ARCHITECTURE, URBAN PLANNING AND DEVELOPMENT

Design in Architecture

Architectural Design Instruments

Conditions of Appearance, Modes of Appropriation and Reconfigurations of Practices

Coordinated by
Sébastien Bourbonnais

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Architectural Design Instruments

SCIENCES

Architecture, Urban Planning and Development,
Field Director – Patrizia Laudati

Design in Architecture, Subject Head – Elizabeth Mortamais

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ISTE WILEY

First published 2023 in Great Britain and the United States by ISTE Ltd and John Wiley & Sons, Inc.

ISTE Ltd
27-37 St George's Road
London SW19 4EU
UK

www.iste.co.uk

John Wiley & Sons, Inc.
111 River Street
Hoboken, NJ 07030
USA

www.wiley.com

Library of Congress Control Number: 2022949587

British Library Cataloguing-in-Publication Data
A CIP record for this book is available from the British Library
ISBN 978-1-78945-105-4

ERC code:
SH5 Cultures and Cultural Production
SH5_12 Computational modelling and digitisation in the cultural sphere
PE6 Computer Science and Informatics
PE6_12 Scientific computing, simulation and modelling tools

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Introduction

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I.1. The instruments of architectural design

Digital technologies have undeniably introduced new modalities into architectural design practice. The changes have been multiform, of varying degrees and have occurred progressively according to the rate of appropriation to each architect's own sensibility. Moreover, it is difficult to consider the digital transition as a homogeneous and coherent whole, since each of the practices has been modified singularly according to the contexts that guide their mutations. It would then be more appropriate to talk about trends that develop, branch out, disperse or even fade away, according to time and context, and sometimes reappear, slightly modified, posing similar questions from another point of view and armed with new tools (both technical and conceptual). In light of the mutations that have occupied practices over the last 30 years, it cannot be denied that these design instruments have introduced new potentialities for projects, or at least modified them in certain aspects. However, the set of elements that are at the origin of these transformations, which have guided and oriented them to give them their present form, obviously cannot be determined clearly. There are in fact a number of factors involved in this appropriation of digital technologies by architects, factors which, moreover, have been intertwined in such a way that it is impossible to dissociate them in order to examine them separately. In fact, the potentialities of these technologies, governed by internal functioning logics, are almost never found in the abstract state, but are always engaged with singular practices that are already more or less defined, and themselves governed by architectural intentions, preoccupations and conceptions that must be understood as

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a whole. In addition to this already complex intertwining, there are other determinations that exceed the individual practices and are inscribed in the spirit of the times.

It is through these processes of appropriation that different behaviors have been adopted in relation to the types of software used, with certain forms of knowledge and know-how, whose coherence is acquired in the very activity of design, thus being prioritized. Architect-designers must be able to adjust, or even set up their instruments to their ways of doing things, knowing that these are or will be modified in turn by the instruments themselves, by their real as well as fantasized potential. It is thanks to this permanent back and forth that technologies are, little by little, perennially introduced into project practices and are managing to transform the sensibilities of architects. It is in this sense that new normativities are set up and take shape as practices change. These processes of singular appropriation, like those for collective appropriation, are being established thanks to the constitution of suitable new environments for these innovative practices which, especially, enable these to make sense by developing modes of expression coherent with the employed technologies.

The starting point of this discussion on instruments is not to consider them as simple tools, external to the practice of architects, but, on the contrary, to see them as instruments which, through their capacity for structuring, bring about transformations in the architect's design methods. Digital technologies would not, in any case, be a simple means to reach an autonomous end, pure or detached from any technicality. Rather, we affirm that it is through the act itself, through experimentation with instruments, that their different potentialities are deployed and consolidated. It is also through these repeated, revised and stabilized experiments that practices are transformed. This is not so much a wish as an observation, which, as such, has been identified in the different practices presented in this book.

Our objective is to focus on those moments where, from singular practices, instruments affect, at different levels, thought processes around design and representation. We will see that the computer has introduced new relationships between humans and technologies and has enabled new sensibilities to emerge. More specifically, with regard to project practices, instruments have established new relationships between theory and practice, leading architects to search for concepts or objects capable of supporting, clarifying and propelling the experiments they were carrying out with these emerging technologies. We will also see that the adoption of certain instruments has enabled a reconfiguration of practices, from top to bottom, by shifting the focus of attention away from design. Indeed, while the drawing, or more broadly the notation regime established since the Renaissance

(Carpo 2011), is authoritative in design decisions, certain data-driven software and platforms have introduced a reversal of perspective, where attention is no longer focused solely on the drawing, the geometric projection, but on the data that enables it to be generated. This shift also raises the question of what to do with this mode of expression, which is strongly rooted in architectural culture – drawing in particular – if it is no longer the "object" of design. These are the kinds of problems we wanted to address and develop in this book devoted to design and representation instruments.

I.2. Terminology choices

It remains astonishing that despite the years, digital technology, and its technological equipment and software have not found a flagship concept. After a few unsuccessful explorations, the architectural community has turned, in common language at least and in English in particular, to the notion of a "tool". Software, for many, is called a digital tool. However, the notion of a tool seems somewhat incongruous when examining this complex technological equipment: this is no longer a simple hammer. It is true, however, that notions, far from being fixed once and for all, have the capacity to transform and expand in order to capture a reality that is constantly developing. Nevertheless, because of the practices we wish to put forward, we have chosen the notion of "instrument", which, at first glance, seems more appropriate, even if, here again, it remains necessary to renew this notion.

This choice is first based on the distinction between "tool" and "instrument" established by the philosopher of techniques, Gilbert Simondon:

> […] if by *tool* one understands the technical object enabling one to prolong and arm the body in order to accomplish a gesture, and by *instrument* the technical object that enables one to prolong and adapt the body in order to achieve better perception; the instrument is a tool of perception (Simondon 2017, p. 130).

If the tool refers to the action, we could say that many programs focus on extending the action of the drawing hand, but, as will be shown in more than one chapter, gestures are no longer simply improved, or "armed"; they are now of a different nature. The senso-motor correspondence between the drawing and the hand is erased to the detriment of a decentered and analytical perception. Displacement takes place in the very actions of projecting, designing and even representing. The "algorithm, line and eye" configuration proposes a new arrangement than the one traditionally established between the hand, line and eye. It is no longer the hand that draws the line, but the algorithm that generates an interaction proposing a variety of

forms. It is the numerous action and feedback operations that are externalized in software, thus obliging a sensibility also externalized in mediation. It is for this reason that we wanted to use the notion of "instrument": to underline the radical transformation of gestures and place emphasis on what is perceived via the digital instrument. Indeed, these different instruments have the capacity to shift points of view, offering new ways of understanding the objects of design as much as their generative processes.

We will develop the "enlargements" that we wish to bring to the instrument notion, but let us take a few moments to examine some of the notions that may have been appropriate to grasp the technological reality of contemporary architectural practices. Let us start with the notion of a *technical object*, developed by Simondon (2017), that was moreover possible to position within the distinction established between "tool" and "instrument". It is important to remember that the philosopher elaborated this expression in opposition to other types of object, principally works of art, for which culture acknowledges a superior value in them, whereas technical objects are mainly considered as simple utensils. This work of technique revalorization, through an awareness of the sense of its objects, shifted the attention specifically onto the objects themselves and their processes of concretization. This revalorization included, among other things, a displacement, which consisted not only of concentrating on their usage value – how are they useful? – but on placing the emphasis on their internal functioning and relationship/coupling/association with their "milieu". In spite of the richness of this position, this notion remains strongly attached to the objects studied by the philosopher (diode, triode, telephone, Guimbal's machine and so on) and consequently bears little relevance in the understanding of our object of study. Nevertheless, as we will see in some chapters of this book, the philosopher's thoughts are very rich in bringing original insights onto our specific object of study.

We could have retained other notions, such as those of *apparatus* provided by the philosopher Jean-Louis Déotte. This theory was largely based on photographic and cinematographic apparatus, as defined by Walter Benjamin, in order to take the technical, even techno-aesthetic dimensions, into which the various arts emerge, such as conditions of emergence, seriously. In addition to these, Déotte proposed a series of modern apparatuses that have served to transform perception, such as perspective, the museum and psychoanalysis. With these apparatuses, "micro-apparatuses" were proposed, such as video, the theatrical stage or even orthogonal projection, as submitted by the architect Boulet (2005), which have the singularity to introduce, each time, a new understanding of reality, which resides mainly in the invention of a new temporality. "These are the apparatuses which give their base to the arts and impose on them their temporality and definition of common

sensibility, as with any singularity. It is they that create an epoch and not the arts" (Déotte 2007, p. 15). This question of "creating an epoch", in the sense of *epokhé,* as a point of stop, of interruption, is central to this theory of apparatuses, since it is precisely thanks to this interruption that it becomes possible to acquire a new common sensibility. Moreover, it was on this precise point that the philosopher did not include digital technologies among the "apparatuses". These are not creating an epoch (where we see the current disruption), as nothing would be allowed to stop or retain the flow of our contemporaneity to the passing time.

Another particularity of the theory of apparatuses was that this had been constructed in opposition to the notion of *devices (dispositifs)*, advanced by Michel Foucault and reactualized by Giorgio Agamben and Vilém Flusser. A device arranges, and inevitably introduces relationships between body, knowledge and power (Déotte 2004, p. 135). Architects have been tempted to use this terminology, as evidenced by the colloquium held in 2004 as part of the *Devices of Design* collaboration between the Canadian Centre for Architecture and the Daniel Langlois Foundation. Without being completely inappropriate, the "device" notion remains, however, too imprecise and to be truly operative would require a system of levels or categories to be established that would make the hierarchization of all the devices present in software possible, such as visualization, lighting, rendering, as well as compilation devices. We could say that digital technology has absorbed as much as annihilated these notions of devices and apparatuses. It is indeed also possible to find simulations of apparatuses as defined by perspective, orthogonal projection, photography and even museums, but these have completely lost their power to create their own temporality. The "digital" perspective no longer manages to create that instant, where lines define their "object", and even the already fragile "that-has-been" of Roland Barthes, of the photograph has completely lost its validity, now without traces on a negative.

Another notion caught our attention, that of *media* or *medium,* which has been employed recently by digital artist and theorist Lev Manovich in order to examine contemporary art practices. He moved from a post-media aesthetic (2001) to *The Language of New Media* in 2002, to propose, in *Software Takes Command* (Manovich 2013), a study of software as *meta-media*, that is, media capable of encompassing all others through remediation, while allowing something more to be added. This notion has moreover been the subject of a collective work, entitled *Art, Médium, Média* (Krajewski 2018). In its introduction, Krajewski recalls the three uses of the notion of medium: popular use, scientific use and aesthetic use. Under scientific use, Krajewski presents two paths: along the lines of Marshall McLuhan, media as technical extensions of ourselves; and another, mediology, as defined by Régis Debray, with special attention on the symbolic dimension, as "the entire

means of transmission and symbolic circulation" (Debray, quoted by Krajewski (2018, p. 10)). Looking more closely, McLuhan's analyses, or even those of an important media theorist like Friedrich Kittler[1], were also attentive to this circulation of the message (albeit, for McLuhan, reduced to the medium itself) and to these effects on culture. The cultural objects on which their analysis is focused, as much as the attention that they pay to their effects on culture, would have given a false lead regarding the intentions expressed in the various analyses assembled here. On the other hand, Krajewski's collective work shows, in spite of the efforts at clarification, the difficulty in using this notion without subsequent redefinition work.

This redefinition work had already been proposed by Sicard (2010), with the shift towards the notion of milieu, as developed by Georges Canguihem. Hui and Mey (in Krajewski's work) proposed a similar shift by treating the medium as an intermediary with the milieu – as a mediator. Hui and Mey added the concept of modulation, more precisely modulation of information, developed by Simondon and then by Gilles Deleuze. As indicated above, a number of these theorists' concepts are truly effective when approaching our subject. They maintain their relevance; however, attachment to the notion of medium seems to be unnecessary to us.

The notion of *techno-social infrastructure*, used by architect and researcher Llach (2005) to address the issues of software and the imagination of design, also merited our attention. By focusing on certain key figures, such as Steven Coons or Nicholas Negroponte, or through an *in situ* investigation of the use of BIM technologies in Abu Dhabi, Llach seeks to emphasize the set of structures that govern the transformations that occupy the architecture community. "Software is not merely an instrument of design, but also a versatile metaphor – and a crucial *infrastructure* – reconfiguring conceptions of design, work, authorship, and what it means to be human" (Llach 2015, p. 2). Infrastructure allows him to emphasize the "combined studies of science technology and society, software and media studies, and the architectural humanities" (Ibid., p. 4). While there are indeed several points of agreement with this notion, our choice, that of keeping the notion of instrument to reform it, indicates a different direction with regard to the approach, as well as the scale with which practices, software and the project will be tackled. The "instrument" notion underlines the almost mechanical workings that modify and restructure project practices.

1. It should be noted that both authors have had a literary education and that their writings make numerous allusions to the literature.

This relatively detailed presentation of notions close to our analyses, as well as our decision to retain the "instrument" notion, was made in order to indicate to readers what we wanted to emphasize. In this respect, *neologism* could have also been attempted, but this is slow in coming to fruition and acquiring its full authority.

Let us say a word about the update we wish to carry out on this "instrument" notion, in order to adjust it to our purpose. While we could have made a connection with artistic instruments which, like the emblematic musical instrument, allow different modalities of expression and are realized according to rules, our connection was instead made with scientific instruments. Following the idea that "science becomes dependent on the perfection of instruments, which themselves depend on the state of science" (Barbin 2004, p. 10), it was a question, by analogy, of trying to identify what these instruments, and perfecting them, bring in new relationships with architectural design: how do they modify the knowledge specific to the design of a project? This idea that there may be knowledge specific to design deserved further development, especially since this has been explicitly put forward by multiple actors who are fully engaged in experimental digital practices. Moreover, many current debates are focused on this precise point as to the place to be given to artificial intelligence in the architecture.

Another particularity of scientific instruments is their capacity to integrate mathematical theorems, or even principles of geometry. Although computers are clearly capable of integrating abstractions, computer sciences, however, differ on one point:

> Computer science, insofar as it is concerned with software, is distinguished from the empirical sciences in that none of its models are physically concrete - they are realized in the software, and in this nonphysical sense computer science models are abstractions (Colburn and Shute 2007, p. 170).

They also differ from pure sciences, such as mathematics, despite their numerous implications, and it is precisely on this point where the differentiation between number and code is made. The distinction between mathematics and computer science lies in their respective use of abstraction. It is on this point that the singularity of computers rests, as shown by the argument developed in Colburn and Shute (2007):

> Computer science, being primarily concerned with developing interaction patterns, "has *information hiding* as its abstraction objective," compared to mathematics, which, developing inference

> structures, "has *information neglect* as its abstraction objective" (Ibid., p. 169).

This distinction between *neglected* and *hidden* information, which was also noted by the epistemologist Varenne (2009), is essential, since it allows us to singularize the processes of abstraction managed by the computer by displacing relationship modes under new technological grounds of observation. In this logic, different software programs store rules, theorems and even mathematical propositions, but their application via specific ways of interacting makes a leap that brings about a change in the nature of the information that is manipulated.

Finally, our choice turned to the "instrument" notion due to its capacity, despite everything, for instrumentalization: instrumenting the instruments of design. It seems important to us to remain attentive to and critical about the determinations that software can bring to architecture. As Horkheimer and Adorno pointed out, the instrumentalization of science, philosophy, and even architectural design is always concerned with and affected by the global production process in which these domains find themselves and evolve:

> [Official sciences] suffer the fate that has always been reserved for triumphant thought. If it voluntarily leaves behind its critical element to become a mere means in the service of an existing order, it involuntarily tends to transform the positive cause it has espoused into something negative and destructive (Horkheimer and Adorno 2002, p. xv).

While the practices observed and presented in this book have rightly sought to avoid the trap of instrumentalizing the design process, the fact remains that for many architects there is a feeling of incomprehension, even dispossession, of the tools they use and their restrictive logic. Our wish is to offer some conceptual tools in order to avoid this instrumentalization of the technological processes that threatens us.

I.3. Composition of the book

The contributions in this work have been chosen to offer different points of view on the subject of design instruments and their repercussions on architectural practices. Indeed, thanks to the different insights offered by each chapter, our objective has been to raise and develop different points of this problem, in order to highlight several of the main issues that many architects are facing. How have architects appropriated digital technologies? With what concept (The Fold)? What object (the *Drodel*)? Also, what has been the impact on their project practices? What

does it mean to design from data and no longer from a geometric representation of an object? What happens to these representations (the drawing, for instance) when they are no longer at the center of the design process? These could have been the questions that guided the whole of this book.

Sébastien Bourbonnais proposes a broad historical overview in order to position the main reference points for this appropriation by architects. From the initial CAD project at MIT in 1959 to recent advances in BIM and online applications, the focus is on the conditions that have led to the emergence of certain programs that have interested architects. More specifically, his observation has been built on the coupling between internal software logic and the different contexts in which it emerges, transforms and evolves. These evolutions enable us to see the numerous factors that intervene in the implementation and development of a piece of software, encompassing both the interrogations of architects and broader societal issues. It has also been possible to identify some of the postures adopted with regard to the technologies that have marked, or even guided, this evolution. The interest has been in defining some of those adopted by certain architects with regard to information technology, by seeking, above all, to understand when they emerge, under what conditions and what questions they address. The interest is also in those moments when these postures fade away, sometimes to the point of disappearing, to make way for the opposing posture. This great panorama, over a period of 60 years, raises a paradox: while several themes have returned to the agenda, or while questions have been raised several times over this short timeframe, sometimes in the same terms, it is surprising to note that there is no direct relation between these questionings and/or themes. It is not so much the questions that have evolved as the technological context in which they have been posed. In this sense, the evolution of the proposed software has not been continuous, or rectilinear, but composed of a trajectory that has risen and fallen from a techno-socio-cultural and economic context, which has transformed itself in a sometimes unexpected way.

This presentation of the principal historical reference points, which offers an overall view, makes it possible to position the technological context in which the practices presented in the following chapters are found. In fact, in the four chapters that follow, it has been a question of presenting and deepening a specific episode and identifying one or more transformations that these instruments have introduced into practices. Through the examples analyzed, the objective has been to draw trajectories of architects engaged in an experimental practice from the different instruments placed at their disposal.

In Chapter 2, Denis Derycke shows that algorithmic, procedural thought is present in many architects, even before the “real” use of a computer. It is not a

question here of finding a remote origin for these practices, but of underlining the concordance between the moment when computers emerged and the moment of a more general interest in this type of process. From the Oulipo to Chomsky's generative grammar, passing through serial music or the structuralism movements (external and internal to architecture), the 1960s saw the emergence of a type of exploration that occupied several artistic domains. By focusing on the *Houses* of architect Peter Eisenman, Derycke presents a concretization of this type of emerging approach. This examination of Eisenman allows him to address the practices of the *Morphosis* agency during the 1980s. While there are similarities between these two practices, Denis shows how they differ, in the generative processes both employed and deployed, as much as in the role accorded to their various representations. The production of *Drodel,* a combination of drawings and models, illustrates the particular status that these intermediate objects acquire.

Focusing on the decade 1990–2000, Florence Plihon presents the particular moment when the computer became, for an important group of architects, a formidable vehicle for exploring certain facets of architecture in order to renew it. Many of them see the capacity to generate non-standard architecture, a way to destabilize it to its very foundations, using software. Through a detailed analysis of the work of Bernard Cache (Objectile Group), Greg Lynn (Lynn Form) and UN Studio (Ben van Berkel and Caroline Bos), she shows that the appropriation of technology is not only a matter of technique and software (which these architects have more or less expertise in), but also encompasses a series of non-technical considerations which have served to accompany these experiments. Indeed, during this decade, many architects made extensive use of the philosophy of Gilles Deleuze, whose "Fold" concept serves to show its relationship in detail, if not concordance, with the non-standard architectural production of the time. Plihon presents a cartography of these different transfers: geographical (between France and the USA), disciplinary (between architecture and philosophy) and methodological (between theory and practice). Based on these numerous back and forths and, above all, thanks to the examination of certain Deleuzian concepts, Florence has sought to understand what was ultimately the interest for these architects in resorting to this sometimes excessive theorization. With historical hindsight, it now seems possible to add a new question: what remains of this theoretical scaffolding when it is removed?

Samuel Bernier-Lavigne presents different tactics for misappropriation used by some architects. Using the distinction between "tool" and "instrument", he shows how a misuse, which is often considered transitory, ends up becoming an innovation that is adapted and more widely used. How does a more advanced control of an instrument affect the way of thinking about the project? Referring to the situationist misappropriation, Bernier-Lavigne shows that the further the object of the

misappropriation is from the subject, the greater its impact. By targeting two precise moments, which correspond more or less to the misuse of two different techniques, he traces trajectories that outline progressive adaptations. Through three examples taken from the years 1990–2000, he shows how architects had to reinvent the ways of representing buildings following the emergence of simulation software. How is movement represented by static means? While kinetic sections first allowed a more or less clear image of the project to be offered, by following the dynamic aspect of the building, it later became possible, thanks to their control, to present more than the building itself, but to integrate the project intentions. Another trajectory is then presented by three recent "graphic objects" projects, realized from different machines: first, using the reconstitution of *plotters*, an outdated technique, then with the misuse of a robotic arm, initially used for digital fabrication, and, finally, the creation of new machines, specially dedicated to this new way of drawing. These different "graphic objects" highlight the major transformation in the ways of representing architecture that is currently taking place. Indeed, what can the act of representation be used for, when it is no longer at the "center" of the design?

This question arises from a shift that Aurélie de Boissieu presents in the final chapter of this book. She shows that following a long period when architectural design was mainly based on a notation system, an informational system, centered on data, is gradually being put in place. While it goes without saying that BIM (Building Information Modeling) practices are participating in this change, and even that they are one of its main representatives, de Boissieu shows us that this data-centered design was also implemented in exploratory practices under the name of computational design. In both cases, design is no longer reduced to an authoritative annotated geometric representation used for construction, but is augmented by other types of representations. It is not that the graphic representation, the shape of the building, is completely redundant – it is, in fact, often present, such as in the form of a digital mock-up – but the crucial point is that, for certain projects or aspects of a project, it is henceforth the data that guides and orients the design choices, beyond, it could be said, the formal aspect of the building or the element to be built. In this respect, there is a "spectrum" of possible positions to be established in relation to the data, from which the importance attached to it is both significant and automated to a greater or lesser extent. De Boissieu also shows the implications that this type of management can have on the practices of increasing numbers of agencies. The recent naming of data-driven design is an indication of this ongoing shift.

This book aims to provide readers with epistemological, historical and practical bases for sharpening their gaze on the meaning of instruments used in architectural design processes and, more broadly, on the redefinition of these processes that stabilize only to better transform themselves again.

I.4. References

Barbin, É. (2004). Préface. In *Instruments scientifiques à travers l'histoire*, Hébert, É. (ed.). Ellipses, Paris.

Boulet, J. (2005). Les appareils de l'architecture, la projection orthogonale. In *Appareils et formes de la sensibilité*, Déotte, J.-L. (ed.). Harmattan, Paris.

Carpo, M. (2011). *The Alphabet and the Algorithm*. MIT Press, Cambridge, MA.

Colburn, T. and Shute, G. (2007). Abstraction in computer science. *Minds and Machines*, 17(2), 169–184.

Déotte, J.-L. (2004). *L'époque des appareils*. Ligne et manifeste, Paris.

Déotte, J.-L. (2007). *Qu'est-ce qu'un appareil ? Benjamin, Lyotard, Rancière*. Harmattan, Paris.

Horkheimer, M. and Adorno, T.W. (2002). *Dialectic of Enlightenment. Philosophical Fragments.* Stanford University Press, CA [Original published 1947].

Hui, Y. and Mey, A. (2018). L'exposition comme médium. Quelques observations sur la cybernétisation de l'institution et de l'exposition. In *Art, médium, média*, Karjewski, P. (ed.). Harmattan, Paris.

Krajewski, P. (2018). *Art, médium, média*. Harmattan, Paris.

Manovich, L. (2013). *Software Takes Command*. Bloomsbury, New York.

McLuhan, M. (1964). *Understanding Media. The Extensions of Man*. McGraw-Hill, New York.

Sicard, M. (2010). Du medium au milieu. *Livraison de l'histoire de l'architecture* [Online]. Available at: https://journals.openedition.org/lha/253 [Accessed 15 June 2020].

Simondon, G. (2017). *On the Mode of Existence of Technical Objects*, translated by Cecile Malaspina and John Rogove. Univocal Publishing, Minneapolis, MN [Original published 1958].

Varenne, F. (2009). *Qu'est-ce que l'informatique ?* Vrin, Paris.

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Evolution of Architectural Software

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The certainty that the technical evolution goes by its own logic in the direction of the progress of the man is not really accepted anymore, but this doubt does not undermine the evidence that there is a technical evolution

Xavier GUCHET (2005, pp. 23–24).

1.1. Introduction

The software used by architects has evolved, and continues to do so, according to different factors that, at their own pace, modify their practices to varying degrees. In order to understand this evolution, it is important to try to combine different factors in order to not only compare software, but also encompass the modalities and conditions that have made it possible for them to appear. Why did this type of software appear at this time? In such a context? If there is certainly an evolutionary trajectory of software, in reality, this trajectory is strongly disrupted according to its internal and normative logics, and sometimes even aligns itself perfectly with the questions of the architects occupied with these technologies, rather than following a progression only dictated by intrinsic technical potentialities. This introduces power relationships that are reflected in the orientations taken by software developments. In addition, at a broader level, a psycho-sociological and cultural context is added,

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which brings its own expectations into the course of this evolution. It is through this complex intricacy that we must approach this evolution of software mainly intended for architectural practices.

The aim of this chapter is to participate in the ongoing construction of a software culture among architects, following the example of the various thinkers who have tried to raise awareness of the meaning of technology and its objects. In order to establish our analysis, we will present different events, software, objects, practices and debates to understand some key elements of this complex interweaving. Indeed, a number of relatively important events related to computer science and architecture have taken place. They have allowed us to report on the debates that took place and raise problems or questions that architects have faced with the arrival of these technologies. A software series, flagship, detects the implicit ways of thinking about the design, while underlining the limitations of their understanding and explanation. It will also be a question of classifying software, an arduous task to grasp some of the trajectories that have structured the appropriation of software by the architectural community: mainly architect-practitioners and architect-researchers linked to different research institutions.

Starting from the initial CAD project, carried out at MIT in 1959, and from the 1964 meeting, held in Boston, on the theme of the computer and architecture, the aim was to highlight the different types of relationships that had been established between architects, computers and software, mainly in the context of design activity. The choice to focus on design was not arbitrary, but rather corresponded to the choices made by architects, at the turn of the 1970s, to use computers for this activity in particular, to the point of calling it into question. While the achievements of the design programs of this period are generally linked to research institutions, the 1980s, thanks to a number of major technical innovations, saw the creation of a new software market, whose main actors no longer had the same links with the architectural community. This led to a rapid growth of computer technologies, on several of its components, as well as on its manageability and accessibility. These advances saw the computer introduced in a massive way in architectural agencies at the beginning of the 1990s. The computer quickly became an instrument to explore differently, generating a singular episode in the history of digital architecture. Finally, we will end this great panorama on the new bifurcation that has occupied architecture for the last 20 years, with increasingly user-friendly software and the practices described as BIM.

This historical picture also aims to put forward the idea that many of the issues that occupy contemporary architects have persisted for a very long time and that, for many of these questions, they are repeated in almost exactly the same terms, but from a different point of view, in a different context, with new technologies. The

presentation of these different preoccupations, placed in their historical contexts, will also be an opportunity to highlight the processes put in place by architects in order to integrate technologies into their practices. It is a question, no more and no less, of establishing trajectories of appropriation which, undeniably, will have had repercussions on the ways of designing architecture.

1.1.1. *Difficulty of classification*

This work on the classification of software aims to put forward specificities and thus understand the fundamental differences of them, in relation to one another. Our bet is to build this method of analysis and classification from the *mechanology* project, the science of the machines, developed at the beginning of the last century. After a short presentation, it will be a question of following the evolution of this project, and then introducing modifications that are able to adapt to our object of study. This detour, as will be explained below, allows us above all to propose an alternative to software studies. It also allows for a somewhat different arrangement from that established in the exhibition *The Architecture Machine,* which was held in Munich (Fankhänel and Lepik 2020). According to the catalog, the exhibition was divided into four main chapters: the computer as a drawing machine; the computer as a design tool; the computer as a medium for storytelling; and finally, the computer as an interactive platform. These distinctions allow for a first efficient and relevant categorization, which we will in some way deepen and nuance. Our attention will be mainly focused on the emergence of these categories: to see how they are installed within the architectural debates of the time and especially, how they transform themselves, the ones in relation to the others, continuously, in a dynamic way. It is for all these reasons, among others, that we wish to return to the mechanological project.

A mechanology project was first proposed by the French architect and engineer Jacques Lafitte. “The science of machines, or mechanology, a normative science, has no other goal than the study and explanation of the differences that are observed between machines” (Lafitte 1972, p. 32). To this mechanology, a *normative science*, Lafitte added, while distinguishing them, a *descriptive science* “devoted to the history, description, and classification of existing machines” and an *art of building* machines. These three branches can be used as a basis for a reflection on software. Let us also underline that the main interest, as much for Lafitte as for our project, lies in the study of differences, because it is thanks to these that Lafitte managed to raise “the very problem of their existence” (*Ibid*.). This is indeed the objective that we set ourselves with this study, that of raising some of the cogs that allow us to shed light on what could be called *the raison d’être* of a software program; by

describing it, by showing its genesis and functioning when possible and, above all, by underlining its differences with other software programs.

Mechanology did not remain at the stage presented by Lafitte, but evolved in at least three phases (Guffroy and Bontems 2018). As Giovanni Carrozzini noted, a similar project was elaborated by the philosopher Gilbert Simondon, while differing from it on some points. If Lafitte wished to classify: "the machines invented by man during the centuries, Simondon developed an analysis that aimed for the understanding of the roots and dynamics underlying the act, the creative and inventive human gesture that are, in his opinion, the true origin of the technical objects". (Carrozzini 2009, p. 30) For Simondon, it is not a question of trying to understand closed technical objects, nor of simply classifying them, but of seizing them in their genetic and dynamic aspect, in their "entelechy" (Simondon 2014a, p. 300), which is opposed to the inactivity and the static state of the machine; the philosopher thus aims to seize the objects being *realized* in the action. His approach also differs in terms of the theoretical tools – notions – employed to capture this evolution of objects:

> Lafitte's approach remains completely linked to the traditional scientific method, whose goal is to simplify the complexity of reality, by using schemes, such as those of *species* and *individual* according to Aristotle. […] On the other hand, Simondon tried to go beyond this opposition […]. The law of the *recurrent causality* and that of the *relaxations* are not laws *manufactured* by science, by the *thought that reflects on the techniques*: they are laws that the Simondonian reflection *discovers* inside the evolution of the techniques. Moreover, the history of the techniques is not a continuous evolution, such as that of Lafitte… (Carrozzini 2009, pp. 37–38).

While it seems obvious that the technical evolution cannot be thought of in a continuous way, but rather in a "sawtooth" way, we wish to insist on the heuristic effort that will be necessary in order to seize the specificity of this software evolution: how do we define the laws which govern this evolution?

Another distinction that Carrozzini mentions is that Simondon will not only focus on machines, but will integrate a reflection on tools and utensils, and will even integrate a study of information machines and networks. Even if we wish to make this new arrangement of mechanology[1] the basis of our analysis, as Guffroy and

1. As both Carrozzini and Guffroy and Bontems underline, it is not a question for Simondon of taking up Lafitte's project and improving or modifying it, because, as these authors indicate, it is highly probable that Simondon only became aware of Lafitte's work after