Leisurator's Surface Kinematics
Architectural Evolution and Fitness Landscapes

[extract from the introduction to the book *Leisurator*, edited by Marco Pastore & Valentina Sabatelli, Bari, 2004, on sell @ www.aiborg.net]

The work is not put in a place, it is that place

Michael Heizer

In the end, everything returns to the surface

Gilles Deleuze and Felix Guattari

I. Inert Bodies

One of the most recognizable symptoms of modern life is a growing inability to move our bodies. A recent study published on urban patterns in the U.S. reports that the average American now walks, rather remarkably, *less* that 300 meters per day—a distance that would take even the slowest of walkers (who I presume must live somewhere in America) about seven minutes. That's a total of *seven minutes* of forward bipedal motion every *twenty-four hours*; a fact that confirms we're all wearing Nikes in order to exercise something other than our muscles[1]. Just as remarkably, today's minimal 300 meters is a distance that continues to decline each year[2]. One overlooked consequence of this ongoing human sedimentation would seem significant to architects everywhere: the modern subject is beginning to more closely resemble the features of permanency, stability and mass long associated with modern architecture than ever before. In an unexpected twist in our species' evolution, we're simply becoming a lot more like our architecture with each passing year. While a lot of us might already look like sofas, trends pointing toward widespread obesity might one day make us all

[1] Nike already reports that athletic uses of its footwear account for less than 5% of the company's multi-billion dollar world-wide sales each year.
[2] This annual decline should be seen as the result of many intersecting technologies and lifestyle factors, rather than any single contributor. The recent invention of such products as the *Segway Human*

into creatures resembling mini-buildings (once we all get a full array of wireless PDA's and mobile phones, we'll basically become information nodes as well).

Not so, the situation created by Leisurator's interactive sports field (www.leisurator.com), proposed for the Barbican in London as a reconfigurable play and athletics surface. Its considerable perform-ability, which allows it to physically move around within the contained compound of the existing Barbican, confirms an alluring urban possibility: that of an architecture in better physical shape than most of its users. Leisurator's structural ingenuity and ability to rearrange its surface configuration seemingly at will is its most striking architectonic innovation. The large, undulating ground plane it creates has a considerable capacity for rearrangement (on its own, or in response to its users' activities and interests). The ability suggests an architectural functionalism currently found in more conventional kinds of athletics equipment, like treadmills or rowing machines. The projects' kinetic capacity allows it to sense, learn, and reconfigure itself (either in *response* to its surrounding environment, or *as* the surrounding environment; I'm still not quite sure of the distinction in a project like this) confirms that it has properties we more normally associate with mobile organic bodies rather than static architectonic structures; it becomes a 'fitness landscape' in the dual sense of the term. It is a loose programmatic field of athletic activities (promoting the fitness of its users), as well as a fitness landscape in the evolutionary sense as a domain shaping, as well as shaped by, the behaviors of the species found on its surface[3].

Leisurator signals an interesting moment in the evolution of architecture occurring today, interestingly, alongside a parallel devolution of its inhabitants. Unlike an architectural or urban space as 'environment' within which activities occur (the fantasy of many architectural theories, which imply a decidedly passive, neutral conception of architectural space), we are confronted here with a genuinely active approach to the performance of architecture. The project's operational diagram depends upon two *different* and active forms of agency;

Transporter (a 'personal transport system') might one day make today's 300 meters seem like a country mile.

[3] The concept of a fitness landscape is a key evolutionary principal describing the relationship between species and their surrounding environment; one that relates in complex ways the relationship between species and environment. For a recent discussion in relation to complex life systems, see Stuart Kauffman, 'Candidate Law 3: Coevolutionary Tuning of Fitness Landscapes and Organisms to a Self-Organized Critical State', in *Investigations* (Oxford, 2000), pp. 194-207.

people *and* architecture (rather than people 'in' architecture) which together form a landscape and whose co-dependence within this larger performative 'phase space' (to use the language of complexity sciences) is genuinely evolutionary[4]. User activities are sensed and provide data sent as signals to the operating systems linked to this surface. The data is converted into meaningful information based on an operating system designed alongside the structure, which then tell the surface to reconfigure itself accordingly; during which its finish materials, shape, light levels, and acoustic properties are adjusted as the basis for a customizable game or event.

In Leisurator, during a time when human bodies are becoming less physical or active than ever before, architectural structures can be seen to be increasingly *inter*active and kinetic. The possibility of these new kinds of 'responsive' environments is now much more routinely possible owing to the growing number of sensors, actuators and operating systems embedded within architectural structures alongside a growing palette of composite architectural assemblies and associated infrastructures (which toady can include pneumatics, electricity, and even biological matter). This situation is creating a world in which physical installations operate more and more as ordinary information or media appliances, assembled at the scale of collective infrastructures. Projects like Leisurator become seamless extensions of their many connective technologies that create feedback loops between an installation and its users, owners, and even designers.

Leisurator was undertaken as a year-long design research project completed in partial fulfillment of a M.Arch Graduate Design course at the D[R]L Design Research Lab at the Architectural Association in London in January, 2003. It's the product of a three-person design team who collaborated on all aspects of its design; Nilufer Kozikoglu, Marco Pastore, and Valentina Sabatelli. These three young architects focus their research on the topic of leisure in the context of London today, and from this develop a concise brief for an open public surface that can be rearranged (by itself, or by its users) based upon changing needs and game requirements. The goal of the brief is to promote new kinds of physical

[4] A familiar image within contemporary architectural discourses for this kind of evolutionary co-dependency is the description of the wasp and orchid found in Gilles Deleuze and Felix Guattari, 'Introduction: Rhizome', in A Thousand Plateaus (London, 1997), p. 10. For a wide-ranging discussion of co-evolution, including a survey of recent gene/culture forms of co-evolution theories ('memes' v. genes), see Edward O. Wilson, *Consilience: The Unity of Knowledge* (London, 1998).

leisure activities, team games, and individual athleticism for an increasingly sedentary urban population; a not unworthy ambition which then also serves the more important purpose of pursuing a wholly new and imaginative architectural agenda. Early research in the project convincingly demonstrates that in London during recent years the growth of accessibility to modern technologies like television or the internet (which far exceeds UK national levels) can be charted by an inverse decline in levels of physical activity; a pattern not unfamiliar to a world of commuters and screen-watchers.

Leisurator seeks to overcome these habits, which the team correctly understands as having been installed as much by existing architectural paradigms emphasizing permanence and constancy as the conveniences of a more infrastructural or mediated kind. The design team's early research shows that the amount of money residents of London now spend on leisure activities has risen sharply in recent years, having the unexpected additional effect of making leisure a new kind of urban luxury. Facts like these serve as a backdrop to a design brief that the team then develops for creating a new kind of leisure environment at the Barbican; one that merges the entire spectrum of leisure activities (from active physical to passive online participation) into a single striking proposal. This is the project that the team named Leisurator, and its broad ambition is to create a single large-scale surface able to induce all kinds of new activities; physical as well as virtual, individual as well as team-based (the virtual aspect is made possible by an online interface through which users can 'reach' the playing field and participate in a networked video version of its games, related in real-time to the activities played out by participants using the Barbican Site).

The architecture of Leisurator is entirely that of a contemporary surface sensibility; that is, one whereby the principal organizational diagram is a large uninterrupted surface using local deformation or modulation as the basis for arranging program and circulation. It's a notion of surface generally at odds with a more traditional sense of the surface as boundary or enclosure of a discrete object; a connotation found often in the writings and projects of modern architects[5]. Leisurator treats the concept of the surface in a very different manner, as a programmatic or distributive field. An operational, landscape-like

[5] 'An object is limited by its surface. If the object is immersed in a dissimilar medium its surface can also be regarded as a boundary', in Frei Otto, *Form, IL22* (Stuttgart, 1988), p.32

modification of an artificial ground is then made even more responsive through its capacity to actually reconfigure and adjust itself.

This notion of the surface as operative or programmatic fields is part of a long and (quite literally) less visible genealogy of modern architecture. It is also one that has enjoyed considerable architectural (and digital) attention during the past several years, to the point of it becoming a near-cliché of today's neo-avant-garde. Diagrams of an active deformed organizational surface are given considerable exposure in OMA's well-known 1992 Yokohama project, and other recent and widely-published projects by Eisenman, UN Studio, RUR, FOA, Hadid, and many others. Experimental projects by these architects explore the potentials of a surface sensibility that sees the manipulation of continuous surfaces as the basis for a certain kind of material intelligence within a project that is able to usefully distribute programs, movements, and structural forces[6]. These and countless other contemporary examples depend on various kinds of folding, bending or other operations applied across a large-scale mostly horizontal surface in order to establish supple, non-hierarchical, organizations. These projects are characterized by their iterative operations of folding, bending, twisting, or warping; deforming operations used to first differentiate, and then reconnect, various aspects of inhabitable surfaces. These local modifications to an otherwise uniform and repetitive surface condition transform generic and abstract planes into unique and differentiated continuous surfaces.[7]

This contemporary architectural sensibility can be seen to closely resemble the landmark 1960s 'ground art' work of artists like Michael Heizer, Robert Smithson, Robert Morris or others, who at the time fled the traditional object-making activities found in galleries to pursue what Smithson called an 'aerial sensibility[8]' for large-scale spaces. It was an approach to the production of art that defied

[6] See Patrik Schumacher, *Digital Hadid: Landscapes in Motion* (Basel, 2004), for a recent discussion of the 'pre-digital' 80's sensibility that can be seen to prefigure today's digital surface work.
[7] For a discussion of the 'new horizontality' and connotation of a landscape found in a project like FOA's Yokohama project, see Peter Eisenman, Alejandro Zaera-Polo, et al, 'Discussion 4', in *Anybody* (Cambridge, Mass., 1997), pp. 210-215.
[8] Smithson amongst others helped theorize what he called the 'aerial' sensibility of this work; interestingly, alongside accounts of more familiar forms of modern architectural production. See Robert Smithson, 'Notes Towards the Development of an Air Terminal Site', in Jack Flam, ed., *Robert Smithson: The Collected Writings* (Berkeley, 1996), p. 52-60.

traditional object-making preoccupations of the artist as well as the gallery[9]. A very similar kind of project can be seen with architectural efforts like those cited above, which move architectural work away from a traditional sense of the discrete architectural 'object', towards instead a loose aggregate field of interaction[10]. We can characterize this shift as a move away from 'space' and towards the 'surface'; no longer a second-order property of a discrete architectural object but rather an entirely new conception of architectural organization. Countless modern projects reveal a rich history of experimentation with continuous surface structures as the literal grounding for a modern architectural project. We can look back now and see in a new light Le Corbusier's early urban plans (which features extensibly shaped ground planes upon which his towers literally depended); the smoothly-connected ramped interiors or Niemeyer; the densely-connected circulatory networks of Smithsons/Team X; the uninterrupted slabs of Archizoom or the infinite grids of Superstudio, or a host of other projects establishing the experimental field of today's interest in the continuous surface.

What distinguishes Leisurator's effort from many of its progenitors, or their contemporaries, is of course an insistence that this surface be literally deformable. Accordingly, its been designed by means of techniques that stress its assembly as a skeletal array of linked and inter-connected parts, a signature feature of today's digital animation software. The techniques associated with these tools focus on the intelligent assembly of a surface through a hierarchical relationship of linked components, joints and influencing objects whose performance can be extensively tested and evaluated in terms of its resulting movements and behaviors. Tools like these and their associated techniques are further advancing today's interest in the continuous surface.

II. Supple Skeletons

Leisurator moves beyond a generic image of a deformed 'smooth' surface to advance instead the design of a calibrated assembly of linked rotational elements and joints. These are then arrayed and synchronized in controllable ways so as to

[9] For a review of this influential art movement, see *Land and Environmental Art*, Jeffrey Kastner and Brian Wallis, eds., (London, 1998) and Gilles A. Tiberghien, *Land Art* (London, 1993).
[10] See Stan Allen 'From Object to Field', in *Architectural Design: After Geometry* (London, 1995), pp. 24-31 for a discussion in relation to contemporary art and architectural discourses.

allow remarkably elastic bending and ruled-surface forms of curvature. The detailed design of the project's many sub-systems, and their dependence on a large number of components is what I find most interesting and convincing in the work, for the ways that this strategy moves the surface away from being simply an image or a diagrammatic possibility to become instead a tangible, highly refined, material organization[11]. Of the many aspects of the project we might point out for a discussion of its qualities, the actual modeling techniques used by the team for the design of this surface are perhaps the most crucial. These are what enable the design of a machinic assemblage of parts whose actual movements are able to achieve the complex overall movements in the final project. I'd like to briefly discuss these modeling techniques, which depend upon, paradoxically, on a skeletal approach to the definition of a surface.

Early physical models of the overall proposal (which consists of an open elevated ground surface stretching in places several hundred meters across) were built not as fixed views showing what this surface might 'look like' in various configurations or scenarios (a traditional representational use of an architectural model), but rather as puppet-like mechanical simulations that could be operated and driven in ways to explore the possibilities for the movement and animation of the final surface. Countless quick hand-built versions led to a series of large-scale mock-ups, designed to allow operators to physically reconfigure the elements of the project. The team's use of physical modeling processes as computational or performative studies (whereby physical models are used to 'compute' the distribution of forces, through continuous material assemblies) have as their predecessors important 60s early experimental work of Otto, Nervi, Piano, Rice, and others working with formally-complex shell structures[12].

Today's more immediate source for this performative approach to modeling stems, I think, from the consequences placed on designers working today with animation software, whose entire orientation is directed towards the making and then movement of digital models. In order for a user to do this animation work in an application like *3dStudio* or *Maya*, all objects in the modeling environment

[11] An example of that kind of project would be the famed collages of Superstudio, or aerial views of projects by Archizoom, created during the late 60s and early 70s, showing various kinds of large-scale, gridded, ground planes inhabited by users able to move freely about on these surfaces.

(including any kind of surface) must be created in incredibly precise, linked and re-usable, relationships. In a node-based program like *Maya* these relationships can be scripted or programmed in MEL or C++, languages that allow a designer to customize behaviors whose routines are themselves objects in a programming sense—discrete and re-usable portions of code that coexist with the other visible elements of the model (the 'objects' in a more conventional sense of the word).

In a program like *Maya* the combination of primary elements creating arrayed and linked together to create surface is another level of fully controllable relationships, whose potential behaviors are described in the program's Hypergraph, a non-visual, hierarchical description or outline of the entire model or scene—including all parts as well as commands used to manipulate how these parts move relative to the others. What we see at work here is a design environment where actions or movements are treated with equal precision and clarity as the components or elements otherwise making up a design; a situation creating an entirely new sensibility regarding how one conceives of, and then develops, something as straightforward as a surface. In *Maya* the Dependency Graph operates behind the visual space of the application's GUI as well as the commands of the MEL editor operating on the Hypergraph. Without getting into the technical aspects of this arrangement, the important conceptual point here is simply its demonstration of how linkage or connection strategies are, in a design tool like this, created and coded in a way entirely equivalent to other more traditional 'parts' of a model—movements or the animation of a structure are integral elements of its conception, organization, and design[13]. The techniques associated with digital animation software for the linking of its various parts are known as kinematics.

Kinematics emphasize a clear understanding of the levels of relationship between the discrete elements making up a mode. Unlike *cinematic* design techniques used for something as straightforward as a simple surface (using collage, montage, or a tool like Photoshop, all of which stress the appearance of that surface) *kinematic* techniques focus instead on a world of joints and connections

---

[12] See especially the series of 1970s publications produced by Frei Otto's *Institute for Lightweight Structures* in Stuttgart, which offer users today a valuable catalogue of computational modeling techniques.

[13] For a more technical description of the application, see David A.D. Gould, *Complete Maya Programming* (San Francisco, 2003).

(*linking together* the parts that go into making up given surface). Today's vocabulary of forward top-down kinematics, or IK or inverse kinematics are two alternative methods for the description of how joints between elements relate to one another when one part is moved in relation to the whole model.

Leisurator uses a kinematic approach for the modeling of its surface; initially digitally, but interestingly, also in its many physical models of the structure. The final surface inhabited as the athletics field of the project is created out of a precisely-programmed definition of literally thousands of moving parts wired together as the basis for the final, machinic, design. The approach mirrors a design pattern found not in architecture today so much as the computer game or film industries, where a process known as motion capturing transposes information gained in the recording of movements in physical models into data describing behaviors and movements of the joints of a moving body, which are then imported into a digital model as the basis for its movements.

Motion captures allow a designer to simulate a remarkably real range of motion applied to digital models. Leisurator uses this kind of approach in straightforward way to make very life-like animations of their structure. More importantly however, the team also uses the strategy as a way to creatively relate their realm of physical and digital modeling; by capturing the movements in one medium and transposing it to the other (it was a two-way exchange—at times, movements in the physical model become the basis for the digital scripting, and conversely, some digital IK solutions were used then as the design criteria for a physical prototype. Developed this way, the dual physical/digital modeling approach forms an incredibly cohesive, informed, approach to the design of a surface—not as a passive and neutral ground plane, but rather as a complex system shaped by the coordinated movements of its internal parts, and external users. This surface becomes a strange mixture of artificial geo-morphology and architectonic cyborg[14].

In Leisurator we are confronted by a 'machinic' assemblage whose overall complexity cannot be reduced to the relative simplicity of its underlying connections or parts; it is an emergent property dependent upon the large number of parts required to make possible global, self-organized, forms of

behavior. However simple the movements of the project might be compared to the complexity of our own (and it does have a restricted range of motion, memory, and speed), the project is nonetheless indicative of a new paradigm of responsive environments and complex machinic design strategies.[15] Ours is an era in which architectural space is now an extension of other larger systems of control, connection, and complexity. Some might just prove themselves as enjoyable a setting for leisure as they are interesting new areas of work. Leisurator demonstrates the considerable potential for both.

Brett Steele
London, March 2004

<bio>

Brett Steele [brettPortable on MSN; 226769474 on ICQ; bbs@aadrl.com]
directs the D[R]L Design Research Lab, a M.Arch Graduate Design Programme at the Architectural Association School of Architecture. He designed and maintains *www.aadrl.net,* an open-source online application that currently contains more than 13,000 downloadable image, model, scripting, video and other files related to the work of the D[R]L. He is also a Partner of D[A]L, an architectural office in London and has taught and lectured at schools in the U.S., Europe, Hong Kong, China and Japan. He is an editor of AA Files in London, and his recent articles have appeared in *Arch+, A+U, Archis, AA Files, Harvard Design Magazine, Hunch, World Architecture, Daidalos,* and are online at *www.desarchlab.com.* Books and other articles are forthcoming (2004).

[14] For a discussion of cyborgs, see Donna J. Harraway, 'A cyborg manifesto',
[15] For more on complex systems, see John H. Holland, *Emergence: From Chaos to Order* (Redwood City, 1998).