ABSTRACT
Advanced software and robotic fabrication tools have made possible an unprecedented level of formal complexity in design. So pervasive is this development that many architects today consider matter and the productive forces shaping it, as central to the meaning and purpose of their work. A “new materialism” now constitutes the founding metaphysics for most of the discipline. But as the capabilities of technology continue to evolve, difficult questions about the limits of computation and the nature of intelligence inevitably arise. This runs thinking directly into the philosophical impasse of the mind body-problem. What happens then to the veracity and cultural value of the digital avant garde when subjective mental states resist persistent attempts to reduce them to physical processes in the brain? If the term “spirit” implies the quest to understand who we are and how we fit into the natural order, then architecture will have to become more than just a material practice.
"I believe that eventually attempts to understand the mind by analogy with man-made computers will be recognized as a huge waste of time." — Thomas Nagel (1986, p. 16)

Beginning in 17th century the universe was imagined like a giant clock obeying the predictable laws of classical mechanics. Later, Sigmund Freud, inspired by the steam engines of his day, described psychic processes in terms of circulating pressures released as vivid images in dreams. Today, computers have become the dominant technology creating a zeitgeist based on digital media. But can computation accurately account for the world and its diverse inhabitants? Are people reducible to physical switches, abstract bits and programming? Or is computation merely another paradigm that routinizes perception and locks us into a particular way of thinking? If the latter case is true then how do we overcome these models and allow art and design to operate as critical methodologies focused on our liberation from newly minted and constantly evolving, techno-centric meta-narratives? Unlike traditional critiques that focus on historically established tropes or post-critical practices that emphasize novelty over analysis, an alternative strategy can capture the best of both worlds. By considering evolving trends and the 'scientistic' zeitgeist as targets for deconstruction, newness is engaged without privileging any single frame of reference. This approach allows us to hold technology 'at arm's length' while keeping pace with contemporary developments in engineering at a time of 'accelerating change'. Along these lines this essay attempts to articulate fundamental flaws in the materialist conception of nature and the paradigms that underpin current thinking in the field of robotics, artificial intelligence, and the 'computational theory of mind'.

Any comprehensive understanding of reality must account for the existence of conscious life. If an ambitious 'theory of everything' can’t do this, then it should be abandoned. The notion that our world and all of the creatures living in it are just universal machines running programs seems highly implausible. By exposing the problematic reduction of minds to hardware and software the critic/builder can actively participate in the search for a truly "New Kind of Science", a science that "takes consciousness seriously" (Chalmers 1996, p. xi).

With the advent of algorithmic architecture, a rational approach to building that derives its value from the expression of discrete, mathematical functions, e.g. genetic codes and recursive systems, we see an almost complete return to the Modernist preoccupation with formal abstraction. Might it be possible then to openly examine the contingent, "value-laden" nature of these founding principles? Might it even be possible to suggest the futility of erecting any sound metaphysics on the basis of language itself? Certainly, consciousness must exist before we can form words and concepts. (An infant can perceive things without ever knowing their names.) But just as the fine-grained details of the world outstrip our ability to adequately represent them, conscious experience must be, in some basic way, non-conceptual or better still pre-linguistic (Note 1). That is, it cannot be turned into an object of thought, a word or an image, and since codes and computations are also languages, it is hard to see how they can encompass
non-representable phenomena. On this account the mind seems to be empty of any concrete form, essential content or fixed identity. Fundamentally, it is a property that cannot be reduced to something more basic. The belief that brains, Turning Machines or even analogue systems can give rise to subjectivity makes little sense in this context especially, if awareness is not produced by anything antecedent to it.

Another way to distinguish computations from consciousness is through the concept of a-temporality. Algorithms are step-by-step processes implemented in time. They leverage memory and logic to calculate results. But experience seems to be very different; it does not, by definition, exist in the past or the future. It is in effect timeless. Only through the selective conceptualization of what has happened already and what might be (nostalgia and desire) can anyone say they sense the flow of time. But this flow is a constructed illusion that does not exhaust or explain being itself. (If awareness is always in the “now” then for an observer there is no becoming—only an eternal present that is unchanging and without duration.)

This brings us to the heart of the problem of defining what consciousness is and how we understand the relationship between subjects and objects. When I find myself enthralled by the blare of a trumpet or mesmerized by brilliant light from an orange sunset, what I actually perceive is confined entirely to a first-person perspective. No matter how much scientists know about my brain and its biochemistry, they will never be able to know exactly how I feel. In fact what it is to actually hear, taste, touch or see will be entirely absent from any empirical description of outwardly measurable structures, functions and behaviors. In other words, as philosopher Thomas Nagel writes, “If the subjective character of experience is fully comprehensible only from one point of view, then any shift to greater objectivity—does not take us nearer to the real nature of the phenomenon: it takes us farther away…” (Nagel 1979, p. 174). Yet, another approach to explaining the difficulty of reducing mental life to observable, spatiotemporal phenomena comes from Frank Jackson’s canonical thought experiment about Mary the colorblind neuroscientist. Mary knows everything there is about the physical process of color perception, but she was born and educated in a black and white room. Despite her understanding of anatomy and optics she has never actually experienced any red things. Her understanding is, therefore, lacking something crucial, namely what colors are like from the inside. This observation bears directly on materialism, computation and the mind/body problem.

To define mental life as an emergent property of the brain makes little sense here. Epiphenomenal theories fail to explain how subjectivity arises from dead matter because they ignore what it is actually like to be aware. In other words how can an ineffable, yet internally accessible reality like personal experience arise from such a concrete, externally posited thing like a neuron? The connection remains a total mystery, and it should cast serious doubt on ‘Neo-realist’ attempts to endow material systems with overarching explanatory power. (Remember, consciousness is unmeasurable, formless and without
time.) When our understanding counts mental life as fully reducible to atoms in motion or worse, automated symbol manipulation, then its veracity as a totalizing metaphysics is diminished. If such insights are to be meaningful for contemporary architecture they must be posited from within the discipline of digital design in a way that can be expressed in built form, using the same terms employed by the algorithmists themselves. In this way language can be seen as a tool for exposing its own limitations either through silence or by placing emphasis on meanings that are undecidable. In other words we can “un-code” the “coding” process through an engaged practice rather than merely rejecting computationalism out of hand. As good a place as any to start this critique is with the now fashionable interest in computer-generated ornament.

AUTOMATION AND THE PICTURESQUE

Cellular automaton programs (CAs) consist of discrete cells (black or white, transparent or opaque, hollow or solid) organized into small groups, or neighborhoods. The configuration of each neighborhood is used to determine the future state of the next generation of cells. Different kinds of patterns can be produced by either altering the code or changing its starting conditions. In an auto-masonry wall composed by simple programs every brick affects its immediate neighbors and the order of the whole. Because the system is very sensitive to small changes, the state and position of each brick matters. (What results is not dependent on a continuous differentiation of parts, but on the application of fixed rules in a discrete composition that requires only two primitives.) Here building details obtain their complexity for free: no external agent or extraneous system is needed to design them (Note 2). This expression of part-to-part and part-to-whole coherence follows one of the guiding principles of modernism, but with a difference: structures driven by simple programs need not be reduced to a limited inventory of ideal types. A brick does not only want to be an arch. The best way to know how a given rule will behave is to set it in motion.

For the San Jose State University Museum of Art and Design competition (2003) a ‘class two’ CA (Note 3) was used to produce both open and closed surfaces from straight courses of stone and glass block. Rooms with windows and galleries requiring large, blank walls for display were laid out in accordance with the client’s brief. Once these parameters were set in place a search was made through multiple iterations in order
to find the most appropriate patterns. For the museum’s exterior and internal subdivisions a five-cell, outer totalistic cellular automaton (Note 4) were found that generated intricate fenestration on the lower floors and windowless walls above. In other words the project’s rules and initial conditions produced the negation of their own porosity generating constraints. (Thin masonry screens containing stairs and elevators were created in the same way using a different sequence of starting blocks.) While the surfaces of San Jose are not themselves governed by structural necessity, they are also not applied decoration. Irregularly spaced bricks at the project’s base determine concrete column locations, which in turn affect beam depths, frame layouts and the overall organization of space. On both the micro and macro scale each element is co-dependently produced. Far from a routine minimalism achieved through the prohibition of intricate details, unadorned surfaces emerge systematically out of heterogeneous patterns that eliminate themselves. Literally, ornament self-organizes its own disappearance. This approach escapes the narrow dialectic that pits excess on the one hand against a strict return to simplicity on the other.

A critique of computationalism in built form can be accomplished by exploiting an important yet less frequently acknowledged feature of simple programs. Consider the two images shown in Figure 3. The first looks random while the second appears as a more coherent set of nested triangles. Where one image seems flat the other can be perceived in low relief. Both were produced algorithmically, but there is nothing in the second rule set that specifies a z value. The perception of three-dimensional space is entirely dependent on the presence of an observer. Flatness and depth in this comparison clearly foregrounds the difference between subjective awareness and code. A similar effect is exploited in the San Jose design.

Through paranoid critical eyes the project can appear like a ruin, forlorn, entropic, dissolving slowly into the ground. The same form can be interpreted in reverse as tall brick tower rising vertically toward the sky forming a closed white box. This double reading is important for two reasons. On the one hand it shows how our cognitive faculties are able to derive evocative content from totally abstract forms. In other words there is something it is like (Nagel 1979, p. 166) to feel architecture. Turing Machines can’t experience anything. Since awareness is non-physical, subjective and timeless no switching devise or piece of software will ever be able to truly understand the information it processes (Note 5). A smile on a robot has no depth if there isn’t anyone behind it. This is why the computer that beat chess master Garry Kasparov did not enjoy its victory (Chalmers 1996, pp. 94-99). While nothing physically collapses in the museum, there is still a palpable anxiety produced by its comparison to a death trap with visitors menaced by a simulation of falling masonry. On the other hand as a literal unit-by-unit calculation changing from simple initial conditions to complex fenestration to blank walls that abruptly terminate, the project implies the expressive limits of computation in yet a third way. If the first reading regards the art market suspiciously as a grim conflation of consumerism and death the second produces an instrumental transition that is
both organic and uplifting. San Jose can be seen as a building rising in stages towards increasing levels of emptiness. Through long rectangular apertures located above its blank surfaces the project reaches into an infinite void of light. This vertical progression is ultimately a move beyond glass and stone, ornament and structure, use and uselessness, inside and out, container and contained, minimalism and the baroque, memory and desire, here and there, becoming and nothingness. Above the roof the ‘machine stops’ and all dualities vanish. At this moment without hope or nostalgia architecture opens spontaneously into a boundless freedom existing before the establishment of codes and constraints, prior even to the division of the perceived world into 0’s and 1’s.

**SERVANT ZOMBIES**

In early 2012, following the success of its driverless vehicle initiative, the Defense Advanced Research Projects Agency (DARPA) issued a call to engineers around the world to develop bipedal robots capable of performing a wide variety of tasks in real world environments. The main goal of the challenge was to spur the creation of machines that could be used on disaster sites like the now defunct nuclear reactor in Fukushima, Japan. But couldn’t these technologies also be employed for more creative purposes?

Developing tools for building complex ‘automasonry’ structures followed two primary tracks. The first pursued the creation of a cell phone ‘app’ that specified block types using a simple MP3 player, while the second explored possible applications for humanoid robotics. Moving digital fabrication out of the factory and onto the job site represents an important shift away from current approaches that mainly focus on stationary devices kept indoors behind cages. As chip speeds and sensors continue to improve, it becomes far less difficult to build sophisticated hardware endowed with increased degrees of autonomy and situational awareness. Highly mobile devices have a key advantage over stationary systems because they can work alongside people and relieve some of the difficulties associated with dull, dirty and dangerous jobs. They are also incredibly flexible and can potentially outmaneuver even the most advanced numerically controlled articulated arms. As Bill Gates once remarked, “…think of the manufacturing robots currently used in automobile assembly lines as the equivalent of yesterday’s mainframe computers” (Gates 2007, p. 60). In the same turn digital tools with eyes, legs and fingers force us to consider the difference between skilled labor and computers. While no one can say with absolute certainty that sentient machines are an impossibility, assuming we had the knowledge would we still want to mass-produce them? Technologies with feelings will deserve the same rights as ordinary workers, which simply means that they cannot be exploited. Owning a slave is bad for the master, but it is even worse for the slave! Non-conscious, Servant zombies are preferable because they’re incapable of suffering and because they can be used as extremely powerful extensions of our own bodies. (A driver doesn’t want to ask her car if it feels like going to the supermarket for milk.) But without consciousness these systems will end up having serious limitations, and that’s a good thing. Far from being threatened by extinction, humans can maintain their worth
by making creativity, aesthetic judgment and social intelligence highly valued resources in an increasingly automated world. In the bargain, workers might also acquire new skills as operator/programmers capable of enhancing the behavior and operating capabilities of their equipment. Just as new industries fuelled the rise of Modernism in the early twentieth century, the inevitable development and potential ubiquity of autonomous and semi-autonomous technologies implies the need for a critical assessment of how the building design and construction industry will change over time. Along these lines we can point to a series of important shifts in computer-aided fabrication that are just now coming into focus:

**HUMANOID HOUSING PROTOTYPE**

As a self-organizing construction system, this prototype loft uses robotically manipulated sandstone blocks to produce an endlessly adaptable live/work studio and private garden. The project consists of individual masonry units that are periodically reconfigured into display platforms, chimneys, stairs, and temporary walls. The space is even able to turn its own interior pavement into fully enclosed sleeping cubicles or an expanded banquet table with chairs. When desired the entire contents of the building can be dismantled back into the floor producing a large, empty space for special gatherings. In this way, architecture makes and un-makes itself through a flexible tectonics adaptable to changing needs and social situations. The most complex part of the project is a wirelessly-controlled humanoid equipped with advanced machine vision technologies. It has a universal payload gripper, fingers, toes, and wheels that enable it to walk on two legs or roll on four and climb tall brick ladders. When not in use the bot connects to a brick enclosed recharging station like a crab returning to its shell. Who knows, maybe if you’re really thirsty, the apartment will even get up and fetch you a beer from the fridge.

**CONCLUSION: MINDS IN A CLOUD**

In the early 1980’s engineers working in the field of artificial intelligence and robotics formulated what is today known as Moravec’s Paradox. It is based on the observation that tasks which humans find difficult are often easier to automate than those we do unconsciously. Brute force data processing, for example, is a function computers accomplish with relative ease. Walking around and interacting with the world (using twentieth century technology) is far more difficult. One explanation for this disparity is that nature
took a long time to perfect sensory motor skills in animals whereas high-level reasoning is a more recent development. But is this hypothesis really supportable? What about idiot savants who exhibit extraordinary computational abilities? Aren’t they in some way perfectly evolved biological calculators? If so, then there is really nothing particularly novel about abstract mathematics. Because the brain co-evolved along with other parts of the body these abilities could be like innate mental powers that are much older than we think. But more important for now is the fact that Morevec’s paradox also falls apart in the other direction. While we are still only in the early stages of designing machines that can manipulate objects and navigate terrain with the same ease as humans, the engineering obstacles are now much less daunting than they were only three decades ago (see Honda’s Asimo; and Ishikawa Komuro’s High-Speed Robot Hand.) Also, it took nature millions of years to evolve legs that could walk upright. Scientists were able to do it in a much shorter time. The really difficult challenge to the field still involves what philosopher David Chalmers calls the “hard problem” of consciousness.

Figure 8
Bricks ascending a staircase. At each step the machine is able to maintain a relatively level payload.

Figure 7
(a) Two fully functional ABS 3d printed and titanium-sintered robot prototypes; (b) A medium-scale humanoid mason uses an onboard video camera to navigate space and track objects in the environment.
While no one would want to automate away their enjoyment of life, certainly the amplification of our senses through increasingly sophisticated means is highly desirable. In this respect buildings are like robots that serve our needs and desires. Buildings can also be thought of as physical extensions of the mind. Unlike other people, buildings are tools that can be used. The existential threats posed against humanity by smart machines are serious not because they might one day have emotions but because they are automatic like bad habits or a nuclear missile that is impossible to recall once launched against a target. To put it bluntly, sentience isn’t really an engineering problem. Because mental states cannot be objectively measured nor considered as bi-products of something more basic there is essentially no way to know which design approach will work or if indeed it succeeded at all. (Robots with biological brains are no exception.) It is, therefore much better to focus our efforts on creating mindless, and highly manageable AI that embodies simulated intelligence in the external world. Think here of the amazing potential of cloud coordinated, BIM connected, co-robotic helpers producing an ever-expanding ecology of humans and machines. Certainly, this vision of the future holds great promise even if its disturbingly life-like, semi-autonomous agents elicit puzzling questions about what consciousness is and how far machines can evolve. But the fact that we have absolutely no idea how subjective experience connects to the brain means that there is still a huge gap in our knowledge of the real. The physical world might actually be a far more interesting place once this relation is better understood, if indeed such a possibility is even open to us. As the mysterian philosopher Colin McGuinn has argued, insight into the link between awareness and matter might be "cognitively closed" to beings with our kind of mental capabilities (Note 6). But if a solution is possible it suggests that we will need an entirely new understanding of nature, one that many believe is "...reserved for a distant intellectual future" (Nagel 2012). With the mind body problem still unresolved we can only guess at what is really happening in the world and how we relate to it. What this basically means is that our current architecture theories need a serious dose of methodological doubt to guard culture against over-simplified views. On this account the "new materialism", shored up by empiricist thinkers like Gilles Deleuze, is either totally false or at best not new enough.
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NOTES

1. See Stanford Encyclopedia of Philosophy (2011) for an explanation of Tim Crane’s and Christopher Peacock’s notion of nonconceptual mental content.

2. This does not mean, as some have suggested, that authorship and individual expression are denied in a design process that employs self-organizing systems. Actually, it is the architect who writes the code, adjusts its starting conditions and determines the fitness of the resulting pattern based on an open reading of the client’s needs. But the author is not an absolute dictator either. Instead, “design agency” is distributed in an expanded network of interacting processes involving simple programs, material effects, and personal taste.


4. ‘Outer totalistic’ is a shorthand format for specifying cellular automaton rules.

5. While Turing Machines cannot be conscious this does not exclude the possibility that some future biomechanical system could have a mind (Warwick 2012, pp. 317-332).

6. For a more extensive description of “cognitive closure” see Colin McGuinn’s The Mysterious Flame (McGuinn 1999).
NOTES


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