Summary

Light matters
John Rajchman
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Architects often understand lightness as immateriality. But can we speak of another kind of lightness that complicates and displaces this familiar understanding? Can we talk about a spirit of lightness capable of moving in even the heaviest brute materials and of showing even the thinnest transparencies to be slow or weighed down? Can we speak of light materialities and heavy transparencies, a strange weightlessness of the earth itself?

When masonry walls were replaced by steel skeletons and reinforced concrete, the old principle of load and support, which Schopenhauer took as definitive of architecture, no longer seemed quite so essential. Buildings didn't have to be seen as holding things up from the ground or base. But this new sense of lightness was at first articulated by glass and other sorts of transparency, and so came to be identified with immateriality. Thus in 1914, in Glass Architecture, Paul Scheerbart speaks of using glass to dematerialize architecture; he dreams of whole cities floating on water, ever rearranging themselves in new patterns. He may thus be said to anticipate some current Japanese ideas of floating, taken up in another original way in Rem Koolhaas's talk of "the lite". But in these contemporary kinds of lightness glass and transparency seem much less important, and translucent skins much more frequent.

The modernists of course also used glass to get light according to the famous stricture of displaying structure. They dreamed of a light and airy sense of space, no longer tied down to traditional heavy materials, ruled instead by the new morality of the clear and transparent. Their light space was free-flowing, open, and unencumbered by traditional earthy materials; but it was also a classical space, whose clean mathematics and types of transparency Colin Rowe would later describe - an optisch rather than a haptisch lightness in the terminology of Alois Riegl, later to be re-elaborated by Gilles Deleuze. The modernists thus endowed lightness with a sense of time - a brutal breaking away and floating free from the heaviness of traditional context.

But immateriality was to acquire another sense in architecture. The change in conceptual terrain is marked by an exhibition in Paris curated by Jean-François Lyotard in 1985, called Les immatériaux (The Immaterial Ones). The focus is on the new electronic postindustrial technologies, and the postcolonial informational and consumer capitalism that they seem to be introducing everywhere in one way or another. It is said these new technologies are bringing about a vast process of de-materialization and de-territorialization - there is a loss of proximity, locality, centralization; nothing seems real or locatable anymore; everything is "floating."

As in the case of earlier industrial modernism, such "immateriality" is understood as independent from context or locale. But now this very independence is taken by some to be the crucial problem: how, it is asked, can we get back to the earth and its stabilizing gravity, how can we "anchor" ourselves and become "Newtonian" again. Thus there is a return to phenomenological notions of the earth as the ground of things; and the heaviness of Tadao Ando's concrete architecture, for example, is taken as a great critical-regionalist challenge to the abstract transparency of global capitalism. Gravity and materiality recur as critical means to combat a postindustrial weightlessness in our dwelling, deprived of its original rootedness in the earthground.

Today we are perhaps confronted with a somewhat different question. It is not a matter of the earthground and of the weight and materiality of tradtition, region, or context. It is rather a question of another conception of the earth itself and of its materialities, no longer separated from the city or caught in the opposition between artifice and nature - the question of a new geology, where the earth is no longer seen as what anchors or grounds us, but what releases in the midst of our multiple material manners of being other light dynamic spaces. But then how different the transparent immaterial lightness of classical modernism looks! It seems so static; it can't move; doesn't float or fly. It is obtained in a negative way through a rarification or purification of any unnecessary materiality. It is as if lightness had been immobilized, enclosed in a glass house, where it was required to be pure, clear, clean, without any excessive ornament. Lightness was made optic and geometric - a bride stripped bare rather than a de-threaded Ariadne who puts a clever "YES!" into the ears of the bull moving lightly along the surface of things. A truth exposed rather than a multiple possibility released.

Many would recoil from this static unornamented lightness. Various kinds of gravity would be invented to wrench the classical denuded bride from her glass house to discover the earth beneath and around her, challenging the vertical-horizontal space of her optical enclosure. And so it is that lightness is asked to "come out" - out from the grid frame of its glass house to move in a freer space, where there exist other possibilities of release from tradition than that of rising above all materiality and context. It is asked to invent another kind of abstraction than that of the immaterial geometric form - the light abstraction of those assemblages which take us out from the gravity of locales and regions, bases and heights, releasing another more disparate sort of movement no longer content to pass from one point to another. Thus lightness might undo its long identification with immateriality and transparency in architecture and find a new concept, no longer opposed to that of the earth.

Differential Gravities
Greg Lynn
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I begin with an image of the burrow, one of the countless abstract spatial types developed by Rudolf Arnheim in The Dynamics of Architectural Form. In the context of discussions of architectural lightness, such a literally and conceptually massive structure might seem counterintuitive. But there is a lightness to the way the molehill is grounded, a lightness that defines itself not against, but in relation to mass, material, gravity, and ground. More importantly, this new lightness is an effect linked to the multiplication of orientations, positions, and movements.

Labyrinthine organizations such as the burrow are light because they are essentially ungrounded, or rather they are not grounded by the single gravitational force of the earth's horizon. Because these structures are both mounded and subterranean, gravity's influence on the organization of the burrow does not mandate any single or essential plane of organization. Subterranean organizations are massive, yet the density of the surrounding matter provides a thickened, overstructured ground within which a multiplicity of potential passages can be developed. Because these various orientations, positions, and movements are not regulated or reducible to a single orientation, position, or movement, the burrow floats below the ground.

The labyrinth or burrow models a lightly grounded architectural space that is light because and not in spite of its massive subterranean location. Within the labyrinth, vertical and horizontal movement are separated by degrees of gravitational force rather than by the right angle. In this way there are as many gravities and grounds for such structure as there are potential orientations and vectors of movement. In order to develop these complex, lightly grounded structures, it is necessary first to develop an architectural concept of multiple and differential gravities that diverges from the normative, singular concept of the earth's one gravity.

Most discussions of architectural weight have involved two linked and seemingly matter-of-fact assumptions: first, that there is one and only one architectural gravity, that of the earth; and second, that this singular gravitational force mandates that, in order to provice shelter, buildings must stand up. In order to avoid an equally simple concept of lightness, one that is defined as a resistance to a simple concept of gravity (this will be described later as a theory of the immaterial or lightweight), it is necessary to develop, first, a more complex idea of multiple and differential gravities, and second, architectural relationships to these gravities that are not reducible to an ideal point or line of resistance.
Lightness is an idea that can make architecture's assumptions about the simplicity of gravity more complex. It is important to acknowledge that resistance to gravity is the most conservative and familiar architectural response to questions regarding weight or weightlessness. Unlike these normative views based on a resistance to weight the concept of differential gravities is based on

a more flexible notion of the ground and grounding. Rather than weighing down architectural thinking with the concept of the resistance of a single gravitational force perpendicular to the earth's surface, lightness offers us the concept of gravitational forces that proliferate between masses and can never be fixed in any single ground form.

Gravity, understood as an unchanging, singular, and universal force, is perhaps the only convention in architecture that has been agreed upon as an unassailable truth - this, in spite of the fact that a theory of gravity has only been developed relatively recently in the history of architecture. One could argue that gravity and its simple resistance is the dominant principle upon which architectural thinking has been grounded. The idea that buildings must stand up to gravity has become a constant in architecture - in the literal sense of vertical structuring, bearing and transfer of loads, and, perhaps even more so, in the theoretical and conceptual grounding that gravity provides architecture. The conventional assumption that buildings should be made to stand up is rarely questioned, and as a result it has become more an intractable truth than a convention. Nonetheless, there are many ways of structuring matter, only one of which is standing it up. The architectural predilection toward verticality, and the linked preference for the horizontal datum of the earth as absolute ground, can be traced to a conception of gravity as a single, constant force that pulls things down to the earth in a simple and direct manner. The structuring of architecture on the horizontal datum or ground of the earth gives architecture its distinct, vertical identity. Moreover, the concept of gravity as a singlular, universal force (which should be distinguished from the phenomenon of things falling toward the earth, as gravity is indeed a concept and does not properly exist) is intimately connected with the identity of shelter and standing up through resistance to the elements.

Gravity provides architecture with a source of grounding. In order to explore the possibility for developing a multiplicity of groundings, however, it is necessary to distinguish several different types of gravities. Architecture can become weighted with radically different qualities depending on our understanding of gravity. Buildings do not, after all, have to be structured as standing up, as they can be and have been structured on principles bridging, hanging, stretching, squatting, leaning, lying, and floating among others.

For example, Lina Bo Bardi's Museo de Arte de Sao Paulo (1957 - 68) is structurally sound despite the fact that it floats over the coffee mansions that once stood on the site. It would be inaccurate to characterize the museum's spanning as gravity defying, since the building is merely suspended at two ends in rather unheroic fashion. Bo Bardi's project floats because it has a loose and complex relationship with the ground, not because it is lightweight - it is, in fact, quite brute. The building floats not because it is immaterial; on the contrary, it floats because its immense mass is suspended as a beam, making the project unexpectedly light. With Bo Bardi's MASP project, a certain presence of materiality and mass becomes integral to lightness. Lightness can thus be seen to emerge when materials are not grounded coincident with the horizon of the surface of earth, but are instead multiply or obliquely grounded.

If weight is conventionally understood as a resistance to the earth's gravity, we can begin to define lightness by reconsidering the ways in which mass is structured as something other than an absolute and direct grounding by the earth alone. Bo Bardi's project offers us the example of a kind of architectural suspension that has a complex, rather than a simple, relation to the ground. This is not to suggest that all relations to the earth should be jettisoned. When the gravity of the earth is understood as one force among many, matter no longer has a primary but rather a secondary, or tertiary relationship to the ground form of the earth. With lightness, more dynamic, multiple, complex, and differential forms of stability emerge.

Before developing alternative "light grounds" for architecture, it is important first to differentiate the concept of lightness from earlier definitions that were defined as resistance to gravity. Previous definitions of lightness in architecture, whether couched in the rhetoric of modern architecture or in the more recent discussions of architecture in the context of electronic technologies, have depended on either the innovation of increasingly lightweight structural systems of suspension and support, or the dematerialization of building materials toward a state of ideal immateriality. The former innovation is dependent on and in fact defines a theory of the lightweight, while the latter is dependent on and defines a theory of antigravity. These two dominant definitions of lightness are opposed to gravity and, therefore constitute an architecturally conservative position of resistance.

Both the lightweight and the antigravitational depend on a literal elimination of mass through dematerialization. Immateriality - the latest in a long history of theories of gravitational resistance - offers a conservative response to the problems posed by the traditional understandings of gravity, and most recently through innovations in electronic technology. Within the discipline of architecture, immateriality is as conservative as the earlier ideas of grounded, rooted, and regional architecture it claims to oppose. Dematerialization invokes an ideal state defined as an absolute minimum condition of ethereal space - cyberspace in the parlance of the theorists of electronic architectures. Transparent materials and minimal structures are the signifying materials of this frustrated project that aspires to an ideal, immaterial space. In the case of either antigravitational levitation or immaterial cyberspace, absolute lightness can only be understood as a resistance to an absolute gravity. An ideal atmosphere of zero gravity is common to both immateriality and antigravity. But lightness is not an absence of materiality and is therefore not simply opposed to the weight and fixity of the earth. This dialectical and oppositional definition of lightness and gravity encourages the rather simplistic speculation that soon the material architectures of the earth will be eclipsed by the new, immaterial technological architectures of cyberspace. Such an argument discriminates between two ideal Cartesian worlds: one of absolute weight, and the other of pure immateriality. Both are based on simple concepts of the earth, matter, and gravity: as there is only one gravity there can be only one lightness. This rather limited understanding of architecture's grounds - as either absolutely earthly and tectonic or absolutely ethereal and electronic - makes it impossible to develop concepts of differing degrees of gravity and different conceptions of the earth.

John Rajchman's call (by way of Nietzsche) for a reconceptualization of the earth as light opens the way for many different gravities, and therefore for a multiplicity of grounds. Rather than liberating lightness from the pull of gravity, what is required is a liberation of lightness from the understanding of gravity as a single force emanating from the earth. From the simple gravitational force of the earth, and the vertical grounding of architecture upon it, lightness moves the concept of gravity in many directions. When defined by the qualitative relations between particularities of matter rather than by the relation of various masses to a single ground form, a multiplicity of potential architectural gravities emerge.

One such departure from an earthly architecture based on vertical structures and horizontal grounds occurs through the multiplication of alignments and grounds and therefore a multiplication of ground forms. Such a proliferation of potential alignments to gravity was present in Rem Koolhaas's characterization of Zaha Hadid's work as planetary. Hadid's planetary architecture announced an orientation of "89 degrees" in relation to questions of gravity. Her suggestion of less-than-vertical alignments to the earth invokes at least two possibilities: first, that buildings might be seen as singularities, or planets, with their own degrees of gravitational force; and second, that relations between these planetary masses will be regulated by the particularities and adjacencies of the elements themselves rather than by the relation of each of the elements to the single, uniform gravitational force of the earth. This allows for a multiplicity of gravitational vectors through, along, and across objects, where loads are transmitted through a network of propped, sloped, cantilevered, sandwiched, and skewered solids.

In Hadid's most recent work the transmission of loads through a network of differential connections has become even more acute. Her comments on the frustrations of attempting weightlessness in the projects should be compared to the successes of her projects in realigning themselves to the ground and to gravity in many oblique ways. Two strategies appear to be at work here. The first attempts a heroic, modernist anti- or zero-gravity, while the second attempts to complicate architecture's alignment to the ground. This latter strategy, in which the term planetary urbanism suggests not the weight of a disembodies celestial light, but a network of intricate relationships between a constellation of somewhat free

elements with different gravitational characteristics, is the more successful and interesting of the two. Hadid's project for The Peak Club in Hong Kong (1982) is intricately grounded as it reconfigures the surface on which it is embedded as a series of interrelated plates. The project is an aggregation of elements resting one on the other rather than a simple perpendicular transferal of mass to the ground. Defined by various fields of attraction between free elements, lightness here is neither gravitational indifference nor gravitational resistance, but a condition of gravity in difference. Where gravity and weight are thought in complex, differential terms, lightness is distinguished as the complication, not the simple loss, of ground.

Lightening the manner in which architectures can be grounded escapes the necessity to think through the problem of support and weight in terms of structural efficiency and dematerialization. It is crucial to maintain the distinction between lightness and the lightweight as the second term involves, yet again, an ideal conception of weight and a conservative mode of resistance. In this way an important distinction emerges between existing theories of antigravity and this proposal for differential gravities. Instead of continuing to resist a single gravity, architects must reformulate the question of weight through lightness understood as a more complex and intricate question of relationships between surfaces and grounds that are multiple and loosely connected. Through a more general formulation of new gravitational paradigms, lightweight structural systems and practically invisible building materials can be developed in conjunction with lightly grounded architectural and urban organizations. With lightness emerge forms of dynamic stability and differential loading that are qualitatively different from the stasis implicit in the singular, perpendicular grounding of the earth. Without appealing to literal movement, one can conceive of lighter compositions where weight is carried through many different vectors that are not subject to the right-angle pull of the earth's gravity.

These new, qualitatively different stabilities do involve an alternative relationship to ground and site that is not merely the loss of specificity or location. The light effects of hovering, levitating, and floating are dependent on an intricate relationship of equalization between a body and the environment in which it is immersed. Dynamic structural principles of walking, flying, floating, skiming, and swimming are not grounded by any single environment but are relational structures that exist between bodies and environments. Insects can only skim across liquids when their mass is supported by surface tension just as lizards can only run across the water's surface when their mass is propelled at an appropriate speed. Floating can be achieved by massive land mammals such as hippopotami once their mass is equalized with that of water. Likewise fish that fly in the air and devilfish that fly in the water suggest to us that qualities of lightness and support are dependent not just on the mass of a body but on its relationship to some larger field. Lightness and gravity are relational not absolute terms. To evaluate a building's lightness is therefore not simply a matter of disentangling it from its context and weighing it. Levitation, flotation, and suspension are achieved when a body occupies multiple positions of stability.

Flotation is a quality that emerges from the particular relationships between things; it occurs when the mass and density, or gravitational attraction, between things equalizes. With this equalization emerge new dynamics and new movements. Characteristic of lightness are several types of flotation, three of which can be developed here. The first type of flotation is aviary and involves the dematerialization of an object to the point at which it begins to float in the air. Bernard Tschumi's Glass Video Gallery (1990) in Groningen, The Netherlands, is perhaps the most radical in this regard. The transparency of the envelope, along with the structuring of the mass itself with glass-bearing elements, dematerializes the mass of the pavilion. This dematerialization is linked to the elevation and sloping of the ground plane from the horizontal datum of the site. In fact, the weightlessness of the gallery is not nearly as evocative of flotation as is the slope of the building's base. Similarly, the dematerialization of the structure through the use of glass materials does not displace the normative gravity of the building, at least to the extent that the inclination of the ground is capable of reconfiguring the gravity of the space.

In the case of aqueous environments, weight is reduced or displaced through the equalization of a body's mass and that of the environment in which it is immersed. Flotation, or the condition of weightlessness, is an effect created by equalization. For instance, it is possible for the human body to float when it is immersed in an environment that has the same weight as our bodies. At the moment our bodies begin to float we lose our mostly vertical posture and enter into a new relationship with the ground and thus the earth. The potential for movement and structure are shifted and multiplied with the differing relations between bodies and environments; in this way there are as many gravities as there are bodies. This principle of suspension - surrounding an object with a diffused field of structure that is roughly equivalent to its mass and density - suggests that in order to become light, structures need to be increasingly dematerialized (becoming lightweight) but must instead become more diffuse.

The deployment of diffused structuring offers an alternative to floating achieved by the use of increasingly lightweight structures. In architecture, diffused structuring can be achieved by employing a dense field of small columns or some other structure that diminishes each individual point of support by multiplying the number of support points. Where Bo Bardi's MASP project floats on two points of support there is only one possible siting for the mass; if those two massive points of support were diffused to form a field across the site, the number of support positions for the mass would multiply exponentially. The proliferation and diffusion of microstructural elements would therefore multiply the potential for objects to float within fields. With these more diffuse structures the air would literally become heavy with support, and massive objects would begin to float in a more equalized environment of structural fluidity. The seemingly weightless flotation of a whale offers an analogy for this diffuse structure. When grounded or beached the whale is anything but light; but in water, where its body mass is equalized with its aquatic context, the whale moves almost effortlessly. In this way, these massive creatures are practically weightless. Their levitation within water is similar to the levitation of a bird in the air, the primary difference being the weight of the bodies in reference to the earth, the primary similarity being the ratio or relation of the weight of the bodies to the weight of their environment. In comparison to the ground of the earth, the gravity of the whale is heavy and the gravity of a bird is not. In relation to the grounds within which these bodies are immersed, their gravity is similarly equalized, allowing both to float. In both cases the gravitational attraction of bodies to the earth - what is thought of in architecture as a single gravitational force - is lightened, allowing us to explore in a more open and multidimensional way the gravities between bodies. Between these two extremes there are seemingly endless variations of light relations between bodies and the environments in which they are immersed. Once the air is thought of as potentially heavy enough to bear the weight of objects and the earth is conceived of as a porous mass capable of supporting objects not only on its surface but also burrowing and floating within its mass, then a new sense of ground will have been established and a new mobility achieved.

We witness the possibilities for these kinds of thickened ground conditions in Rem Koolhaas's two library projects in Paris - the Bibliothèque de France (1989) and Jussieu (1992) - and in their Urban Ring Exhibition (1991) in Yokohama, Japan. In the Yokohama project, the fact that the surface of the site and the surfaces of the floors and roof are malleable and deformable allows the project to develop a thickened ground throughout that supports various spaces, programs, and passages. These OMA projects suggest a return to Arnheim's diagram of the burrow, whose labyrinthine structure seems to be the least grounded and the lightest type of architecture imaginable. The hypothetical moles that might inhabit these spaces would indeed float in the thickened and multiple grounds of the barrow, rather than remain fixed on the ideal plane of the earth's surface. In his discussions of spatial mobility, Arnheim opposes the abstract type of the "shelter" to that of the "burrow".

He does this by arguing that there is no plan regulation in the burrow as there is in the shelter. Arnheim speculates that the primary consideration of the shelter is the resistance to gravity, where in the case of the burrow there is only a desire for connectivity and movement. The shelter is initially geometric and exact as it is structured vertically while the burrow is in some way proto-geometrical and anexact as it is grounded neither horizontally nor vertically.

In Arnheim's model of the subterranean burrowing into a labyrinthine space, there is a condition of weightlessness that develops from the density of matter in which one is burrowing. The relationship of the burrow to the ground is light because there is no single gravitational force that fixes the space of the labyrinth because practically any direction or orientation is gravitationally and structurally possible. The burrow occupies the earth not as a horizon or ground but as a field of potential spaces, orientations, and positions.

Lightness is not the elimination of gravity but is instead an equalization of gravities. Immersion implies that the boundaries between figures and grounds become blurred and envelopes become negotiable. There are countless possibilities for architectural grounds once the simple concept of weightlessness and dematerialization gives way to a more complex and open concept of differential gravities. This type of lightness does not ascend to an ideal, immaterial space, but instead descends into the questions of matter, support and burrowing, opening the way for more than one lightness and the possibility for masses to float within mass, as in the labyrinth. As a result, floating is transformed from an idealized state of immateriality to an immersion and suspension of masses in material contexts with particular qualities and characteristics - shifting from an ideal space in which bodies are grounded by fixed points to dynamic fields, with multiply configured supports.

The Buffalo and the Bird
Sanford Kwinter
p. 56

John Breshear's Bridge humbly proposes itself as a study in the history of tools, a modest exploration of the logic of technology transfer, or the transposition of abstract mechanisms and functions from one material domain into another. Yet more properly, and at a much more ambitious level, his bridge may be seen as a sustained essay on the theory of form, even a philosophical exploration of universal organizational principles - those that govern every "managed" encounter of active force and directed matter. Now, it has, of course, never been established that anything like universal organizational principles exist at all, and yet it is almost mathematically impossible that they do not; somewhere the universe must "remember" its specific successes for later recitation, at the very least in some ethereal blueprint form. Otherwise, no complexity may ever have arisen, no adaptation, no "intelligence", no enduring or coherent pattern or form. In fact, the reason that geometry exists at all is precisely because successes must be stored: it is these that are encoded not only in the configurations of atoms, molecules, materials, cities, and civilizations but also in the charges, flux patterns, and fields that hover inexplicably above and within them and govern behaviors, rhythms, and future pathways of unfolding.

What Breshears means by technology transfer is not at all a simple economic contrivance mechanically unfolding in an arid boardroom landscape, but in fact a complex and spontaneous "evolutionary strategy" identical in every way to the optimization pathways taken by physical forms as they migrate through animal or plant populations. Forms, quite simply, do not remain constrained to the concrete milieus in which they first are developed or arise; rather, they stream transversely from one genetic line or phylum to another according to a mechanics that is just beginning to be understood. Indeed, how else to account for the astonishing phenomenon of plant and animal mimicry, for the uncanny morphological resemblance, say, between the body of the orchid and that of the wasp? The deep logic of forms is indeed always an active and creative one, irrespective of whether it unfolds within organic or nonorganic milieus. There is simply no longer any sustainable opposition to be made between biological and machinic continuums, and it is important to the thought and innovation in both of these domains that such comforting but obsolete intellectual prejudices be abandoned. Breshears Bridge clearly belongs to a small but growing body of work appearing in the journals and the schools today in which these at once new and old-fashioned attitudes and modalities of research and invention are coming to be deployed.

What is both "new" and old-fashioned in all of this, is the method, the movement of thought, that carries a problem seamlessly and unproblematically from its formulation within an organic milieu to its expression in a technical one. At what point is it possible to say that a structure becomes an animal and an animal a structure? For Breshears that point is both a sliding scale of infinitely divisible grey-tones and an utterly false problem. A structure is animal when it is reasonable, and reasonable when it gracefully relates its parts and elements by processing their multiple interactions with the fluctuating environment that it penetrates and by which it is suffused. Its grace follows from a more mundane but no less elusive quality called organization - the capacity to change with change or to suffer movement - of any kind - gladly. Breshears method recalls the experiments of Alexander Graham Bell, less for the obvious visual rhymes with Bell's speculative tetrahedral structures (early attempts at flying machines) than for the patient manipulations and investigations of Bell's own dog's laryngeal apparatus, perfectly ingenuous pranks that nonetheless led directly to the first prototype telephone. It would not be wrong to compare Breshears' work to either that of Muybridge and Marey in the nineteenth century or indeed to that of the computational biologists of the last few years who have begun to "grow" autonomous adaptive systems in purely silicon and electromagnetic environments.

The key to relating all of these things is the concept of integration. Biological thought was revolutionized in this century when it was proven that organisms develop "epigenetically" and not simply as the rote unfolding of encoded genetic instructions. What this means is that organisms are in fact elaborate and continuous formal responses to their mileus, to the forces which both oppose them and traverse them, to the accidents and contingencies that fix them in time. The animal body is a geometrical code, a matrix or data base of successes compounded one on top of, and inside of, the other. In some sense, all of both nature and the technical world - at every scale - can be seen as such a catalog of geometrical solutions powerfully interconnecting and subtly inflecting each other's continuing evolution. It is in this rarified matrix that one discovers the abstract elegance of Breshears' Bridge; it is here as well that we discover the improbable but certain cohabitation and involution of the buffalo within the bird.

The vertebrate body is a system of envelopes - a complex solution one could say - linking many motor fields, or systems of movement, both in space and in time. It links not only one thing to another in linear spatial sequence (like the suite of individual vertebrae) but also concentric interacting fields of pressures, actions, and constraints. The type and quality of movement of which a body is capable - indeed its entire nature and essence - is determined by the particular way in which these fields are enveloped and combined around the nucleating axis. The hump of the buffalo may be said to draw the buffalo's body into taut high-point suspension over the forelegs, centering both gravity and the animal's motive power on the same vertical axis. The spine separates the animal into two horizontal fields: compressive below and tensile above - an essentially sluggish, though utterly dependable, load-bearing system. Yet imagine drawing this animal through a topological operation: the hump (see this now as a geometrical ideal, originally independent of a spine that only coincidentally over the ages migrated upward to embrace it) now folds in on itself, pressing down into the animal's body, past the central axis, downward ever further, freeing the compression in the spinal core now to expand and contract freely, and binding its terrible concentrating force into a knot below where it takes up the precise position of a sparrow's sternum. Not only does this comprise a new envelope of forces, a new distribution of rigidity and fluidity, but also a new animal entirely has been composed, for we are no longer dealing with a buffalo but indeed, a bird.

Now this topological operation does not exist only ideally, it is real. The migration and circulation of forces, which permit structural stability both in flight and in (horizontal) load-bearing and grazing, resolve themselves dynamically in Breshears' single, highly engineered, multiply articulated structure. The bridge not only spans and joins, hangs and pivots, but also flexes and arcs - it metabolizes all the physical fluxes around it while remaining, in an important sense, autonomous, indeed almost self-directed. But the project envelopes its own intrinsic forces, too, and projects these outward as if it were itself in the throes of some strange bionic ontogenesis. For the levity of the bird is here brilliantly made to unfold within the gravitas of the buffalo, proposing a quietly monstrous new species, even a kingdom perhaps, whose general outlines a few designers today - Breshears clearly among them - seem ready, and willing, to grasp.