Because Technique Is Ourselves

KIEL MOE
Northeastern University

INTEGRATING DESIGN WITH LIFE

Current digital techniques in architecture—from digital fabrication appliances to building performance simulation—disclose the rudimentary, clumsy, and far-from-automated capacity of digital computation when contrasted with a living entity. As Sanford Kwinter once noted, "no computer on earth can match the processing power of even the most simple natural system, be it of water molecules on a warm rock, a rudimentary enzyme system, or the movement of leaves in the wind."[1] These molecules, enzymes, and leaves serve as a welcome reminder of the richness of processing in the physical world and that processing far exceeds the crunch of numbers. Even amidst ponderous waves of digital production in recent architecture, however, the salient task and promise of architecture occasionally remains clear: to integrate design with life.

While this fundamental aim of design technique is intermittently achieved in recent digital work, much digital work is driven by a strain of technological determinism and a desire for autonomy that has beset architecture throughout the last few decades. Such an approach is a potent cocktail of technological euphoria and technological capitulation that enacts the terms of its retreat because it confuses technique as an end. In doing so, such work divests the capacity of design to integrate with life and its multifarious performances; a receding horizon for architecture and innovation. Reflecting on this larger dimension of contemporary technique and life, philosopher George Grant stated that "we can hold in our minds the enormous benefits of a technological society, but we cannot so easily hold the ways it may have deprived us, because technique is ourselves."[2]

In part what deprives us in this technological determinism that dominates our practices, pedagogies, buildings, cities, and lives, is a burgeoning paucity of judgment. Judgment itself is a profoundly sophisticated and integrating algorithm. In a period of digital techniques characterized by technological determinism, judgment is the agency that prevents us from descending into pure technique, from becoming pure technique ourselves. As such, digital computation should always remain a subset of judgment. Digital computation is an increasingly interesting and necessary adjunct to other more powerful and integrating processes in the human-digital milieu, but a subservient adjunct nonetheless. This hierarchy is necessary to integrate design with life rather than merely subjugating life to technique. It is also amplifies a core expertise of the architect in integrative thought and its manifestation in judgment that has been the core of the architect's expertise since Vitruvius.[3] In discussing the problems inherent in a turn towards technique-dominated architectural production, Wes Jones has noted:

> The displacement of the sense of necessity from the subject to the computed, from the judged to the measured, amounts to a change in values that questions the very meaning and sense of "necessity." When the measure is quantifiable, conviction becomes satisfaction, and inspiration becomes justification. But the sense of necessity attending the architectural experience is supposed to exceed mere satisfaction and bypass all requirements for justification; those are sentiments grounded in the values of efficacy and efficiency, which are of no concern to architecture when it is viewed as other than simple building or shelter.[4]

In what follows, I will discuss the uses of one digital technique of building simulation—computational fluid dynamics (CFD)—in these terms and offer two practices as emblematic alternatives. Technique should be deployed in such a way that design can accrue with life, as in these emblematic alternatives. Diverging from this end, however, digital techniques are frequently misunderstood, misappropriated, and misused. In other cases, they demand inordinately elaborate evaluations of simply the wrong phenomena; deterring, not expanding, opportunities for innovation. This is certainly the case of digitally-driven techniques for building simulation, especially in unreflectively instrumental applications. The capabilities and culpabilities of CFD technique can have substantive effects on the polyvalent performance of buildings—from their efficient performances related to energy conservation, to the performances of comfort and aesthetics, to the performance of the digital techniques themselves and their efficacy in contemporary design—yet only when astute judgment guides technique. To discuss the case of CFD techniques, however, it is important to first establish from whence CFD techniques emerge, for as Gilles Deleuze stated, "the principle behind all technology, is to demonstrate that a technical element remains abstract, entirely undetermined as long as one does not relate it to an assemblage it presupposes."[5]

TECHNIQUE

Current digital techniques, in must be understood, are merely the nascent edge of a much larger technique of numerical control. Numerical control is a technique that is used to abstract otherwise qualitative and sensorial properties into numbers in order to effectively regularize and routinize that which is otherwise is irregular and aleatory. The aim is to constrain transient behavior within a blanket of numeric techniques that yield predictive and standardized outcomes for the irregular phenomena. There is no better term that characterizes the thrust of Western technics (i.e. the history of our technical practices), calendars and clocks, capitalism, education, economic crises, failed risk management, or the proliferation of digital technologies of all types than numerical control. While much can be gained by reducing the number of variables of otherwise unruly behavior for study, it must be noted that much can also be lost in the process and that the outcomes may not necessarily conform with the complexities of the real. CFD techniques emerge from this technique of numerical control and this thus should necessarily condition our engagement with the technique, otherwise it risks remaining abstract and undetermined as a technique—a precarious position for a discipline.

So, as this larger assemblage of numerical control techniques suggests, it is critical to grasp that any numeric treatment of reality—by the terms of its technique—may be as incomplete as it is inaccurate. Further, numerical models of the world typically serve to answer only small questions. In architecture, the efficacy of a model—its capacity to amplify an architectural agenda rather than merely affirm its own assumptions and aspirations—depends on such parameters and, most importantly, the judgment of the designer.

THE DYNAMICS OF COMPUTATIONAL FLUID DYNAMICS

Frequently engaged as a source of assurance and as an enabler of building performance, CFD is typically used as a way to model properties such as air flow and temperature in proposed buildings. While its capacities to do so are touted, its culpabilities are generally unsounded. This has significant implications for design processes and techniques reliant on CFD modeling.

A major issue with CFD technique, like many models, is that data output from the model is only possibly as good as the data that is entered and the structure of the parameters that condition the model. The quality of the model and the exercise depends entirely on the capacity of human judgment and data entry. Often the result is models that do not model reality, that do not model the complexity of the real, but rather a rather an abstracted subset. As Michelle Addington has noted,

> Notwithstanding the array of input data establishing the physical definition of the problem, decisions are also required regarding the choice of algorithms, which terms to neglect in the governing equations, the numerical form of the convection operator, the configuration of the mesh, the relaxation method, which turbulence model to use, what thermal mechanisms are significant, and so on. In short, in order to accurately model a problem for CFD analysis, researchers must be as knowledgeable of numerical methods and theoretical fluid mechanics as they are of the specific physical characteristics of the problem...CFD modelers have grabbed on to CFD methods

> without embracing their theoretical basis--boundary layer theory. This lack of history in the development of computational fluid dynamics has led to its application as a tool rather than as a philosophical approach[6]

After decades of technical acquiescence and capitulation in the realm of building energy systems, such expertise is rarely present in the field of architecture, even engineering. Further, the complexities Addington describes above merely concern the parameters of the model, a highly abstract and simplified milieu. Ultimately such a model does not actually test for performance but rather merely conformance to the assumptions and parameters embedded in the model. As such, it speaks in only limited ways to the complexity of the real conditions in real building milieus. The real thermodynamic performance presents greater complexities as Addington noted elsewhere:

> the fluid mechanics of a room are vastly more complex than those of an airplane, and comparatively speaking, much less consequential... Unlike most other problems in fluid mechanics, in which one or two mechanisms may dominate, building air flow, particularly when centralized air systems are included, is a true mixing pot of behaviors: wide ranging velocities, temperature/density stratifications, transient indoor and outdoor conditions, laminar and turbulent flows, conductive, convective and radiative transfer, buoyant plumes and randomly moving objects (people).[7]

Underlining this technique, then, is a question about the judgment of what and what should not be included in the model and when it should be deployed. In this realm, judgment is a sport of thresholds that set limits on what can and should be modeled, and accordingly, how thus to interpret the results if the technique is to in fact inform design thinking rather than determine it and become pure technique. This is undoubtedly part of the reason that many recent LEED certified buildings actually perform below the existing energy code.[8] The parameters of the required energy model projections must be awry for such gross disjunctions in performance. In turn, it becomes apparent that our judgment about LEED and sustainability is thus also awry. In short, the dynamics of CFD—its input, computation, and results—are not automatic but rather remain subject to judgment and misjudgment.

TAUTOLOGICAL SPACES

If the question of what to model and how to model remains subject to judgment, then the more fundamental question of the utility of CFD in building design itself—especially as a determinant of performance-based decisions—should also be open to judgment for its very presence as a technique in building design stumbles on a fundamental and problematic tautology:

> The realm of building simulation considers CFD to be a useful tool for predicting the performance of building systems, particularly HVAC systems. The science and engineering disciplines consider CFD to be a powerful numerical model for studying the behavior of physical processes. These disciplines also recognize an inherent and problematic tautology...the greatest utility of CFD is for the investigation of problems that can't be empirically tested. As such, many CFD simulations are at best extrapolations—more than sufficient for the investigation of phenomena, insufficient for predicting actual performance.[9]

If, then, CFD is at best an extrapolation that is insufficient for predicting performance, its touted role in design is perhaps misguided; it should be directed towards other purposes and roles in design. Architects seem to routinely stumble over such misappropriations of techniques, as Reyner Banham noted in the sixties:

> A generation ago, it was 'The Machine' that let architects down-tomorrow or the day after it will be 'The Computer,' or Cybernetics or Topology...Throughout the present century architects have made fetishes of technological and scientific concepts out of context and been disappointed by them when they developed according to the processes of technological development, not according to the hopes of architects.[10]

Beyond such misappropriation, normative uses of CFD in building HVAC design also reveal another problematic tautology: they are most often used to model, and perhaps refine, the behavior of pressure-driven convection patterns in a given space. This perpetuates other unquestioned assumptions in architecture, for instance, that air is a reasonable medium for heat transfer.

Air, while a dominant medium, is ultimately a poor medium for distributing thermal energy in a building. Since air is about 832 times less dense than water, air is in fact a better insulator, not a conductor, of heat energy. Further complications arise because air is difficult to control due the complications Addington listed above begin to describe. However, an equally significant observation here is to recognize that bodies primarily use fluid and thermally active surfaces to heat and cool itself with radiant transfer rather than convective transfer.[11] Imagine if the human body used air to heat and cool itself: bodies—our lungs, our arteries and veins, our heart, our caloric intake—would need to be about 800 times larger to accommodate sufficient air mass to exchange heat energy and maintain comfort. This is as absurd as it would be inefficient and it is hard to imagine why we heat and cool buildings in this way. Alternately, thermally active buildings based on the simple observation that water is denser than air, and thus based on radiant transfer, would finally occupy the same thermodynamic space of a body rather the convection-based strategies that CFD models.

Further, in addition to the energy and human comfort benefits, thermally active material systems make architecture more architectural by enabling new relationships amongst body, program, technology, material, and form. Suddenly the fabric of the building itself is no longer merely a passive container of space, but rather an active agent in the performances of the building. When structure, enclosure, and human comfort merge into one system, architecture gains new roles for itself; a cascading set of effects based on a seemingly innocuous shift from air- to water-based conditioning of the thermal milieu. Consequently, when coupled the twin tautologies of CFD—its inadequacy for performance prediction in general and more specifically of a non-optimal medium of heat transfer—the design of the thermal milieu seems to require a different approach.

A simple quantitative observation, that water is denser than air and that is why bodies use fluid as its primary heating and cooling mechanism, points to a vastly different incorporation of numeric and quantitative techniques in the realm of design thinking and computation. It is suggestive of an alternate paradigm for integrating design and performance with life: to simply look more directly at life itself. In the realm of thermal milieus, there is considerable efficacy in looking at the actual physiology and thermodynamics of the human body as a source of polyvalent performance for buildings—and this is quite distinct from so-called biomimicry. Such a paradigm, as evident in the following practices, places the processing power of physical bodies in space as the basis of a system as opposed to the unwarranted complexity and impoverished parameters of CFD model.

TWO PRACTICES

The following two practices exercise productive doubt about normative uses of computation in practice—specifically the assumptions embedded in most CFD practices—in service of new and exceedingly rich architectural experiences. In these two exploratory practices, the actual thermodynamic and physiological performance of a body in a space sponsors new architectures. To do so, these examples that look more directly at life itself rather than technique as the beginning and end of design. As such, they serve as compelling examples of the role and place of computation and judgment in design capable of innovation.

figure 1: Philippe Rahm, Hormonorium

In his 2002 Swiss Pavilion for the Eighth Venice Architecture Biennale, *Hormonorium*, Philippe Rahm modulated the light and oxygen levels of an interior space to mimic the energy levels of a high-altitude Swiss glacier. In an empty, white space, Rahm deployed 528 fluorescent lights under a Plexiglas floor and reduced the oxygen level in the space to two-thirds normal levels. In doing so, an occupant's melatonin levels were correspondingly modified while the early stages of hypoxia released endorphins and additional red blood cells. Here the computation and sensation of architectural figuration occurs primarily and directly within physiological responses to light and oxygen levels. The architecture triggers processes within the body that are central to the experience of the architecture. Immaterial systems in this case literally figure the simple material systems of the architecture as well as the more complex endocrine architecture of the body.

This transference of the computation from digital preoccupations to the rich processes with the body amplifies Kwinter's reflection on the power of natural processing systems. It is also consistent with how Gilles Deleuze described as the Figure, “The Figure is the sensible form related to a sensation; it acts immediately upon the nervous system which is of the flesh, whereas abstract form is addressed to the head and acts through the intermediary of the brain, which is closer to bone.”[12] Thus, in Rahm’s approach to corporeal computation a whole new type of figuration emerges in architecture that, to paraphrase Deleuze, gives us new eyes all over: the in the lungs, the glands, and in the nervous system.[13]

Figure 2: Philippe Rahm

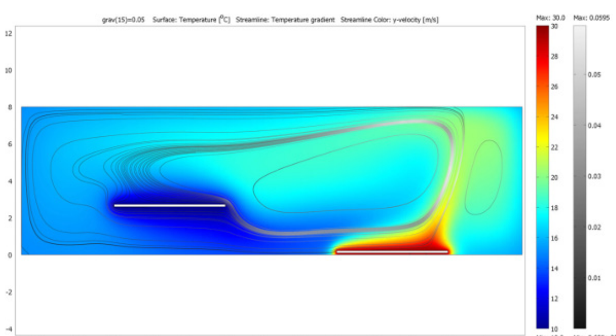

Figure 3: Philippe Rahm

In a more recent project (figure 2,3), Rahm engages CFD analysis not to refine a HVAC system for a space but as a generator of a new type of space altogether. Here his aim was to create thermodynamic diversity in a space in order to program that space around the thermal requirements of various domestic activities. The movement of air and people is guided by the buoyancy-driven flow created by two asymmetrically placed hydronic thermally active surfaces that create thermal asymmetries in terms of air and surface temperatures. Thus, in addition to tempering the space thermally, the thermodynamic conditions are set first and then programs are assigned respectively; reversing multiple aspects of a typical design process. Here computation is used in a generative capacity for a new milieu but in a manner that transcends the problems and tautologies of normative CFD analysis.

PETER MEIERHANS & PETER ZUMTHOR

Developed during the same period as CFD techniques became more present in architecture, engineer Peter Meierhans and architect Peter Zumthor designed a thermodynamically and physiologically novel figure for the Bregenz Kunsthaus (figure 4) that formalized a new relationship between body and building. The relationships between the body, energy efficiency, structure, and aesthetics have often been treated as discrete systems in recent architectural production. While this building is well known from the nineties for the visual presence of its material systems, less is known about its immaterial, thermodynamic genesis and its resultant anomalous convergence of construction, energy, and program agendas that make the architecture so rich in the end. While almost all buildings are designed to heat and cool spaces, the Kunsthaus’s architecture emerged from a more accurate physiological understanding of, and response to, the body. The concrete surfaces in the Kunsthaus, like a body, are hydronic, thermally active surfaces that temper the thermal comfort of bodies in the space through radiant heat transfer rather than the minor ventilation air system in the building. Further, like a body, the building decouples its ventilation system from its thermal conditioning; negating the problematics of CFD techniques that might otherwise be engaged to find novel solutions to building conditioning. While these observations about the body and their associated quantification may initially seem simple, they ultimately enable the building’s austere appearance and low energy consumption. If minimal in appearance, the building can be seen, however, as a maximal form of non-visual ornament for the nervous system.

In these practices there is great leverage in simpler quantification and computation (the relative density of air and water, for instance). They help substantiate that a technique such as CFD should only

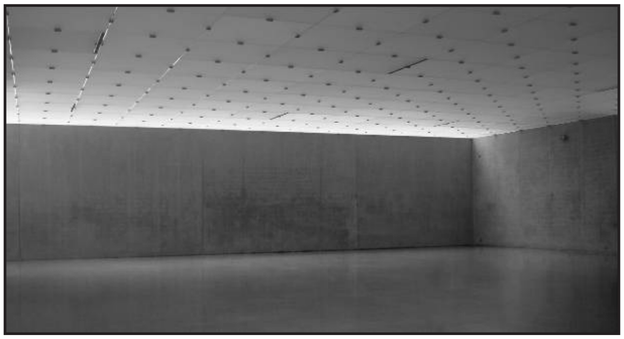

Figure 4: Peter Zumthor and Peter Meierhans, Kunsthaus Bregenz

be engaged, discretely, for its capacity to inform and direct architectural judgment and new architectural agendas, as in the case of Philippe Rahm. In architecture, computational techniques should be used to ask larger, not smaller, questions of the performance of buildings, of bodies in buildings, and of the discipline itself.

CONCLUSION: RECUSE OR RESCUE?

In these examples, various forms of digital computation play minor roles to larger architectural agendas. Not seen as ends or even the means to an end, in these examples digital computation plays critical but limited and pointed roles to yield novelty. The perceived novelty of digital techniques by no means exhausts the projects here. In each case, computation is used to amplify prospects for the richness of new architectural experiences and for design and computation integrating with life that processing in ways that far exceeds the authoritative crunch of numbers. At the core of each of these practices is a more nuanced judgment about the role of technique—digital or otherwise. Despite the presence of computational techniques in these practices, their substantive architectural responses remain the product of judgment and the 'apprenticeship of the imagination', in Lyotard's terms. Despite the availability of digital techniques, the most refined processor and algorithm in these practices remains the integrating capacity of the mind as well as the most subtle thermodynamic and physiological processor—i.e. the body—that make these architectures so rich.

The question confronting architecture today, as posed by the topic of this panel session, ultimately bears on architecture's burgeoning habit to recuse itself from judgment by letting technique become ourselves, become our discipline. Rather, we ought to rescue ourselves from the techniques that many designers let over-determine their practices. When the capabilities and culpabilities of technique are taken for granted, technique unreflectively becomes ourselves. In doing so, the discipline diminishes the role of design and its relation to life; thereby foreclosing on advancements of the discipline. If we are to integrated design with life and achieve our discipline rather than become pure technique, judgment must remain the supra-processing technique in architecture.

ENDNOTES

1 Sanford Kwinter, "The Computational Fallacy," *Thresholds 26*, (1995), 90.
2 George Grant, 'A Platitude' in Technology and Empire (Toronto: Anansi 1969) p 137-43.
3 The first sentence of the first book on architecture states the integrating capacity of the architect by claiming that "The architect should be equipped with knowledge of many branches of study and varied kinds of learning, for it is by his judgment that all work done by the arts is puts to test." Vitruvius. *The Ten Books on Architecture,* (New York: Dover, 1960), 5.
4 Wes Jones, "Big Forking Dilemma: Contemporary Architecture's Autonomic Turn," *Harvard Design Magazine* 32, 2010, 10.
5 Gilles Deleuze and Felix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia, (*Minneapolis: The University of Minnesota Press, 1987), 397-8.
6 D. Michelle Addington, "Good-bye, Willis Carrier," Proceedings of the 85TH ACSA Annual Meeting And Technology Conference, 1997, Dallas, TX, 89-90.
7 Ibid., 89.
8 Cathy Turner and Mark Frankel, "Energy Performance of LEED for New Construction Buildings: Final Report," New Buildings Institute, (March 4, 2008).
9 D. Michelle Addington, "New Perspectives on Computational Fluid Dynamics Simulation" in Ali Malkawi and Godfried Augenbroe eds., *Advanced Building Simulation, (*New York: Taylor & Francis, 2003), 145.
10 Reyner Banham, "The Science Side: Weapons Systems, Computers, Human Sciences," *Architectural Review* 1 27, no. 757 (March 1960), 183-90.
11 The body produces about 400 BTUs per hour from its metabolic processes. 90 BTUs are used to maintain life functioning. The additional energy must be dispersed from the system or the body over heats. In most situations, the body transfers about 190 BTUs through radiant transfer. About 110 BTUs are transferred with by convection. The remainder is transferred via respiration and other processes. Thermally active surface systems, based primarily upon radiant transfer, target the most significant physiological heat transfer mode and thus modulate human comfort more directly. The body's largest organ is its skin (about 15% of its mass over 2 square meters) regulates deep and surface body temperature through exchanges with the integumentary and circulatory systems that uses the skin as a thermal sink and source. One square inch of

skin contains up to 4.5m of capillary mat blood vessels, the contents of which is heated or cooled before flowing back to influence the deep body temperature. As evidence of the importance of radiant heat exchange to the body's thermal equilibrium, living human skin has extraordinarily high absorptivity and emissivity (0.97), greater than most architectural substances, matte-black metals included. Consequently, we are highly responsive to changes in radiant temperature. The body is essentially a highly efficient hydronic heating and cooling system with most of the transfer occurring in its own thermally active surfaces.

12 Gilles Deleuze, *Francis Bacon: The Logic of Sensation,* (Minneapolis: University of Minnesota Press, 2002), 39.

13 Ibid., 45.