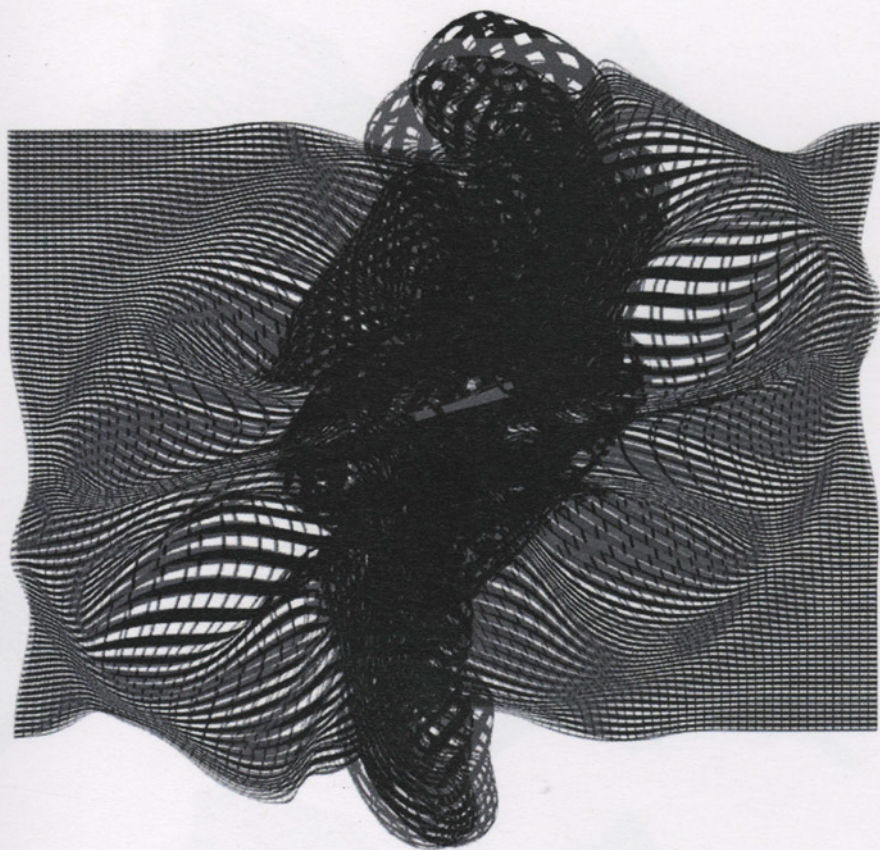


The series of final studies analyzed the application and method of layering key frames on top of one another, to explore the relationship from one moment of the animation to the next. Of particular interest were the high density areas as well as the moments where the grid was in the process of transforming from its original state to its evolving state. In the images above and on the following pages (Pages: 24-27), the overlaying of the series of the frames displayed these moments of high intensity, where the pattern appeared to blur and blend between the one layer of the key frame to the next.

The most interesting moments of

the simulation were actually the frames in which the form was transitioning from its existing state into its latent potential, rather than merely focusing on the end result. The beginning of the original state of the pattern and the end results of the form manifested a set of unique properties that occurred while in the process of the animation: there is a *transitional* state from existing to evolving.

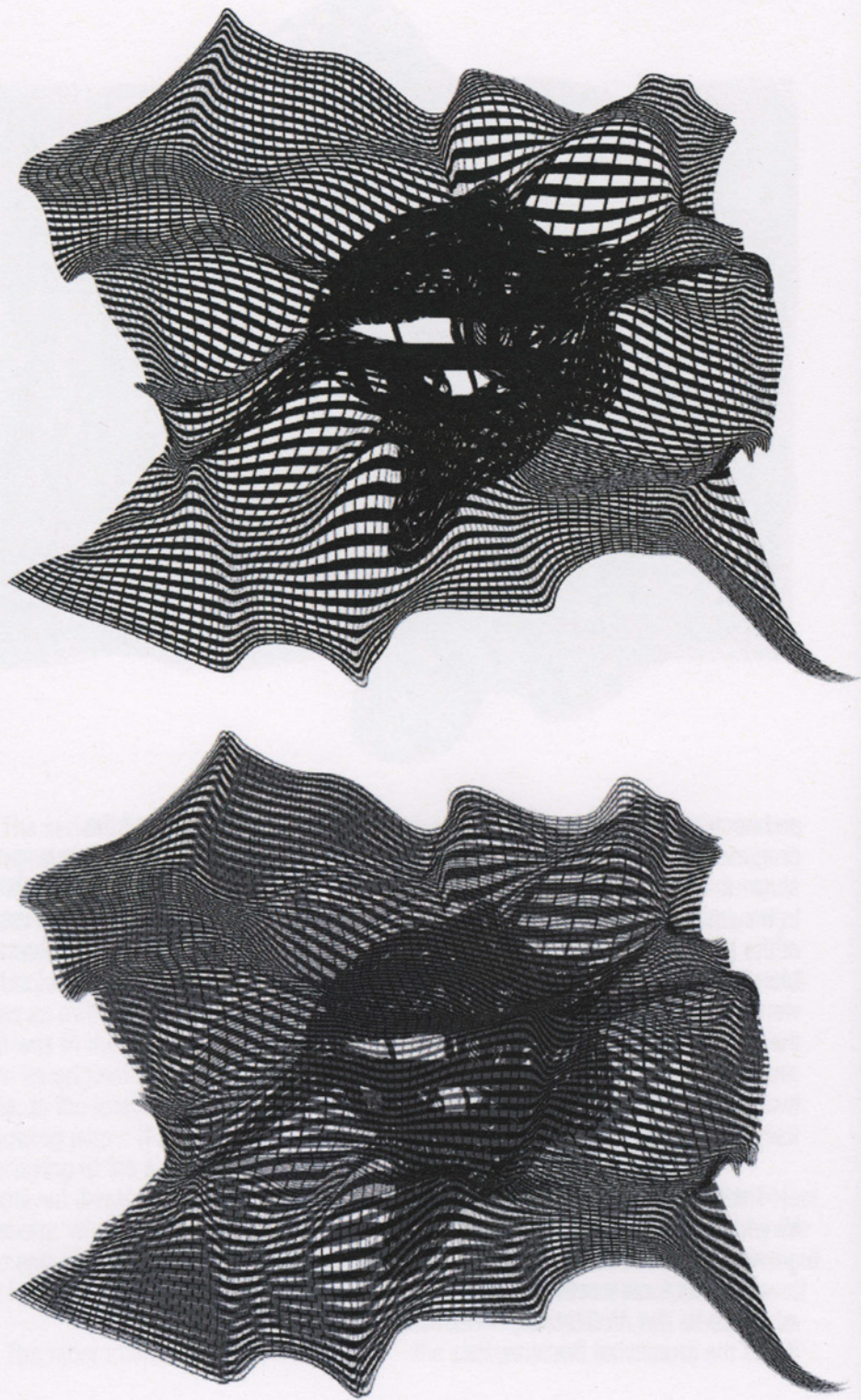
In these particular studies, the object and boundaries were not defined by the application of a box in Maya, but instead the constraints were the applications of time and gravity, both key elements in the presence and process of

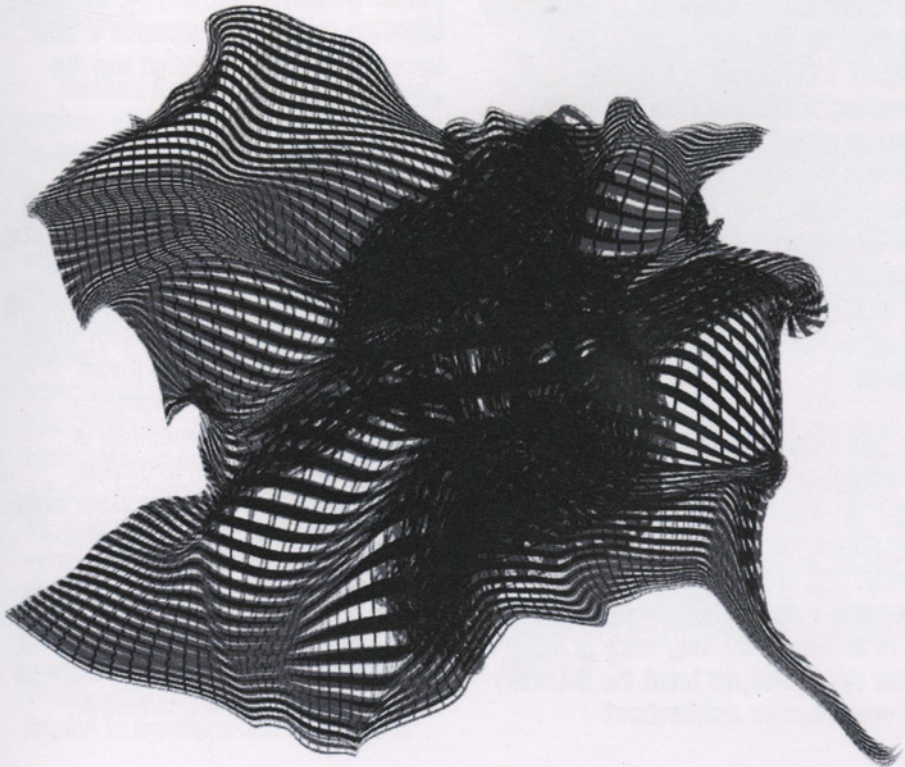
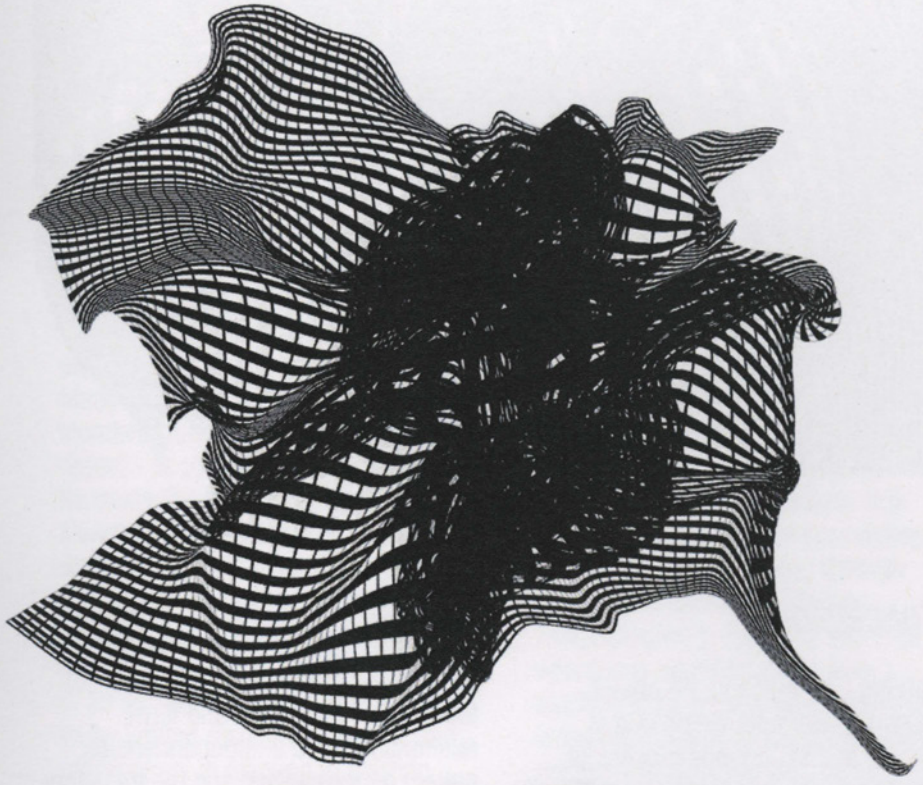


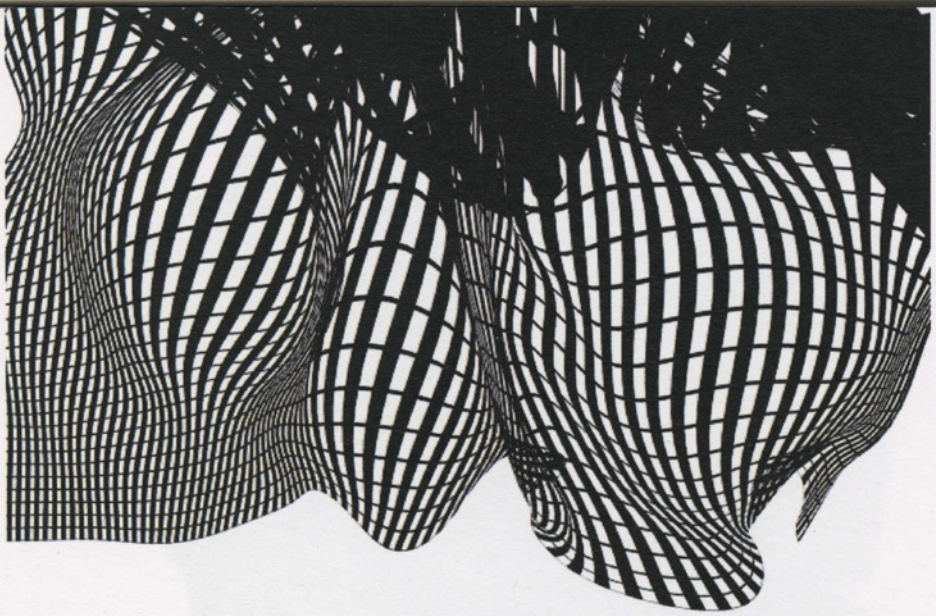
architectural design. As the form progressed in reaction to gravity, its shape manipulated in response similar to the earlier studies with the object of the box, creating the blurring and blending of lines and regions that were exposed in the application of the pattern. In this case, the form had more freedom in its design discoveries, twisting, contorting, and reacting only to itself, gravity, and time.

The last study of “Topological Inversions” experimented with *time* and gravity as a set of existing conditions to which the form reacted around. In reference to *The Architecture of Patterns*, it was the process of the form, its

design discoveries, and the performance of the patterns in response to a series of existing conditions that generated a personal theory into the ideology of *reactionary* architecture.







[Conclusions]

“Nothing - no function, no object - can remain isolated; everything is involved in a continuous process of transformation; everything is necessarily opened up and leaking away. Such ‘liquid’ architecture is not about nice, pleasing or sculptural forms; since form is action and action is form, there is always a certain *risk* involved. This includes the risk of form being swallowed up in the abyss of the formless, and without this risk, the act of architecture seems utterly pointless.”
 - Lars Spuybroek *The Architecture of Continuity*

The theories and philosophies that encompass the field of architecture have evolved substantially in an effort to critique the way that we view design today. One of the criticisms that was personally posed throughout this thesis is in relation to the stagnancy of design. How can a designer break the boundary of unresponsive architecture?

Several conclusions and ideas were manifested during the process of “Topological Inversions,” including theories behind object and form, relationships and interdependencies, pattern performances, and the transitory blending and blurring states of a form between the existing design and the evolving design.

Related to the argument by Spuybroek, architecture is about taking *risks*; architecture is not about accepting the conditions and copying what has worked in the past, but rather generating ways to critique what has already been done. The execution of this thesis experimented with the opportunity of pursuing variational methods in which a form can begin to display characteristics and qualities associated with a new vision of architectural and reactionary design. By introducing a new form into a set of existing conditions - and viewing and analyzing the performance of the form’s response to such conditions - it provided an

alternative view of a reactionary architecture and progressive type of topology rather than the present state of stagnancy in design.

One of the most notable findings from this thesis was the exploration into the philosophy and process behind *simulations* as well as the experimentation of animation software. Many designers today produce standard buildings that act as an object - according to architectural theorists like Greg Lynn and Sanford Kwinter - without the presence of a dynamic and reactionary form. But the exploration into the animation software provided opportunities to experiment with the properties of the introduction of an architectural form, manifesting ideas behind resiliency, latency, and morphology in reaction to existing conditions.


Sanford Kwinter described the two entities of the object and the form in *Architectures of Time* as separate in nature. However, from the design operations utilized in this thesis, they are more dependent on one another than initial research into the theories and philosophies between the two showed. If it were not for the object, the form could not be generated, whether that object be an existing structure, a landscape, or even gravity. What makes a form successful is that it must react to an object - something that is negatively viewed by designers and critics as stagnant or unmoving in space.

The light, coloration, and texture studies strengthened the concepts related to reactions: the response of

the form to the object allowed the application of the pattern to react as well. The inclusion of colored lighting to the simulation displayed areas among the form as it began to distort or invert, thus the reaction of the form would not be as prominent had it not been for the application of a pattern.

Architectural theorist and University of Pennsylvania Professor, Ferda Kolatan, stated in a lecture that "Architecture is not about the mere feasibility of a structure. It is about assigning a set of boundaries, and strategically breaking through [those boundaries]" ("Fleeting Morphologies"). From the series of operations resulting in the form's reaction to an object, the morphological language became a byproduct of the design response and discoveries. Every response and reaction to the object, or the set of existing conditions, was due to the presence of an object.

The morphological language of the form and the pattern became more critical in the simulation in comparison to the mere presence of a stationary object - a design philosophy that many critics, such as Kolatan and Kwinter, are beginning to view in terms of existing conditions. The entirety of "Topological Inversions" was driven by a personal desire to address and question a design philosophy of establishing not what things are, but what they might be - a critique on escaping from the stagnancy in design and evolve into a new reactionary and responsive architectural language.



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