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The Demise of the Identical
Architectural Standardization in the Age of Digital Reproducibility

At some point in the early 1990s, digital tools for design and manufacturing began to inspire new theories about design, and architects and theoreticians started to think that something new could be designed and built digitally that could not have been otherwise. That was the beginning of the digital revolution in architecture, now almost halfway into its second decade.

But ten to fifteen years is quite a stretch in internet time. Most of the “irrational exuberance” that marked the love story between architects and new technologies at the end of the last millennium is now gone, and as the pace of change has slowed down somewhat, this is not an inappropriate time to take stock. What is the net gain of fifteen years of digital design? At a glance, the most pervasive and visible consequence of digital technologies in architecture appears to be, oddly: roundness. Let’s face it: for most of the last fifteen years digital designers have been practicing or advocating rotundity. Some of the most iconic high-tech buildings of the nineties are round. Or fluid, or floppy, or flaccid, or flexible--occasionally fluffy, or flatulent. We have seen blimps, blobs, and blurs. Yet the empathy between digital technologies and round forms that characterized the early phases of the digital revolution in architecture was not a quirk of history; it was the rational consequence of several deep-rooted technological and cultural causes.

Architectural deconstructivism, which climaxed in the late eighties or early nineties, had fostered a fractured environment of dissonance and disjunction, parataxis and angularity. But, as art historians have known at least since the time of Heinrich Wölfflin, forms have a well-known tendency to swing from the angular to the curvilinear, from parataxis to syntax. The nineties were no exception: after the excesses of decontructivist angularity, a rebound was inevitable. The digital revolution in architecture crossed paths with this trend, and amplified it stupendously.

Consider this remarkable chain of coincidences: An influential book by Gilles Deleuze on *Leibniz, the Fold, and the Baroque*, originally published in French in 1988, translated into English in 1993, included a chapter on Leibniz's mathematics of continuity and differential calculus, with reference to the new tools for computer-aided design and manufacturing, and to their mathematical underpinnings. At the same time some of the most popular software programs for computer-aided design were putting various families of algorithmically generated, continuous functions in the hands of scores of digitally inclined designers around the world, who could apply them regardless of their mathematical expertise. The mathematical basis of these early tools for design and manufacturing was, for the most part, still Leibniz's mathematics of continuity, a math of derivatives and points of inflection (which Deleuze had famously renamed Folds or *Plis*), which is one reason why smooth and continuous forms and surfaces rose to esthetic prominence in the late 1990s: end of millennium design software was fold prone and angle averse. After the fold came the blob, and after the blob the wave of topological geometries that briefly swept the scene at the end of the decade. After that, however, came the crash.

Throughout the second half of the nineties, digital roundness surged alongside the fortunes of the NASDAQ; it fell with it and, just like the NASDAQ, didn't bounce back. As was the case with many excesses that had characterized what was then called the “new economy,” digital design fell out of favor in the aftermath of the economic crash and during the social, military, and political turmoil that followed. In the more sober and sometimes repentant environment of post-2001, computer-based architectural design and production have been subsumed into the larger and more general category of “non-standard” architecture. There is some lingering disagreement, however, on what “non-standard” architecture is. Non-standard architecture is often defined in purely visual terms. Yet what characterizes non-standard architecture is not the way it looks but the way it was made.

Algorithmically generated continuous functions can be used to digitally produce individual items, but also to produce whole series or families of items. These are series where all items, although incrementally different, share a common algorithmic matrix. In its simplest technical definition, non-standard production means the serial reproduction of non-identical parts. A non-standard series is not defined by the individual items that compose it, but by the law of incremental change that creates the series; what counts in a non-standard series is the differential between items, not the specific attributes of each one of them, including visual forms, which may come in any shape.

This definition of non-standard seriality implies a complete reversal of the mechanical paradigm that we have been familiar with up to very recent times. This paradigm is best illustrated by one of the foundational technologies of the mechanical age: the printing press. In a printing press, a mechanical cast physically stamps the same matrix onto multiple copies. The making of the matrix requires a significant up-front investment, hence the incentive to print as many copies as possible, as the more copies printed, the cheaper each copy will be. At some point in the series stands the watershed between profit and loss—-the break-even point. Additionally, if all goes well, and barring accidents and contingencies, all the imprints will be identical. This is sometimes an advantage, sometimes a disadvantage, and sometimes irrelevant, but is inevitable. Mechanical mass production or serial reproduction generates economies of scale on the condition that all items in the same mechanically mass-produced series be identical, as in a traditional assembly line. If you want a different item, you must start a new series, and pay the full cost of setting it up.

On the contrary, digital technologies applied simultaneously to design and manufacturing can generate the same economies of scale while mass-producing a series where all items are different; but different within limits. The print analogy still applies: compare the technologies of mechanical printing with digital printing. When we use a laser printer, the cost of printing one thousand times the same page is identical to the cost of printing a thousand different pages in the same format. (I did not include the cost of authoring the pages, as in our trade as a rule authors cost nothing). The same principles that apply to a page printout can also apply to the production of three-dimensional objects. Thanks to the integration between computer-based design and manufacturing, and seamless file-to-factory technologies, objects that are digitally designed and measured on a computer screen can automatically be built by digital machines--printed out, as it were, in three dimensions without any human intervention. We cannot yet produce Gothic cathedrals in this way, but within limits and under certain conditions rapid prototyping, stereolithography, CNC milling machines and other similar digitally controlled manufacturing tools can already bring digital designs to life, so to speak, and translate digital files directly into three-dimensional objects.

When objects are designed and serially reproduced in this way, individual variations can be introduced into a series at no extra cost (except, once again, the cost of designing the variations). Hence the iron law of mechanical mass production does not apply in a digital environment: identical reproduction does not make digital reproduction cheaper. Consequently, all the economic rationales for identical reproduction and product standardization that came into being with the rise of the mechanical environment will cease to be with the rise of the new digital environment.

The logic of mass-production was often interpreted, rejected or exploited and ultimately sublimated by architects and artists in the twentieth century. If we accept the logic of mechanical manufacturing, to achieve economies of scale we must mass-produce, and to mass-produce we must reproduce identically. In order to offer better and cheaper products to more people, we must offer the same product to all. This included houses, which many modernist architects considered a commodity. But now technology has changed. We may still cherish identicality for a number of reasons, but in the digital world identical reproduction is cost irrelevant. A thousand identical copies or a thousand different variants of the same digital prototype can be produced by the same machine at the same unit cost. Also known as mass customization, this new approach to production suggests a major paradigm shift in our technical environment, and it implies equally epoch-making social and cultural changes in the way we make things, in the way we use and look at manufactured objects, as well as in the way manufactured objects can represent and convey meaning and value--including market value.

Digitally made, mass-customized architectural objects can be, within limits, custom-made just like traditional hand-made objects used to be, but without the costs of hand-making; and can be serially mass-produced as machine-made objects used to be, but without the constraint of identical reproduction. In the best case scenario, differential reproduction of the digital age can combine the advantages of the variable reproduction of the artisanal age with those of the mass production of the mechanical age, without the disadvantages of either. In plenty of instances where one standard size does not fit all, both literally or figuratively, we can anticipate that non-standard technologies, when available and when suitable, will be put to use. When this happens, we shall have to face the many and diverse challenges of a new non-standard environment.

This may seem like a small point, but it is a big one when seen in historical perspective. For some centuries now we have been living in a visual and technical environment characterized by exactly repeatable visual imprints. Consequently, we now tend to think that seriality causes identicality. If and when the new digital paradigm replaces the old mechanical paradigm, we shall have to learn to associate seriality with new forms of variability. Non-standard seriality creates differences within repetition. Items in the same non-standard series can vary within limits, but they must also be to some extent all similar, as they inevitably share some common attributes: they were generated by the same algorithms, and made by the same machines. Unlike a mechanical imprint, which produces identicality, an algorithmic imprint generates similarities. In this new technical and visual environment, similarity and resemblance will matter more than identification and identicality. Different but similar signs may have the same meaning. And in this new, non-standard environment we shall have to learn to get along with a new universe of invisible algorithmic norms, which will replace the old world of exactly repeatable visual forms where we have been living, for better or for worse, for the last five centuries.

We shall have to learn, did I say. Not quite. After all, we did well without mechanical standards and without mechanically reproduced imprints and icons for quite a while. We may simply have to learn again. We built plenty of decent architecture before the rise of the mechanical paradigm. We have reason to infer that we may still be in the architectural business when the mechanical paradigm is no more. We may even infer that the algorithmically dominated visual environment of the imminent future may in fact have something in common with the visual environment that we lived in prior to the rise of the age of mechanical reproducibility.

In a non-standard environment, fixed algorithmic genera count for more than endlessly morphing, varying visual species. On the eve of the digital revolution Gilles Deleuze famously introduced the notion of the “objectile” to define something similar to what we now call a non-standard series: in philosophical terms, a non-standard series is simply a generic object. But genera and species are not new terms. They are Aristotelian, and Scholastic. Genera define families, or classes of events that have something in common; species, etymologically, means the way events look, their appearance, which in the digital world, as in the pre-mechanical world, is often variable and unpredictable within the limits of each class or set. This Scholastic dualism, according to a famous essay by Erwin Panofsky, was at the basis of Gothic architecture. Now powered by electricity, it is at the basis of today’s digitally driven non-standard environment. This is a world that Aquinas and Alberti might recognize, but Mies van der Rohe couldn’t--and Rem Koolhas probably wouldn’t. It is a world where variations are the rule, and identicals are the exception--just as it always was in the West before the rise of the mechanical age, and incidentally, just as it still appears to be in nature.

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