

# Representation Degree Zero

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## “Drawing vs. moving”

“Conventionally, of course, drawing is an active process which leaves a trail of carbon on the paper. With a computer sketch, however, any line segment is straight and can be relocated by moving one or both of its end points.” [Sutherland 1963, p. 102]. With these surprisingly laconic words, the twenty-five-year-old Ivan Sutherland described, in his doctoral thesis [1], the most obvious difference between a traditional drawing and an electronic graphic document. Creator of the first interactive design system to be made public, called *Sketchpad*, presented precisely in the abovementioned thesis, and the first man to have drawn luminous lines on a monitor, he posed questions that have not yet been fully resolved even today, more than fifty years after that earliest act. Is it possible, in fact, to

call this new iconic artifact with the same name by which an object drawn by hand has been defined? Sutherland answered in the abovementioned chapter that he had significantly entitled *Drawing vs. moving*: “[...] there is *no* state of the system that can be called ‘drawing.’” [Sutherland 1963, p. 102] (fig. 1).

The distance between the manual, physical, material tracing of a graphic mark on a sheet of paper and the digital, abstract, immaterial equivalent, was now definitively handed over to the pages of the history books that could thus record the *zero degree* of representation. It was not a slow, centuries-long change –as in Barthes’ analysis of literature [Barthes 1960]– but a sudden change, as instantaneous as it was unexpected.

*This article was written upon invitation to frame the topic, not submitted to anonymous review, published under the editor-in-chief’s responsibility.*

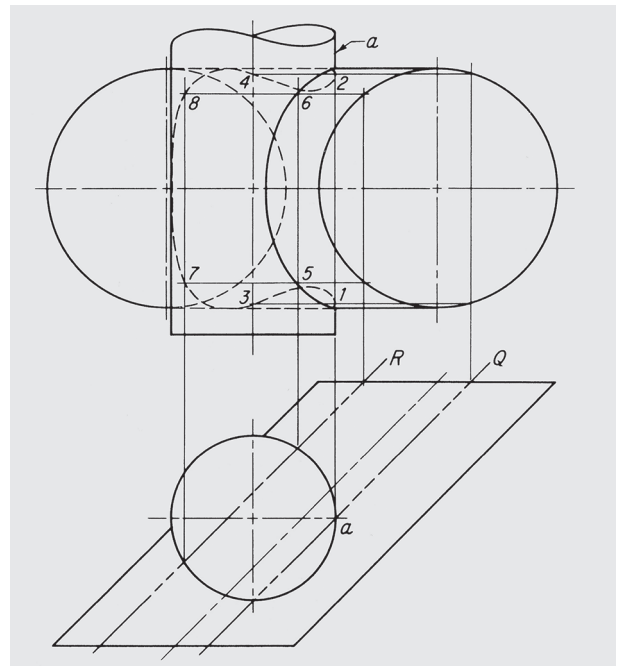
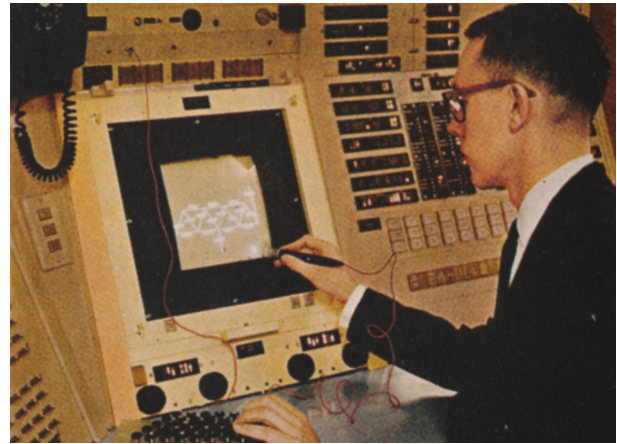
It was certainly not the light pen, from which a beam of radiating light emerged and remained imprisoned in the screen, that could evoke the radiant charm of a pencil held by a draftsman. Despite being of the same shape and size, this new tool forced an unnatural, mechanical behavior, which denied the user the spontaneity of an instinctive and instantaneous gesture, even if it offered in him a surprising precision in exchange, that no other drawing tool –whether ruler or compass– had ever granted him.

Nor could the rules for learning the art of drawing described, for example, by Eugene Viollet-le-Duc in his *Histoire d'un dessinateur* [Viollet-le-Duc 1992], or by Ruskin's *Elements* [2] be any longer applied. Although, paradoxically, about 150-180 hours of practical application for learning the art of drawing suggested by John Ruskin –“an hour's practice a day for six months, or an hour's practice every other day for twelve months,” [Ruskin 1857, p. 3] as the well-known teacher's promise goes– correspond to the average duration of the learning course of a Computer Aided Design (CAD) or Building Information Modeling (BIM) software.

Closer, perhaps, to the rigorous methods of descriptive geometry that accompany the designer in the recognition of syntactically congruent forms, thanks to the delineation of discrete segments and arcs, or to the enigmatographic games in which hidden pictures are revealed by connecting numbered points in sequence, the mark made up of bright pixels on the screen can represent geometries of surprising complexity in a very short time. Morphologies so articulate that they would have taken a student of Gaspard Monge –or the same *professeur de mathématiques* himself [3]– hours of work to solve similar operations of geometric construction. It is no coincidence that Steven Coons [4], professor of mechanical design at the Massachusetts Institute of Technology, responsible for the theoretical formalization of the system later developed by Sutherland, in the book written with John T. Rule [Rule, Coons 1961], has dedicated many pages to the graphic solution of geometric-descriptive problems of solids and their intersections in space (fig. 2). It can be well understood, therefore, that Sutherland's work was born downstream of a collective work of investigation on these research topics and following a substantial funding by the U.S. Department of Defense, which had previously also funded the SAGE system [5], progenitor –in terms of video pointing systems– of Sutherland's system.

Fig. 1. Ivan Sutherland and the Sketchpad system, Massachusetts Institute of Technology, 1963.

Fig. 2. Intersection of solids [Rule, Coons 1961, p. 218].



In fact, starting from 1959, MIT's *Computer-Aided Design Projects* had been initiated with the aim of defining the characteristics of a representation system based on electronic technology. In one of the first reports on the subject, written by Coons and Robert Mann [Coons, Mann 1960], it is established that "the objective [...] is to evolve a man-machine system which will permit the human designer and the computer to work together on creative design problems" [Coons, Mann 1960, p. III], with a further specification in the foreword, namely that "it is not contemplated that fully automatic design without human guidance and decision is a possibility for the foreseeable future" [Ward 1960, p. V]. It was, therefore, to define a "perfect [digital] slave" [Cardoso Llach 2015, p. 49], leaving to the human being the creative contribution in the design process. To confirm the fact that the work that had led to the realization of Sketchpad was collective, it is sufficient to skim the proceedings of the Spring Joint Computer Conference held in Detroit in 1963, in which a whole session –entitled "Computer Aided Design," continuing for more than fifty pages– is dedicated to the presentation of this new drawing tool [6].

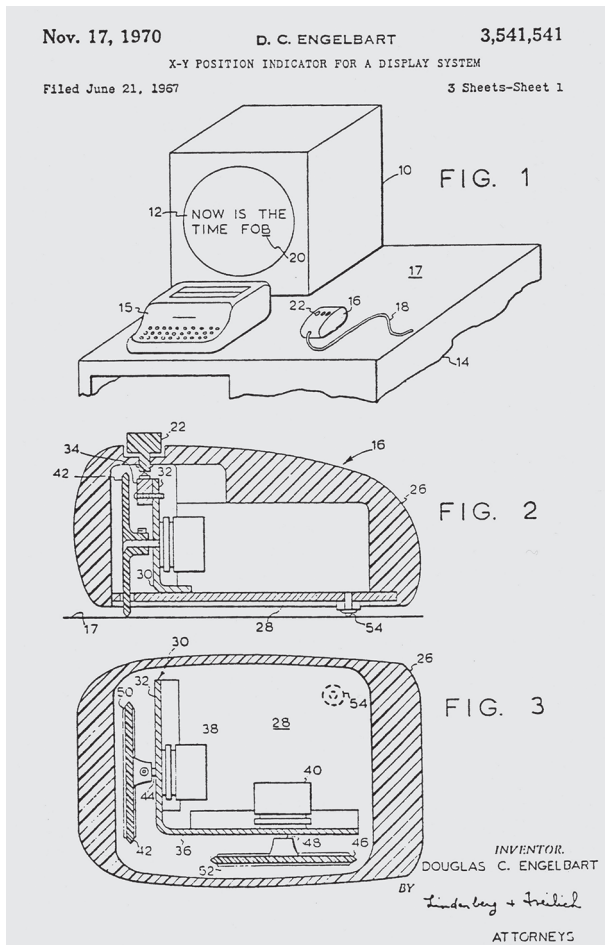
Research for characterizing drawing more towards diversified strategies for the formalization of contents would soon begin: on the one hand, experimentation in the aerospace and automotive industries, at first mainly by Boeing and General Motors, and on the other hand, the development of applications oriented toward architecture and construction, immediately renamed with a different acronym: CAAD, or Computer Aided Architectural Design [Negroponte 1975; Mitchell 1977]. But this greater qualification of the graphic document could hardly have remedied that sharp distinction between manual drawing and digital representation that, at the same time, would have developed a greater distance, especially with the definition of an unprecedented graphic modality: three-dimensional representation.

### 3D

If innovation in the field of representation manifested itself with the technological transformation of the instrumentation available, the real technological revolution consisted in the informative and communicative paradigm that for the first time offered itself to those

who wanted to represent a form. In the same Lincoln Lab of MIT in which Sutherland gave rise to the origin of two-dimensional computer graphics, Timothy Johnson [Johnson 1963], in the same period, translated into three dimensions the genetic code written by his friend and colleague, so much so that we can say without fear of contradiction that the drawing done with the computer is born with a stereometric characteristic, not granted to traditional drawing. An added value that immediately leads us back to Malevich's description of his *Black Square* [a black square on a white background] of 1915: "I have transfigured myself into the zero of forms," said the Russian painter, "and have gone beyond the zero" [Malevich 1915]; with these words he anticipated by a few years his most decisive work, that *White on White* [a white square on a white background] that did not allow any possibility of mediation with the past. "Going beyond the zero" could, therefore, mean, if we consider the three-dimensionality of a drawing, completely modifying the operative paradigm with which a drawing is done: no longer a stable product on our sheet of paper, static in its Cartesian coordinates or bound to proper or improper projective procedures that prevent its variation, if not a physical erasure of lines and a re-drawing of the figure. Now *drawing* –if it can still be defined as such– becomes dynamic, mobile, infinitely variable, without leaving a trace of a possible elimination of segments. Infinite perspectives can be generated by the simple touch of the pointing tool, which remained in the shape of a stylus until the next decade. The patent for the mouse (fig. 3), in fact, was obtained in 1970 by Douglas Engelbart [7] seven years after the birth of *Sketchpad*. But parallel projections, enlargements and scale reductions were also foreseen in this new *digital notebook*. With a further figurative peculiarity based on the transparency of its filiform essence and presenting itself as the computerized translation of that graphic stratagem which calls for the stratification of a traditional drawing with layers of tracing paper. In this case as well, the difference between tradition and innovation is evident: hand drawing uses semi-translucent paper to express different contents on various levels, such as the drawing of a floor plan or an elevation, in an integral form. In the case of digital drawing, instead, the *layers* can hold small homogeneous parts of the same altimetry or planimetry, such as, for example,

Fig. 3. Drawings accompanying Patent No. 3541541 filed by D.C. Engelbart for the mouse, 1970 [Bardini 2000, p. 100].



openings, stairs, windows, with an additional discretization of the components, which can contain infinite structures of information.

A clean cut with the past, then, a new graphic technique that contemplated a figurative device that negated with one stroke, surpassing them, the two principles at the base of projective geometry: the concepts of projection and section. It is now possible to generate a filiform model, which has little to do with the outcome produced by a manual draftsman, bent over his table, amidst pencils and sheets of paper.

Starting from that 1963, solids, more or less complex, began to twirl on the screens of computers in their three-dimensional representation (fig. 4), replacing the less captivating strings of characters that, until that moment, were common to the life of programmers and users alike. Computer technicians and users of software from then on would have lived different experiences, the first regulated by algorithmic systems composed of endless lines of code, the latter by visual and interactive contents, always richer in shapes and colors, so as to make even that machine, that looks so unattractive and untempting, seductive and user-friendly.

The real subversion, in fact, is deposited in a sort of exponential similarity that this *new drawing* has with the real, full-scale object: if the model has always been, as Massimo Scolari reminds us, "an initiation instrument for generations of architects who in the realization of objects in the form of small architectural works were preparing to build on a large scale" [Scolari 1988, p. 16], the digital model is at once analogous to the real object and equivalent to its scale copy, of which it retains that morphological affinity that has made it an irreplaceable tool for new representations.

Models of skeletal airplanes, of filiform cars, of urban landscapes in the form of simple luminescent parallel-piped, begin to be hosted in technical magazines and public presentations: all artifacts strictly produced in a paperless mode, that is to say without the consumption of paper.

This sharp distinction between traditional drawing and digital representation has expanded over time thanks to the invention of new means of expression that, starting from three dimensional contents, reverberate in more complex contexts, through the intercession of another important mediation between analogical and digital: the invention of the electronic image.

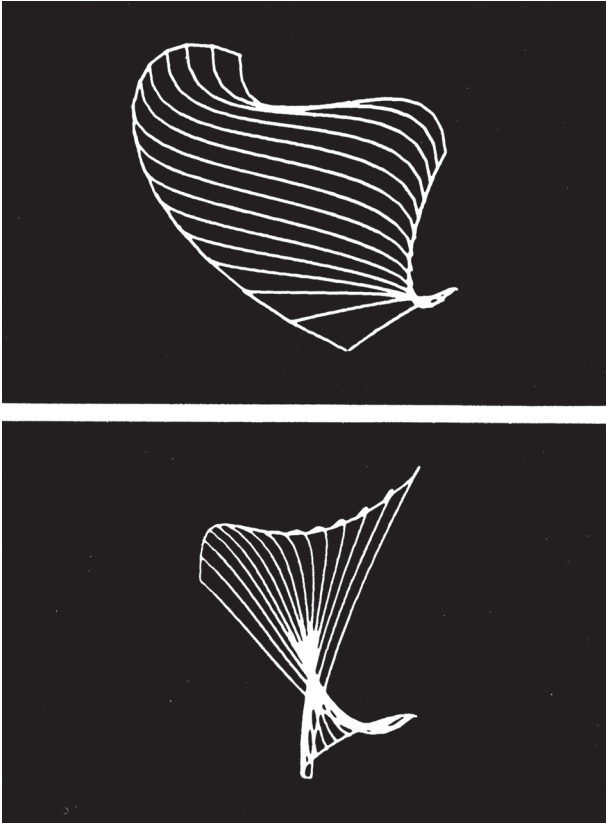


Fig. 4. Double curved surfaces realized by S.A. Coons, 1967.

### Discretizing images

“We have chosen to sample at 500 KC rate and we define each one of these samples as a picture element or a *pixel*” [Billingsley 1965, p. 3]. It may seem strange that one of the most significant terms in the history of computer graphics –the definition of pixel, a contracted form of picture element, that is, the unit of measurement of the digital image– appears for the first time in the form of a remark in a technical essay of 1965 written by Fred C. Billingsley, a researcher at the Jet Propulsion Laboratory of the California Institute of Technology, as set out in a recent paper [Lyon 2006]. Above all it is unusual that this

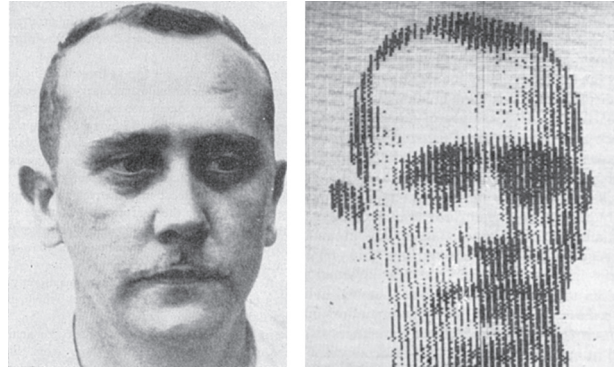


Fig. 5. Original image and numerical scan realized with the system of R.A. Kirsch, 1957 [Kirsch 1958, p. 223].

should appear at a distance of almost two decades from the first use of the term.

The invention of the instrument capable of translating analog images into digital pixels, in fact, took place in 1957, when a group of researchers coordinated by Russell A. Kirsch, gave life to the first linear scanner in a laboratory of the National Bureau of Standards, which would be officially presented in December of the same year at the *Eastern Joint Computer Conference* held in Washington [Kirsch et al. 1958].

But in rereading the proceedings of that conference, it appears that the revolutionary nature of what had been presented there was not appreciated. The essay that described the scientific procedure and tools was not given more space than the other papers, unlike what we have seen with vector drawing. Yet within the nine pages of the essay there was described the translation of a photographic image into an image formed by dots, or “pixels,” which will forever mark the path of digital image processing, becoming, in fact, a new mode of iconographic elaboration and laying the foundations for that substantial transformation in the field of photography and cinematography that has not yet today been fully accomplished.

Paradoxically, therefore, the problem of digital scanning of paper-based data was only reported as a means of reaching what was considered the real objective: the automatic recognition of forms and characters from a pre-existing analogue document, with the aim of speeding up manual input processes by an operator.

From a technical point of view, the machine was based on a rotating roller system, on which the image to be scanned was placed and illuminated by a beam of light. Through a complex optical impulse detection mechanism –which also included the use of a stroboscopic disc– the object of the research was achieved: a square ID photo having measuring 44x44 mm. The scan time was 25 seconds and the digital result consisted of 176x176 points (30,976 characters) (fig. 5). These points –which, as we said, only in the following decade would be called *pixels*– were black or white: the first to identify the figure, the second to describe the background. Although not considering the shade of gray, nor undoubtedly, colors, the essay underlined some experiments on the recognition of form and character which immediately raised interest in the participants. This modality of use in black and white, in fact, allowed the simplification of the operations for the identification of text and figures: regarding, in the first case, the subsequent development of OCR systems [8], and in the second case –as also emphasized by Kirsch himself in the final discussion [Kirsch et al. 1958, p. 229]– the instantaneous association of fingerprints with the face of a criminal. If the image described above, concerning the scanning of a human figure, appears only in the abovementioned essay, Kirsch has stated that, in reality, the first scanned photograph was that of the face of his newly-born son, Walden. The original of this scan has been kept since 2003 in the archives of the Portland Art Museum [9] (fig. 6). Although this record is recognized by the web's search engines, it is not confirmed by official publications that describe, as does the essay we have mentioned, the outcome of the experimental research: probably, however, the association between the invention of a new scientific instrument –such as the scanner– and the image of a new-born child, can be perceived as a more effective equivalence on the communicative level. Having defined the way in which it was possible to see on a monitor any analogically-produced graphic document – be it a drawing, a page of a book or a photograph– opened the doors to fully digitalized representation, as a further evolution of the CAD representation systems that we have described at the beginning.

It is no coincidence that among the first questions raised by researchers there was the problem of shading a 3D model, or rather, of how to give a true-to-life appearance to those filiform objects which, in fact, did not look very realistic.

Already in the late 1960s, the problem of hidden lines presented itself as a topic for experimentation. Many algo-

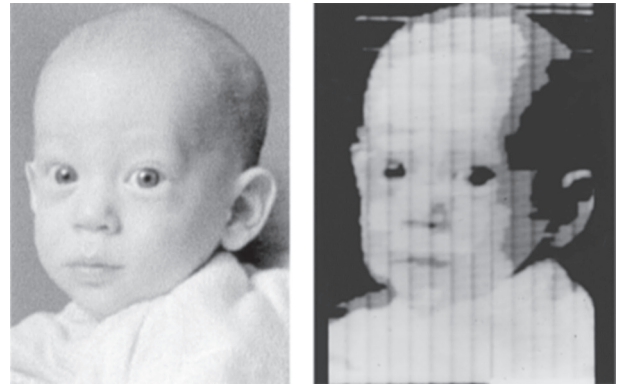


Fig. 6. Original image and numerical scan of Walden Kirsch, realized with the system of R.A. Kirsch, 1957 <<http://portlandartmuseum.us/mwebcgi/mweb.exe?request=record;id=2112;type=701>> (accessed 2018, September 20).

gorithms were created, permitting the problem of the simulation of shading to be quickly solved.

If the first algorithm for the generation of chiaroscuro on a surface was based on the law of cosines –defined about two centuries earlier by Johann Heinrich Lambert in his *Photometria* [Lambert 1760], shortly thereafter various researchers proposed different solutions that over time were indispensable for obtaining that figurative realism that can now be obtained with any simulation software.

The rendering images that from the 1970s began to hesitantly emerge from researchers' computer screens led to a further level of innovation that, once again, clearly distanced itself from all previous experiments: Virtual Reality (VR). In fact, thanks to VR, from an operational point of view, what had already appeared as a primary source of new visual suggestions –the 3D model– acquired a strong expressive value in terms of total, complete, immersive interaction. From a conceptual point of view, as Franco Purini wrote, “virtual reality presents itself not as what can happen but as what just happened, like an *accelerated present*” [Purini 2000, p. 108].

### New virtualities

“The fundamental idea behind the three-dimensional display is to present the user with a perspective image which

changes as he moves.” [Sutherland 1968, p. 757]. This is how the young creator of Sketchpad would present his stereoscopic and interactive visualization system only five years after his revolutionary invention, calling it, similarly to what had been done for the CAD drawing system, with an equally evocative term: *The Sword of Damocles* (fig. 7). Like the legendary sword, hung by a strand of horsehair by Dionysius I, tyrant of Syracuse, and suspended over the head of Damocles, it referred to the dangers always threatening the man of power; just like a support anchored to the ceiling, holding a mobile helmet equipped with special viewers, could be worn by a daring user. The movement of this particular helmet allowed the user to visualize a virtual space—made up of transparent threadlike volumes constructed with Sketchpad—as though he were virtually present in that scene. The movement of the user’s head also changed the perspective view of the object.

A few years after the invention of CAD, the foundations were laid for what Jarom Lanier defined twenty years later Virtual Reality, that is to say, a system that associated a virtual scene with a digital viewer, allowing movement within it by use of particular electronic gloves to be worn by the user, called *datagloves*. If the electronic drawing completely changed the figurative register codified through a slow development of the history of representation, the reflection around a virtual reality system induced to consider new paradigms also of theoretical-speculative order; fueling a debate, perhaps already inherent in the first association made by Sutherland, between its system and the danger of an impending blade suspended over the head of Damocles.

Virtual reality was followed by other experimental researches that make use of computerized systems of vision and perception, which amplify the distance between new media and traditional tools for the use of objects and spaces. Think, for example, of Augmented Reality (AR), in which the interface allows users to superimpose digital contents of various kinds—videos, texts, images, sounds, etc.—analogue artifacts, demonstrating the added value of a new communication system. Founded in 1990 as a technical instrument for visual inspection of the electric cable system inside the equipment of an airplane fuselage, thanks to the intervention of Tom Caudell [Caudell, Mizell 1992], called by Boeing to solve this problem, it soon became a very widespread tool both in the field of scientific divulgation—in museum spaces that can be explored interactively thanks to this system—and in the commercial

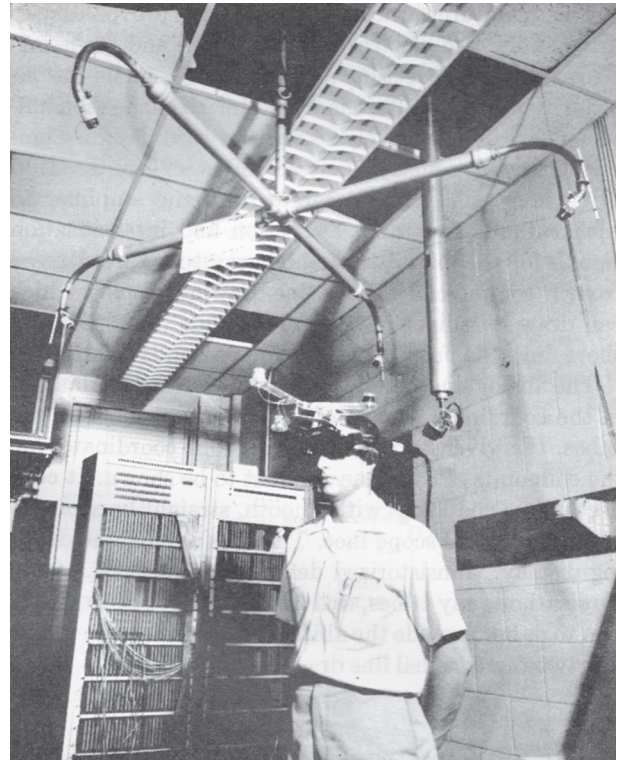


Fig. 7. *The Sword of Damocles* created by I.E. Sutherland, 1968 [Sutherland 1968, p. 760].

sector—offering the possibility of superimposing a virtual article to a real environment, as seen in the catalog of one of the most important furniture chains [10]—both in the entertainment sector, with applications such as Snapchat—for the superimposition of digital masks on real faces—and Pokemon Go, based on a GPS geolocation system that allows the search for fictitious creatures within a real environment. Among other things, it cannot be concealed that this recent electronic game—commercialized starting in July 2016—also takes into account a previous digital experience based on the construction of imaginary worlds, which with its name declares a clear separation from traditional contents: Second Life (SL). The concept that welcomes the visitor of this new web-based explo-

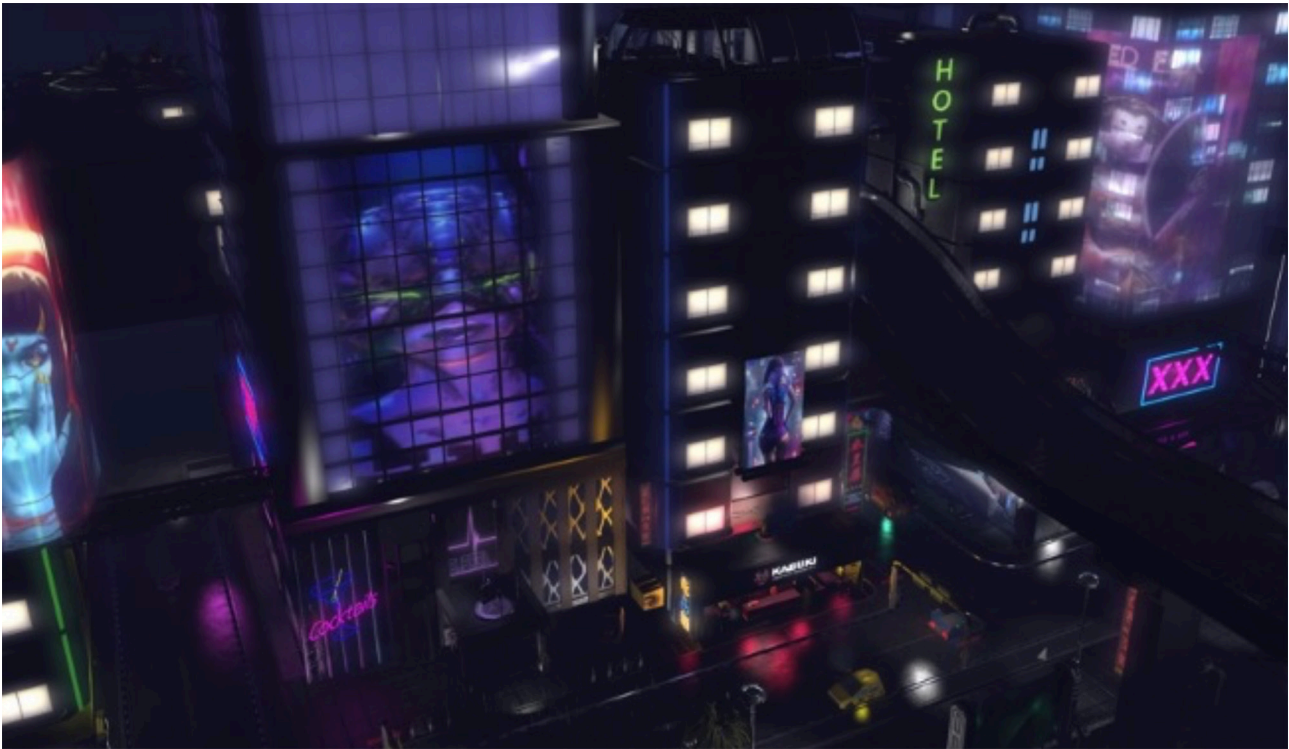


Fig. 8. Nunox Cyberpunk City in Second Life. <<https://secondlife.com/destination/nunox-cyberpunk-city>> (accessed 2018, September 20).

ration platform is different from the logic of videogames. The user, in fact, through an avatar –a 3D copy of himself in digital form– can perform all the functions of a human being, doing them in an electronic environment, like in a kind of *virtual life* [Unali 2014]. He can visit places with a traditional appearance, such as Rustica or Lake Templeton Beach or futuristic places like InSilico or Nunox Cyberpunk City (fig. 8), play a musical instrument, talk to other users, purchase items using a virtual currency, carry out business activities, or make digital artifacts –such as a sculpture or a building– giving free rein to his creativity and without a specific purpose

The contents envisaged by the general concept of the *digital divide* –that is to say, the gap that electronics determines between users who use advanced technology and those who are excluded from it– now constitute an unbridge-

able gap between those who live in the virtual space of SL and all of mankind, whose life is still firmly –and inevitably– anchored to the earth’s surface.

The extreme creativity, however, offered by SL to those who want to generate morphologies of any kind can only introduce another central theme, that of the use of advanced digital modeling for the construction of architecture with surprising complexity.

### Electronic architecture

A few years ago we proposed the neologism *e-architecture* to indicate those architectural works that owe their design to digital processing tools [Sdegno 2001]. And we had pointed out two prominent personalities –Peter Eisenman



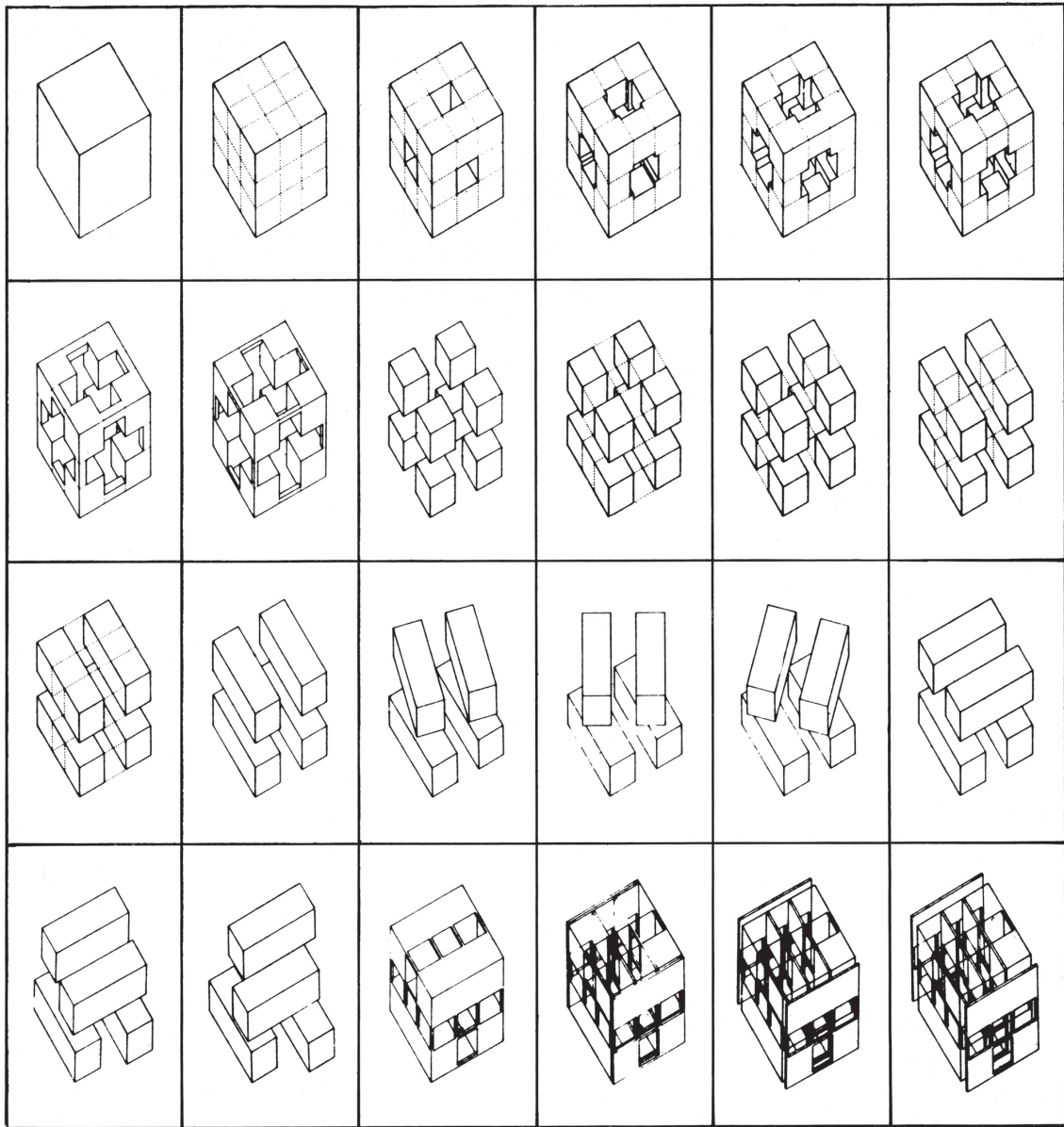


Fig. 9. P. Eisenman, House IV. Falls Village, Connecticut, 1971. Diagrams for the compositional process.

and Frank O. Gehry— as those architects who impersonated two quite different behavioral strategies, which identified—even in the simplification of such a classification— two different types of relationship between designer and digital tool: that is, one who works *ex ante*, with electronic tools right from the initial, conceptual phase of the design, and the other who works *ex post*, when the design is practically finished, using digital technology to give constructive consistency to their design ideas.

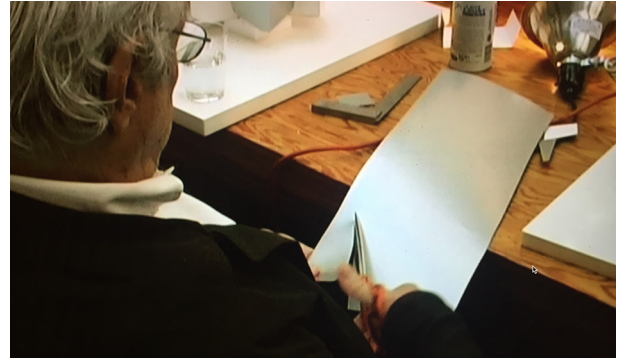
This diversity has remained substantially the same today: on the one hand there are those who use morphological control procedural systems, such as the Grasshopper visual programming language [11], and algorithms of advanced modeling; on the other hand, there are those who use traditional methods of drawing based on the realization of physical models or technical drawings at appropriate scales, then translated into digital format.

The two architects mentioned were indicated for the uniqueness of their experiences: Eisenman, in fact, also used Boolean geometry for the construction of his houses of the 1970s (fig. 9), in the absence of digital technology; Gehry, on the other hand, did not change his traditional behavior towards designing, still building small plastic and cardboard models—as can be seen in the film on him created by Sidney Pollack [Pollack 2006] (fig. 10)— whose three-dimensional forms will be subsequently digitized for the realization of the wireframe model within the modeling software. It is no coincidence that both authors are present in a recent volume devoted to digital archeology [Lynn 2013].

There are countless digital tools available to designers, so much so as to be in the presence of a real “information technology revolution in architecture” [Saggio 2007], in which a new “electronic paradigm” is defined [Eisenman 1992, p. 17]. But one cannot ignore a decisive factor manifested with this new operating mode of design: the risk of the loss of authorship.

Mario Carpo has in various ways dealt with this issue, both in relation to the issue of copying and reproduction [Carpo 2011], and underlining a new substantial change introduced by the digital tool, with reference to the previous use of technology [Carpo 2017]. A recent essay further reiterates this aspect: “architects—Carpo writes—cannot do without technology, but technology can do without them” [Carpo 2018], distilling in such an effective critical consideration how, long ago, it had vehemently emerged in a two-way dialogue between Jean Nouvel

Fig. 10. Frames from the film *Sketches of Frank Gehry* [Pollack 2006].



and Jean Baudrillard [Baudrillard, Nouvel 2003]. Also in that case the topic of authorship was repeatedly put in stricter terms: "Is there anything easier than reusing existing data –the architect wondered– given the fact that the computer can modify that data so quickly? You change a parameter here, another there, and after a few hours, it's done. The system is ready for a new building. [...] Within that architectural space –the philosopher asked himself– does the possibility still exist for the architect to make his mark? [...] Most of the time –replied Nouvel– there is no architect in the sense generally understood. There are engineers who are pretty efficient at working with the standards." [Baudrillard, Nouvel 2003, pp. 53, 54].

## Notes

[1] Sutherland 1963 as well as Sdegno 2013.

[2] Ruskin 1957. On the theme of the didactics of drawing according to Ruskin see also: Levi, Tucker 1997.

[3] As is well-known, Gaspard Monge is defined mathematician, physicist, engineer, draftsman. Here we use the most frequent definition. For a further analysis of his figure, see the recent volume: Cardone 2017.

[4] On the figure of Steven A. Coons see: Sdegno 2012 and Cardoso Llach 2015, pp. 49-72.

[5] SAGE is the acronym of Semi-Automatic Ground Environment, air defense system for the American territory that used a light gun aimed at a screen.

[6] The mentioned session of the Spring Joint Computer Conference is found at pp. 299-353, with texts by S.A. Coons, D.T. Ross, J.E. Rodriguez,

The extreme engineering of the architectural product, even in the form granted by BIM technologies, branches, in fact, into different competencies the success of a project, so that in some cases –as in the example described by Livio Sacchi in this issue [Sacchi 2018, p. 138]– the actual creative contribution of the work is hardly imputable to a single human subject. It is no coincidence that Jean Nouvel concluded the debate with a few disarming words confirming the significant change taking place within the discipline: "an automatic architecture created by interchangeable architects. This fatality doesn't bother us; it's an essential part of today's reality" [Baudrillard, Nouvel 2002, p. 80].

R. Stotz, E.I. Sutherland, T.E. Johnson, all MIT researchers or professors: AA.VV. 1963.

[7] The patent for the mouse was issued on 17 November 1970, with U.S. Patent No. 3541541: Bardini 2000, pp. 81-102.

[8] OCR stands for Optical Character Recognition, a system for the recognition of text characters.

[9] The image is archived with Code No. 2003.54.1: <<http://portlandart-museum.us/mwebcgi/mweb.exe?request=record;id=5273;type=101>> (accessed 2018, July 8).

[10] We are referring to Ikea Place, permits placing virtual furniture in a real setting: <<https://www.ikea.com/gb/en/customer-service/ikea-apps/>> (accessed 2018, October 10).

[11] Grasshopper was developed for the Rhinoceros 3D modeling software.

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