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Compelling Yet Unreliable Theories of Sustainability

Theories of sustainability in American architecture are contingent upon a number of compelling yet unreliable claims that condition the discourse and practice of sustainability. This article identifies illustrative examples of these claims and discusses their importance today. The intent is to emphasize the cogent aspects of these claims while also discerning other approaches to sustainability. The major conclusion is that teaching technics and the expansion of the concept of context constitutes the most productive means for the advancement of sustainable practices.

> *There is an ecology of bad ideas, just as there is an ecology of weeds, and it is characteristic that basic error propagates itself* —Gregory Bateson[1]

In the case of the unreliable narrator in fiction, the compromised credibility of a narrator becomes evident through narration that is at once compelling yet fallacious, biased, misguided, or otherwise misleading.[2] As a device within fiction, this type of narration slowly compromises its reliability and thereby alters the reader's interpretation of a text. In doing so, such narration opens up new perspectives on previous events and ideas in a text. Consequently, the reader comprehends previous content in new ways.

In what follows, I contend that the discourse on sustainability unwittingly follows the logic of an unreliable narrator. Some of its assumptions are biased, misguided, or misleading. These claims include what I describe as the *Energy Crisis* and the *Construction Industry Waste* claims. I also discuss the claims central to *Technological Determinism* and *Vernacular/Regional Determinism*. Over the years, these claims have compelled policy and action, but they contain limitations.[3] To be clear, I do not contend that the protagonists of sustainable architecture are themselves personally unreliable. Rather, the claims at the base of common approaches to sustainability prove unreliable. The aim here is to reconsider this basis. In doing so, I intend to amplify sound aspects of these claims while also proposing other approaches to sustainability engendered by a more thorough understanding of technics and context.[4]

Claim 1: Energy Crisis

Prior to the oil shortage in the early 1970s, issues pertinent to current sustainability in architecture were pragmatic topics devoid of rhetorical exaggeration. Researchers such as James Marston Fitch and Victor Olgyay developed environmental issues primarily as technical, albeit provocative, advancements of modern architecture.[5] After the oil embargo, this attitude changed. The temperament of topics related to the sustainability of architecture shifted from the literal and actual to the rhetorical.

Since then, claims about the scarcity of energy resources have routinely been used to warn of an impending energy crisis. These claims have become pervasive in our culture, reestablished by periodic spikes in the price of oil. In time, these claims have become a core component of sustainability. Introductions to several books on sustainability in architecture base aspects of their arguments for sustainable practices on statistical claims about potential energy shortages.[6] In the context of certain resources such as petroleum or coal, such claims are valid. But when considered broadly, the claims can be shown to be rhetorical escalations designed to incite awareness and urgency rather than foster reflective and intelligent practice. As Figure 1 demonstrates, there is in fact no real energy shortage. There is only a crisis of human choices in respect to our energy practices.[7] Every building site—every milieu—is a vortex of surplus solar-induced energy. As George Bataille noted, ''On the surface of the globe, for *living matter in general*, energy is always in excess; the question is always posed in terms of extravagance. The choice is always limited to how the wealth can be squandered. . . . Hence the real excess does not begin until the growth of the individual or group has reached its limits.''[8] Architects compelled by the *Energy Crisis* claim underutilize this excess.

In architecture, one response to the *Energy Crisis* claim has been the paradigm of conservation. In this paradigm, the aim of the good is to do less bad. While conservation is well intended, it is a thermodynamically pessimistic paradigm and ultimately a futile pursuit. By focusing on reduction

1. Daily arrival of solar energy on earth compared to other energy quantities. Based on William P. Lowry, *Atmospheric Ecology for Designers and Planners* (New York: Van Nostrand Reinhold, 1991), p. 317.

Solar energy received by the sun each day	**1**
Melting of an average winter's snow during the spring	10/100
A monsoon circulation between ocean and continent	10/100
Use of energy by all mankind in a year	**10/100**
A mid-latitude cyclone	1/1,000
A tropical cyclone	1/10,000
Kinetic energy motion in earth's general circulation	1/100,000
The first H-bomb	1/100,000
A squall line containing thunderstorms and perhaps tornados	1/1,000,000
A thunderstorm	1/1,000,000,000
The first A bomb	1/1,000,000,000
The daily output of Boulder Dam	1/1,000,000,000
A typical local rain shower	1/10,000,000,000
A tornado	1/100,000,000,000
Lighting New York City for one night	**1/100,000,000,000**

rather than production, conservation conditions architects to work on the wrong problem. It diverts architects from a more optimistic approach grounded in the surplus and excess described by Bataille. In contrast to the conservation paradigm, the aim for architects should shift from using less energy toward the means of *capturing*, *channeling,* and *producing* energy available in the milieu of a project.[9] For example, current building physics consultants such as Transsolar, Atelier Ten, or Peter Meierhans work to maximize the thermodynamic potential of a building in its physical milieu and demonstrate a more optimistic mode of practice. The paradigm of conservation, on the other hand, remains focused on mitigating the problem of what Reyner Banham described negatively as ''power operated solutions.''[10] The building physics consultants seek the integrated ''structural solutions'' that Banham sought. The claims and techniques of conservation limit an architect's conception of a project's milieu.

The energy in the milieu is maximal, not minimal. As such, architects need a more imaginative yet real conception of the physical milieu of architecture. A pedagogy that exposes architects to the full vitality of this milieu would focus not only on maximizing available energy resources but would consider the relationship between energy and our technics as well.[11] Technics refers to the broader context of technologies, as embedded within a historical, social, economic, ecological, and intellectual framework. Regrettably, architecture tends to teach its technical practices as isolated and technologically determined rather than socially constructed. Technology in other disciplines is a variable of social practice and progress, not its determinant. As Gilles Deleuze has stated, ''Tools always presuppose a machine, and the machine is always social before it is technical. There is always a social machine which selects or assigns the technical elements used.''[12] Social needs and desires predetermine any technical system. For example, the social, economic, marketing, and physiological history of air conditioning technology is central to the conditioning of spaces, people, and energy practices in the twentieth century. As Gail Cooper demonstrated, the marketing and social choices of air conditioning determined as much about the development of air conditioning as its engineers.[13] As such, the somewhat irrational history of air conditioning marketing is more central to its widespread use than its efficacy as a means of achieving human comfort. As these systems developed over time, the habitual conditioning of spaces, people, and energy practices with air conditioning systems became a prime factor in the perception of an energy crisis. The relationship between air conditioning and energy use has been determined socially rather than scientifically *and so will its alternatives*. When presented as socially constructed, architects can understand the positive and insidious possibilities of conditioning and develop alternate modes. Such instruction belongs alongside conventional pedagogical approaches to the technical descriptions of ''environmental control systems.'' Merely teaching architects the technical components, systems, conservation strategies, and their integration in ''environmental control'' courses limits the horizon of sustainability.[14]

Claim 2: Construction Yields Half of the Landfill Waste and Buildings Consume Half of the Energy in the United States

A litany of statistics about the material and energy wastes of buildings is a common rhetorical device in American sustainability. These statistics are central to the introductory arguments for numerous books, articles, and Web sites on the subject.[15] The statistics draw attention to the role of the construction industry in a context of increasing consumption and diminishing resources.[16] Yet, one must also keep in mind another statistic that should temper responses to these statistics: all architecture firms represent about 3 percent of the total construction economy in the United States.[17] The other 97 percent comprises everything from road construction, bridges, and other infrastructure in addition to buildings not designed by architects. Consequently, architects are directly in control of 3 percent of the waste flow so often cited. While architects clearly need to provide leadership through example and affiliation, architects in conventional practice are not as immediately empowered to alter these industry-wide statistics as the claims suggest. In the arguments about material and energy waste, these statistics routinely overstate architecture's direct ability to affect waste flows.[18] Architecture is one among several culpable industrial parties. Our technics contain energy and material flows unimaginable to many architects trained to view buildings as autonomous objects rather than extensive systems. Effective strategies for construction waste must address the reality of larger, more systemic problems. Architects certainly have a role here. However, the rhetorical escalation of our role in conventional practice obfuscates cogent strategies.

One response to these statistics has been recycling. Recycled steel, reclaimed wood, and leased carpet are obvious and necessary choices in building production. However, it remains an open question whether recycling reduces consumption or merely engenders ever-increasing consumption.[19] While the habit of recycling has increased, so have more depleting forms of consumption. These larger consumptive habits dwarf recycled content.[20] In terms of electrical illumination, Michelle Addington has demonstrated that increased square footage in construction negates the gains made in energy efficiency over the same period, resulting in a net consumption of resources.[21] This logic of negated efficiencies applies to recycling as well.[22] By recycling, we often consume slightly less as we consume more and more overall. Once again, the aim of the good is to do less bad. Recycling, like conservation, distracts architects from identifying and working on the right problem. Beyond the common sense impulse to specify materials with recycled content, architecture should develop much deeper knowledge about the material effects of the construction industry.

All material produces profound effects that exceed the aesthetic or technical ends that determine most specifications for construction. The specification of material in architecture immediately implicates a vast network of effects.[23] These effects range from the molecular to the territorial and include social, economic, and ecological implications.[24] Architects are disproportionately aware of the constructions they propose and woefully unaware of the inverse architecture of material extraction, production, and transportation. Material knowledge should not focus merely on the properties and performance of materials in building assemblies. Rather, architects should grasp the way materials fundamentally organize, animate, and transform life. The production and application of materials alter unseen ecologies, sway local and distant economies, amplify or inhibit social progress, and even engender the rise and fall of cultures. Only architects with an operational sense of the history, processes, and distribution of materials will sufficiently comprehend and thus alter material usage toward sustainable ends. This suggests a pedagogical approach to material knowledge more closely aligned with the Annales School than materials and methods alone.[25] For Fernand Braudel, the material exchanges in the commerce, geography, and climate of everyday people and habits were the focus of his pan-disciplinary approach to history. In his view, these practices accumulated into a more consequential history than more prevalent narratives of major historical figures and events. Similarly, architecture must extensively consider the material effects of our practices in order to amend the material flows within the construction industry. Then, *along with the construction industry*, architects would thereby realize what Ulrich Beck describes as ''reflexive modernization'' and practice effective material sustainability.[26]

Claim 3: Technological Determinism

Our culture frequently perceives technology as a compelling approach to sustainability. For many, new technology is the key to sustainable practices. This approach is evident in a building such as Renzo Piano's project for the New York Times Headquarters as well as the battery of engineering consultants, computational hardware and software, and technocratic programs such as LEED that engenders such a building. The success of technologically determined practices imparts the impression that technology and its quantitative authority guarantee a degree of sustainability. This is what David Noble describes as the ''machine mentality'' of our culture: no matter what the problem, technology is the solution.[27] Commenting on this approach, George Grant stated, ''We can hold in our minds the enormous benefits of technological society, but we cannot so easily hold the ways it may have deprived us, because technique is ourselves.''[28] If technique and technology are ourselves, we should temper our assumptions about its role in sustainable practices because technology, by itself, is unreliable.

While technological developments often amplify prospects for sustainability, we never cultivate proper technological management practices that would account for the constituent by-products of a technological world. Three Mile Island, Chernobyl, and Hurricane Katrina represent large-scale examples of failed technological management. In these cases, society unduly demands of technology what it cannot reliably provide: assured protection from hazard. Today, the difference between vibrant life and utter destruction increasingly becomes a problem of risk management based upon calculations of what is just less than hazardous. We manage the risks of technology with outmoded methods that assign culpability to individuals and individual causes. However, broader personal, political, and industrial choices actually produce this context of risk, *not individuals or individual technologies*. Hazard increasingly characterizes our world, what Ulrich Beck calls a ''Risk Society.''[29] The threats, sources, and effects of these hazards can no longer be isolated to any single culprit or cause. In our age, the sources, sites, and effects of catastrophe approach the continental and the global. Risk now leaves no life, and no aspect of life, untouched.

In our culture, there is precarious asymmetry between technology's *capabilities* and its *culpabilities*. While technology may engender and accelerate progress, it will minimally manage its associated risks. Technology offers no automatic security or promise on its own. Only the agency of personal and collective choices will determine sustainability. As David Noble stated, ''There are no technological promises, only human ones, and social progress must not be reduced to, or confused with, mere technological progress.''[30]

Without critical reflection, technology is as likely to engender, as it is to annihilate unintentionally, sustainable possibilities. In this view, sustainability is principally a subject of our technics, what Lewis Mumford called ''The Machine.''[31] ''The Machine'' represents not only the apparatus of technical production—its tools, machines, and networks—but also the agencies, histories, and habits of mind that comprise the substrate of technical production. Thus, to work on sustainability is to understand the problem of ''The Machine.'' To understand the problem of ''The Machine'' is to study the social, economic, political, ecological, and intellectual substrate of technical practices. Rather than perpetuate the determinist trap and perpetual rush toward new technologies, architecture should situate technics at the core of sustainability. Presenting the culpabilities of technology alongside its capabilities would establish a more robust, albeit less euphoric, connection between technology and sustainability.

Claim 4: Vernacular and Regional Determinism

The *Vernacular and Regional Determinisms* each contain claims regarding sustainability.[32] In the Vernacular approach, architects perceive indigenous patterns of development as inherently sustainable responses to their respective sites and contexts of production. Similarly, Regionalism pursues sustainability by focusing on local conditions and resisting globalization. Each is pertinent because they observe established ecological and social conditions. In doing so, they seek sensible adaptations to climatic, resource, and building problems.

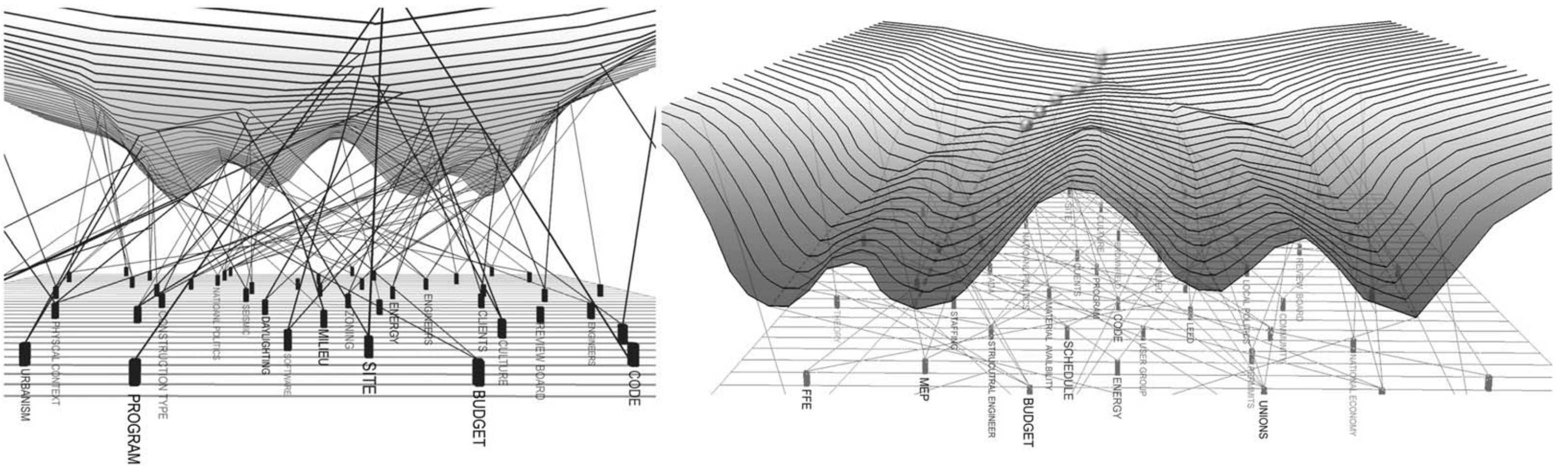
It is difficult, however, to imagine a reliable form of sustainability that does not engage previous *and* current technics.[33] Today, every region is a mongrel of local and global conditions. In his own way, Lewis Mumford developed such a concept of the region. According to Liane Lefaivre, Mumford merged his interests in technics with idiosyncratic aspects of regionalism. [34] Together they yielded a productive and nonsentimental approach to regionalism. For Mumford, ''regionalism is indissociable from the universal or global.''[35] Mumford cannot conceive of a region or a site without the global and historical substrate that presupposes it. He never intends to resuscitate prior artifacts. Rather, he studies a region to discern its technics. This expands the concept of a region from a place-only concept to the broader technics that now comprise any place.

What is fundamentally at stake in any vernacular or regional approach is a definition of context. Increasingly, context must include a broader set of agencies in its definition. A project's actual context exceeds the predominant conception of context as either that evident in figure-ground analysis, the style of a building's adjacent real estate, or its spatial region as understood in a variety of ways. To grasp the complexities of context in contemporary buildings adequately, these agencies must include political, economic, temporal, technical, ecological, social, cultural, and material parameters.

Ultimately, context is anything that may engender a decision, building, or practice. This could be too vast a pool of potential agencies, but the only context that matters is the specific context responsible for a particular decision, building, or practice. This expanded definition of context can become so extensive that a key problem is the means to visualize the integration of its multiple factors. Architects must expand their concept of context yet also be able to visualize the process of material and immaterial integration in a context in order to engender sustainability.

Currently, architecture has few, if any, theories of integration that are instructive in this way. Sanford Kwinter has developed an observation about integration that applies to this problem. In his understanding of Michel Foucault's ''materialism of the incorporeal,'' Kwinter discusses the problems of organization, integration, and coordination in design.[36] His approach relies upon ideas from developmental biology and his discussion of these scientific theories in respect of architecture points to a more comprehensive definition of context. While prevalent architectural definitions confine context to adjacent spatial and material conditions, Kwinter's observations connects a much broader explication of context with one means to visualize it.

To guide his reader into an understanding of context, D'Arcy Thompson wrote in *On Growth and Form*: ''The form of an object is a 'diagram of forces,' in this sense we can deduce the forces that are acting or have acted upon it.''[37] Thompson views present form in terms of its shaping forces, the pattern of its historical development. Developmental biologist C.H. Waddington visualized this pattern of development occurring in an abstract, multidimensional space called an ''epigenetic landscape.''[38] An epigenetic landscape is a virtual topography of developmental pathways that determine the development of a physical entity. All the shaping forces—political, economic, historical, technical, ecological, social, cultural, material—perpetually tug on this virtual topography. The epigenetic landscape negotiates this sport of forces and ultimately accounts for the characteristics of a developing entity. A developing entity inevitably encounters events that shift development toward new ends. As Figure 2 shows, such transformations are the task of architects: strategic alterations to a project's developmental pathway. At times, these developmental transformations produce only minor inflections. At other times, these transformations produce more radical changes even if the inflecting force is the same. Such radical inflections occur when the entire system is poised, ready for qualitative change. Biologists identify this poised state as a ''period of competence.''[39] This is the most opportune time to inflect a system toward a desired end. Intervening outside the period of competence requires a greater effort to bring the epigenetic landscape back into a state of competence. This discussion applies



2. This is the epigenetic landscape of an architecture project, as seen from below and above. The multiple shaping factors of a project constantly tug on the surface from below, altering the course of a project. The resultant surface directs a project in specific directions and toward particular ends. Based upon C.H. Waddington, *Tools for Thought: How to Understand and Apply the Latest Scientific Techniques of Problem Solving* (London: Jonathan Cape, 1977), pp. 29, 36.

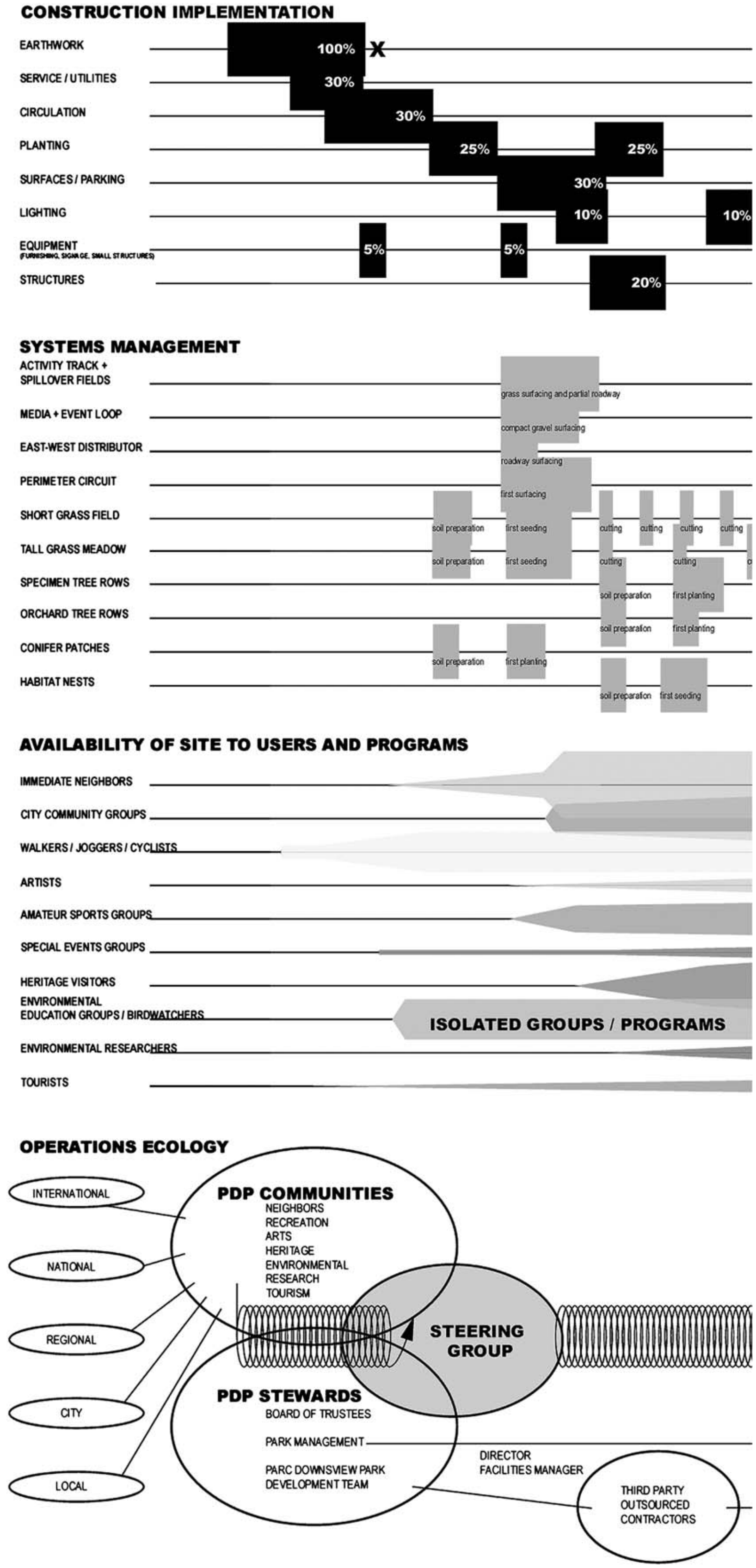
literally to architecture because *context is the epigenetic landscape of architecture*.

One recent example of such thinking is a board submitted by Field Operations for the 1999 Downsview Park Competition in Toronto. Figure 3 shows how this board organizes many of the factors and agencies—administrative, ecological, economic, political, cultural, social—that ultimately frame the development and design of the project. The diagram organizes the factors in time, not space. The designers included everything from government and user groups, to construction and systems management, to biota introduction and the ''Operations Ecology.'' This visualization attempts to envision the context of implementation. Here, design is understood in terms of its shaping forces. Rather than the design of isolated objects, these designers identify strategic spatial and temporal interventions given a particular *context* as a *pretext* for design.

My point here is that architects can no longer understand context as spatial and material configurations alone. Rather, architects must understand and design the multiple immaterial agencies that constitute any actual context. The vital, if not delirious, constitution of contexts can instigate more effective approaches to sustainability. As stated above, such approaches will require greater knowledge, better representation, and the integration of the immaterial agencies of architecture. Without an extensive concept of context, architecture will not be able to identify and integrate these larger dynamics of sustainability.

Compelling Yet Reliable Sustainability

Each of the claims presented above contribute to our assumptions about sustainability. The claims are unreliable, ultimately, because they contain a limited conception of architecture's context and technics. As such, they limit the practices of sustainability and preclude approaches that would engage architects in the much larger dynamics of sustainability. The shift in approach suggested here is not more statistics, checklists, or technologies but the development of deeper knowledge with regard to the actual context and technics of any architectural project. The most significant adjustments to the discourse and practice of sustainability will involve a shift to more literal and extensive conceptions of context and technics. Our technics are pervasive; technology is by now our nature. It dominates our practices and our lives; yet, as a discipline, we know relatively little about it. Technics, as taught through the history and philosophy of technology, should be core content for architectural education. This will prompt a radical immersion into architecture's complicated contexts. To teach architects about the systemic agencies of our technics and contexts already teaches a more potent understanding of sustainability. Architects need an operational understanding of the physical milieu of their work, expanded knowledge of material ecologies and effects, the capabilities and culpabilities of technology, the social basis of technology, the actual situation of architects in our industries, and a more vital conception of its time-imbued context. Only



3. Construction Implementation, Systems Management, and Operations Ecology by the office of Field Operations for their entry to the Downsview Park Competition, Toronto, 1999. (Courtesy James Corner/Field Operations.)

then will architecture practice what David Harvey has described as the ''advancement of more socially just, politically emancipating and ecologically sane mix of spatiotemporal processes.'' [40]

Notes

1. Gregory Bateson, *Steps to an Ecology of Mind* (New York: Ballantine Books, 1972), p. 484.
2. Wayne Booth, *Rhetoric of Fiction* (Chicago: University of Press, 1961), pp. 158–59, 274.
3. For a more general discussion of common approaches to sustainability, see John S. Dryzek, *The Politics of the Earth: Environmental Discourses* (New York: Oxford University Press, 1997).
4. The elusive concept of sustainability here includes, in principle, the accepted definitions of sustainability such as the 1987 Brundtland Report's definition as human development that ''meets the needs of the present generation without compromising the ability of future generations to meet their needs.'' However, I am more interested in the means and outcomes of the topic than its congested title. In many ways, the topic's title seems to confine the imagination and polemically segregate the profession. What constitutes sustainability is a set of commonsense set of decisions that should be at the core of any design practice, a basic fiduciary assumption. It no longer makes sense to differentiate sustainable practices from presumably unsustainable, yet taught, practices but rather to integrate these theories and practices directly into pedagogy and practice.
5. Amongst the two authors' books, two in particular are pertinent here: James Marston Fitch, *American Building and the Environmental Forces that Shaped It* (Boston: Houghton Mifflin, 1972); Victor Olgyay, *Design with Climate: Bioclimatic Approach to Architectural Regionalism* (Princeton, NJ: Princeton University Press, 1963).
6. Such introductions occur in each of the following books on this topic: Brenda and Robert Vale, *Towards a Green Architecture* (London: RIBA Publications Ltd., 1991), pp. 15–68; Richard L. Crowther, *Ecologic Architecture* (Boston: Butterworth Architecture, 1992), pp. 1–31; Rocky Mountain Institute, *A Primer on Sustainable Building* (Aspen, CO: Rocky Mountain Institute, 1995); Laura C. Zeiher, *The Ecology of Architecture: A Complete Guide to Creating the Environmentally Conscious Building* (New York: Whitney Library of Design, 1996), pp. 1–24; Klaus Daniels, *The Technology of Ecological Building: Basic Principles and Measures, Examples and Ideas*, trans. Elizabeth Schwaiger (Boston: Birkhauser Verlag, 1997), pp. 7–44; and Sandra Mendler and William Odell, *The HOK Guidebook to Sustainable Design* (New York: John Wiley & Sons Inc., 2000), pp. 1–13.
7. David Nye, *Consuming Power: A Social History of American Energies* (Cambridge: MIT Press, 1998), pp. 217–64.
8. Georges Bataille, ''The Meaning of General Economy,'' in Fred Botting and Scott Wilson, eds. *The Bataille Reader* (Oxford: Blackwell, 1997), pp. 184–9. *Emphasis his.*
9. I use the term ''milieu'' throughout in contrast to terms such as ''environment.'' ''Environment'' has many cultural and historical associations, which I seek to avoid. ''Milieu'' retains a more focused

view of the energy and materials systems that surround and constitute architecture.
10. Reyner Banham, *The Architecture of the Well Tempered Environment* (London: The Architectural Press, 1969), pp. 18–20.
11. This is a recurrent topic for Lewis Mumford and is the topic of his most comprehensive book on technics: *Technics and Civilization* (New York: Harcourt, Brace & World, 1934).
12. Gilles Deleuze and Claire Parnet, *Dialogues II* (New York: Columbia University Press, 1987), p. 70.
13. Gail Cooper, *Air Conditioning America: Engineers and the Controlled Environment, 1900-1960* (Baltimore: Johns Hopkins University Press, 1998), pp. 183–90.
14. One example is the Solar Decathlon Competition. This well-intentioned event requires the research, design, development, coordination, and construction of a solar powered house located on the National Mall. The dramatic irony of its broader technics, however, is that the houses often require more energy in their transportation from remote locations to the National Mall than the house itself either conserves or produces. For instance, to transport the Cal-Poly house in two trucks 2400 miles each way requires nearly 1.5 billion British Thermal Units of energy, dwarfing the energy saved or produced by the house itself.
15. James Steele, *Sustainable Architecture: Principles, Paradigms, and Case Studies* (New York: McGraw-Hill, New York. 1998); Mendler, Sandra F., and William Odell, *The HOK Guidebook to Sustainable Design* (John Wiley & Sons Inc), pp. 1–13; www.architecture2030.org (accessed July 14, 2006).
16. This article uses the U.S. Energy Information Administration data. The most current forecast on energy demand is http://www.eia.doe.gov/oiaf/aeo/demand.html, based upon the following assumptions: http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/residential.pdf, http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/commercial.pdf, http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/industrial.pdf (all accessed July 10, 2006).
17. James Cramer, Presentation to the AIA Chicago Board Members, 2005; as quoted in Daniel S. Friedman, ''Architectural Education and Practice on the Verge,'' *AIA Report on Integrated Practice*, adapted from the forthcoming chapter in T. Fisher, J.L. Nasar, and W.F.E. Preiser, eds., *Designing for Designers* (New York: Rothchild Books, forthcoming).
18. Recent reorganizations of energy consumption data from earnest protagonists such as Ed Mazria in *Architecture 2030* serve as a current example. Edward Mazria, www.architecture2030.org (accessed July 14, 2006). It should be noted that in certain arguments, it proves difficult to cleanly distinguish process energy loads from architectural energy loads in a laboratory, light industrial facility, and some factories.
19. John Tierney, ''Recycling is Garbage,'' *New York Times* 30 (June 1996), pp. 24–29, 44, 48, 51, 53.
20. Ironically, even initially opposing positions on the issues now agree on this contested issue. Both the Worldwatch Institute and Bjorn Lomberg have stated that the actual merits of recycling are in doubt: ''ultimately, recycling simply results in the manufacture of more things.'' Worldwatch Institute, *Good Stuff? A Behind-the-Scenes Guide to the Things We Buy*, from Worldwatch Institute, *State of the World 2004* (New York: W.W. Norton & Co., 2004), p. 1; Lomberg: ''. . .the current recycling level is reasonable, but that we perhaps should not aim to recycle much more.'' Bjorn Lomberg, *The Skeptical Environmentalist* (Cambridge: Cambridge University Press, 2001), p. 209.
21. Michelle Addington, ''Energy, Body, and Building,'' *Harvard Design Magazine* 18 (Spring/Summer 2003): 18–21.
22. By far, the most sustainable building is the one not built. These facts prove difficult for a program, such as LEED, that measures its success in the increasing square footage of LEED certified new construction in the United States.
23. John Fernandez, *Material Architecture: Emergent Materials for Innovative Buildings and Ecological Constructio*n (Oxford: Architectural Press, 2006), pp. 299–305; Charles Kilbert, Jan Sendzimir, and G. Bradley Guy, eds., *Construction Ecology: Nature as the Basis for Green Buildings* (New York: Spon Press, 2002), pp. 7–28.
24. Examples of this material agency saturate the history of technology. A few examples include Lynn Whyte, *Medieval Technology and Social Change* (London: Oxford University Press, 1980); Gilles Deleuze, *Treatise on Nomadology: The War Machine* [A Thousand Plateaus: Capitalism and Schizophrenia], trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1987), pp. 394–415; Cecil D. Elliott, *Technics and Architecture: The Development of Materials and Systems for Buildings* (Cambridge: MIT Press, 1992). More recently, popular books on the history of materials have also emerged: Mark Kurlansky, *Salt: A World History* (New York: Walker and Co., 2002); and Jared Diamond, *Guns, Germs, and Steel: The Fates of Human Societies* (New York: W.W. Norton, 1997).
25. Most of Fernand Braudel's work is pertinent here; however, the cycle on *Civilization and Capitalism* is particularly useful for our technics: Fernand Braudel, *Civilization and Capitalism, 15th-18th Century.* 3 vols: v. 1. *The Structure of Everyday Life*. v. 2. *The Wheels of Commerce*. v. 3. *The Perspective of the World* (New York: Harper & Row, 1982–1984).
26. Ulrich Beck, ''Reflexive Modernization'' in Ulrich Beck, Anthony Giddens, and Scott Lash, *Reflexive Modernization: Politics, Tradition and Aesthetics in the Modern Social Order* (Stanford, CA: Stanford University Press, 1994), pp. 1–55.
27. David F. Noble, ''Statement of David F. Noble at Hearings on Industrial Sub-Committee of the 98th U.S. Congress,'' in David F. Noble, *Progress Without People* (Chicago: Charles H. Kerr Publishing, 1993), p. 100.
28. George Grant, ''A Platitude,'' in *Technology and Empire* (Toronto: Anansi 1969), pp. 137–43.
29. Ulrich Beck, *Ecological Politics in the Age of Risk* (Cambridge: Polity Press, 1995).
30. Noble, *Forces of Production: A Social History of Industrial Automation* (New York: Alfred A. Knopf, 1984), p. 351.
31. Mumford, *Technics and Civilization* (New York: Harcourt, Brace & World, 1934), pp. 9–12
32. Bernard Rudofsky, *Architecture without Architects: An Introduction to Non-Pedigreed Architecture* (New York: Museum of Modern Art, 1964); Peter Calthorpe, *The Next American Metropolis: Ecology, Community, and the American Dream* (New York: Princeton Architectural Press, 1993); and Kenneth Frampton, ''Towards a Critical Regionalism: Six Points for an Architecture of Resistance,'' in Hal Foster, ed., *The Anti-Aesthetic: Essays in Post-Modern Culture* (Port Townsend, WA: Bay Press, 1983), pp.16–30.
33. See Steven Moore, ''Technology, Place and the Nonmodern Thesis,'' *Journal of Architectural Education* 54 (Spring 2001): 130–139, for an elaboration of this point in the form of a critique of Critical Regionalism.
34. Liane Lefaivre and Alexander Tzonis, *Critical Regionalism: Architecture and Identity in a Globalized World* (Munich: Prestel, 2003), pp. 33–39. Lefaivre is careful to emphasize that Mumford's work in the 30s in particular is relevant here. In this period, Mumford's work in technics is combined with communication with Patrick Geddes and work with Benton MacKaye produces an idiosyncratic but potent approach to regionalism.
35. Ibid., p. 35.
36. Sanford Kwinter, ''The Materialism of the Incorporeal,'' *Columbia Documents in Architecture and Theory* 6 (1995): 85–9.
37. D'Arcy W. Thompson, *On Growth and Form* (Cambridge: Cambridge University Press, 1951), p. 16.
38. Biologist C.H. Waddington uses the terms ''Chreod'' (Greek for necessary path) and epigenetic landscape to describe this virtual developmental landscape and these terms have become standard. See C.H. Waddington, *Tools for Thought: How to Understand and Apply the Latest Scientific Techniques of Problem Solving* (London: Jonathan Cape, 1977), pp. 103–29; C.H. Waddington, ''Tools of Thought about Complex Systems,'' *Ekistics* 218: 16.
39. Ibid., 111.
40. David Harvey, ''The New Urbanism and the Communitarian Trap,'' *Harvard Design Magazine: Changing Cities* 1 (Winter/Spring 1997), pp. 68–69.