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## Resisting Matter: Creating an Armature for Future Digital Practice.

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# Resisting Matter: Creating an Armature for Future Digital Practice.

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*Matter (three definitions):*

- 1** That which has mass and occupies space.
- 2** Material for thought or expression.
- 3** Any substance in, or discharged from the body.

The use of generative computer processes is a significant example of a major shift in the mode of architectural production. Until recently it was assumed that the 'digital stuff' of three dimensional design models, although bound by an insistent cartesianism, was infinitely malleable. Software tools can mimic processes like evolution and mutate forms in response to non existent forces modelled by mathematical algorithms challenge our fundamental assumptions about digital technique as it has developed to date. Three dimensional models that are able to respond to forces signal the reintroduction of a kind of matter into the design equation. When designers work with physical matter they encounter resistance – signs or qualities that carry potential to affect and be affected.

Resisting matter makes digital models go beyond representation into a kind of direct relation with force and intensity, bypassing the diagram and proceeding directly to form with almost no intervention from the user – or such is the temptation. The very density and precision of numbers contained within a computer model seems to suggest a kind of 'truth value' to the computer model, but is this kind of manipulation to produce form as product of 'forces' alone necessarily where the design process should stop? Indeed the kind of instrumental design practice that digital ways of doing lend themselves to can be a kind of 'trap' for the unwary user, wherein they risk losing some quality of expression and invention that is present in the hand crafted.

'Obsolete' techniques may point the way for future direction in digital design which deals with matter-like potential. Close attention to the Rococo (1700-1760) and its uncertain formal tendencies reveal it to be startlingly contemporary in its outlook. At the same time eclectic and formless, content became mobile in search of form. It was an architecture expressive of a sensibility that was free from any particular ideology – a way of doing that was quietly revolutionary in its approach. In particular the mastercrafters of stucco, who employed a range of casting and manipulative practices, demonstrated an extraordinary ability to create complex forms from matter that particularly lend themselves to current digital practice.

**Title:** Resisting Matter: creating an armature for future digital practice

**Abstract:** Until recently it was assumed that the 'digital stuff' of three dimensional digital models, although bound by the rigid co-ordinates of Cartesian space, was infinitely malleable. Now software tools can imbue digital models with simulated physical properties, making form through the relations between virtual forces. The forms generated by this process, resulting from the relations between mathematical algorithms have a bizzare birthing proces. Often 'blobby' or amorphous, they are startling - and strangely alluring - to a profession steeped in a history of design technique through representation which is dedicated to the idea of progressive refinement of form. Of particular interest are recent experiments with a program called 'Evolver', an interactive software tool for the study of surfaces shaped by energies and constraints. Three dimensional digital models that are able to hold the qualities of active force and material resistance suggest the possibility of a new kind of 'hand crafted' approach to digital design

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**Paper:**

*'Take wood. A woodworker who sets out to make a table does not just pick any piece of wood. She chooses the right piece for the application. When she works it, she does not indiscriminately plow into it with a plane. She is conscious of the grain and is directed by it. She reads it and interprets it'* (Brian Massumi, 1992 pg 12)

Those who create art in material mediums, for example sculptors, work directly with the tangible qualities of matter to create their art. Architecture comes into being through abstract representations, the plan and section drawings amongst others, Robin Evans put the dilemma for the building designer succinctly when he said 'Architects draw buildings, they do not generally make them' (Evans, pg 154). Three dimensional digital models that are able to hold the qualities of active force and material resistance reinsert a 'matter-like' quality to the design process making possible a new kind of hand-crafted approach to digital design work.

When an artist works with physical matter they encounter resistance - signs or qualities that carry potential to affect and be affected. The artist's intent or will is translated into

action. The play of the eye across surface and the movement of hands against the haptic qualities of whatever medium they happen to be working in is an intricate dance of relations. Will is pitted against matter – but this is no antagonistic encounter, rather a productive one where the qualities of that matter can be brought to a certain expression. Architects have long been distanced from this kind of direct or tangible engagement with the matter on which their design intentions are brought to bear. They make a series of jumps between drawings, from sketch to finished construction sets the potential building is translated into being. This process is carried out in a medium from which any sense of haptic resistance is largely absent, the actual matter itself has largely been seen as the problem belonging to those who are labouring on site.

Recent experiments with a program called 'Evolver', software that can bring to bear the qualities of force and resistance to a given three dimensional model, are interesting as they suggest a different way that architects might engage with material like properties during the design process. 'Evolver' is an interactive software tool for the study of minimal surfaces. A minimal surface is the smallest area of surface that can span a given boundary, for example a cluster of soap bubbles have minimal surfaces between each bubble. The program works by allowing the user to allocate particular energies to distinct objects in a model file and to then manipulate the constraints that bind their interactions. The result is a massaging of this digital matter into new configurations as the program 'evolves' the surfaces to the desired level of smoothness. To date constraints in a digital sense have been understood in relation to parametric modellers like 'Catia' which hinge around the construction of a rules based schema. This schema determines the extent of the manipulations that can be performed on any given set of geometry. By contrast 'Evolver' is more akin to the work of the pottery maker. For the potter, the initial throw of clay to the wheel is a crucial act in the process of making, if it is not thrown so that the mass lands in the centre of the wheel the pot will be miss-shapen. In 'Evolver' the user defines an initial surface condition with a data file, as simple as a number of different sized cubes set in relation to one another. The program then 'evolves' the surfaces between the objects toward 'minimal energy'. These surfaces are the result of such energy equations as surface tension, gravitational energy, squared mean curvature, user defined surface integrals or knot energies. These energies can be bound by constraints of different kinds – volume, boundary, crystalline integrands and so on which further shape the surface properties. This program is interactive, using the Open GL drivers to allow the user to modify the minimal surface or, as the documentation rather charmingly puts it, 'keep the

evolution well behaved'<sup>1</sup>.

'Evolver' was first investigated for its architectural potential by Minifie Nixon, a Melbourne based practice who are interested in co-opting pure mathematical form into architecture. In their project proposal 'Minimal triply periodic housing studies' for the Archilab conference and exhibition in Orleans, France 2001 they used Evolver to generate triply periodic schoen surfaces. These schoen surfaces are an example of a minimal surface that has a crystalline structure which repeats itself in three dimensions. The surfaces were then given various thickness in order to test the forms for ways in which they could be inhabited. The result is a series of suggestive images that appear to be simultaneously table top objects and large urban gestures. These images display a strange tension, wavering somewhat uncertainly between the pure mathematical abstraction of the original schoen figures and a kind of 'almost building' or a 'not quite sculpture'.

Evolver, by giving this mathematical abstraction a manipulatable form, has made possible an architectural investigation of intangible forces. Normally the way that forces or intensity are taken into consideration in an architectural design process is through the act of diagramming through drawing, in another 'Evolver' project the role of diagramming shifts to become the primary tool of the design process. Jonathon Podsborek, a recent major project student at RMIT supervised by Paul Minifie, used 'Evolver' to resolve a complex three dimensional form as a given form into an almost building. The initial form, a hybrid of office, hotel and apartment, was generated through a kind of cellular automata operation scripted in the modelling program 'Rhino'. Cellular automata generate complexity through the interaction of a number of elements that behave according to simple rules. In this case it was used to create a series of floor plates of functional configuration derived from the 'tendencies' of the various programmatic elements to seek various locations on the plate; for example the apartments attempt to orient themselves to the best views or the office space to the better street address. The floor plates were joined by a lofting operation that made a three dimensional 'braid' of ropes of form, an extremely complex three dimensional shape. 'Evolver' was then used to curate this complex form through the resolution of minimal surfaces between the forms, a way of preserving the intricacies of form while allowing inhabitable spaces to be carved from its mass. The result is a potential building that is almost completely 'diagrammatic' in its resolution. In Podsborek's project the step of diagramming coincides with the act of generating three dimensional form. The evolved

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<sup>1</sup>[Http://www.susqu.edu/facstaff/b/brakke/evolver/html/intro.htm](http://www.susqu.edu/facstaff/b/brakke/evolver/html/intro.htm)

building is a kind of hyper – diagram where the difference between architecture and mathematics becomes fuzzy, in fact there is some confusion as to where the diagram stops and the form begins or whether in fact it is important to make the distinction between the two.

To profession steeped in a history of design techniques that deal with the progressive refinement of form and a necessary gap between the diagram and the architectural resolution this represents a major shift of thinking. The complex forms that result from a program like 'Evolver' might seem to bear a closer relation to mathematics than architecture as we traditionally understand it to be, but mathematics and architecture have always had more intimate relationship than other design disciplines. Mathematics is the science of structure, order, and relation that has evolved from elemental practices of counting, measuring, and describing the shapes of objects. Mathematics employs the diagram as a way of representing both simple and complex problems, architecture uses the diagram as a way of describing the relations between the quantities and qualities that constitute a potential building. 'Evolver' requires an abstraction of quantities and qualities into mathematical forces that become a diagram of relations rather than just graphical representations. As architects this is difficult ground to negotiate, making and manipulating form with mathematical abstractions is quite distinct from drawing with pen and paper and not an easily achieved skill. However, because Evolver makes these forces visible as a three dimensional model it is accessible to the average user.

Some may view the potential of 'Evolver' to take on a life of its own unless forced to 'behave' as an unacceptable loss of control which might push the design outcomes in unexpected directions, while others might see it as an opportunity to explore the unknown territory. I think to limit the discussion about these new tools to questions of legitimacy is to miss the point of what programs like 'Evolver' might have to offer for new ways of thinking and making. For the designer working 'without hands' in the digital medium 'Evolver' and other programs like it have the potential to help us make sense of the design process through a new kind of materiality, one makes the process of making in the digital realm more palpable. The architect can work more like a sculptor, reading the signs and qualities a way of 'feeling through form' as an opened ended engagement with the process of a building's coming together. Of course 'Evolver' is itself another type of abstraction, the software does not directly model the real qualities of the matter which makes buildings. Rather 'Evolver' gives form to the abstraction of other kinds of virtual forces, such as

MinifieNixon's opportunistic borrowing from mathematics. This kind of 'digital matter' allows computer models go beyond representation into a kind of direct relation with force and intensity.

This sort of design approach requires a different sort of sensibility – a cultivated feeling for form - in order to effectively grasp its instrumentality. 'Evolver' opens a possibility for a more 'hand crafted' design process. I mentioned the pottery maker, the way the initial throw of the clay the wheel determines to some extent the outcome, but depending on the composition and mass of the material the potter can shape the clay into a great variety of forms from a single starting point. The clay is then worked on the wheel by impressing, bulging, carving, fluting, faceting, slicing, and other methods to take on individual form and expression. The initial starting point of the 'Evolver' model is similar to that lump of clay, the force which is assigned to each 'blob' and the distribution of the 'blobs' in relation to one another determine the initial minimal surface result. The shaping process that the potter goes through, running their hands and pressing with certain force and direction is directed through equations which determine 'Evolver's' constraints. By changing the energy ratios contained in the different blobs of digital matter the overall shape can be manipulated with some degree of precision. This precision is not determined by the software but by the user's 'hunch' that it will go in a desired direction. This hunch, which the designer has to learn to rely on, is the avenue through which their sensibility their own particular way of feeling through form - has to operate. The force and resistance that the designer can expect to encounter in 'Evolver' adds a logic or 'fibre' to the operational parameters of the design process, a productive mode of operational constraint for digital matter. This is a way of making which is more open to change and variation in expression, something which has been a constant criticism of digital design to date. Like the potter the architect now has a chance to know the limitations of his or her materials, to work with them to generate form, but with the added ability to design the actual material constraints for themselves. 'Evolver' and other programs like it allow the architect to express themselves with a new kind of freedom - which is after all what really matters.

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