PREFACE

Not long ago, in the nineties, no one doubted that a "digital revolution" was in the making—in architecture as in all aspects of life, science, and art. Today (early 2010) the very expression "digital revolution" has fallen into disuse, if not into disrepute; it sounds passé and archaic, at best the reminder of an age gone by. Yet digital technologies, now ubiquitous, have already significantly changed the way architecture is designed and made. They are changing how architecture is taught in schools, practiced, managed, even regulated. Etymologically, as well as politically, the notion of a revolution implies that something is or has been turned upside down. It may be too soon to tell if the digital is a revolution in architecture, but it is not too soon to ask what may be upended if it is. If the digital is a "paradigm shift," which paradigm is shifting? If architecture has seen a "digital turn," what course has turned?

This work will trace the rise of some aspects of modernity that have marked the history of Western architecture. They all relate to one key practice of modernity: the making of identical copies—of nature, art, objects, and media objects of all sorts. From the beginning of the Early Modern Age, and until very recently, the cultural demand and the technical supply of identical copies rose in sync. Identical copies inspired a new visual culture, and prompted new social and legal practices aimed at the protection of the original and its owner or creator. At the same time, new cultural technologies and new machines emerged and were developed to produce and mass-produce identical replications: from printed images and text set with moveable type to the

industrial assembly line, from perspectival images to photography to the Xerox machine.

Two instances of identicality were crucial to the shaping of architectural modernity. The first was Leon Battista Alberti's invention of architectural design. In Alberti's theory, a building is the identical copy of the architect's design; with Alberti's separation in principle between design and making came the modern definition of the architect as an author, in the humanistic sense of the term. After Alberti's cultural revolution, the second wave of identical copies in architecture came with the industrial revolution, and the mass production of identical copies from mechanical master models, matrixes, imprints, or molds. Industrial standardization generates economies of scale—so long as all items in a series are the same.

The modern power of the identical came to an end with the rise of digital technologies. All that is digital is variable, and digital variability goes counter to all the postulates of identicality that have informed the history of Western cultural technologies for the last five centuries. In architecture this means the end of notational limitations, of industrial standardization, and, more generally, of the Albertian and authorial way of building by design.

This book recounts the rise and fall of the paradigm of identicality, and shows that digital and premechanical variability have many points in common. It discusses the rise of new forms of postindustrial digital craftsmanship by showing their relation to hand-making and to the cultures and technologies of variations that existed before the humanistic and modern rise of machine-made, identical copies. The first part of the book is a synopsis of the general argument; the second focuses on the mechanical rise and the digital fall of identical copies. A bit of repetition is inevitable, but the argument is simple—symmetrical, in a sense—with a beginning, climax, and end.

This chronicle situates today's computational tools in architecture within the ambit of a centuries-old tradition, with all of its twists and turns, of which the digital represents the most recent. Technologies change rapidly—"new" technologies in particular. To predict, and even interpret, new developments in cultural technologies on the basis of their recent history is risky, as one needs to extrapolate from a curve that is too short and build on evidence that has not been sifted by time. A more distant vantage point entails a loss of detail, but may reveal the outlines of more general trends. I shall endeavor to highlight some of these trends, and accordingly offer some conclusions—almost a morality, as in old tales.

In addition to the many friends, colleagues, and publishers that are mentioned in the book, special thanks are due to Megan Spriggs, who edited earlier drafts of most chapters, to Cynthia Davidson, who turned those chapters into a book, and to Peter Eisenman, who found a title for it.

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VARIABLE, IDENTICAL, DIFFERENTIAL

On the evening of Sunday, August 15, 1971, U.S. President Richard Nixon announced in a televised speech[1] a series of drastic economic measures, including the suspension of a fixed conversion rate between the dollar and gold. The end of the gold standard, which had been reinstated by the Bretton Woods Agreement in 1944, had momentous economic consequences.[2] Its cultural fallout was equally epochal. Only a few years later, the founding fathers of postmodernism saw in "the agony of strong referentials"[3] one of the symptoms of the postmodern condition, and Nixon's abolition of the dollar's gold parity should certainly rank among the most prominent harbingers of many postmodern "fragmentations of master narratives"[4] to follow. From what is known of him, chances are that Nixon (who died in 1994) was never fully aware of his inspirational hold on Deleuze and Guattari's rhizomatic theories of mutability.[5] But from the point of view of historians of images, the end of the dollar-gold standard should also be noted for tolling the knell of one of the most amazing and miraculous powers that images ever held in the history of the West—one that art historians have often neglected.

British banking history may illustrate the relationship of paper currency and precious metal over a longer period of time than the history of the dollar would allow. From 1704, when banknotes were declared negotiable in England and Wales, until—with minor interruptions—1931, when the Bank of England in fact defaulted,

proximation thereof: it is not known whether this happened by chance or by design), and still bear logos, trademarks, and some archaic machine-readable characters in relief—a reminder of the time when they were invented in the late fifties. But today the validity of a credit card depends almost exclusively on a unique string of sixteen digits that identifies it, regardless of its format, color, or the material of which the card is made.[8] Indeed, for online transactions the physical existence of the card is neither required nor verifiable. The first way to confirm the validity of a credit card is to run a check on the sixteen-digit sequence of its number using a simple algorithm, known as Luhn's formula, which in most cases (statistically, nine times out of ten) is enough to detect irregularities. No one would try to judge the creditworthiness of a credit card by looking at it, in the way one would peruse a banknote or inspect its watermark. Visual identification is now out of the game. In this instance, exactly transmissible but invisible algorithms have already replaced all visual and physical traces of authenticity.

Albeit anecdotal, these monetary examples illustrate three paradigms of visual identification, essentially related to three different ways of making things. The signature, the banknote, and the credit card: when objects are handmade, as a signature is, variability in the processes of production generates differences and similarities between copies, and identification is based on visual resemblance; when objects are machine-made, as a banknote is, mass-produced, exactly repeatable mechanical imprints generate standardized products, and identification is based on visual identicality; when objects are digitally made, as are the latest machine-readable or chip-based credit cards, identification is based on the recognition of hidden patterns, on computational algorithms, or on other nonvisual features. This loss of visuality, which is inherent in the mode of use of the latest generation of credit cards, may in turn be a prelude to the eventual disappearance of the physical object itself: credit cards are in most cases already obsolete, as many of their functions may soon be taken over by cell phones, for example.

The list of objects of daily use that have been phased out by digital technologies is already a long one: digital consumer appliances tend to merge on a single, often generic technical platform a variety of functions that, until recently, used to be performed by a panoply of different manual, mechanical, or even electronic devices (from address books to alarm clocks to video players). Industrial designers and critics have taken due notice, as is shown by the ongoing debate on the disappearance of the object (or at least of some objects).[9] However, alongside and unrelated to this seemingly inevitable wave of product obsolescence—or perhaps, more appropriately, product evanescence—digital tools are also key in the design and production of a growing range of technical objects, old and new alike—from marble sculptures to silicon chips. And the technical logic of digital design and production differs from the traditional modes of manufacturing and machinofacturing in some key aspects.

A mechanical machine (for example, a press) makes objects. A digital machine (for example, a computer) makes, in the first instance, a sequence of numbers—a digital file. This file must at some later point in time be converted into an object (or a media object) by other machines, applications, or interfaces, which may also in turn be digitally controlled. But their control may be in someone else's hands; and the process of instantiation (the conversion of the digital script into a physical object) may then be severed in space and time from the making and the makers of the original file. As a consequence, the author of the original script may not be the only author of the end product, and may not determine all the final features of it.

To go back to image theory, a comparison may help to make the point. Each print of a picture in the same print run looks the same. All mass-produced series include minor accidental variances, but by and large, all buyers of the same postcard (printed, for example, in one thousand copies) will buy the same picture. On the contrary, a digital postcard, e-mailed from a computer to an electronic mailing list of one thousand recipients, is sent as a sequence of numbers that will become a picture again only upon delivery—when it appears on one thousand different computer screens, or is printed out by as many different printers. The digital file is the same for all. But each eventuation of that file (in this instance, its conversion into a picture) is likely to differ from the others, either by chance (some recipients may have different machines and applications), or by design (some recipients may have customized their machines or may deliberately alter the picture for viewing or printing). Some of this customizable variability certainly existed in the good old days of radio and television, and even of mechanically recorded music. But the degree of variability (and indeed, interactivity) that is inherent in the transmission and manipulation of digital signals is incomparably higher. We may well send the same digital postcard to all our friends. Yet there is no way to anticipate what each of them will actually see on the screen of his or her computer or cell phone (and even less, what they will see if they decide to print that picture on paper—or on any other material of their choice, for that matter).

The loss of visual significance that is so striking in the instance of the credit card may simply be the terminal phase of the general regime of visual variability—or sensorial variability if we include other senses beyond sight—that characterizes all digital environments. Variability is also a diacritical mark of all things handmade, but artisanal and digital variability differ in another essential feature. Handmade objects can be made on demand, and made to measure. This makes them more expensive than comparable mass-produced, standardized items, but in compensation for their extra cost, custom-made objects are as a rule a better fit for their individual user. In other instances, however, artisanal variability may be a problem, rather than a solution. As hand-making is notoriously ill suited to delivering identical copies, this tends to be the case whenever identical copies are needed. To take an obvious example: before the invention of print the transmission of texts and images was at the mercy of the will and whims of individual copyists, who could make mistakes and unpredictable changes at all stages of the copying process. The inevitable random drift of all manually reproduced texts and images was for centuries a major impediment to the recording and the transmission of all sorts of cultural artifacts—from poetry and music to science and technology.

Some degree of randomness is equally intrinsic to all digital processes. In most cases, we don't know which machines will read the digital file we are making, or when, or what technical constraints or personal idiosyncrasies will ultimately determine the conversion of our work from machine-readable documents into something readable (or otherwise perceptible) for humans. But, to a much greater extent than was conceivable at the time of manual technologies, when every case was dealt with on its own merit, and individual variations were discussed, negotiated, and custom-made on demand, the very same process of differentiation can now be scripted, programmed, and to some extent designed. Variability can now become a part of an automated design and production chain. Indeed, this is what the most alert users of digital technologies have been doing for the last fifteen years or so—artists and technologists as well as entrepreneurs and capitalists.

Both the notions of a manual drift in artisanal and script cultures, and of a digital drift in contemporary computer-based environments, will be discussed at length in the central chapters of this book. But a simpler instance of digital "differentiality" (a term introduced by Greg Lynn to describe the new forms of serial variations in the digital age)[10] may clarify the matter here. As is well known, various features of many web pages are now automatically customized based on what the page makers know of each individual page user. This is why the advertising (and increasingly, the content) which appears on some of the most popular web sites differs based on the computer, the browser, network, or protocol we use to access those pages, and varies according to the time of day, the geographical location of the user, and a number of other arcane factors that are well-protected trade secrets. This is, at its basis, the golden formula that has made Google a very rich company.[11] Variability, which could be an obstacle in a traditional mechanical environment, where identical copies were pursued, expected, and had intrinsic value, has been turned into an asset in the new digital environment—indeed, into one of its most profitable assets. As content customization seems to be, for the time being, almost the only way to make digital content pay for itself, web users are learning to cope with its side effects. Readers of the same online edition of the same newspaper often end up reading, at the same time and in the same place, a permanently self-transforming hodgepodge of different texts and images (sounds can be added at will). Following on the same logic, experiments are reportedly underway to replace conventional printed billboards in public places with electronic ones, capable of detecting certain features of the onlookers standing in front of them (through physical or electronic markers) and adapting their content accordingly.[12]

There was a time when daily newspapers published more than one local edition (and a few still do); but the notion that each reader may find his or her own custom-made newspaper (or web portal, or advertisement in a railway station) to match his or her unique profile goes far beyond technical variability, or digital differentiality, and induces a feeling of cultural instability that many may find disturbing. Over the course of the last five centuries the "typographical man" became increasingly dependent upon a high degree of visual predictability to facilitate the storage and retrieval of written information. Visual and graphic stability in the layout of texts and images arose with print technology, and thence spread to all tools and instruments that were mechanically mass-produced (again, printed from the same matrix or mold). These same patterns of graphic recognition are still at the basis of many cultural and social practices that play an important role in the ordinary conduct of our daily lives. We used to look for a certain column (or index, or price) in the same place on the same page of the same newspaper; similarly, certain electromechanical interfaces, such as analog instrument panels with dials and gauges, used to assign specific data sources to fixed, distinct, and memorable visual loci (as in all cars of the same make, for example, where a given warning signal always lights up in the same place, form, and color on the dashboard).

None of this applies to digital interfaces, where even the fonts and sizes of alphabetical texts may change anytime, often without warning, and the same piece of information may pop up anywhere on the isotropic surface of a muted LED display or of an interactive control panel, in all kinds of different sensorial species (as sounds, pictograms, drawings, diagrams, alphabetical warnings in a variety of different languages, perfectly impenetrable numerical error codes, etc.). Indeed, there is a certain logic in that the company that most contributed to the variability of digital images (Adobe Systems, the makers of Photoshop) should also have created new software specifically to counter this digital drift—to freeze images and force users to view visually

identical graphic layouts. Adobe's PDF, or "portable document format," essentially uses web technologies to transmit electronic photocopies—faxes sent over the Internet. Not without success: clearly, in many instances our societies cannot yet do without the iron inflexibility of the typographical page—a mechanical attribute *par excellence*. Tax forms must be identical for all (even when downloaded from a web site, or, more recently, filled in online) because line 33A-14 must appear on page 7 on all tax returns. This clearly shows how income tax returns could not have existed before the age of printing: even in the electronic era the internal revenue services of most countries, when they go online, are forced to use the most sophisticated technologies to reduce the ectoplasmic variations of digital images to the mechanical fixity of printed pages. The web sites of various ministries and national services that deal with tax returns are true works of electronic art, and Marshall McLuhan would have delighted in the digital emulation of Gutenberg's machine recently perfected by modern state bureaucracies: the typographical man is so integral to the modern state that the modern state, even after adopting electronic technologies, is forced to perpetuate a mimesis of the typographical world.[13]

So it seems, to sum up, that in the long duration of historical time the age of mass-produced, standardized, mechanical, and identical copies should be seen as an interlude, and a relatively brief one—sandwiched between the age of hand-making, which preceded it, and the digital age that is now replacing it. Hand-making begets variations, as does digital making; but the capacity to design and mass-produce serial variations (or differentiality) is specific to the present digital environment. Unlimited visual variability, however, may entail a loss of visual relevance: signs that change too often or too randomly may mean less, individually taken, and may in the end lose all meaning.[14] This was already the case in the old age of handmade variability, when the economy of visual communication was dysfunctional because of a penury of recognizable images, and is again the case in the new age of digital differentiality, where the economy of visual communication is dysfunctional because of an oversupply of variable images.

The sequential chronology of these three technical ages (the ages of hand-making, of mechanical making, and of digital making) lends itself to various interpretations.[15] Some objects were still handmade well into the mechanical age, and some will still be handmade, or mechanically made, well into the age of digital making. But, by and large, the second break in this sequence, the passage from mechanically made identical copies to digitally generated differential variations, is happening now. The first break, the transition from artisanal variability to mechanical identicality, occurred at different times in the past—depending on the classes of objects and technologies one takes into account. The defining shift from artisanal hand-making to mechanical manufacturing (or machinofacturing) came with the industrial revolution. However, if next to traditional objects of manufacturing (rails, sewing machines, or automobiles) we also look at media objects (texts, images, sounds, and their modes of recording and transmission), we may encounter some slightly different chronologies.

New media theorists[16] tend to situate the transition from variable to identical copies in the nineteenth or twentieth century, as they associate the rise of identicality with indexical realism, which is often seen as the distinctive property of photography and of cinema. Unlike an artist's drawing, a photographic image is a machine-made, quasi-automatic imprint of light onto a photosensitive film: by the way it is made, it can only record something that really happened. Traditional media scholars[17] relate the rise

of identically reproduced, mechanical images to the invention of print and—almost simultaneously—of geometrical perspective in the Renaissance. Well before modern photographic technologies, Alberti first and famously defined perspectival images as the trace of light rays on a surface.

The history of architecture features a conflation of different technological timelines. Built architecture depends on the production of material objects (bricks, nails, iron beams, etc.), hence its modern history is linked to the traditional chronology of the industrial revolution. On the other hand, architectural design is a purely informational operation, and its processes are defined by a specific range of cultural and media technologies. For centuries the classical tradition was based on the recording, transmission, and imitation of architectural models. In turn, this tradition, or transmission, was and still is dependent on the media technologies that are available, at any given point in time, to record a trace of such models and to transmit them across space and time. What cannot be recorded will not be transmitted, and what is neither recorded nor transmitted cannot be imitated. Additionally, and unrelated to the publication, circulation, and reception of architectural rules and models, building may also be dependent on the cultural technologies needed to notate specific design instructions that are conceived by some to be carried out by others, sometimes in the absence of the original designer. A key issue in the modern, notational theory of architectural design, this technical, point-to-point exchange of building and construction data is once again a matter of recording and transmission—a media problem.

1.1 Architecture and the Identical Copy: Timelines

The history of architecture in the machine age is well known. As it has been written and rewritten many times over by the militant