# How Drawing Changes

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Compared to just a few years ago, architects' drawings today seem to have changed substantially, especially as regards a few important general questions which are, furthermore, closely related, some well-known, others perhaps less: parametric design, BIM, Big Data and artificial intelligence. In the background, there is yet another revolution concerning authorship, of both drawings and, of course, projects. But let's proceed in an orderly fashion. We can state, to begin with, that architectural drawing has enjoyed extraordinary historical stability over time. On closer inspection, it has remained substantially unchanged, subject only to small instrumental innovations such as, for example, the adoption of the drafting machine or of transparent paper, which speeded up the operations of correcting and of tracing copies on superimposed layers of paper. On the methodological level, parallel and central projections, of which Vitruvius writes, have remained the same for about 1,500 years; the Renaissance added the section and, above all, rediscovered the culture of perspective, dictating canons for the following five centuries. The changes to which drawing appears to have been exposed in recent years, on the other hand, seem to be quite different in nature and extent compared to the previous, reassuring continuity. This implies
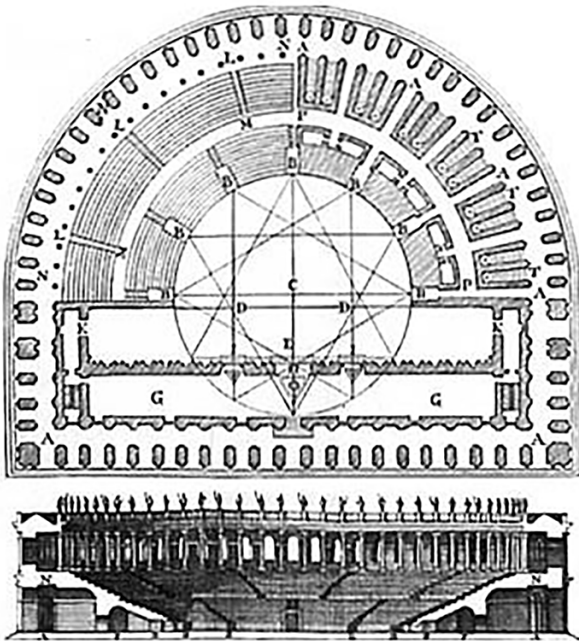
that we must pay great attention: to avoid the risk of finding ourselves prematurely sidelined from a professional point of view, and to avoid, from an educational point of view, training young architects who become old before they even start to work. Of course, and fortunately, not everything has changed: it is reassuring to recall that, as always, drawing serves us, that is, architects, for designing: it is a medium for representation and analysis, and the principal, unavoidable medium at our disposal. Designing is an operation of conception and communication essential for the construction of architecture; a project is therefore a primarily predictive tool, something that precedes reality, anticipates what it will be, but also an instrument able to move and overcome the limits of what can be realized. And that is no small thing, at least insofar as it reaches its goal: the construction of a good building. By simplifying a little, it is possible to identify at least four different types of projects: the architect's project, and then the client's project, the engineer's project and the contractor's project, bearing witness to its inclusive and versatile nature. Such not-particularly-original types, referred to among others by Patrick Schumacher [Schumacher 2011], deserve, in any case, further consideration. The first is evidently constituted by the architectural project, which includes the initial part of work in which the designer enters into a dialogue with himself in search of the best solution and the one addressed to other architects (communication targeting magazines and websites, the juries of competitions, exhibitions, awards, etc.). The second consists of the part specifically addressed to a client (a communication, therefore, addressed to non-professionals), which includes concepts, renderings and mood-boards (or sample-boards), the drawings that present materials, finishing and the relative combinations used in interior design; but it is also constituted by the direct contribution that the client gives to the project, according to his maturity and ability to interact. The third type consists of the structural and plant design. Its importance has grown for at least two foreseeable reasons: on the one hand, the progressive abandonment of the old and new classical codes, including rationalism, has made contemporary planning much more exposed to the authority of structural engineers than it was in the past; on the other, the new centrality assumed by the digitization of buildings and their sustainability, energy efficiency, etc., has burdened building systems projects with a historically unprecedented load. Finally, the fourth is constituted by the so-called shop drawings, the executive worksite plans, but also bills of quantities and specifications, as well as plans for the construction site's set-up, safety plans, etc.: charts often drawn up in collaboration with manufacturers of construction and finishing materials, with artisans and different operators. We expect that, in the renewed climate of sharing triggered by BIM, the 3D model will assume absolute centrality: the four types shown above, in reality more numerous and articulate, determine a circular process of progressive approach to the solution to take to the construction site. Today, designing is done in 3D, realizing what is ultimately the dream of every designer, who has always, more or less clearly, known that the essence of architecture is the internal space that is determined, the resulting void inside the envelope designed

by us, but also the reverberation that the volumes have on the urban or, in any case, open space, surrounding the building. The 3D model generates, only subsequently, the 2D: plans, elevations and sections. The plan is still, in many aspects, generative in the creative, conceptual process of a building, but the three-dimensional model is the new protagonist. Quantities are measured from the model; the technical and performance contents are specified; compliance with standards is verified; it is possible to visualize spaces with renderings, even photo-realistic ones,

Fig. 2. Piero della Francesca, *Study for a chalice, 15th century, pen on white paper, 34 x 24 cm.*
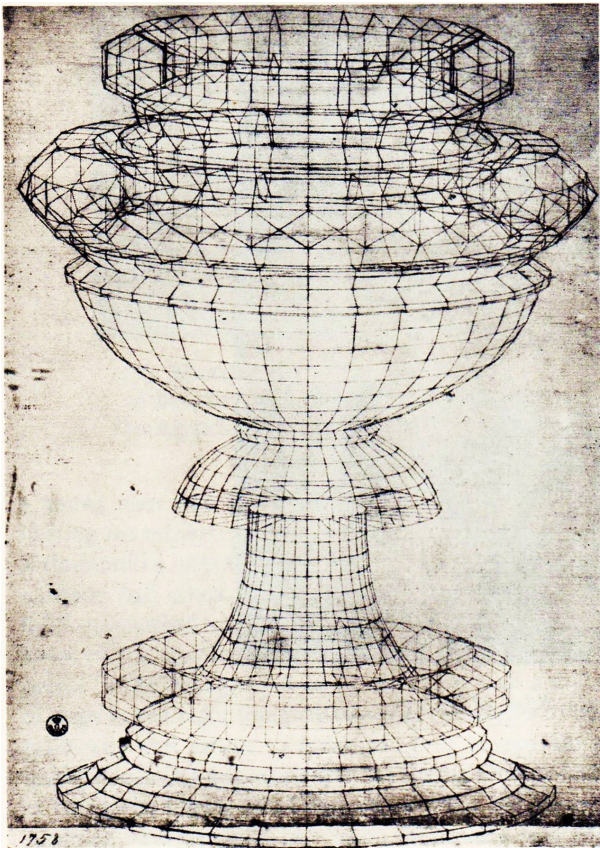
often so effective that it is difficult to distinguish them from a photograph; finally, the more or less interactive navigation of the designed spaces is obtained, anticipating the fourth temporal dimension, so essential to the concrete experience of architecture. Almost thirty years ago, William Mitchell rightly attributed to the model the task of ontologically defining the projectual sphere as opposed to the building [Mitchell 1990]. Rightly, Mario Carpo recently spoke of "Digital Renaissance of the third dimension" [Carpo 2017].

But let us now examine the four general questions mentioned at the beginning, which more than others seem to summarize the changes taking place.

Parametric design

This is an experimental form-finding process that allows the architect to design structures of considerable geometrical complexity using parametric software, which recur to algorithms. The first research conducted in schools such as the Institute for Computational Design of the University of Stuttgart or the Bartlett School of Architecture of the University College of London, immediately gave interesting results, following the expe-

Fig. 3. Vincenzo Scamozzi, *Copy of the preparatory drawing for the Theater of Sabbioneta, 1589.*
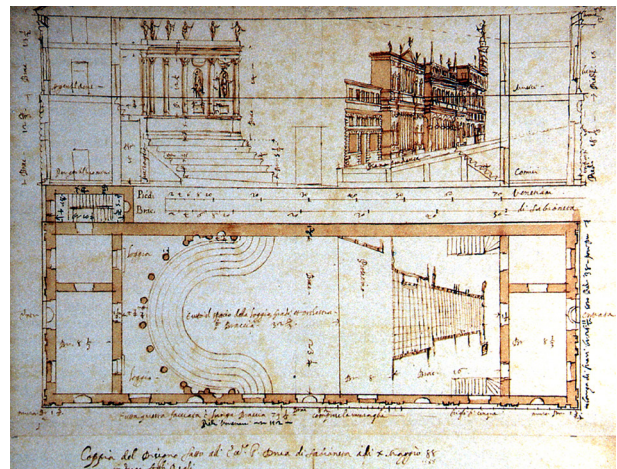
riments started, as early as the 1990s, on the curves, or splines, generators of more or less complex surfaces. A pioneering work, carried out by a few architects operating between the end of the last century and the first years of the new century, all more or less influenced by what was called the 'Deleuze connections', which spread following the publication of the book The Fold: *Leibniz and the Baroque* [Deleuze 1993]. It was probably the aforementioned Patrick Schumacher, at the *Smart Geometry Conference* held in Munich in 2007, the first to give a name to the new 'ism': Parametricism [Schumacher 2016]. Since then, architects have begun to work with primitives such as splines and NURBS, using design procedures different from traditional ones (even if the standard charts for clients and companies have continued to be presented in the traditional form). A drawing essentially based on the use of straight or curved lines that separate portions of surfaces or mark their intersections, is replaced by drawing based on three-dimensional parametric modeling. Revit, which, as is known, is a software developed by Autodesk, or Digital Projects, which Gehry Technologies developed from the now historic Catia of Dassault Systèmes, have long allowed all this, albeit with different methods (everything is referred to a single master model in the first case, and to an open network of correlated models in the second). With parametric design –which undoubtedly determined the fortune of some great studios, first of all ZHA, Zaha Hadid Architects– architecture, while risking to see the image prevail, if not transform itself into celebrative self-representation, has reached formal horizons unimaginable earlier. The spectacularity of the forms is linked to their arbitrariness, the latter made possible by the adoption of algorithms that, with the aid of *Visual Programming Language* (VPL), such as Grasshopper, which regulate geometric complexity, charting schemes and production. Forms based on the serial repetition of formal elements that, sharing a common mathematical structure, reintroduce the organic discourse (think of a text like *On Growth and Form*, published a century ago, to be precise in 1917) [Thompson 1917].

BIM

Acronym of Building Information Modeling, BIM designates –as it is known– a design process that allows the digital simulation of building construction in a computable,

interoperable way, able to ensure consistency between the elements that compose it, also responding to the phenomena that could occur at every stage of its life cycle. A digital representation of the constructive process that facilitates the exchange and interoperability of information in digital format, ie a method based on sharing knowledge as suggested by Chuck Eastman, director of the Building Lab of Georgia Tech [Eastman et al. 2016]. It is, in other words, a process that –using digital technologies based on parametric logics able to combine geometric and alphanumeric data, thus overlaying images and information, and ensuring design consistency thanks to the verification of the financial (cost) and chronological (time) dimensions– has assumed increasing importance in recent years within the processes of conceptualization, design, realization, management and maintenance of buildings. Interoperability and consistency of 3D models are the key words that, better than others, summarize the main features. With BIM, all the subjects involved in the design of a work carry out, together, a real digital construction of the artifact, in which the logical and temporal prerequisites are not dissimilar from those of realization, and possible errors and omissions become obvious before the construction site is set up, and can, therefore, be correct or resolved.

Fig. 6. Ludwig Mies van der Rohe (1886-1969) con Philip Johnson e Phyllis Lambert, New York 1955.


An interesting aspect of digital design is that, unlike traditional drawing, it can be modified by anyone, at any time. With BIM this aspect becomes even more relevant if we consider the fact that all the many different operators (architects, structural engineers and installers, interior designers, landscapers, builders, suppliers, experts, etc.) intervene, at different times, modifying and refining the model; the latter is open-ended, that is, never really ly concluded until the moment work starts at the construction site. But even during the construction of the building it continues to permit the correction of possible errors, while a laser scanner survey of the construction phases, which in major works can take place even daily, allows its progressive adaptation to what is being built, gradually bringing it to coincide with the so-called 'as built' drawings that document the completed building. This final model will subsequently be used for facility management, that is, for the management and maintenance of the building over time. It should be noted that this process is somewhat far from the authorship with which the project was –or was imagined to be– managed the in the past: instead, the result is achieved with progressive approximations, a very long series of shared revisions: a process that is, on the one hand, circular, which closely resembles the hermeneutic circle, and on the other hand, redundant, according to a principle –precisely that of redundancy– widespread in graphic software (just think of how many different ways there are to obtain the same result). To limit ourselves to a first provisional conclusion, we can say that the main objective of BIM, in addition to saving time and money, seems to us to be that of reducing the gap between design and construction, bringing architecture closer to its true nature: that of being the 'art of making'. No small thing.
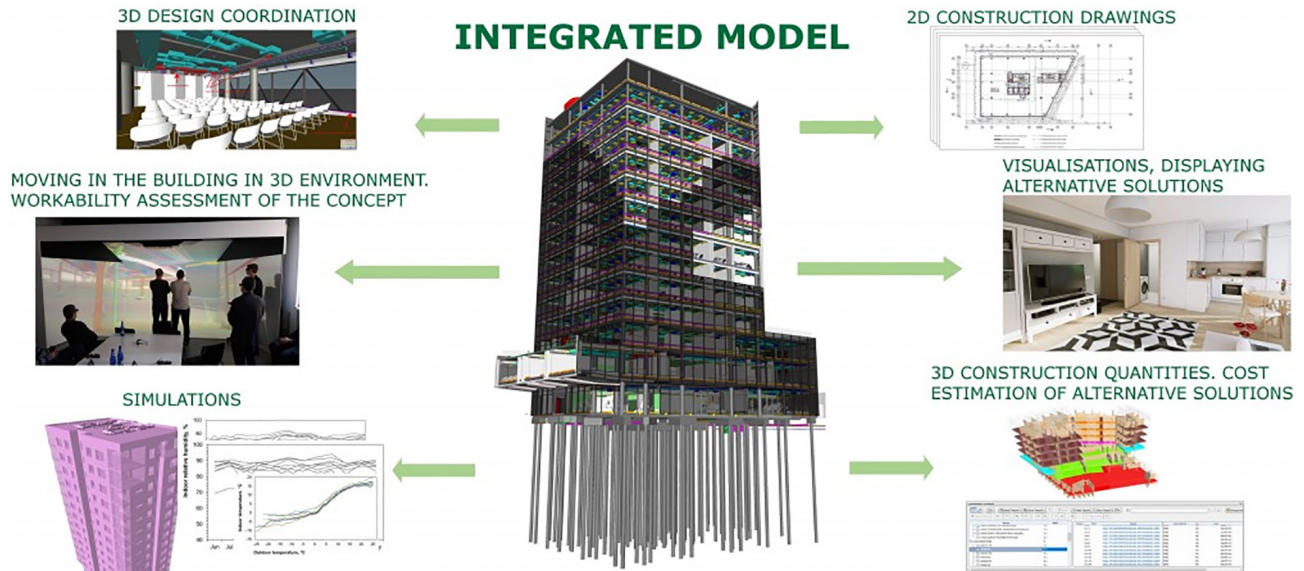
Big Data and artificial intelligence

Big Data is a well-chosen term first used in 1999 by Steve Bryson, David Kenwright, Michael Cox, David Ellsworth and Robert Haimes in an article published by the American journal *Communications of the ACM* [Bryson et al. 1999] which summarizes a complex process: on the one hand, it indicates the impressive amount of data we are exposed to, and on the other, the increasingly demanding work of analysis that we are called upon to do. At the root of the issue is crowdsourcing, which

Fig. 7. The figures of BIM.
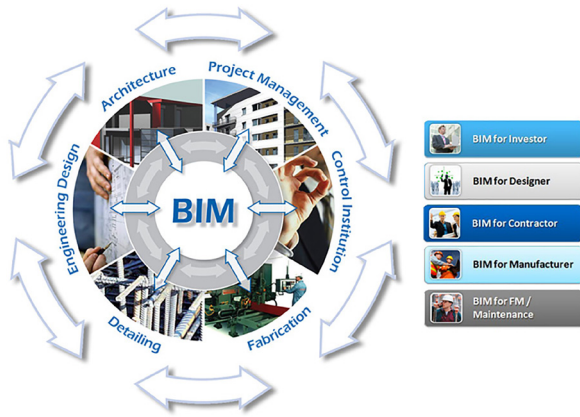
essentially led to the replacement of encyclopedias with Wikipedia (think, for example, of the end of the publication of the authoritative *Encyclopaedia Britannica*), and the so-called Internet of Things, which with its 'related objects' contributes significantly to the accumulation of these data streams. Even the architect who is about to design a building is exposed to numerous data, perhaps much more numerous than those controllable, if not those actually needed. Their management certainly makes our task more complex. Hence the delegation to software, able to collect and analyze in our place. These are more or less advanced forms of artificial intelligence, in a process, once again circular, of design optimization. Learning to use artificial intelligence from the standpoint of designing will take some time. But it is undeniable that it is entering, massively and inadvertently, into everyone's life. Facebook, for example, is able to analyze the photos and texts that we post, thus orienting the advertising messages addressed to us (and making the use of such advertising messages more profitable).

Fig. 8. The composition of the integrated model into the BIM.

In addition to being the title –*AI, Artificial Intelligence*– of a film by Steven Spielberg released in 2001 based on an idea by Stanley Kubrick, artificial intelligence is a set of advanced technologies that allows computers –more generally, to machines (think of MBUX, the system just marketed by Mercedes Benz based on user experience)– to understand, learn and act accordingly. Together with robotics, it is destined to radically change architectural design and construction scenarios. To stop at the first ones, that is to say to the design scenarios, we cannot fail to ask ourselves two symmetrical questions. What is the degree of creativity of artificial intelligence? That is: what impact can it have on the design process? Some answers are easily imaginable: today many software help us to perform operations related specifically to designing. It is not difficult to predict that the architect will deal more and more with the intuitive and creative part of the work, linked to strategic choices, while the development of the project, the part currently often delegated to collaborators, will be carried out by software. But it is also easy to think that, gradually, we will come to the definition of increasingly effective methods: Google, IBM, Salesforce and other companies are working on software able to optimize the interaction and use of the product with the final user. Google AutoDraw, for example, allows you to easily transform rough sketches into well-defined drawings. Not surprisingly, the slogan that advertises it is: "the tool that transforms doodles into drawings." Artificial intelligence helps the process, but, at least for now, it hasn't stolen any designer's job.

The crisis of authorship

As we mentioned earlier, against the background of the reasoning on how architects' drawings have changed, yet another revolution is taking place regarding the authorial nature of drawings as well as of projects. Will we come to jointly-authored architectural projects created by many 'hands'? Certainly yes, it's already been that way for a long time. In order not to move away from our field, we should remember that it is not difficult to look, for example, at a city like a work made by many authors; similarly, different forms of collective creative intelligence have been expressed by schools and artistic movements. Will it be so –or maybe it is already so– even for an architecture, or at least for an architecture of a certain

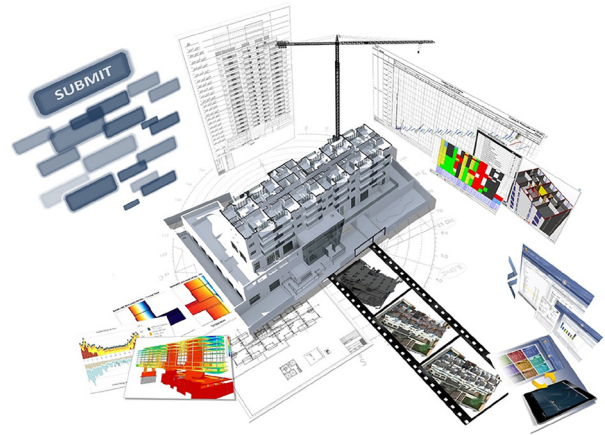Fig. 9. Three-dimensional model as a project information generator.

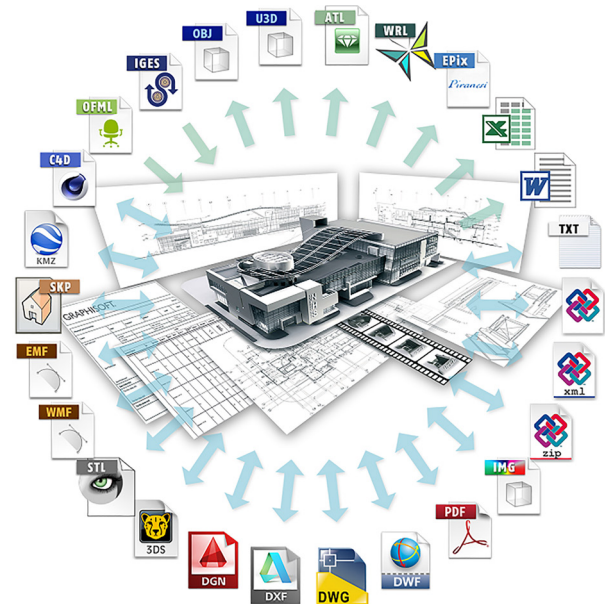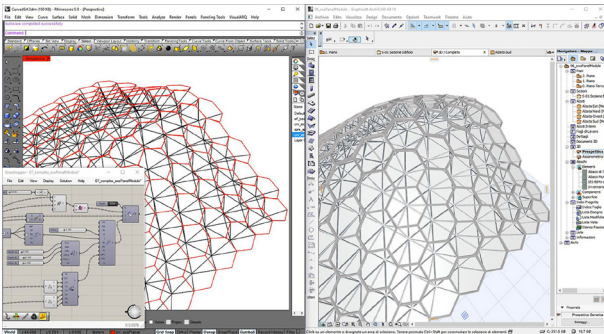Fig. 10. The export of information in the specific formats of different softwares.

Fig. 11. Zaha Hadid Architects, building site of the King Abdullah Petroleum Studies and Research Center (2009-2017).

Fig. 12. Grasshopper graphical interface.

complexity? Is the creative and constructive intelligence of multiple minds, supplemented by the support of artificial intelligence, really better than that of a single designer?

An interesting contribution to this reflection is offered by the comparison between two large, relatively recent projects. The first, modern, the product of the creativity of Frank Lloyd Wright, undoubtedly the authorial mind *par excellence*: we refer to The Illinois, the famous Mile-High Skyscraper designed by the American architect just over sixty years ago, precisely in 1957. A project of extraordinary propositional force, which was never realized, also because it was too advanced for the construction techniques of the time. The second, contemporary, rather, in progress: we are referring to the Kingdom Tower in Jeddah, Saudi Arabia. The formal resemblance to Wright's design is evident. But who can claim to be the author of such an ambitious work, destined to exceed 1,000 meters in height with the aim of conquering the title of the "world's tallest tower"? This is not easy to understand. In reality, it is a large group of different firms, all very well known, in their different sectors, at the international level: to mention only the main ones, Thornton Tomasetti for the structures (a giant based in New York and with about fifty branches scattered throughout the world); Environmental Systems Design for construction technologies and acoustics; Langan International for geotechnics, traffic and parking; Lee Herzog Consulting for façade access; SWA Group for the landscaping; Rowan Williams Davies & Irwin for wind resistance; Rolf Jensen & Associates for fire prevention; AEGIS for security; Fortune Consultants for vertical transport; Lerch Bates for the management of materials and waste; Forcade Associates for signage; Fisher Marantz for lighting. There are also, of course, the architects: Adrian Smith + Gordon Gill Architecture, a studio founded in 2006 in Chicago by a group of former SOM partners (authors, among other things, of some of the world's tallest towers: from Burj Khalifa in Dubai to Jin Mao in Shanghai). We are aware of how it is not correct to compare an idea of a project, what we would now define a concept, even if it emerged from Wright's extraordinary intelligence, with an executive project currently in construction; we are also aware of how the architectural idea that presides over the realization of the Kingdom Tower is probably attributable, at least to a large extent, to Adrian Smith. But we think the comparison is, in any case, very informative.

Fig. 13. Kohn Pedersen Fox Associates, Abu Dhabi International Airport, elaboration of the BIM structural model.
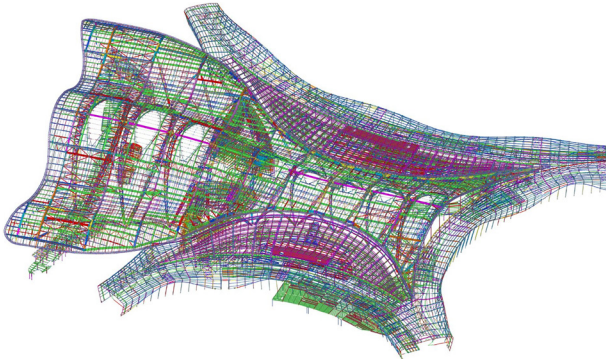
Fig. 14. Zaha Hadid Architects, Dongdaemun Design Plaza, Seoul 2007-2015, integrated BIM model.
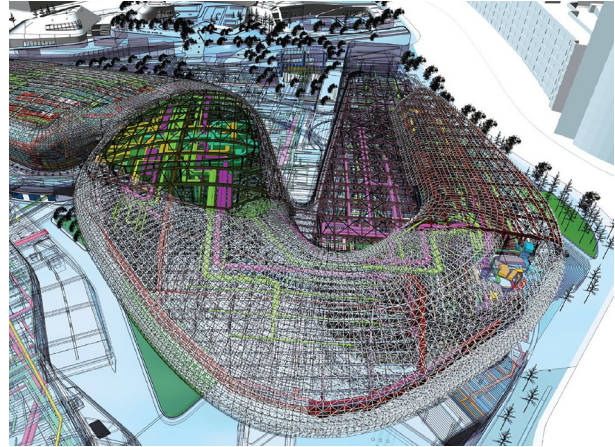

Fig. 15. Use of BIM for urban-scale designs of technical systems.

Mario Carpo, who in his *The Second Digital Turn* deals extensively with the issue of artificial intelligence, cites two contradictory anecdotes: on the one hand the story of the camel which is "a horse drawn by a commission" [Carpo 2017], assuming that a camel is uglier than a horse and that group creativity is the result of compromises that make it difficult to produce something beautiful. On the other hand, the so-called Galton experiment. Galton was an eclectic mathematician and scientist of the Victorian period related to Charles Darwin who studied a curious case: at a cattle fair, the average of the rough estimates of the weight of an ox was closer to the real weight of the animal than each individual estimate was. What emerges from this experiment? First of all, the affirmation of a sort of supe-

riority *ante litteram* of crowdsourcing (we must not forget, however, that this was a large, but not generic group, as it was made up of expert breeders). It then allows us to reflect on the dichotomy that contemporary political scientists are so worried about: on the one hand, confidence in the ability to identify problems and their possible solutions on the part of the masses, for example those of voters in democratic systems; on the other hand, the positive results achieved by the technocracies, more or less disguised as democracies, which seem to work so well in some countries of the world.

In conclusion, we will go back to the theme of authorship. We are faced with three lines of thought: the first simply considers digitization as something capable of speeding up the design process and of managing large amounts of data more easily, without affecting the architect's creative role; the second one, instead, foresees the gradual disappearance of the authorial role of the architect, who withdraws in the face of increasingly intelligent machines, with the consequent, substantial, though not easily foreseeable, downsizing of his creativity; the third, hypothesized by Lluís Ortega [Ortega 2017], lastly outlines an expansion of new

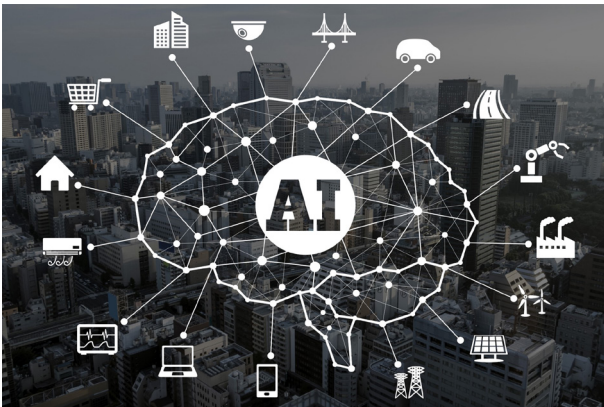*Fig. 16. Scheme of the interactions of Artificial Intelligence.*

Fig. 17. Scheme of the fields of interest of Artificial Intelligence.
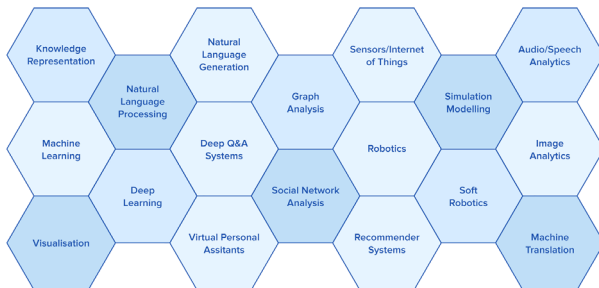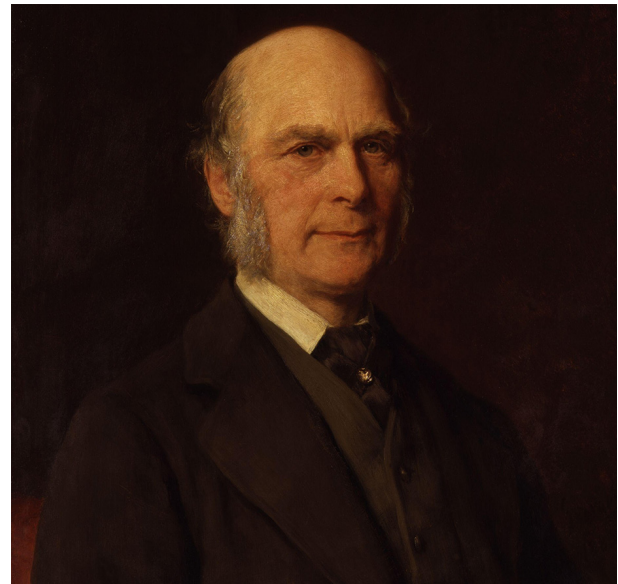

Fig. 18. Sir Francis Galton (1822-1911).

design horizons, a sort of 'augmented reality' made possible by digitization, which will not lead to the architect's being stripped of his authority, but rather to a growth of his awareness, elevating his role to that of mediator or negotiator between his personal creativity and the collective creativity deriving from different forms of crowdsourcing and artificial intelligence. Therefore, a *Total Designer*, rather than an *Automated Architect*: to quote Artaud, "a manager of magic, a master of sacred ceremonies" [Artaud 1938].

Fig. 21. The Mile High Skyscraper (on the left) and the Kingdon Tower in Jeddah (on the right).

Fig. 19. Frank Lloyd Wright (1867-1959) with the project for The Illinois, The Mile High Skyscraper and design drawings.

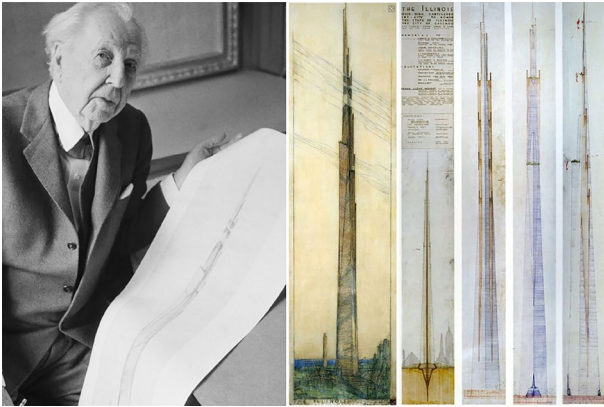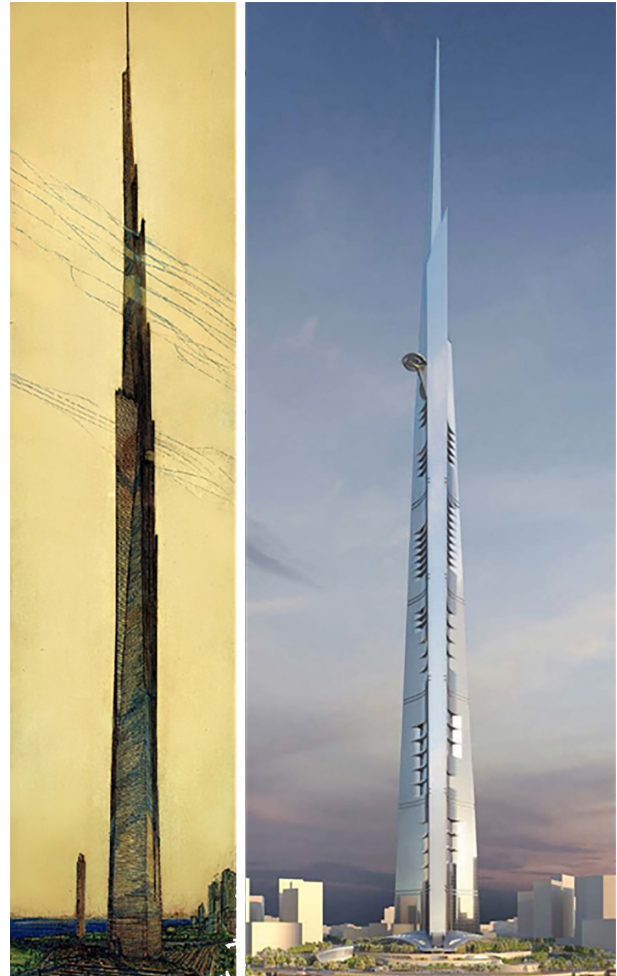*Fig. 20. The building site of the Kingdon Tower in Jeddah at the beginning of 2018.*

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