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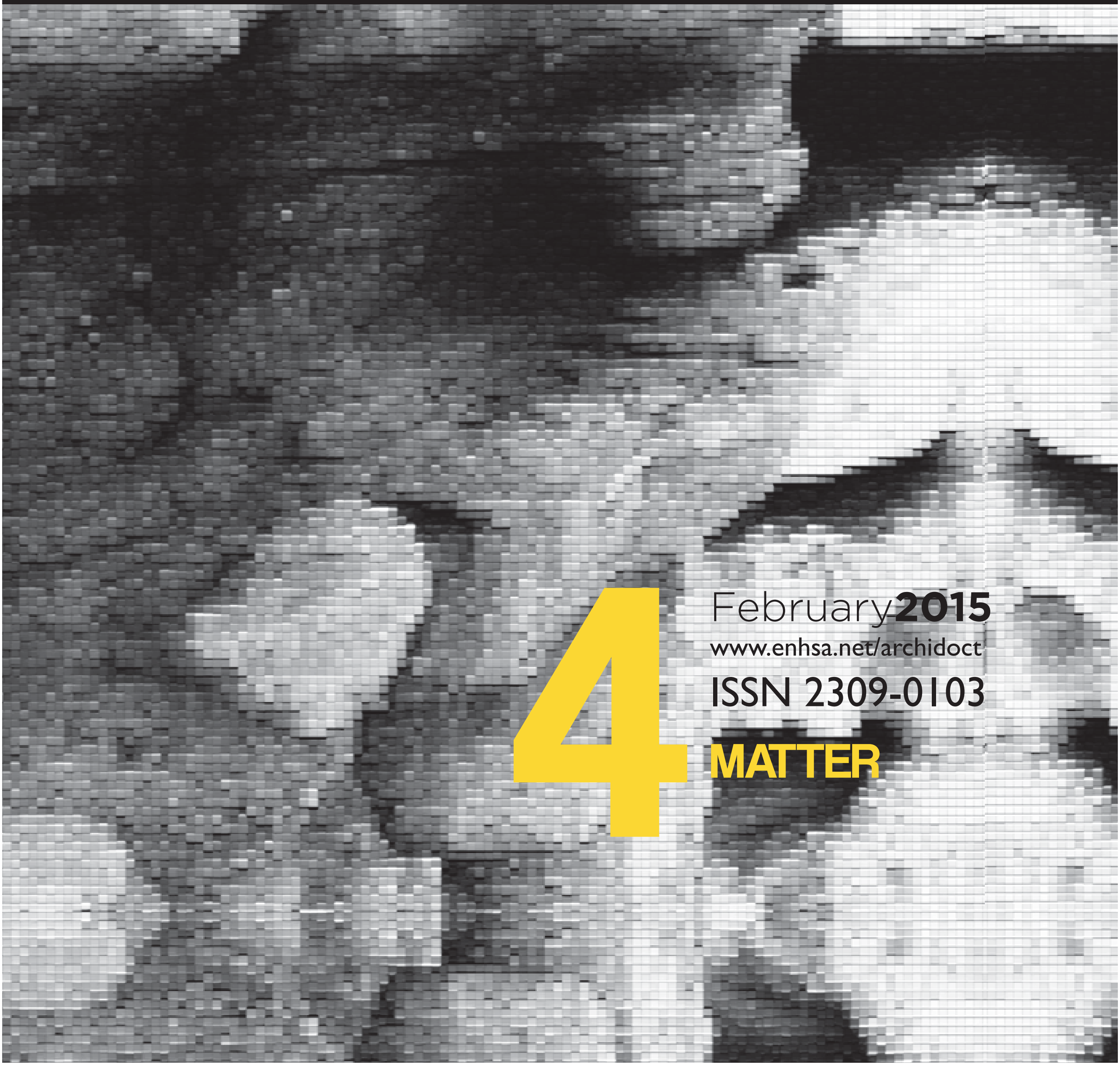

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A Good Practice Example // 11

Hacking architectural materiality towards a more agile architecture

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Abstract

It is a condition of architecture to constitute a statement, -a strong, meaningful cultural statement. As statement requesting the 'other', the better, more appropriate and expected, architecture cannot help rejecting the existing or established. This very profound revolutionary nature of architecture is accountable for its agility. Agility in architecture is always historically relevant as well as relative. From Vitruvian times, right through to modernism and later postmodernism, architecture, with a relative time lapse, has been steadily and latently agile in its own right. Agile in its obligation to move rapidly towards the new and different as prescribed by society's demand and commitment to change and progress.

It is only in the recent past that the agility of architecture began acquiring (a different shade and pace, becoming bolder, omnipresent, ubiquitous and faster. Agility can be perceived not only as an effect, an obligation or a commitment of architecture to its human, social, political and ethical dimensions, but also in terms of its increasingly more vivid, more evident, more affective and faster attributes. This new demand for agility stems from not only the speed of changes occurring in all spheres of our daily social, political and economic life. It is also dictated by a new conception of architectural materiality as it is now emerging through computational and advanced digital technologies. The creation of architectural form is now conceived as the result of the 'genetic process' dictated by the implementation of computation upon the formation of matter. It is the new role of the material aspect of architecture in morphogenetic processes that accelerates and reinforces the agility of architecture as a whole. The present essay argues that in IT- driven architecture, agility is a modus operandi; it is an affect, a preoccupation, an objective throughout the genesis of form through the exploration of materiality. Agility has become a mission of architecture itself. It has become a value, a meaningful objective to be achieved, an expected goal to be attained and, as such, a driving force in the way we think, design and fabricate architecture itself to be more agile.

Keywords

Design Agility; Pregnant Matter; Digital Fabrication; Hacking; Hacked Materiality

Note

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ISSN 2309-0103
www.enhsa.net/archidoct
Vol. 2 (2) / February 2015

Agility

Whilst at first glance the word agility echoes its English French (agilité) or even its Latin origin (agilitas=activity, quickness), in a more thorough investigation its Proto-Indo_European ag root derives from the Greek agra, agein, axios and Latin agere / ambactus. The Greek word agein (άγω) on the other hand comes to mean the verb to guide, to lead, to move. It is interesting to note however that from its contemporary French connection and the verb agir (=act) that come from the Latin equivalent (agere=drive, urge, conduct)) agility could come to mean the action of moving fast towards a given stimulus. Another connection that will prove useful in the development of this essay is that of the verbs act and react, that are associated with physics and chemistry, both of which are necessary to grasp certain aspects of the material existence of contemporary artifacts.

Agility and architecture

Architecture in its perpetual effort to reflect the zeitgeist or spirit of the time by means of transcribing values and ideas into built form is obliged to be agile, to move quickly towards the new and changing, thus differing from what it was. Through agile architecture, one appreciates the sensitive, reflective, adaptive, flexible and alert act of transition in its formation.

Despite its inherent mobile capacity, architecture, as an entity, has also always been stable both physically and metaphorically (just like a tree, with its root and shoot system -crown and trunk). The root system is what is deeply founded and hidden in the earth whereas the shoot system is what grows above ground level[1] with(deep, heavy, strong, rigid, old hidden roots forming the root system and with fresh, airy, light, vulnerable, young branches, leaves and buds forming the shoot system. It is interesting to observe the connotations of each of the two systems in architecture. On the one hand, the roots –its history, tradition, values and derivations- are there to hold the tree intact in place and time, nurture it, filter the bad, benefit from the good and maintain its support and growth. On the other hand, the crown –its growth and relation to the new world, reaching outward and forward looking-benefiting from the sun and fresh air, while simultaneously, vulnerably exposed to the elements. Historically speaking, architecture with a seemingly paradoxical, binary opposed nature of motion and stability can alternate between both, but in a sequence (Similarly, it can be immaterially founded on ideas, values and material through its physical presence, rendering architecture conceptual and materialisable). Any isolation of the materiality of architecture from its conceptual references is utterly dismissive. What has rendered architecture stable and agile, material and immaterial, conceptual and materialist at the same time?

1. http://www.phschool.com/science/biology_place/biocoach/plants/basic.html

Agility, Architecture and Materiality

'..matter should not be used merely to suit the purpose of the artist, it must not be subjected to a preconceived idea and a preconceived form. Matter itself must suggest subject and form; both must come from within matter and not be forced upon it from without.'

C. Brancuzi[2]

2. As quoted in Bach, F., T., (1995)

The characteristic of the so-called conceptual architectural paradigms of the pre-computational times is that the designer imposes materiality; in other words, the appropriate

ISSN 2309-0103
www.enhsa.net/archidoct
Vol. 2 (2) / February 2015

putational times is that the designer imposes materiality; in other words, the appropriate material is chosen on the premise that it can best serve to materialise the envisaged form. The designer has firstly conceived a form and comes to test its materialization through appropriate materials. Architecture observes the change and adapts to its context.

The shift that has altered this perception radically, more than ever before, is that in computational times the genesis of form is understood as yet another natural and biological process. Any artifact and, consequently, any architectural creation is now conceived as another material entity, as part of nature. Architecture is now attempting to be part of the Cosmos. And it is its materiality that comes to offer its ultimate morphogenetic power. Nature is now defined as the materiality of the universe.

According to this new vision, matter is conceived as a dynamic system with capacities and properties. These capacities and properties are considered as the fundamental agents of architectural creation, the dynamic interaction, which with other agents can have a decisive contribution to the generation of form. Matter as a non-linear, dynamic system in its interaction with other agents and small changes can cause great effects. According to Manuel Delanda (Delanda, 2009) a material as yet another complex, dynamic system actively organises itself into new structures and forms. Material performance comes from the complex dynamic behaviour of the components of a material that attribute to it emergent properties. Delanda points out that the expressivity of material is a "capacity of matter to express itself in many ways, from the simple emission of information to the deliberate use of melody and rhythm" (Delanda, 2009) . It is a conception of an agile materiality.

Appreciating how this materiality generates form becomes a challenge for contemporary architectural experimentation. Understanding through the appreciation of form generating mechanisms of reproduction, evolution and development not through physics but through the chemistry of proteins in generating, preserving and evolving life. Life is agile. The generating mechanisms of reproduction, development and evolution are extremely agile. This is why agility becomes a value to be assured, an objective to be achieved.

Agility, Architecture, Materiality and Computation

'We are beginning to recover from a certain philosophical respect for the inherent morphogenetic potential of all materials. And we may now be in a position to think about the origin of form and structure, not as something imposed from the outside on an inert matter, not as a hierarchical command from above as in an assembly line, but as something that may come from within materials, a form that we tease out of those materials as we allow them to have their say in the structures we create. '

(Delanda, 2004)

In the notional framework of computational times, agility is strongly related to the virtual. Virtual is a key word in understanding the ethos underlying this new condition. According to neo-materialist philosophers, the virtual is a potential state, a state of agility, which could become actual. In contrasting the virtual with the actual, but not real, it appears as something, which though not real, displays the full qualities of it, and for this

ISSN 2309-0103
www.enhsa.net/archidoct
Vol. 2 (2) / February 2015

the real, the virtual is embedded into it in the form of seamless boundaries. As the artefact (artificial) is now conceived as virtually alive (natural) -not following the image of the alive or according to its functionality or its expressive ability- and in this new condition of virtuality, the alive is no longer a reference, but a body embedded into the artificial and inseparable part of this new hybrid condition (Oosterhuis, 2002: p. 161), which is creating a new species resulting from the availability of the advanced digital means and this new vision of reality.

Expressivity as a capacity not only of form, as suggested in the pre-computational design approach, but also of matter, appears as a legitimising mechanism that shifts the focus of interest to the materiality of form as a morphogenetic agent. Thus, computation can allow the designer to have low access to the properties of the material by changing parameters through simulations in order to appreciate the affordances of a system.

It is interesting to note that dealing with materiality in computational design is adherent to the development of digital fabrication. An essential trait of digital fabrication is that it has changed the perception of building production, which has been traditionally autonomous with implications in labor division and specialist role attributions. Digital fabrication attempts a dynamic and agile involvement in the process of generating form at two different and parallel levels. The first is that it can provide speedy, rectifying feedback in the manufacturing process, which reactivates a new loop in the design process. This can occur as: (a) the immediate correcting of mistake(s), b) an obligation to reassess in a short time some parameters that have been over or underestimated or even omitted in the form generation process, and c) new emergent ideas that came out of the manufacturing process. At a second level, digital fabrication attempts to delve into the design process undertaking, to a greater or lesser extent, a small or a large part of it. In this case, digital fabrication is not an a-posteriori indication of a transformation, but the active participation in the morphogenetic process.

In contrast to the past where, as previously mentioned, the designer imposed materiality to a preconceived form, and was, therefore, not in partnership with natural morphogenesis, computation assures an exploration of materiality both as genesis and fabrication of architectural form, as well as exploration of matter as such. Change happens in real time, simultaneously and rapidly, in an agile manner. Based on the fact that any material has expressive and morphogenetic powers, makers do not let it form in its predictable natural formations but work with it and tease out of the material its full repertoire of capacities, forcing it to do what they want[3]: Designer/makers and harnessed material meet half way and work in a partnership; On the one hand, designers can compute[4] in an analogue way trying to optimize problems, just the way Antonio Gaudi and Frei Otto did. On the other hand, the material does its minimization process while, on the other hand, designers do their constraining process[5].

Agility, Architecture, Materiality,Computation and Hacking

Materiality is at the core of experimentation in Architecture nowadays. The use of computation to deal with the complexity of form generation, the implementation of algorithms to simulate and reproduce patterns of evolution and the consideration of new parameters related to the broader environment of morphogenetic process render materiality the core investigation on the agility of architectural creations. The agility of architecture assured by the computation on its materiality can be ultimately augmented and further accelerated by hacking this computation.

3. It is interesting to observe that respect for and harnessing of material was an innate part of the work of craftsmen of the 19th century. Class arrogance toward craftsmen, however, dates back to ancient Greece where society would undermine their preoccupation to harness material by manipulating it with fire, as opposed to engaging in the art of developing theories to harness material by manipulating it with fire, as opposed to engaging in the art of developing theories and philosophy in the Agora (the market place). Meanwhile, Deleuze and Guattari make the distinction between royal and minor sciences by associating the former with the exercise of power, and by praising the latter for becoming the source of philosophical intuition. The work of minor scientists revealed the open-ended repertoire of capacities of the material world around us. Nature, through its materiality, can be inventive, cre-

ISSN 2309-0103
www.enhsa.net/archidoct
Vol. 2 (2) / February 2015

ative and divergent. In: Delanda, M. (2004), Material Complexity, In: Digital Tectonics, Leach, N., Trunbull, D. and Williams, C. (eds), Willey Academy, London, pp. 14-21

4. To compute does not necessarily mean to use the computer to calculate. Origin early 17th cent.: from French computer or Latin computare, from com- 'together' + putare 'to settle (an account).'

5.Any material as a dynamic system can offer elegant and optimized formation if left to form itself. On the other hand, designers try to adjust to the form envisaged a formation that meets half-way between a desired form and that which the material would wish to form. Take for example a soap bubble which would form in a sphere. Frei Otto used soap liquid to simulate a topological surface of a saddle shape by forcing the soap to 'inhabit' the boundary condition of the saddle shape.

6. It's not necessarily high tech. It has to do

In his book "The Hacker Ethic: and the Spirit of the Information Age" Pekka Himmanen offers insights into the life, values, operations and traits of a hacker, clarifying from the start that hackerism is a life style and does not necessarily concern those that work on information technology exclusively. In fact, he argues that the same attitude (of hacking) can be found in a number of other walks of life -among artisans and the 'information professionals'. From managers and engineers to media workers and designers. ….'You can be a hacker carpenter'[6] he claims.

On this premise the communalities that can be identified between the world of hackers and that of designer-makers that work with the logics of form generation in nature are that: 1.They are both passionate and enthusiastic about what they do. 2.They both live in and deal with the intertwined worlds of material and immaterial, programme and information, virtual and actual. 3. Despite the fact that through hacking they try to bifurcate towards innovation they refuse to serve the ruling class through patenting and copyrighting their fresh ideas. They are an open source of information sharing but not patent protected. 4. On the contrary they live as part of, and contribute with their work, to the evolution of a broader open source network. They are enthusiastic programmers who are after abstraction and not after money making. 5. They see innovation as a political act with social responsibility and they support innovation that comes from individuals and not from the ruling class that controls forms of production. 6. They share a similar view of nature. The computational architect is a population thinker and not a typologist[7]. Above all they code and decode life not necessarily in this sequence, which is what architects need to do.

A Building Agility and Agile Building

There can be observed five types of materiality which, through their hacking, the agility of architecture can be enhanced. Materiality can be hacked by:

1.Plugged-in materiality in computational architecture:
The use of anisotropic, Agile Matter: stretching limits, capacities and properties of existing materials
2.The exploitation of Agile dynamic, real-time Fabrication
3.Creating machines to fabricate materiality:
The exploitation of Agile dynamic, real-time Fabrication
4.The literary use of agility through the design of adaptive buildings through phase or shape changing materials and/or form, positioning of construction components (sun protection systems, control of the degree of porosity and pixellisation of building envelopes…) that is of a more technical preoccupation and therefore irrelevant to the content of this essay [8].

1. Plugged-in materiality in computational architecture:
The use of anisotropic, Agile Matter: stretching limits, capacities and properties of existing materials.

This approach can integrate material by intervening and 'customising' some of its properties. Still at experimental stage, some of the material properties can act as another parameter in a software. Plug-ins are form-finding, structural-design biased and can introduce the variable density of a material depending on its location and role in the structure. D'Arcy Thomson's (Thomson, 1961) work analyzes the variable composition of bone structures depending on their role of undergoing certain loads and distortions.

ISSN 2309-0103
www.enhsa.net/archidoct
Vol. 2 (2) / February 2015

with craftsmanship and caring about what you are doing.

7. p.58 Intensive Science….Delanda, For the typologist the type (eidos) is real and the variation an illusion, while for the populationist, the type (the average) is an abstraction and only the variation is real. No two ways of looking at nature could be more different.

8. This approach deploys computational materiality which, unlike what we have discussed so far, sees the building as part of the agile system from its conception to its materiality and performance. Interactive and adaptive buildings are agile by their nature. Chuck Hoberman, Michael Fox, Robert Kronenburg. Peter Cook (http://www.youtube.com/watch?v=HoICIJVL-BWE) and Frei Otto with their known biases belonged to the group of pioneers that talked about adaptive architecture.

9. http://www.achimmenges.net/?cat=236

10. http://web.media.mit.edu/~neri/site/

work of Achim Menges[9] focuses to a great extent, on the correlation between structural performance and materials.

The material is not used with its given physical or biological properties. Material is born out of the interrelation of the properties of its units (voxels) and the environment. The material units involve qualitative parameters, data which determine their behaviour, their morphologies and their assembling. It is a controlled auto-genesis, a dynamic which integrates Geometry, material and energy. Fabrication becomes energetic and works morphogenetically real time, being defined as an aggregation of any materials, physical or biological. By appreciating the logics of cellular automata, voronoi diagrams and other mechanisms, materiality can be designed and based on the computation of an agent-based materiality. Structure and matter are bound in colonies that progress from generation to generation. Through evolution, it is possible to change the quantitative, qualitative and traditional parameters of an architectural program, but maintain the same rules of generation. Hacking has a role to play. For example, hacking in the variation of the structural capacity of a component has implications on the degree of freedom for formal variations based on the fact that form and structure coincide.

Neri Oxman's work[10] developed the theory and practice of material-based design computation. In this approach, the shaping of material structure is conceived as a novel form of computation. Some of the work involves creating entities synthetically by the incorporation of physical parameters into digital form-generation protocols. Projects combine structural, environmental, and corporeal performance by adapting thickness, pattern density, stiffness, flexibility and translucency to load, curvature, and skin-pressured areas.

2. The exploitation of Agile dynamic, real-time Fabrication

This approach works on the emergent properties of certain materials that derive from experimenting with fabrication machines that manipulate them. Mette Ramsgaard Thomsen's (Thomsen, 2011) work is about transcending the formal properties of materials through the use of fabrication techniques and by customising the machines to offer materials with new capacities. The transformations of materials that have been elaborated through digital fabrication offer new perspectives in their use as revised, emergent and afresh.

Hacking the natural properties of materials by harnessing and 'stretching' their known properties with new processes of pleating, weaving and folding, happening at once or simultaneously, offer new possibilities that not only systematically control variation, but fundamentally change the performative understanding of materials. Here work focuses on algorithms that will describe and calculate materials with regard to their employment. For example, the variations of the pervasive surface condition are the ornaments that depend on the levels of pixellisation through perforation that determine the grain of the surface material (Thomsen, 2011: 138-158).

3. Creating machines to fabricate materiality:
The exploitation of Agile dynamic, real-time Fabrication

Research focuses on developing tools, improving machine time and speed of tooling towards greater tool efficiency. Nevertheless, that would still not necessarily involve matter in the evolutionary process of generating form. However, Robert Aish[11], given his bias as software developer, suggests that the creativity and experimentation of the designer should go as far as to interact and develop the machine in order to define the relationship between the computational abstraction and the design intent. He argues that tools have to be creative, intelligent and customizable. Tools have to embody conceptual knowledge and

ISSN 2309-0103
www.enhsa.net/archidoct
Vol. 2 (2) / February 2015

challenge the designers as much as the designer challenges them.

In their fairly recent essay 'Factory @ Home: The Emerging Economy of Personal Fabrication', Hod Lipson and Melba Kurman supported by Andrew Dermont[12] suggest that owning a personal fabricator is the way forward towards all-inclusively cheaper customised and personalised objects This concept is based on hacking and programming small-scale machines known as fabbers. Matthias Kohler and Fabio Gramazio[13] have been pioneers in developing a unique digital craft through the systematic use of medium-sized robots. Hacking takes place by designing the construction trajectory so that brick laying acquires new non-standard formations.

Along the lines of interacting, developing and ultimately devising a tool, Marta Malé-Alemany's work is experimental, based on trial and error. Small-scale robots are designing the trajectory, introducing parameters that can affect and be affected by the fabricated structure that will emerge. Namely, the design of a robot trajectory, to drop acid on a polyurethane panel offers different degrees of porosity, transparency and tactile qualities of material. Marta Malé-Alemany[14] also experiments with phase changing materials such as wax used as a 3D printing material, which is injected through a nozzle, as another example of active fabrication. The wax solidifies in cold water. The formal proposition of these experiments is assessed and the composition of the material changes through reinforcement to offer new formal possibilities with different structural capacity. Work develops not only on changing the composition of material that gives away its emergent properties but on hacking a CNC milling machine by replacing its drill with a home-made deposition nozzle. Matthias Kohler and Fabio Gramazio similarly experiment with robots that by designing algorithmically their paths, they can 'arrange' active foam to create acoustic panels. Finally, Italian engineer, Enrico Dini's[15] works on large scale (6-meter stroke of the printing head) colossal stereolithography from CAD (-CAE-CAM) drawings to 3D objects Z-Corp 3D printing machine sandstone buildings with no human intervention in the construction, thus offering new perspectives in the construction industry.

Informing Materiality and Agile Architecture

"In "Regarding Economy' Adolf Loss argued that the "the old love of ornament" should be replaced by a love of material. In proposing materiality to replace ornamentation, he was advocating the exposure of "inherent qualities" of materials, which has remained an enduring, at times nostalgic, approach towards materiality in architecture. This correlation overlooks Loos's deeper argument of societal values and taste toward materiality, which must therefore be constantly reevaluated and questioned."

Gail Peter Borden and Michael Meredith[16]

The contemporary exploration, questioning and reevaluation of architectural materiality is directed by a new value of architectural creations, which is that of agility. Agility is no longer just a condition or a property of the materiality of the artifact but a value- an objective to be assured, a goal to be fulfilled. The exploration of possibilities to assure agility is unlike the insular research pursuits of an acclaimed transdisciplinary area of digital design where form-generating techniques, study of advanced geometry, development of robots and laboratory experiments on new materials are undertaken. Rather it is an exploration of natural processes that enable us to arrive at a design. By following processes that generate form in nature, processes of morphing in architecture can be generated.

publications/publications.html
11. Aish, R. (2011) Foreword, In: Glynn, R. and Sheil, B. (eds) Fabricate, Riverside Architectural Press, London Architectural Press, London
12. http://web.mae.cornell.edu/lipson/FactoryAtHome.pdf
13. Gramazio, F, and Kohle, M. (2008), Digital Materiality in Architecture, Lars Mueller Publishers, Zurich
14. Malé-Alemany, M. (2010) Machinic Control. Design Experiments with Customised CNC Machines, In. Voyatzaki, M. (ed.) The Design and Fabrication of Innovative Forms in a Continuum, Charis Ltd, Thessaloniki
15. http://www.d-shape.com/d_shape_presentation.pdf. D-Shape

ISSN 2309-0103
www.enhsa.net/archidoct
Vol. 2 (2) / February 2015

16. Gail Peter Borden, Michael Meredith: Matter: Material Processes in Architecture, Introduction

17. "…..genuine creative novelty is not about emulating stylistic trends … instead it is the irruption into the normative sphere of architecture something that touches on the condition of truth :: generic fidelity to the infinite … / … now tell me: which digital architect is concerned with opening up the path for creative novelty that is in tension with generic truth instead of fetishizing the technical and the stylistic … ?" Karl Chu in his facebook page

Architecture in its effort to pursue agility is offered a great opportunity to flourish through the exploration of its materiality through hacking. Hacking the materiality of architecture can render architecture agile. This hacking of architecture speeds up its agility, gives it an active and dynamic role, unlike in the past where its vocation was to latently reflect with a time lapse.

Agile is the architectural act of moving fast towards a given stimulus. The verbs act and react, in connection to the ultimate degree of agility in architecture through hacking its materiality is exactly about the relationship of affect and effect, of influencing and being influenced. It is about the dynamic relationship between the seemingly opinionated designer-maker and the uncompromising matter that in computational design and fabrication loosen up and meet half way through in a reciprocal, giving relationship of mutual respect of one another's dynamism towards a more agile architecture.

As Karl Chu states in his facebook: 'genuine creative novelty is not about emulating stylistic trends … instead it is the irruption into the normative sphere of architecture something that touches on the condition of truth: generic fidelity to the infinite … '. As he explains to use readymade software or even to use readymade scripts will produce architecture of a debatable and parochial style and technical accomplishment. If architecture is about novelty that it can find through hacking. Computation can transcend itself through hacking. Hacking the materiality of architecture is yet another 'irruption into the normative sphere of architecture something that touches on the condition of truth"[17]. Architecture, through this hacking, is there to stimulate, generate and sprawl ideas in order to provoke, stimulate, challenge and revolutionize contemporary societies. In-forming materiality becomes progressively an essential part of the design process and the core of contemporary design thinking, guided by the will and wish for a more agile architecture.

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ISSN 2309-0103
www.enhsa.net/archidoct
Vol. 2 (2) / February 2015

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