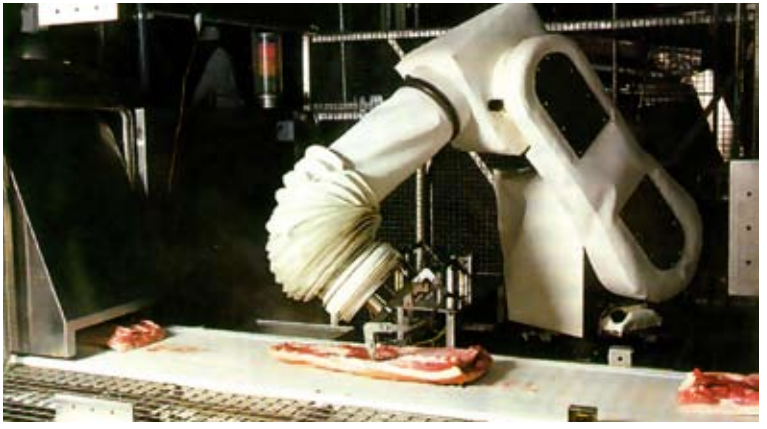
Fig. 1. *"*Robotic butcher slices through pork: doing the work of at least four people" Maclean's Magazine, June 5, 2000



There can be no doubt that digital technology has profoundly altered what we have assumed were the material limitations to our art. While digital tools have allowed us to effortlessly develop new architectural topologies far removed from the traditional constraints of the Euclidean world, the material art of actually making buildings remains curiously rooted in what would commonly be understood as "traditional" forms of construction. If anything can be said about adoption of "digital technology", it is that the wholesale adoption of new technology into the mainstream of architecture, risks the widening the problematic gap between the representation of architecture and its true material expression.

Indeed, architecture through the centuries has experienced a gradual but certain crisis of relevance[1]. At the heart of the problem is the reduction of the making of architecture to a rote task of formal representation. Ironically, it is intention of representation that lurk at the core of digital technology. It is these misrepresentative intentions that have only served to widen the gulf between the idea conceived and its execution into built work.

Craft was the critical bridge between theory and matter. This relationship would be crucial to making architecture. Despite our assumptions about the individual architect as lone vanguard, in the traditional practice of architecture, it was the ingenuity and creativity of the artisan that permitted the leap between these extremities. Using the universal principles of geometry and proportion, the artisan mediated between the world of ideas (the drawing) and the world of physical toil (the construction site). It is within this mode of practice that the vitruvian principles of geometry, proportion, adjustment and tolerance, guide the exploitation of material into architectural form. Both the architect and craftsman shared this understanding of an underlining geometric order of materials. Process, method, intuition and creativity were indistinguishable components of the true artistry of interpreting the manifestation of lofty ideas by the mutable transformation of materials.

Eventually, the artisan's intellectual contribution to built work began to give way to rote execution[2]. But the gradual deterioration of the cultural values that permitted this assumption of roles in architectural production, began to exclude the artisan from a defining role in the building process. Process and method were eventually extricated from the integral whole of artisanship and the entirety of this endeavour was reduced to our current dependence on

manufacturing and fabrication[3]. Architects were increasingly forced to prescribe the precise geometric instructions and methodic material specifications that once were the intuitive domain of the artisan. This was paralleled by the expectation that architects should be able to accurately predict the appearance and experience of buildings by means of perspective and descriptive geometry.

The making of complex form, such as ornament, relied on the transformation of matter using the self-contained and propelled algorithms of geometry, proportion, adjustment and tolerance. If geometry was this scaleless set of idealized spatial instructions then, proportion was its agent of execution in the material world. Proportion was the mechanism by which geometry adjusted itself to the infinity of constraints either found in the natural world or accumulated by the resulting gradual contrivances evolving through the building process project. Within any surface, any space and any opportunity the procedural order of self-contained proportionate algorithms would project themselves, wrap themselves, adhere themselves and even carve themselves into the malleable world. The artisan was the privileged master with the gift of mediating these extremities. Through intimate knowledge of his materials and tools, the artisan was compelled to fill the *horror vacuii* with the intuitive interpretation of the algorithms of geometric proportion[4]. *Amor infiniti*, the love of infinite frames and permutations of ornaments would be interpreted into surfaces, woven through structures and projected into broad spaces[5].

Geometry also exploited the boundary condition of the human body as an idealized prototype for all orders originating from human endeavor. For example Vitruvian geometry can best described as a proportionate spatial relationship between the human body and the material world: A haptic dance of limits and boundaries. This discreet order at the origins of everything manufactured or produced could only intentionally be revealed through the elaborated work of the artisan[6]. Geometric order was intrinsically tied to the gestures of the artisan as they spatially negotiated the crafting of material. The mediation of matter with this order had more to do with the dance of strings, steps, marks, cuts and jigs than the pure and rarefied theorem of what we have come to expect from a “Euclidean” mind. The successful appearance of geometry would depend on the practical artistry of the artisan and his/her seemingly mysterious ability to coax and encourage the transmutation of chaotic form into geometric order. Rather than being a rule, proportion helped with the difficult negotiation between idealized geometry and imperfect matter.

The true genius, then, of the artisan was not reflected in the creation of perfected geometric ornament. Quite the contrary, in the less-than-ideal situation, geometry and craft were forced into innovative discovery: a knot of reaction wood within an otherwise homogeneous surface would force a novel adaptation of geometry, totally responsive to and generated by the imperfection. It is precisely this combination of indeterminacy and non-representational skill that led to the discovery of form, authenticity and uniqueness in the building arts.

Craft and Resistance

One could suggest that Craft is an intentionality embedded in the resistance of the material world to action. When we make something, we engage in a playful challenge to the limits of the material. Play mitigates the resistance of material, whether this material is language or matter. Even though one may begin an engagement with a subjective intention, it will only succeed if it provokes a reciprocal response from an intentionality embedded in the material. Craft depends on the extended actions that this

relationship entails. “something begins with me before I begin”. Instead of predetermining action, we must discover a map of engagement. We must “play by challenging and resisting”[7]. When we play, one challenges the material, it in turn reveals an intentional resistance that provokes yet another challenge, and on and on and on. Craft is the state of play embodied between the challenge and the resistance[8]. This state has is own material incarnation in the tool.
What profoundly determines the nature of the craft is the intermediate materiality we use such as our instruments, our motor skill or even our voice[9].
The reality is that the true generator of form was, in fact, the material process. It is this faith in the material evolution through the consequence of craft that we seem to have lost.

The notion of resistance as essential to making may be taken even further. For Richard Sennett, resistance is a necessity the body cannot do without: “Resistance is a fundamental and necessary experience for the human body: through feeling resistance, the body is roused to take note of the world in which it lives. This is the secular version of the lesson from the garden.
The body comes to life when coping with difficulty”.

Sennett points out that the heart of our contemporary ideology, the idea of freedom and resistance, have their roots in the French revolution. In the years that followed this important event, the streets of Paris were widened and cleared of all obstacles, such as trees and buildings to make way for the physical space of freedom[11]. Paris would be driven by this agenda for years to come, as Hausmann would demonstrate.
Yet liberty as defined by eliminating resistance is really only a perversion of its experience. Liberty is formed by the experience of struggle. Hence, it depends on impurity, obstruction and difficulty[12] An artist would know this liberation as the moment of epiphany when they finally begin to command a difficult medium.
As design educators we patiently apprentice our students to reach that point through drawing and making.

Liberty once divorced from the experience of resistance becomes nothing but an abstract demand. While the experience of resitance is crucial to our aspirations, a culture of liberation; one bent on eliminating resitance once and for all, has a profound implication on our cultural future. In our modern cities, the body has become a passive organism that simply occupies space in the city. Our bodies are intentionally disconnected from space and in time. Our cultural and civil industries are charged with the duty of providing an environment free of “encumbrance, engagement or even effort.” In other words to emancipate us with the last freedom “freedom from resistance”[13].

Even Adorno’s cultural crisis is blamed on the steady disintegration of materials. In this case, the syntactic materials of language and music. Materials have lost what their a-priori self-evidence[14]. Much like the narcissism of the virtual world, our dwindling familiarity with the limits and embedded resistance of material, such as; harmonic scales and even linguistic structure has signaled the triumph of being for other[15].

Our current trend of “designed” objects presents us the product of this disintegration. Our objects have lost their edge – literally. We are being surrounded by the baby-smoothness of new consumer items, like the imac, that are more reminiscent of a nursery toy than utilitarian function[16]. Automobiles for instance, are designed to warmly cocoon our bodies as we reach higher and higher levels of speed and convenience. It is important that we remain unaware of their inherent resistance ie: what pulverized concoction of materials they were made with and what poor souls made them at a barely sustainable wage.

For Philosopher Barbara Becker, The gradual erosion of materiality is at the core of the post modern condition[17]. The new digital interfaces that we are toying with now in digital "space" are conditional on the complete subjugation of materiality[18]. In other words, the eventual result of a digital materiality would be the absense of intentionality. For Becker, this is precisely the problem with virtuality. Even if we were capable of reducing the material world to a subjective consciousness, that discourse would be grounded within the lexicon of the phenomenal world[19]. Ultimately this would create an even worse world than we have now. For if we deny our embedded intentionally we are only existing in the world for ourselves without the other: an almost textbook definition of narcissism[20].

It is at this point that we may be able to turn to the dilemma that we are currently in. The resistance of the material and its cycle of engagement is what generates craft[21] . If making is dependent on the embedded resistance of the material, how does one make when the material itself is isolated as pure subjectivity? In this case it is not enough to merely resist for the sake of resistance itself. The danger being that somehow we would devalue the work to something ephemeral rather than lasting. In Adorno's words it would focus only on a "bogus promissory note on the future"[22].

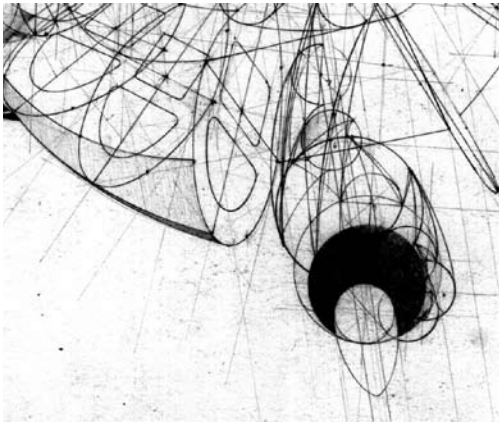
The representation of digital space is undergoing a fundamental transition: From the highly precise facsimile of traditional Euclidean geometry, that we currently use in most CAD and modelling software to the visual interpretation of dense data arrays, as is emerging in GIS (Global Information Systems). This shift from a Vectorial world to a bitmap world is perhaps the most challenging to our historical and perhaps necessary assumption that Euclidean geometry, such as proportion and projection, is at the heart of making architecture. Does this shift imply an ultimately fatal divorce from the Vitruvian tradition of architecture through geometry or is it re-directing the interaction between computers and architecture into perhaps a more appropriate and creative realm of opportunity?

After more than ten years in development, Rapid Prototyping has evolved into an established technology for the translation of digital form into physical reality. This technology is now used in industry, industrial design, and occasionally in architectural visualization. To date, the practical use of the diverse methods used in prototyping have been limited by a small scale and high production cost. Because of these assumed limitations, there has been little research into the potential of larger scale applications for the construction and design industries.

With the practice of the patient and experienced artisan as almost extinct in all disciplines, a re-evaluation of our relationship to emergent technologies found in the hard sciences, engineering and manufacturing are in order. The key to this new opportunity is in how the architect necessarily interfaces the digital realm with the making of the work.

However**,** a technology that could effectively translate what is architecturally designed in the virtual environment into substantial form could have profound implications for both the building industry and the design disciplines. The ability to physically realize the current sophistication of designed form would, in general, elevate the standards of both the building industry and the design professions. More so, the ability to fuse traditional construction methods with computerized visualization systems will have a profound impact on the efficiency and cost of the design-construction relationship.

Figure 2: Patrick H Harrop: Black Flag stereometric series



It could be said that the very craft of the artisan *is* this relationship between algorithm/interface/world. Proportion and geometric order are idealized mathematical constructs (interface) yet the preoccupation of this "interface" is its application to the surface of the real and tangible world. Although geometry and proportion are idealized mathematical states, we all know that site and context are never such a case. In fact, this is the purpose of the artisan: the art of reconciling the idealized and the real through the interpretation of craft. In other words, the algorithm must meet the real world through the dialectic of geometry and resistance.

A possible avenue for us would be to re-evaluate the very idea of control and predictability in the making of architecture and examine the possibilities of strategy as opposed to prediction. We put ourselves in the company of many science fiction writers who have already dreamed about the possibilities of a robotic architecture; nano scale robots that mix concrete, plaster and polymers and gradually build structures over an extended period of time[23] bio-engineered cells that organically cultivate buildings using the genetic map of plant life[24]; construction automata or "waldos" each with specific algorithmic tasks to carry out a building project[25]. In all of these literary scenarios, the resulting architecture is complex, rich and dense specifically because of the unpredictability of the end result, especially when the same artisan technology is used by competing interests. In these imaginative schemes the builder is hardly controlled, yet the strategy is clearly one of tolerance, adaptability and reconciliation of the algorithm (the idealized geometry) with persistently "adversarial" contexts (our lived world).

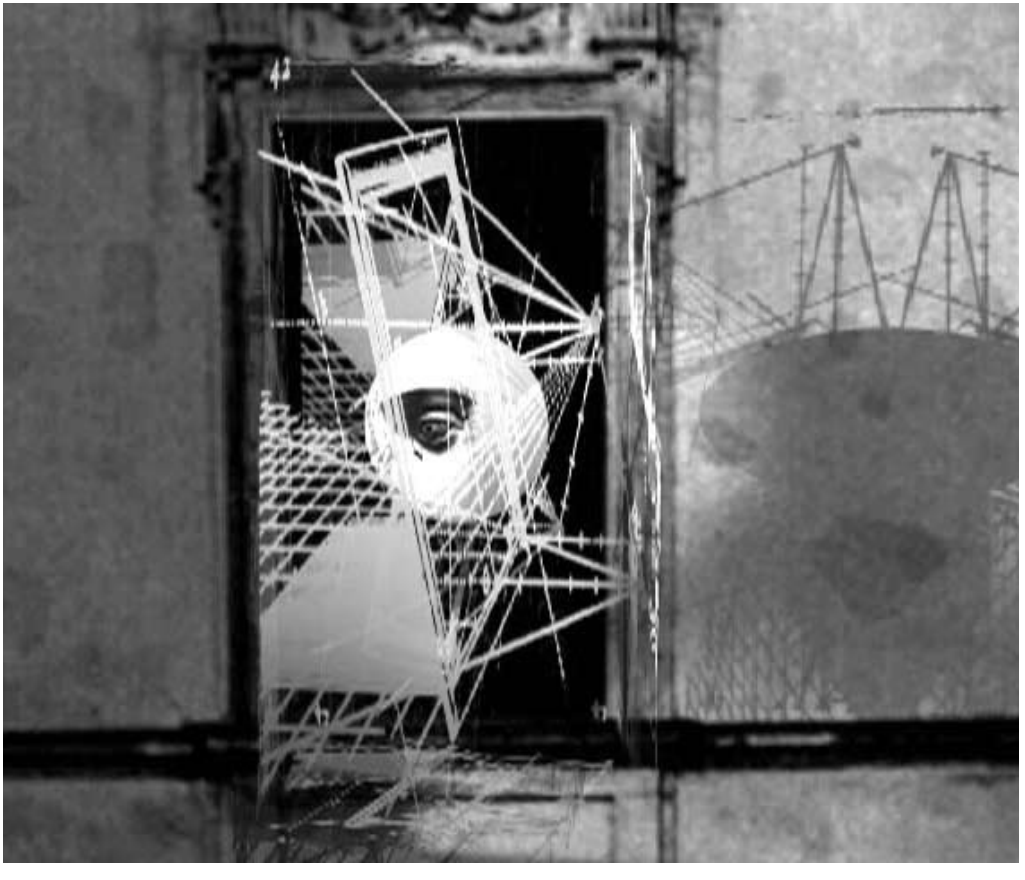
The implications for an alternative and experimental practice could be far reaching. The architect could adopt a role similar to an orchestra conductor, coaxing the ensembles of algorithms to a pre-determined and classical score or better still, strategically setting the field for an improvised work whose outcome is responsive to the immediacy of the environment, interaction of the players and the inspiration of moment itself. Architects could become directly involved with the tools themselves; creating tools that respond to specific technical or environmental tasks, or even the creation of whimsical ornamental detailers that are merely sent into the fray of the construction hive. An entire community of exchange could emerge where algorithmic tools, rather than abstract ideas, become the currency of ideas in the experimental art of building.

Philibert de l'Orme limits his discourse to the machinations of stereotomy for masonry construction[26]: And finally J.J. Lequeu further limits his inquiry of tools to drawing instruments completely bypassing the issue of construction altogether[27]. It is perhaps this contemporary absence of any discourse about the instruments of architecture that is telling about our relation to machines in architecture. The truth is that architecture has always been about the art of building: building as a *verb* as opposed to the *noun*. The art of building is a civic act, sometimes a dramatic spectacle whose orchestration demands the fluid and tolerant principles of geometry, proportion and adjustment as

the foundation for improvising the creation of a building project.

The true viability of these technologies and their implications to the design culture of architecture have been explored in several research initiatives and analogous experiments developed by the author. The potential of such possibilities, given the pace of advancements in computer technologies, robotics and material sciences, seems to be clear, the realization of this idea at the scale of the building arts has been an especially challenging one for a variety of reasons. Yet every indication seems to suggest that the technology is potentially there and waiting to be put together.

Figure 3: Patrick H Harrop: Shadow Robot from (anna and meta morphosisters: video)



Notes

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