Twisted: Literal & Phenomenal

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Twist: To form (something) into a particular shape by taking hold of one or both ends and turning them; Turn or bend into a specified position or in a specified direction; To move one's body so that the shoulders and hips are facing in different directions; Cause to rotate around something that remains stationary; To wring or wrench so as to dislocate or distort; To alter the meaning of: pervert; To cause to take on moral, mental, or emotional deformity.

'Turn,' 'bend,' 'distort,' 'pervert.' These terms are but some of the ones selected from definitions of the word twist found in the Oxford and Merriam-Webster dictionaries. "The French translations are: *tordre, torquere*. Torquere (similar to the English torque/torsion) means to turn, to turn around, to torture. The association with the notion of torture is particularly interesting: tying up and strangling with a powerful and unavoidable turn enlivens the image of twisting."[1] 'Turn' and 'bend' describe a benign mechanical action. 'Distort' and 'pervert' suggest something more adverse. In contemporary architectural parlance, both are favorable, as they belong to a lineage of motion[2] on one hand and dislocation[3] on the other. But twisting is a specific kind of bending/distortion that has all but been exhausted in the past two decades of architectural production. Examples abound worldwide and at various scales, and not for unwarranted reasons. A simple twist to a material, form, or body can yield powerful effects. The dance craze "the twist" became an overnight sensation throughout the U.S. and Europe when, in one summer of the late 1950s, Chubby Checker performed it on Dick Clark's "American Bandstand."[4] The main part of its appeal to teens and young adults is that it *perverted* what was considered socially acceptable movement between male and female: the gyrating and twisting action of the body on the dance floor suggested sexual activity and desire, *which dislocated the metaphysic of dancing*. In architecture, a specific kind of dislocation occurs in relation to twisting, and a qualitative distinction must be made between an actual or *literal* and an apparent or *phenomenal* twist.

First, let's try to pin down a more specific material[5] definition of each as they might pertain to architecture. Literal twisting is the *deformation of a generic substance/material through opposing rotation at its ends along an axis perpendicular to those ends*. Phenomenal twisting is *the appearance of such achieved by other means of for-*

Figure 1: Signal Box. Basel, Switzerland. Completed in 1994. Herzog & de Meuron.

mation. The key terms of distinction being *deformation* in the former and formation in the latter, foregoing any implication as to one being real and the other being a mere appearance.[6] They are both considered equally real. In the philosophical genre of phenomenology, the doctrine of intentionality claims: "There are no 'mere' appearances, and nothing is 'just' an appearance. Appearances are real; they belong to being. Things do show up....Things that had been declared to be merely psychological are now found to be ontological, part of the being of things."[7] In Jeffrey Kipnis' essay on the Nelson-Atkins Museum of Art in Kansas City by Steven Holl entitled "...and Then, Something Magical," he takes a brief detour to distinguish between two models of existential phenomenology as it applies to architecture in relation to technology: Heideggerian vs. Merleau-Pontyan. In short, the Heideggerrian model associates appearances and technology with inauthenticity, whereas: "Merleau-Ponty rejects his colleague's position that meaning and authenticity arise from a metaphysical relationship between appearances and being, preferring to inquire how these evolve from perceptions of a body living in a world as phenomena. To ground his discourse thoroughly in perceptions, he discusses the interplay of things, experiences, and ideas in terms of the *visible* and *invisible*, emphasizing the way these two interact with and change each other, calling attention to what he calls the 'profound carnality of their doubling.'"[8] In terms of effects, isn't this precisely what twisting does: produce an oscillation between the visible and invisible parts of a surface/form? Doesn't twisting provide a *doubling*, or the simultaneity of turning away from and toward another object (be it a viewing subject, another building, geographic orientation, etc.)? Isn't this the core of its power and why it has gained such popularity and become so ubiquitous over these past two decades? Along with these performative effects of twisting, the ushering in of the digital era of the early 1990s and an aggressive interest in topology also greatly contributed to its popularity. To be sure, we must catalog the various scales at which the twisting effect occurs and the qualitative and quantitative differences between them.

Twisting in architecture can be categorized into three scales: the *material component* (small), *massing moments* (medium), and the *whole mass* (large). An abundance of great examples abound, both built and speculative, but I have selected only one or two built ones for each category that I find most clearly demonstrate the differences and effects set out by the paper's framework. At the material component scale, we typically find strips or slats of sheet material (metals, wood, plastics, etc.) and usually in large numbers. This scale requires small parts and lots of them (hundreds and thousands) and begins with the literal twisting of a basic strip of material. The phenomenal effects achieved are delivered at a larger scale when a critical mass of twisted strips yields field effects such as moiré patterns. In the better cases,

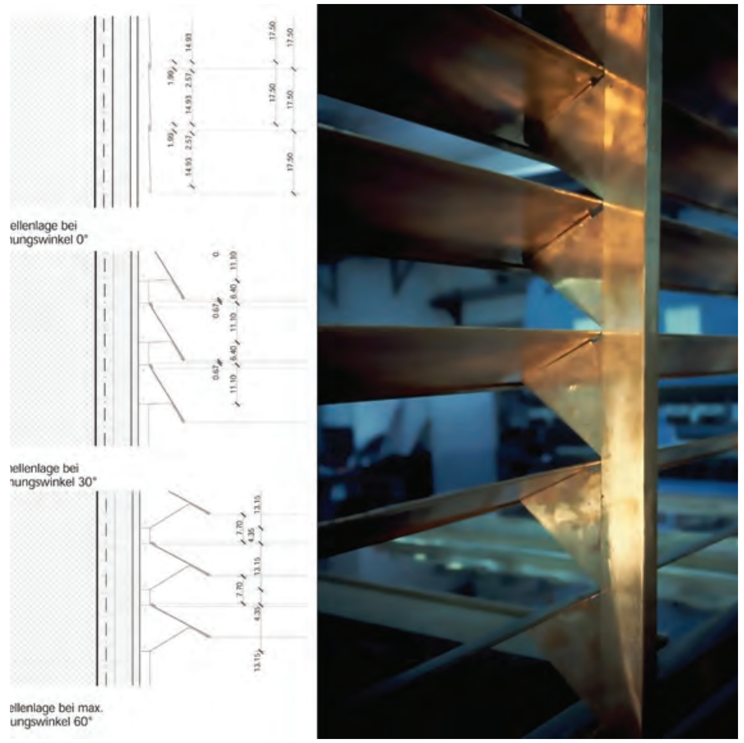
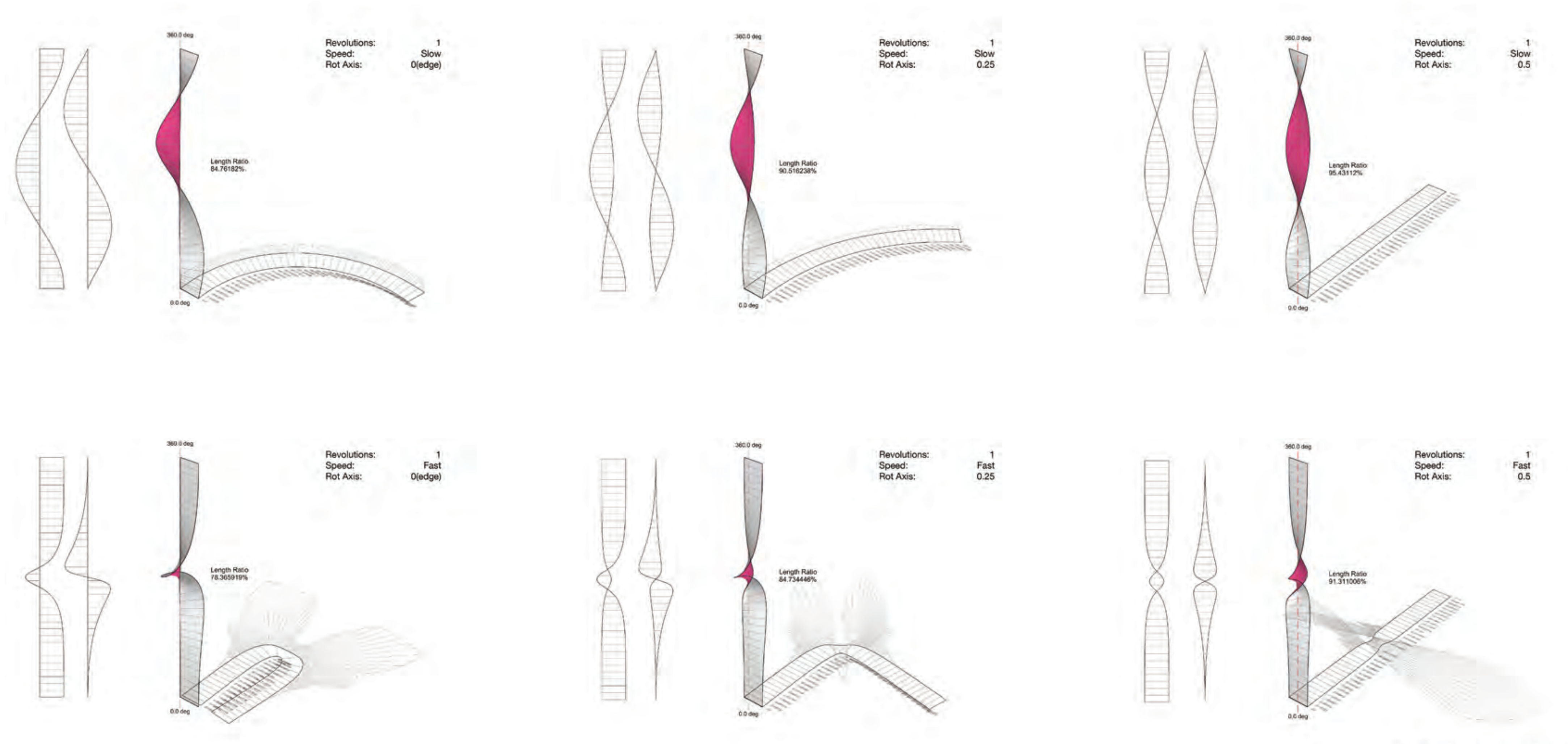


Figure 2: Details and mock-up of angled support intervals.

a dematerialization of a larger surface occurs where the accumulated twisting of the strips reveals something akin to an apparition of the thing it is enveloping. It produces atmospheric effects. A prime example of this is Herzog & De Meuron's Signal Box in Basel, Switzerland, completed in 1994 (fig. 1), which is wrapped in horizontal strips of copper at 17.50 cm wide that twist from zero degrees (flat and closed) to 60 degrees from negative z (fig. 2).[9] While the conventions of frontality and facade are maintained, continuity occurs in both the surgical handling of assembly and a small fillet rounding off the corners. The limitation of the twisting from zero to 60 degrees is one imposed by material and methodological constraints. The twisting occurs gradually over a long enough span not requiring mechanical means of deformation. It is simply a byproduct of connecting the strips to gussets at evenly spaced and variably angled intervals. But the limitation also contributes to the apparition-like qualities: by not twisting to a full 90 degrees, the conventional interior is never fully revealed when viewed frontally. This also privileges viewing it from the ground at a specified distance in order to receive maximum (but never full) exposure of what lies beyond. Twisting a planar and rectilinear strip of material beyond a certain angle threshold would result in the distortion of the material into a new figure and requires advanced means of formation vis-à-vis computation. Arguably, the Signal Box project serves as a contemporary canon for twisted effects found in digitally generated architecture. Ironically, the project was achieved through analog means, right at the cusp of the digital era.

Figure 3: (Left) Leaning Satyr, c. 130 AD. Roman copy of sculpture by Praxiteles, c. 4th century BC (Right) Venus de Milo by Alexandros of Antioch, c. 130–100 BC.

Figure 4: (Left) Replica of David by Michelangelo, c. 1500. (Right) David by Bernini. 1623.



TWISTING DIAGRAMS: 0 TO 360

Figure 5: Twisting Diagrams

Moving on to the middle scale, we find a shift in effects and material logic. Massing moments of twisting are found when a project employs the twisted surface at a scale larger than the material component but not as one large move of a single mass. It is a means to simultaneously break down a building's massing yet maintain coherence through surface and spatial continuity. While twisting at the scale of the material component focuses all of its energy on surface (perceptual) effects, this middle scale of twisting enters into organizational territory: the scale of the twisting action moves space around. At the small scale, the twisting effect is directed at the eye. At the middle scale, it is directed toward the body. It exchanges deformation of material for deformation of massing geometry and can be constructed out of an undistorted planar sheet logic, a modular unit (brick), or a mold (cast-in-place concrete).

A clear example of the latter is Miguel Fisac's Jorba Laboratory, located just outside of Madrid, Spain, and built in 1968. A seven-story tower of repetitively stacked floor plates is distorted by rotating the alternate ones 45 degrees in plan. The rotation is interpolated by twisted surfaces made of cast-in-place concrete. The overall mass is broken down into constituent parts (as floor volumes) yet made continuous through the twisted surfaces. The eye is invited to wander in rhythmic undulation, from any stationary vantage point, from base to top. But more importantly, the body is invited to move around the building to receive alternating compositions of the stacking as it snaps into alignment every 45 degrees: a double sense of frontality where "whole units of space are put into motion."[10] In this case, the twisted element is revealed as an index of the form-work, and one can identify the panel seams located at ¼ intervals along each edge of a face. The literal twisted unit of construction appears to be modular and repeated, with each half being composed of two inversions of the ¼ unit. This legibility gives way to an understanding of the analogical sequence, thus the lack of need for computational intervention.

A more idiosyncratic version of this, dependent on computational intervention, is Preston Scott Cohen's Herta and Paul Amir Building in Tel Aviv, Israel, completed in 2011. The twisted effect operates at a similar scale to Fisac's example but is of a different tectonic logic and contains variable resolutions of twisting. In this case, rotation of the stacked volumes is neither repeated nor adheres to regular angle intervals. Rather than a doubling of the expression of two clear orientations, the building's tension lies in the simultaneous desire of the massing to maintain a sense of frontality while being distorted into something other than. This kind of turning away is continuously wrapping around and oscillating from ground to mid-section to roofline, pulling the viewer's eyes and body sometimes in conflicting directions. The tectonic logic of the panels, a blend of large triangulated and quadrangulated planar pieces, indexes which faces of the mass are normal and which are twisted. Each of the twisted surfaces is variably subdivided, with the panel seams almost always continuous with those of the normal surfaces. The twisting moments of the massing

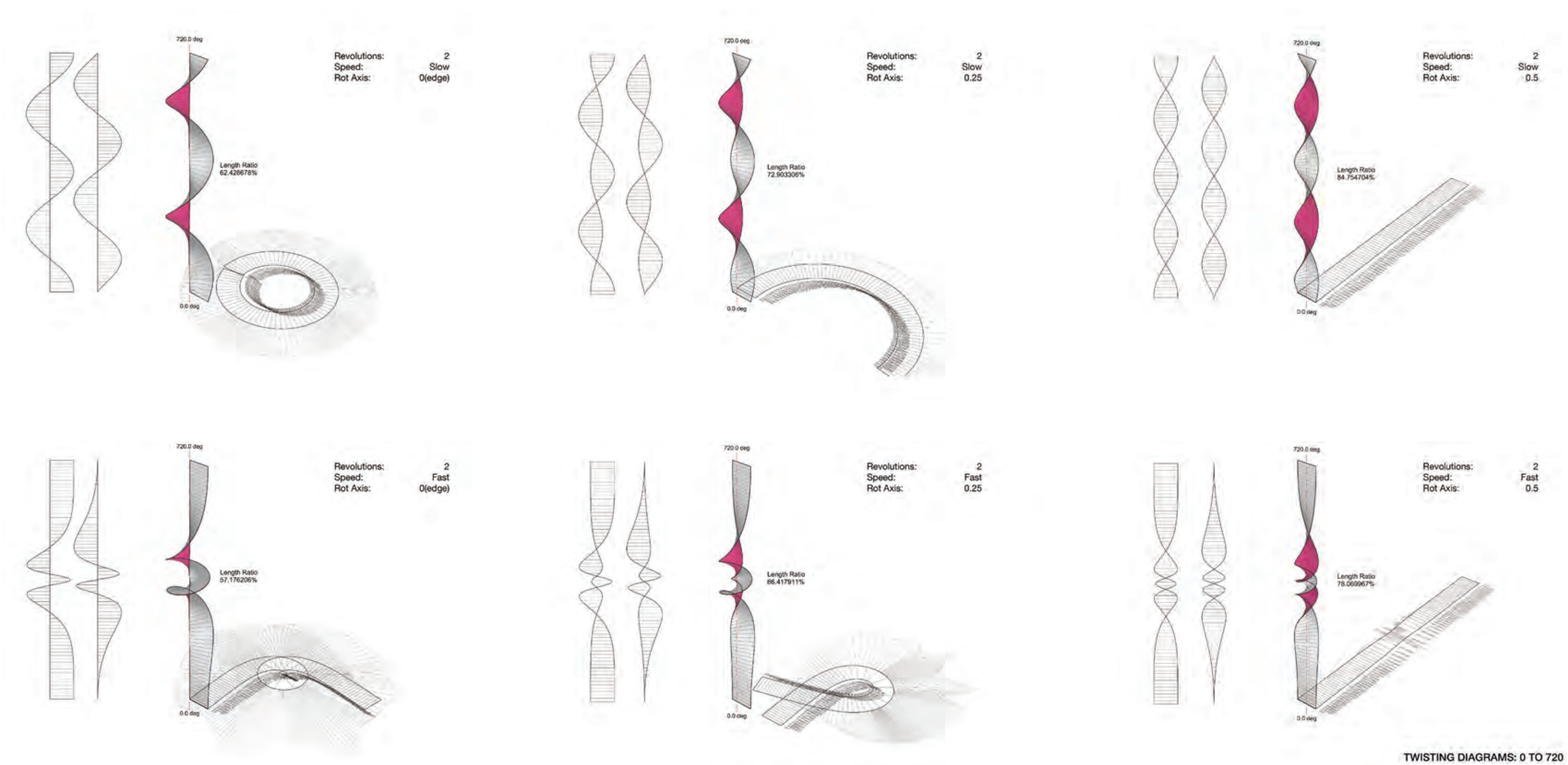


Figure 6: Twisting Diagrams

pulls the body in, out, and around, dislocating the notion of a privileged position.

At the large scale, that of the single twisted object, we again find a shift in effects from the previous two, but often a shared tectonic logic of the middle one. This scale is best exemplified in the typology of the tower and is probably the most global, due to its ability and ease in achieving iconic status. The problem with the examples at this scale is that they tend to be either large caricatures of the small scale but in singular form, or simply metaphors of bodies in motion.[11] A case in point is the Turning Torso (an explicit adherence to the body metaphor) by Santiago Calatrava, located in Malmo, Sweden, and completed in 2005. Inspired by a similar sculpture by the architect that is supposed to resemble a twisting human spine, the residential tower twists a full 90 degrees from base to top and is comprised of nine pentagonally-shaped stacked volumes. It certainly achieves a confounding of frontality and a simultaneity of turning away from and toward a viewing subject. But at this scale, it doesn't seem enough. The added feature of an exoskeleton, where the structure is exposed on two of the five faces, incurs an inflection in the envelope (where the other sides slightly bulge outward), and adds a bit more drama to the story. In this example there is the phenomenal twisting at the large scale but also a literal twisting at the component scale. The aluminum skin panels are actually twisted, which does contribute to the smoothness of the overall twist, save for the two-meter deep gaps every sixth floor.

A similar project, but of a more modest scale and expression, is the Gehry Tower in Hanover, Germany, by Frank Gehry, built in 2001, Rather than being an isolated object, this nine-story building is situated at the corner of an urban block. The rotation from base to top is limited to approximately 20 degrees. This subtlety of twisting is less about confounding facade orientations and more about the mass gently turning about to find its comfort zone. It is more of a suggested turning away than a full-fledged one. Similar to the Turning Torso (at the non-exoskeleton sides), the exposed faces of the Gehry Tower have a slight bulge to them, and the skin panels are comprised of curved metal, stainless steel in this case. The site constraint, paired with the subtle handling of the mass, seems to be productive in regards to the twisted object-building: it replaces the ambitions of iconicity with one of posture and character, which is more of an "aw-shucks" presence than one announcing, "Here I am."

To expand on this notion of posture and character in relation to twisting, we can turn to the Classical and Renaissance sculpture of the human figure.[12] Contrapposto, which means counter-posture, or counter-balance, in Italian, was a Classical (Greek antiquity) sculptural effect revived during the Renaissance. It dealt with the problem of how to distribute the weight of the body in a seemingly natural way that affected a psychological disposition. In contrast to the S Curve, which involves more of the body and idealizes it into a sinuous S shape, Contrapposto was used to produce tension in the figure between a relaxed and dynamic posture. Sometimes the distinction is subtle. The key element in contrapposto is that the "human figure is standing with most of its weight on one foot so that its shoulders and arms twist off-axis from the hips and legs."[13] An example of this subtle distinction can be found in two Classical sculptures a few centuries apart: the Leaning Satyr and the Venus de Milo (fig.3). The former is vaguely both an S Curve and contrapposto, although not elegantly either. We can draw and locate an S Curve from head to toe, but it is merely frontal. And we can see that most of the weight is distributed to the left foot, until we account for the tree branch that the figure is "leaning" against. It is as if the figure is flaunting its indifference to either principle. The Venus de Milo on the other hand displays the quintessential S Curve, where the whole figure, from central axis to silhouette, is tuned to the sinuous shape. A subtle twist can be detected between the orientation of the legs to that of the torso and head, an elegant composition but lacking in any affect or disposition.

Just over a century apart, two versions of the statue of David represent the height of Renaissance and Baroque sculpture: Michelangelo's and Bernini's, respectively (fig. 4). In the version from the former, we have quintessential contrapposto: the body's weight focused on the right foot; the left foot and leg slightly relaxed and forward; a twist at the neck turning the head away from the body's frontal orientation; and the overall tension of a psychological disposition between conscious decision and action.[14] Bernini dislocates the metaphysic of contrapposto by first deciding to depict David in the throes of action. The entire body is contorted into a more complicated twist, where the arms and torso are twisted against the frontality of the head and legs. The tension is more physical and immediate, compounded by the coiling drapery through the groin and around the waist. It should be noted that the scale difference in the image is no accident. Michelangelo's David is larger than life, standing at 17 feet tall, while Bernini's is human scale. The scalar and postural differences account for another set of effects related to distance. The former's is intended to be observed at a distance, occupying its own mental and physical space. The latter's is intended to occupy the space of the viewer, to collapse any sense of distance, producing an intimacy. In all cases, a phenomenal twisting (of the body) is achieved in the formation of stone through the tools of chisel and hand.

Early examples of literal twisting in architecture and related practices can be found in medieval metalsmithing. From cutlery to weapons to ornamental grilles, twisted iron has a long tradition of at least accessorizing our environment. And despite the stigma of the lack of other forms of progress during the Middle Ages, iron manufacture and the three interrelated practices of mining, smelting, and smithing made significant advances during this time. The blast furnace and the application of waterpower are two important technological advances made in this period. "The blast furnace used waterpower to increase draft and, therefore, temperature, allowing iron to be smelted much faster, cheaper, and with the option of creating cast or wrought iron."[15] Steel is the combination of both cast and wrought iron with small amounts (1% or so) of carbon. The wrought variety (wrought, from "wreak": to bend or twist) is a soft and ductile version and is closest to pure iron. It can be easily worked and bent into various forms but loses its sharpness easily and is only moderately strong. The cast variety comes out of the smelter in liquid form and is poured into molds not unlike bronze. It makes up for the former's lack of strength but is very brittle and will crack if worked over, even at high temperatures. So the twisting of iron is limited to its wrought form.

There was an array of implements used to twist wrought iron, from small hand-held tools to larger machines. One such device was used to produce numerous and continuous twists, or rotations, from end to end of flat stock material or bars. Another kind was used to make half-turns of flat stock where the twisting action occurs within a variable span of material.

This device raises the issue of the mechanics involved in the literal twisting of generic materials, such as strips and bars. In this case, great force (torture?) is required to twist a relatively small flat metal bar at least one full revolution (but often times several) of 360 degrees. In contemporary architecture, we rarely see this degree and type of twisting. Moreover, given the role of computation, the literal twisting of flat stock material has given way to a literal twisting of geometric surfaces, which are sometimes also referred to as ruled, scroll, or developable, which are then unrolled into flat shapes for fabrication to produce phenomenal effects. The primary difference between a ruled and developable surface is that developable surfaces can be unrolled without deformation (stretching) while the same is not always true of the former. Most developable surfaces are ruled, with the exception of those embedded within four dimensions.[16]

There are various definitions of ruled surfaces depending on which branch of geometry is being referred to. Wikipedia offers a clear definition that is taken from the publication *Compact Complex Surfaces*:

> *In geometry, a surface S is ruled (also called a scroll) if through every point of S there is a straight line that lies on S. The most familiar examples are the plane and the curved surface of a cylinder or cone. Other examples are a conical surface with elliptical directrix, the right conoid, the helicoid, and the tangent developable of a smooth curve in space. A ruled surface can always be described (at least locally) as the set of points swept by a moving straight line. For example,*

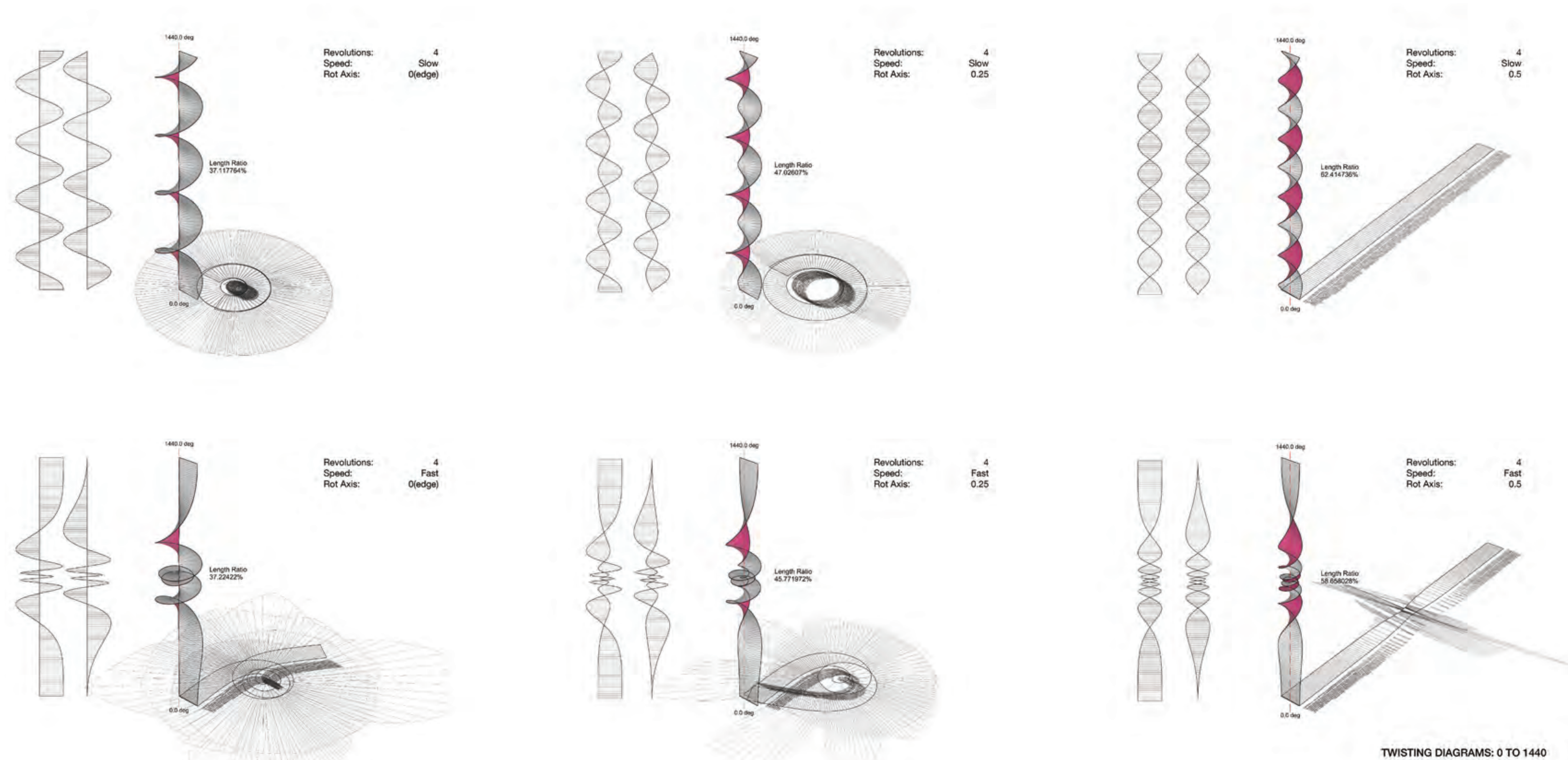


Figure 7: Twisting Diagrams

Figure 8: Mobius sequence from two-sided ring

> *a cone is formed by keeping one point of a line fixed whilst moving another point along a circle. A surface is doubly ruled if through every one of its points there are two distinct lines that lie on the surface. The hyperbolic paraboloid and the hyperboloid of one sheet are doubly ruled surfaces. The plane is the only surface which contains at least three distinct lines through each of its points.*[17]

A series of diagrams (figs. 5–7) attempt to geometrically simulate the variable twisting (torturing) of a surface strip to visualize the relationship between a ruled surface in three dimensions, its unrolled (flattened) projection in two dimensions, and the degree of deformation between the two.

Each set of diagrams corresponds to three different numbers of revolutions occurring from base to top: one (360 degrees), two (720 degrees), and four (1440 degrees). Each diagram is organized vertically according to speeds of twisting (slow on the top, fast on the bottom). These speeds refer to the vertical distribution of rotation angles per strip. Horizontally, the variable is the location of the rotation axis: justified to one edge; 25% along the edge; and the midpoint. The strip is shown in axonometric with the colored region indicating the back face. Projected in XY is the unrolled version of each showing the flat shape required to produce the twisted strip in question. The faint erratic set of lines is the curvature graph of the unrolled strips, which graphically indicates the degree of deformation occurring. To the left of the axon strip are the front and side views, respectively, orthographically projected to the picture plane. The "Length Ratio" number indicates the ratio of the longest unfolded edge length to the length of the strip.

While this is not a major revelation or a one-to-one correspondence of geometry to matter, it does reveal that even in the least torturous version (360, slow, 0.5 axis) there is some deformation, consistent with that of material behavior. It also shows the impossibility of some of these to be materialized as a single uninterrupted piece of material. The unrolled projections that fold (intersect) onto themselves would have to be rationalized into parts, thereby foregoing deformation (literal) techniques and requiring other means of formation to produce phenomenal twisting (like most in the tower genre). The ones that don't intersect themselves could be considered absolute twists, where a literal twisting of material produces phenomenal twisting effects.

To make the case for the role of topology in the contemporary obsession with twisted surfaces, we need look no further than the Mobius strip, probably the most referenced topological model in architecture's recent history. But before getting into the specifics of the Mobius, some background on topology's general appearance in architecture is in order. There is a distinction between topology as a branch of mathematics and how it is used/understood in architecture. For hardcore mathematicians, topology should not be visualized in images because it reduces the equations they represent to caricatures. Because topology deals with certain kinds of shapes and spaces, architecture has relied on precisely those images that mathematicians try to avoid. In a general sense, topology is the study of continuity. More specifically, "A topologist is interested in those properties of a thing that, while they are in a sense geometrical, are the most permanent—the ones that will survive stretching and distortion."[18] This provides the reason why a torus (donut) can become a coffee cup and why a square is no different than a circle, as long as the sequence of points defining the curve is maintained.

The desire for continuity was part of a broader agenda, articulated in *Folding in Architecture*, the canonical publication edited by Greg Lynn in 1993, for moving past the conflict-and-contradiction values of deconstructivism. In the 2004 revised edition, Mario Carpo succinctly sums up the goal of folding: "Folding is a process, not a product; it does not necessarily produce visible folds (although it would later on); it is about creating built forms, necessarily motionless, which can nevertheless induce the perception of *motion* by suggesting the 'continual variation' and 'perpetual development' of a 'form becoming'...." Eisenman himself, at this early stage in the history of folding, defined it as a 'strategy for dislocating vision.' In an essay published the same year by Greg Lynn, he states: "Deconstructivism theorized the world as a site of differences in order that architecture could represent these contradictions in form. This contradictory logic is beginning to soften in order to exploit more fully the particularities of urban and cultural contexts. This is a reasonable transition, as the Deconstructivists originated their projects with the internal discontinuities they uncovered within buildings and sites. These same architects are beginning

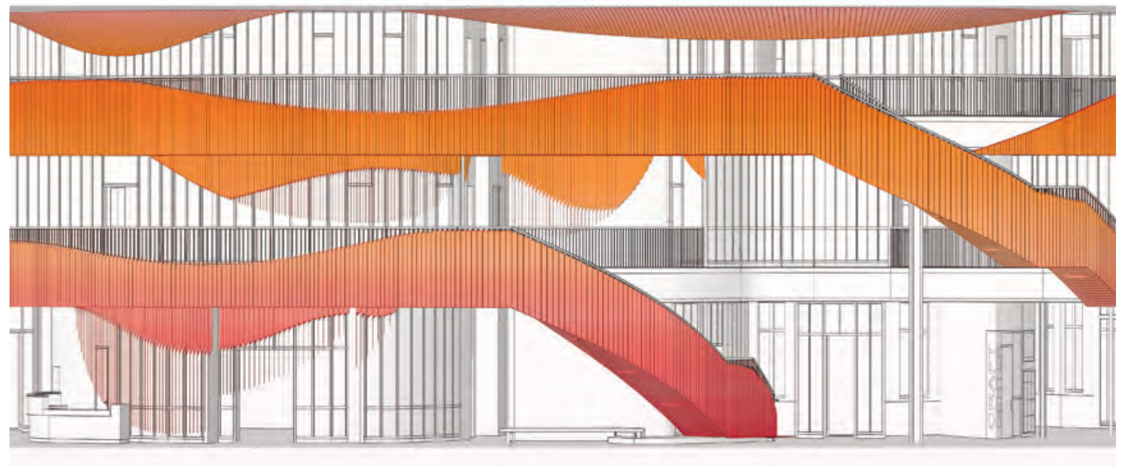


Figure 9: Afterglow: unrolled interior perspective elevation

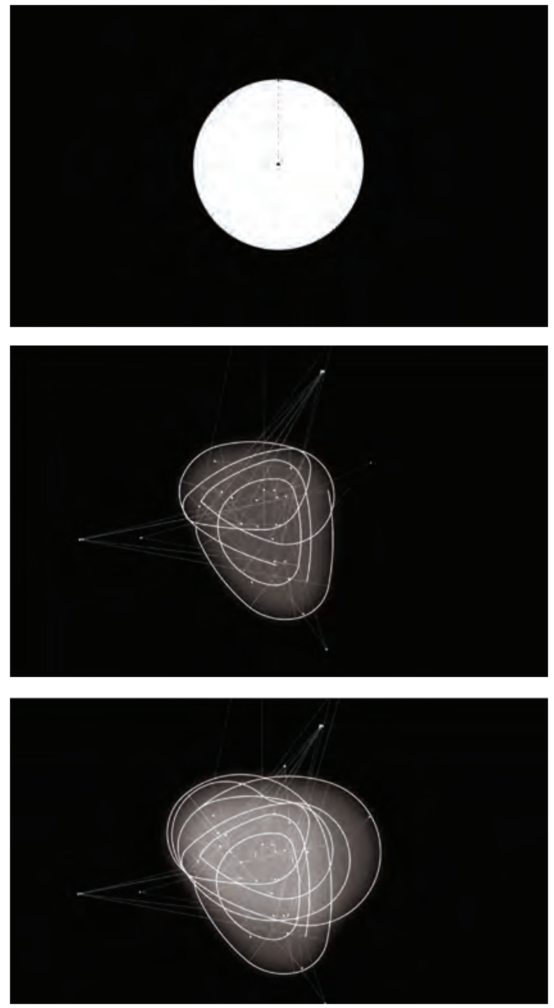


Figure 10: Afterglow: plan diagrams

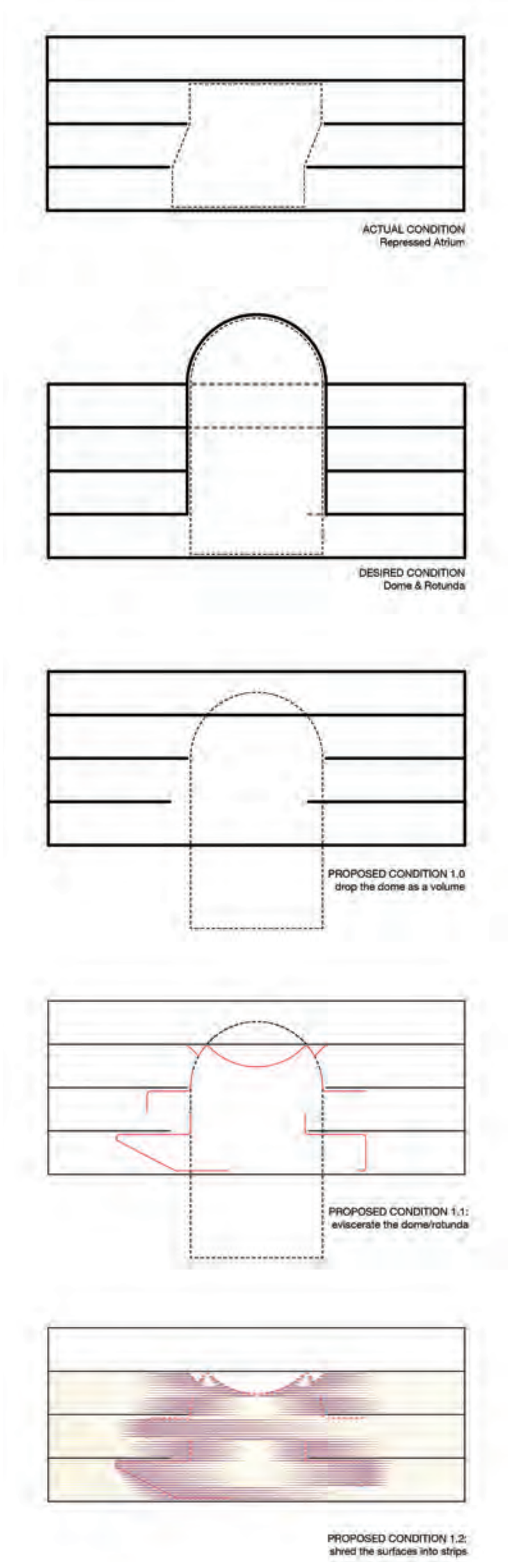


Figure 11: Afterglow: section diagrams

to employ urban strategies which exploit discontinuities, not by representing them in formal collisions, but by affiliating them with one another through *continuous* flexible systems."[19] This theoretical position paved the way for topology as a diagrammatic and morphological instigator in the smoothing of architectural form. A set of terms/operations born out of this discourse of continuity set the stage not only for advancing techniques for practitioners but also for pedagogy: bending, twisting, pleating, braiding, knotting, weaving, etc.

The Mobius strip, as a diagram, clearly illustrates the power of this brand of continuity. As a surface object, it confounds the notion of sidedness: it is a single-sided surface where inward and outward facing moments are within a continuous system of exchange. As a spatial object, it confounds the notion of interiority/exteriority: space moves continuously and seamlessly between the two. This diagram represented a holy grail of sorts for those seeking a new sense of political freedom associated with spatial and surface effects. Technically speaking, there are a number of ways to produce a Mobius strip. You can take a flat and straightened strip of material or geometry, twist it 180 degrees, then connect the ends, or you can start with a strip as a ring, splice it, twist one end, then reconnect it. As a sequence, the former example violates the principles of topology since what started as disconnected ends in a connection. The latter example complies with topology since it begins connected, gets disconnected, and is then reconnected: the original and final conditions match. For architecture, this dogmatic approach was irrelevant. What mattered was the final result, no matter how it was achieved.

Figure 8 illustrates the latter example and actually reveals the contradiction of continuity/discontinuity when seen as a generative sequence. If we disregard the color and notational codification, then we do have a single-sided continuous surface. But if we account for the operational sequence, then its two-sidedness is revealed in the color-coding of each side as well as the orientation in the lettering sequence. In its Mobius form, one end is upside down in relation to the other. Maybe this is less a contradiction and more an ambivalence: simultaneously having it both ways. Or, more precisely, perhaps it is the difference between a literal and phenomenal Mobius, with architecture heavily privileging the latter. Since a literal Mobius has already been rejected as a possibility by mathematicians of the highest ranks, then architecture could only contend with either the appearance of one, or, more productively, treating it as a primitive that undergoes further transformation as it absorbs increasing amounts of information (i.e., site constraints, structure, program, circulation, ornament, etc.).

A case study will now be used as an example of a minor lateral advancement (as opposed to a major vertical advancement) of phenomenal twisting at the material component scale. It is a project entitled *Afterglow*[20]

Figure 12: Afterglow: worms-eye oblique

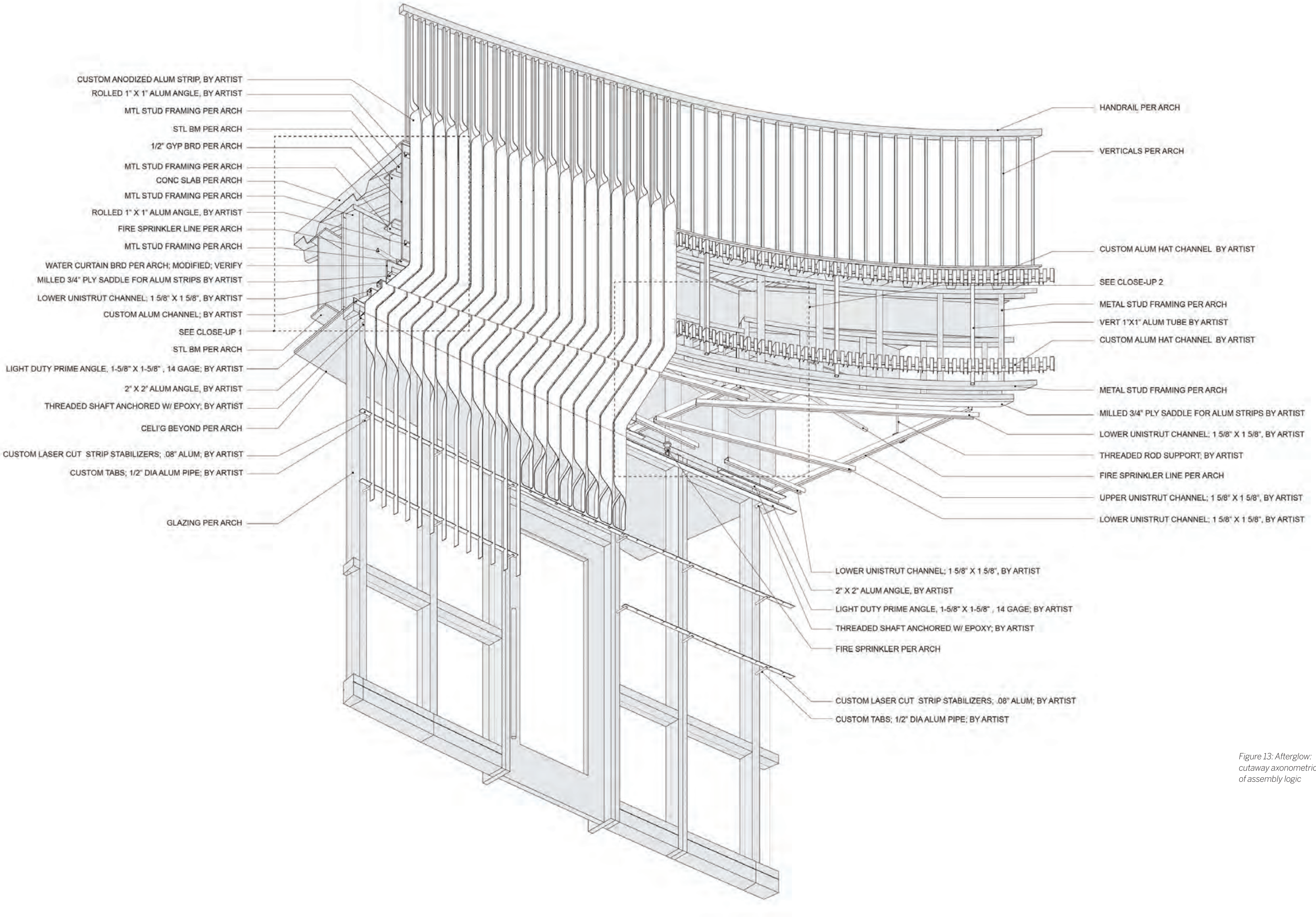


Figure 13: Afterglow: cutaway axonometric of assembly logic

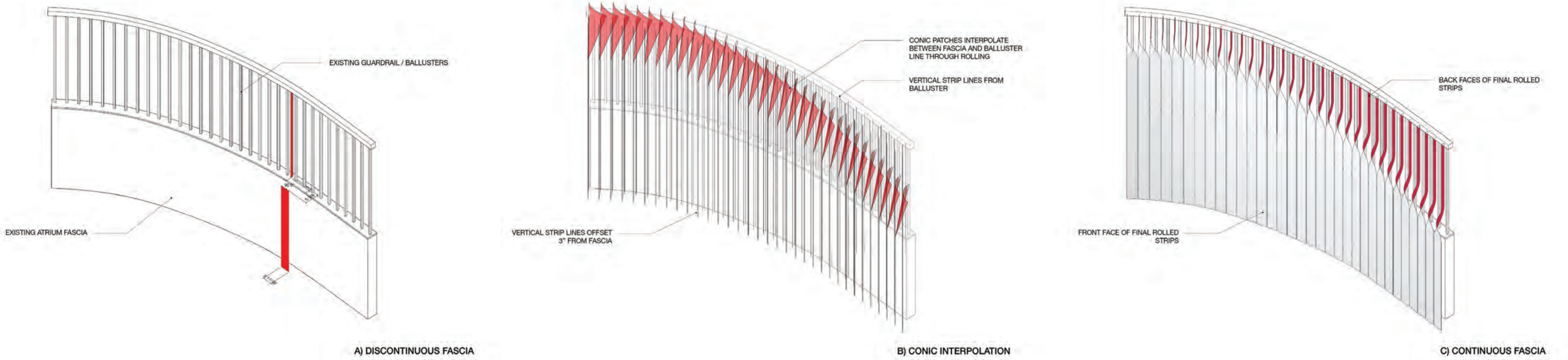


Figure 14: Afterglow: diagram of conic interpolation

(fig. 9) that belongs to the aesthetic subgenre of atmosphere[21] and that my office[22] is currently fabricating and will soon be installing. It is a permanent installation for a new Student Union building at Oregon State University in Corvallis. The building is a four-story structure with a three-story eccentric atrium terminating at the ceiling of the third floor. While the exterior of the building is required to mimic the neoclassicism that pervades the campus, the interior is more contemporary. The atrium of the architecture is comprised of overlapping elliptical figures that stack and contains a public staircase that is integrated with it. We saw this as an opportunity to intersect two diagrams, one planimetric (fig. 10) and one sectional (fig. 11), that fictionalize different formal narratives of the building.

The plan diagram is *empathetic* and understands the architecture of the atrium as an eccentric (in the sense of having multiple centers) space and seeks to amplify that toward the ecstatic by multiplying and extending the radial curves. The sectional diagram is *sympathetic* and understands the atrium as a frustrated dome and rotunda in that the vertical ascension of space is cut short at the last level, never breaking into the sky. Our proposal conceptually forces a dome and rotunda into the existing space, which then undergoes transformation due to the mis-fit. The final result is a two-part intervention (fig. 12). One continuous shredded surface adheres to portions of the stair, fascia, guardrail, ceilings, and walls. A separate ceiling piece is bounded by an undulating and variable shredded surface with mirrored flat tiles on the interior. The pattern of the mirrored tiles is the flattened projection of two intersecting, hexagonally subdivided hemispheres based on the outer radii of the ceiling figure. The mirror is intended to bring back the vertical effect of the absent dome. But what is relevant to this essay is something more local: the geometry, materiality, and fabrication of the fascia strips (fig. 13).

The atrium fascia is composed of the floor edge and the open guardrail with balusters spaced at 4" intervals. Their current relationship is discrete, in that there is no continuity between them. Our proposal supplements this condition with a continuous shredded surface that mediates baluster, fascia, and ceiling in the form of (or what appear to be) twisted strips. The problematic of the fascia is that there is an almost 6" offset between the strips at the floor's edge and the baluster (fig. 14A). This means that the twisting of a straight, flat strip of material would not resolve the discrepancy without having to add extraneous support. But even then, any sense of continuity would be lost since the guardrail and baluster would remain dis-integrated. The solution employed is a conic patch that interpolates between the outer edges of generic vertical strips with those of the balusters (fig. 14B). This produces phenomenal twisting (fig. 14C) achieved through the rolling of a formed (figured) flat shape. Figure 15 illustrates the geometry and mechanics involved in conic rolling, which is a developable surface since there is no deformation when unrolled. This solution can be situated between the techniques of bending and twisting (fig. 16) in that it is the only one that employs a different operation from the effect it produces.

Similar to the medieval devices for twisting flat stock wrought iron, positive and negative molds were made that allow for the rolling of pre-figured, laser cut strips of aluminum into its final shape (fig. 17). The mold is attached to a pneumatic press the aluminum shapes are slid into until they snap into place. When compressed, the strip is rolled between the positive and negative conic sections. All of the twists are identical, with the one variable being their vertical position along the strip. The result at the individual component is a literal roll/phenomenal twist (fig. 18). As a whole, the atmospheric effect is due to the intensity of color[23] and density of parts. The installation oscillates between being sympathetic with the atrium's multiple centers—by tightly adhering to and smoothing out floor edge, balusters, and ceiling—and indifferent at its edges, where the plan figure folds down at the transparent and opaque partitions (fig. 19).

Indeed, twisted surfaces in architecture are a contemporary phenomenon due in large part to the computer and advanced geometry. But they also have a lineage in related disciplines and other cultural modes of production. At the large scale, the twisting effect seems to have

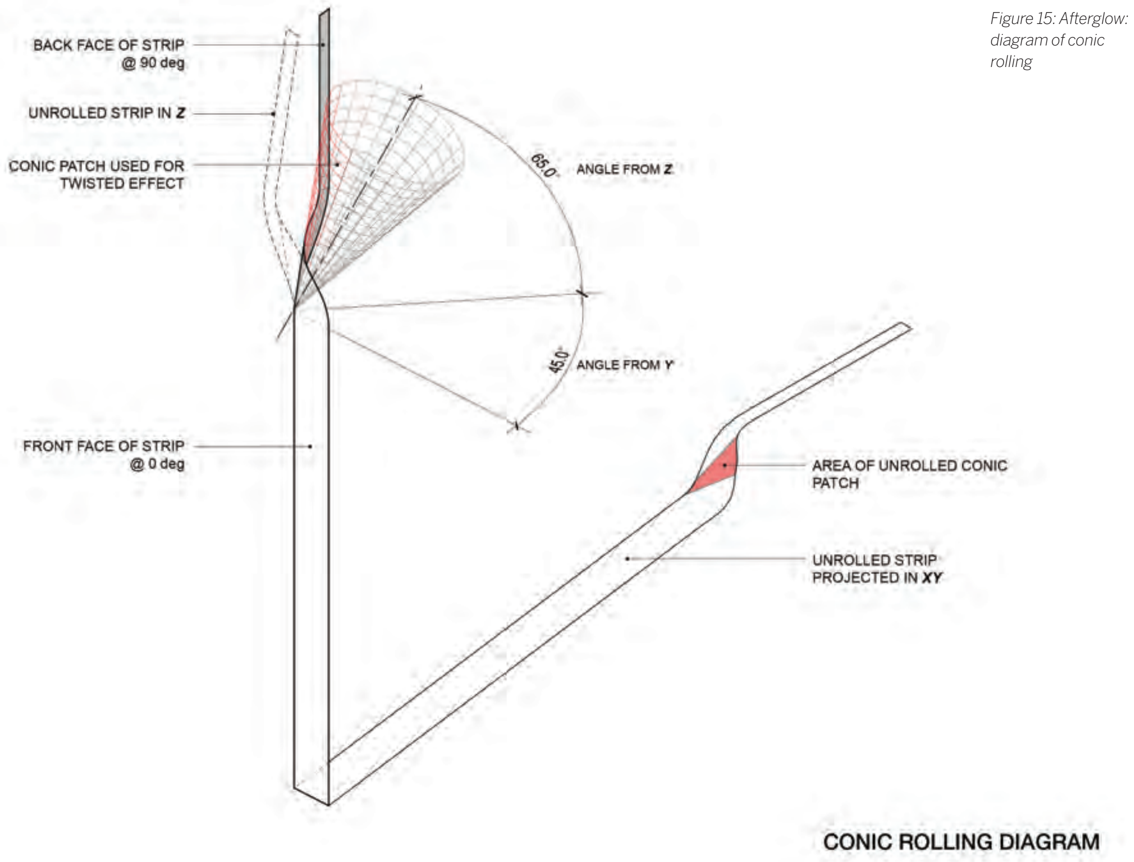


Figure 15: Afterglow: diagram of conic rolling

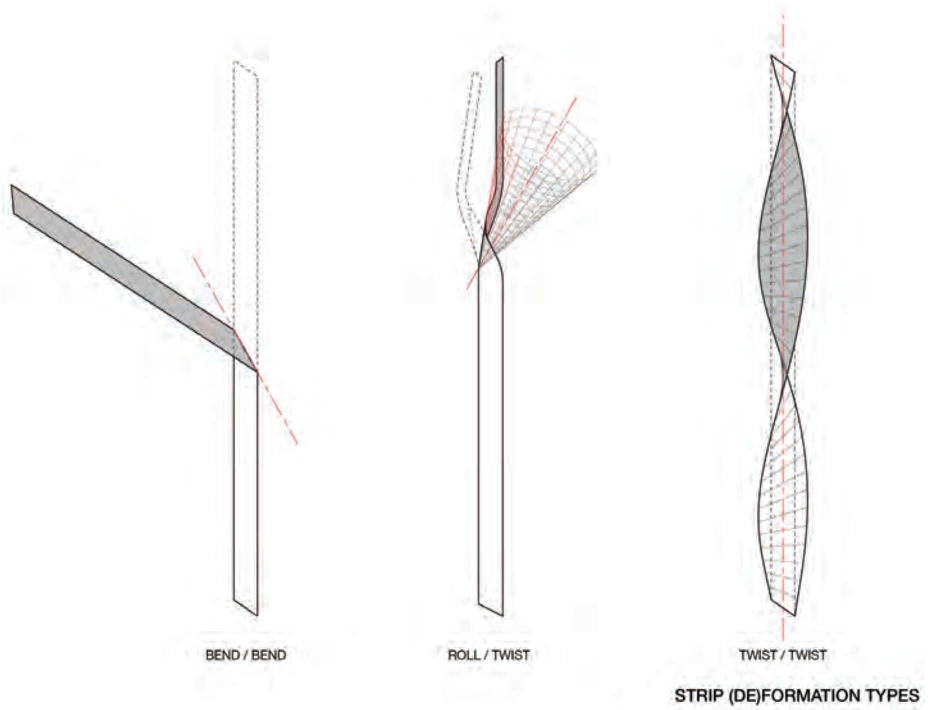


Figure 16: Strip (de) Formation Types

been all but exhausted. It may be that the small scale has also reached its limit in terms of field effects such as atmosphere. The middle scale appears to have the most room left to engender a broader range of effects, such as posture and character. This is due to its ability to address the body and the eye in a sophisticated choreography of space. It can also absorb the effective qualities of the other two scales, producing a possible matrix of twist-on-twist action, both in the literal/phenomenal and geometric/tectonic sense.

The literal/phenomenal template, set up by Colin Rowe nearly 60 years ago, still proves useful across a range of architectural qualities and effects. What is different, and hopefully implicit, in this paper is the attitude toward such a binary framework. The modernist ideal was to sustain distinctions, maintain categorical boundaries, keep the labels in their place. A contemporary attitude allows for the relaxing of initial dichotomies toward strange mixtures, requiring a more complicated form of judgment. Or, as Bruno Latour argues for: "Whatever label we use, we are always attempting to retie the Gordian knot by crisscrossing, as often as we have to, the divide that separates exact knowledge and the exercise of power—let us say nature and culture."[24]

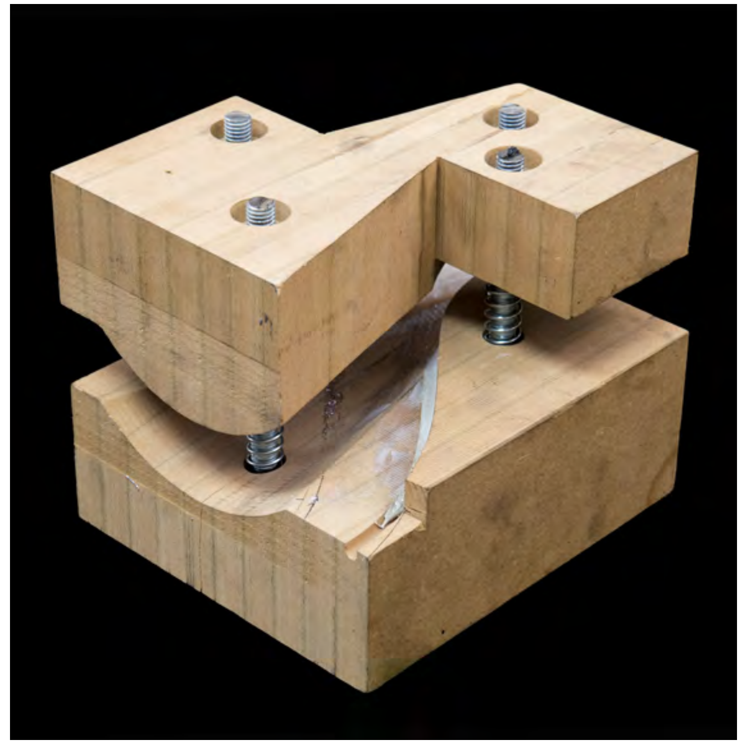


Figure 17: Afterglow: mold for rolling aluminum strips

ENDNOTES

1. Karel Vollers, *Twist & Build: Creating Non-Orthogonal Architecture*. (Rotterdam: 010 Publishers, 2001).

2. Some examples of this are the Baroque favoring of the ellipse over the Renaissance circle, the Futurists fascination with speed associated with the automobile, and the more recent forays into animate form.

3. This directly refers to Peter Eisenman's notion of "the dislocation of an ever-reconstituting metaphysic of architecture" in the essay "Misreading Peter Eisenman" in *House of Cards* (New York: Oxford University Press, 1987).

4. Christine Keeble, "The Twist and 60's Fad Dances," *How to Jive*. January 31, 2008.

5. Later on I will discuss the geometry of twisting and expand its definition accordingly.

6. In Colin Rowe's essay, whose title this paper is stolen from, he alludes to the notion that literalness is associated with the real while phenomenal merely seems to be.

7. Robert Sokolowski. *Introduction to Phenomenology* (New York: Cambridge University Press), 15.

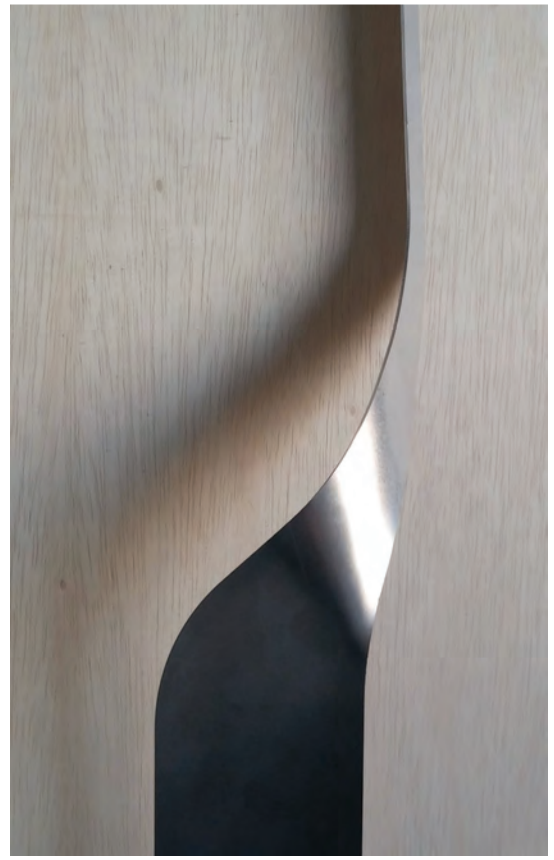


Figure 18: Afterglow: rolled strip test

Figure 19: Afterglow: interior rendering

8. Jeffrey Kipnis, "...And Then, Something Magical," in *A Question of Qualities: Essays in Architecture*. (Cambridge, Mass.: MIT Press, 2013).

9. There is a sister Signal Box in Basel that was completed in 1999. They are almost identical except for a massing change whereby the sister version is a trapezoid at ground and a rectangle at the roof, producing a large-scale twisting of one of the facades, as well as ribbon window cutouts of the copper strips.

10. Quoted from Preston Scott Cohen during a lecture given at SCI-Arc in 2009.

11. My gripe with metaphors in general, and with metaphors of the body in particular, is that they are a cheap and easy way to justify or locate value in, for the layperson, architectural forms when they are in fact completely different animals. The twisting of an architectural object at the scale of a tower is a big move and should do more than simply conjure an image of the human body in that same pose. It assumes the layperson's understanding to be too inadequate for more robust associations.

12. You might be thinking that I am about to contradict my earlier, implicit chastising of Calatrava's body metaphor. But this aside has no interest in directly applying these forms to architecture as a stand-in for the body. It is simply a means to understand how the related discipline of sculpture has dealt with the effects of motion through twisting.

13. Andrew Stewart, *One Hundred Greek Sculptors: Their Careers and Extant Works*, Polykleitos of Argos, 16.72.

14. Action in reference to David's battle with Goliath

15. Brigitte Weinsteiger, *The Medieval Roots of Colonial Iron Manufacturing Technology* (Penn State University Center for Medieval Studies), http://www.engr.psu.edu/mtah/articles/roots_colonial_iron_technology.htm.

16. David Hilbert and Stephan Cohn-Vossen, *Geometry and the Imagination*, 2nd ed. (New York: Chelsea, 1952).

17. Wolf P. Barth et al., *Compact Complex Surfaces*, Ergebnisse der Mathematik und ihrer Grenzgebiete. 3. Folge / A Series of Modern Surveys in Mathematics (2004).

18. Stephen Barr, *Experiments in Topology* (New York: Thomas Y. Crowell Company, 1964).

19. Greg Lynn, "Architectural Curvilinearity: The Fold, the Pliant and the Supple," Architectural Design 102 (March/April 1993).

20. Afterglows are the optical phenomena associated with the scattering of light particles during sunset that produces a range of rosy hues in the sky. This effect gets amplified by the occurrence of volcanic ash in the atmosphere, which deepens the color range with reddish hues. While the last major eruption of Mount Hood was over a century ago (1866), it has contributed to the atmospheric effects all across Oregon, and beyond, to this day. This can be experienced during the hour of twilight in certain climatic circumstances (clear to partially cloudy skies) and is one of the elements that makes Oregon's atmosphere unique.

21. I consider atmosphere to be a sub-genre of field effects in architecture, in the perceptual rather than organizational sense.

22. In collaboration with Matthew Au.

23. The aluminum strips are being powder-coated.

24. Bruno Latour, *We Have Never Been Modern* (Cambridge, Mass.: Harvard University Press, 1993).

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Figure 4: Left photo via Wikimedia Commons: Jebulon, CC0 1.0: https://commons.wikimedia.org/wiki/File:Replica_Michelangelo%27s_David_black_background.jpg; Right photo via Wikimedia Commons: Black leon, CC BY-SA 4.0: https://commons.wikimedia.org/wiki/File: File: Джованни_Лоренцо_Бернини._ДавИд._01.JPG

Figure 9, 17, and 19: By Amorphis