DIGITAL WORKFLOWS IN ARCHITECTURE
DESIGN—ASSEMBLY—INDUSTRY

SCOTT MARBLE, EDITOR
Precise Form for Imprecise World

Neil Denari

In worlds other than those that are technically governed, where intent for precision can be measured against a physical object. Novelists, mathematicians, poets, playwrights, film directors or painters all search for forms of precision in their respective fields. One imagines that the brush strokes in a Mark Rothko painting or the camera angles of a Hitchcock thriller are as precise as two sheets of aluminum coming together on a knife-edged corner. Whether with paint, words or lenses, people who make things practice their craft in relation to tools, techniques, and systems, and it is this interrelation with technology and materials where one articulates ideas that in themselves may be abstract or conceptual.

A Brief History Since 1995

When technology services an argument or an idea, meaning and content become materialized via an appropriate application of technology. Conversely, when technology itself is the argument, technique becomes content. This absorption of the conceptual into the technical is no doubt the most natural state of events when new tools and techniques are introduced into specific cultures, and this state has come to define, however (in)accurately, the condition of architectural design that emerged fifteen years ago. Primarily through the use of software such as Softimage and Alias Power Animator, packages that had already been introduced to the film industry, architects and their students were able to suspend architecture between the virtual and the material and at the same time begin the theorization process that comes along with all paradigm shifts. With tools used to model animated cartoon characters, it is no coincidence then, that the term "blob" flourished at the end of the 1990’s, because the shape-making possibilities with NURBS software allowed new users to proliferate topological surfaces in unending measures, most of them generated out of excitement rather than discipline. Indeed, even a crudely sculpted digital model could be captivating, the equivalent of pouring random chemicals into a beaker in search of unknown reactions. While this excited many and possibly disturbed even more, such raw production of form was quickly disciplined by the likes of Greg Lynn and Jesse Reiser, both of whom invoked Gilles Deleuze’s concept of the "a Scanner Darkly" topological body, or more accurately, a speculative form disciplined by precise derivation and modeling. In fact, it could be argued that the longest-lasting

Impressions left by the rise of digital culture were created at its very origin, when formal novelty immediately outsized the modernist complexities of the Deconstructivist period of the late 1980’s A new regime of form-making that had emerged, one that challenged all prevailing ideologies not through a different conceptual ideology but through a technical one. At this moment, the digital more decisively invoked a Kiesler-esque freedom than a new machine-based precision. Although Frank Gehry and his team at the time were disciplining his more visually intuitive working method with the introduction of CATIA into the documentation (not design) process of his Bilbao Museum in the late 1990’s, the computer was largely a medium of radical experimentation with 3D curvature, surfaces for which drawing or modeling by hand were nearly impossible to master. With the advent of computerization in architecture, suddenly the "what could be done" agenda eclipsed the "what should be done" questions born out of conceptual thinking, creating friction not only among generations but also among those who imagined or experienced architecture as a slow accumulation of instinct and iterative working processes. Indeed, this new technology challenged architecture perhaps by offering more and more freedom without the added discipline needed to effectively guide the new tools. By simply moving from pencils to mice, the act of making a drawing had shifted to the construction of a 3D digital model, altogether different in mood and feedback than either a handmade drawing or physical model. In the black ether of Cartesian coordinates, the digital world profoundly affected our senses, and further, our judgment. Only a massive graphic awareness could support such doubt, passion and rancor in a field that had always been defined by technological progress. But what began as a wild frontier of formal experimentation with little expectation for construction, had by the 2000’s transitioned into a scene that brought aspirations and expectations with commissions into contact with technology that would ignite their curiosity for extreme architectural solutions. We no longer fueled purely by the unconstrained freedom allowed by the machine, this work began to shape the identity of the digital world as we know it now, as an environment based on numerical precision and quantification. Projects such as Frank Gehry’s Walt Disney Concert Hall (2004) and Harzing & De Meuron’s Beijing Olympic Stadium (2008) typify the transition of spectacular forms of...
geometry into structure given life through technology. One is inclined to summarize this decade as a time of unfettered construction, quickly bringing to fruition the promise of new organic forms. Material experimentation set out by the young digital prospectors ten years before.

This shift from a kind of art practice—the black screen as empty canvas—to one of information processing, ideas have returned in sharp relief among the designing agents, in theory at least. The arc of computerization is still clearly ascendant, but the initial, feverish conditions of its launch with seemingly endless design possibilities have given way to a culture that not only uses technology ubiquitously but also as a tool to leverage quantification into new forms of irrefutable logic. To a certain extent, decision-making has returned, and herein may lie the core of the new debate: has machine logic (data, the script, etc.) replaced human judgment as the most disciplined form of inquiry in architecture?

opportunities of the digital

Prior to the advent of robust computational power, architecture was to a certain extent governed by the ability of the architect to manage and think through complex conditions with ordinary forms of representation (drawings, physical models, etc.). Being precise in this context involved a logic of form-making that related to industrial standards of construction. Modernism, for example, was a language of gridded, panelized construction systems derived directly from those standards. Customization, then, could be a laborious process. Today, precision is embedded in a design process that generates multiple unknown, less predictable and foreclosed design outputs via many inputs (the parametric).

This represents opportunity unhungled from the history of disciplinary forms of design control, as invoked, for example, by typological or stylistic paradigms. Indeed, with the robust sets of tools now available in the design process, greater levels of flexibility can be managed, allowing architects to operate with lesser-known, more provisional paradigms. Especially obvious in proprietary script and code-writing, architects are constructing, through processed means, outcomes that cannot be sketched out or illustrated in any a priori fashion. This, in turn, has led to an understanding of regimes that are driven by a productive relationship between theory (cultural query), logic (argument) and data (requirements). Moreover, if modernism worked on the basis of clearly defined organizational devices such as the machine and philosophical mandates such as Form Follows Function, then when a computationally charged environment takes input/output and causality to new levels in architecture. But whereas modernism sought to reduce forms to their most infected, sober state of directness, new digital processes are defined by multivalent systems that can produce, given a particular agenda, forms that are entirely responsive to vast amounts of initial data. One thinks here for instance of biological models, concepts of cellular automata and time-based design processes that cannot in any essential fashion be explored outside of a digital environment, as they are far too complex to model otherwise.

In this context, two very dramatic conditions occur: 1) from an aesthetic point of view, new forms may emerge, giving architects who view form as an important and indeed necessary component of advanced design, a process of invention that relies less on sheer compositional skills and more on the directing of information, and 2) a clear belief that the machine precisely determines the forms and produces the highest level of performativity in them. When seen together, these conditions suggest that new forms are also innovative forms, capable of functioning across a variety of criteria, from basic program to atmospheric effects. Innovation, here, is defined as the renewal or improvement of existing models. In architecture, innovation rather than novelty is the precise term for incremental changes to prevailing types or paradigms. Through computation, forms that look different are also arguably capable of performing better, because criteria related to functionality can be simulated and inserted into a design methodology abed by digital control.

Apart from implied or expressed interests in new genres of form, digital environments have also provided opportunities for greater levels of analysis and simulation across all aspects of design and construction. From versioning to optimization and beyond, the process has become more fluidly experimental, creating a built-in R&D component to design that was previously reserved for research-oriented dedicated research budgets. Although progress is not always linear in such a fluid environment, new simulation tools employed by architects allow for more informative, higher-tier, comparison-based method. Often yielding matrices like information grids, multiple design schemes may be cross-referenced against one another, analyzed around issues such as affective behavior, assembly method, cost, time and sustainability of the model, once the metaphorical model of Modernist architecture, are now the true servants to any architectural agenda that will rely less on the artisanal nature of craft and more on the mathematics of computation.

limits of the digital

Has, therefore, the above-mentioned conflict surrounding idea as content versus technique as content entered into a new period of cessation, relieving the propagation of the antagonisms of generational and ideological resistance to the computer? It is clear that craft, historically defined in relation to human skill acquired over years of experience, has been partially redefined through new forms of expertise with machines that remove the hand as the basic interface of both design and fabrication. Whereas precision was formerly understood to be pre-invested in the work ethic of the architect (to think through an argument, then make a design, which fits the logic), now precision can be supplied, at least partially, by machines. There are extremely heightened expectations of precision, based on the promise of digital analysis, simulation and fabrication: expectations that color the very thought processes involved in design. The innate passion for the rigorous practice of craft has passed into the hands of digitally controlled tools, allowing a variety of new contexts for precision to emerge. In one context, precision is understood to be ensured through the proper operation of software-controlled machines. In another, data themselves become precursors of form. Indeed, data are one of the most prominent contemporary phenomena to be used in the construction of logical digital control. Though, to be definitive because of their mathematically derived accuracy, data present information and ideology as one and the same. As work becomes more by data and controlled by software and less by the impetus of intuition or judgment, then it must be rigorous, complete and ultimately precise. Oddly enough then, as the digital realm offers the potential for new spatial and material experiences, it also sets standards and expectations perhaps no mania for accuracy can withstand a sustained dissonance between that which can be designed and documented and that which can be built.
of materials, to name just a few of the many contingencies of building, making it impractical for the physical outcome to be literally measured against its digital precursor in a presumed search for the highest level of fidelity possible. In most material sciences related to engineering, the accuracy of a measurement system is the degree of closeness of a quantity to its actual value. Translated to architecture, accuracy is construed as the degree of closeness of the physical rendition of the building to its data set. While this has always been the case with architecture—that it is measured against a set of descriptive documents—the nature of contemporary digital processes has pushed the drive for precision from an obligation that characterizes the discipline of architecture to an expectation that presupposes a one-to-one translation from idea to realization. Surely a new discipline will arise out of these expectations, one in which numerical precision will no longer simply supply a convenient ideology for design. The power of digital tools will indeed engender or even proliferate conceptual processes that put machines in service of qualitative assertions and intellectual inquiry.

**ENDNOTES**


---

**HL23 AND THE MANIA OF ACCURACY**

**WORKFLOW CASE STUDY**

In 2005, the Special West Chelsea District zoning plan was amended to accept development around the High Line, a new urban park on an elevated rail track that extends twenty blocks in New York City. As the High Line slices through mid-block, a new type of site emerges, yielding a hybrid building with an infill base and three-sided tower above. Typical to the area north of 23rd street, a 150ft easement was placed along the east and west sides of the elevated track, thus permitting an as-of-right tower width of only 25ft on the 40ft wide building site. The client requested a project with more than the allowable volume. The task was to design a non-conformist building that would resist the zoning envelope yet at the same time feel contextually responsive. The project design was developed through a series of 3D models that from the very start closely considered the structural challenge of cantilevering over the High Line. A highly detailed model of all building components from structure to enclosure helped to develop fabrication and construction sequence that would preserve the precision of the design. HL23 relies on the accuracy of shop-produced, prefabricated and coordinated components to attain its constructed level of fidelity to its digital precursor. The exterior cladding consists of large "mega-panels" that maximize shop-controlled fabrication procedures and simplified on-site assembly. Throughout construction and prior to installation, the structural steel frame was surveyed multiple times in an ongoing process to keep the fabricated panel frame well within allowable tolerances. Within an accurate frame, the shop-controlled megap Panel was installed consistently with parallel joints and coplanarity panel-to-panel.

---

**Workflow 1 (above left).** A zoning variance allowed HL23 to cantilever beyond the 15' easement along the High Line.

**Workflow 2 (above right).** Rendering from design model looking north along the High Line.