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BIM: Dimensions of Space, Thought, and Education

BIM: dimensioni dello spazio, del pensiero, e della formazione

Much of the aim of present epistemology seems to deal with filling the gap between analogue traditional and digital practices, which for a long time have been considered profoundly opposite, with heavy consequences in terms of integrity of knowledge.
BIM is among the most representative cases in this discussion. Able to integrate and compute several sets of parameters and algorithms, it shows a clear picture of the interdisciplinary opportunities which are connected with by smart use of its devices. It is not by chance that it is expected to be the standard operational format in the fields of Architecture, Engineering, and Design. The quintessence of BIM is in its many dimensions, which are not only digital dimensions, but also dimensions of knowledge.

Una parte consistente dell'epistemologia contemporanea si rivolge al gap instauratosi fra tradizione analogica e pratiche digitali, per lungo tempo considerate reciprocamente oppositive, con pesanti conseguenze in termini di integrità delle conoscenze.
Il BIM è tra i casi più rappresentativi in questione. Capace di integrare ed elaborare svariati pacchetti di parametri e algoritmi, esso mostra con chiarezza le potenzialità inter-disciplinari connesse con un uso intelligente dei suoi dispositivi. Non è un caso se proprio il BIM è pronosticato come il futuro standard operativo nei campi dell'Architettura, dell'Ingegneria, del Design. La quintessenza del BIM risiede infatti nelle sue molteplici dimensioni, da non intendere soltanto come mere dimensioni digitali, bensì anche come vere e proprie dimensioni della conoscenza.

key words: BIM, AEC-BIM, Architectural Geometry, Architectural Representation, Computational Design
parole chiave: BIM, AEC-BIM, architectural geometry, rappresentazione architettonica, computational design

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DIMENSIONS OF SPACE

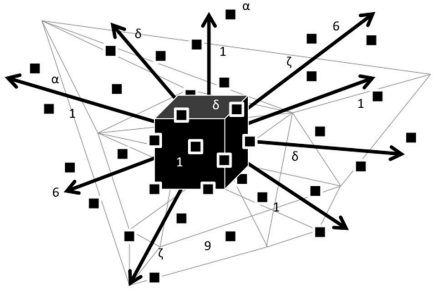

Figure 1_Metaphor of the many dimensions and codes of BIM architectural space (diagram by author).

As we know, building information modelling is a transdisciplinary field. From an architect's specific point of view, the most interesting potential of BIM is in the possibility to coagulate information and various parameters around representative geometric configurations of either built or prefigured architectural spaces, and most of all, in the possibility to manipulate them through visual interfaces. As a multi dimensional graphics platform, it is thus naturally relevant to our disciplinary field.
Since its early start about forty years ago with An Outline of the Building Description System, a research document by Charles Eastman and other researchers of the Carnegie Mellon University, the aim was clear: how to describe a building with a unique database, based on the principle of data aggregation. Like elements and systems in the real world, digital info about those elements and systems could be defined and assembled. As much simple the principle is, as complex it was to realize it. According to the early digital revolution, at the time the market of software was very specialized and fragmented in addition to being very far from any standard format. In other words, the wake point was the lack of a trustful interoperability among software programs. But the idea behind what later would have been called BIM was so interesting and strong it pushed software houses to try to converge towards shared standards.
In the analogue world, those belonging to analogue generations learnt from Morris, Schmarsow, Pevsner, Norberg-Schulz, Zevi, and other theoreticians that the essence of architecture is space, but what kind of space? An existential space experienced during time, built for certain uses, with certain materials and costs, reflecting certain historical, geographic, social, symbolical contexts, that is, a very complex species of space, made of many components and aspects, to which we will refer here as dimensions of space, therefore requiring integration among various expertise to be realized.
A primary need for architects has always been a trustful representation of the geometry of space, able to show metrical details and perceptual effects at the same time. After perspective and orthographic projections, CAD systems provided the first powerful tool generating properly said 3D models of space but in these systems, only pure geometry was offered as a modelling option while relationships among geometry and any other data were in the hands of the operators according to their sensitivity and skills, as well as relationships among drawings and the other separate piles of documents like statics calculations, cost estimations and so forth, were in the analogue era. Manipulating space was finally possible, but still in a very fragmented and abstract way.
In relation to architectural design, the disconnection among information patterns implied that any change in a certain group of documents required updates in all the other groups of documents, opening the way to possible involuntary omissions or accidental mistakes. Drawings were the main reference system for all the experts working on the project, from architects to plant designers and builders, but these experts used to work separately from each other in their own offices. However, the versatility of bit gave the opportunity to play with many language codes and, most of all, to integrate them into unitary digital products, opening the way to a new syncretism, where texts became hypertexts, images became hyper-images, and 3D models became hyper-3D models.
Another revolution was provided by network, making operators able to work together in real time, thanks to remote connections, around the same documents, to share information and to have always at hand the latest updated version of the projects. Summarizing, this double revolution was about connecting information as well as about connecting people, or, referring to letter M in the acronym BIM, about testing a new way in the related fields of modelling as well as management. We could also say that BIM aimed at providing a one-to-one relation between dimensions of space and dimensions of representation.

DIMENSIONS OF THOUGHT

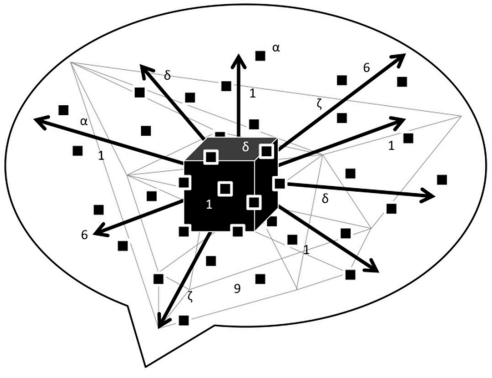

Figure 2_Metaphor of the many dimensions and codes of BIM as a "state of mind" (diagram by author).

Asking BIM experts the direct question "What is BIM?" usually they never mention software. Instead, they talk about approach and methodology, emphasizing that of course software is evolving towards holistic packages, but that it is only a sophisticated tool in the hands of BIM operators. BIM, indeed, has fed as well as requires, a new vision about architectural knowledge and design processes from the operators. As a more powerful machine, let us say, it requires more skilled pilots. About two decades of intense use and rapid diffusion of BIM all over the world has offered a great opportunity to test the possibilities of an integrated approach to the work in our field. Over time, the technical features of BIM have also significantly affected the epistemological level, offering a "free zone" to interaction, dialogue,

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and integration among skills, that is, a trading zone in the prophetic words of Peter Louis Galison (Galison, 1996). Only to mention a relevant example with reference to our operational field, we nowadays talk of AEC-BIM, indicating that the benefits of BIM are covering the wide area across Architecture, Engineering and Construction industry, as noted by Clark C. Cory (Cory, 2015), which consequently tends to be seen in terms of a unitary process. In our opinion, many other letters might appear as a prefix in the future according to the specific fields in which BIM is used.

Looking at BIM from a theoretical point of view, continuity more than discontinuity with the past seems to be the dominant trend. In the analogue era, referring to the theory of three worlds by Karl Popper, indeed, we used to consider architectural representation as the third world, located in between reality and thought and working as a connector between them. According to this theory, all the languages belong to that median world. A text page, for example, although showing the thought of the writer or a real situation, in its deep essence is neither a thought nor a situation: it is just a written representation, based on the verbal language. It lives in a kind of disquieting limbo, the same where graphic representations based on the visual language live (Cocchiarella, 2015). Far from suggestions, we can easily understand role and power of this apparently ineffable world in our everyday life as well as in our long history if only we try to figure out how a life without any representation could be. It is then when we realize that, together with allowing to record news, documents, and icons, the world of representation is also the place where we sketch and develop our ideas and projects. It is the world of architectural models and utopia and in a way, it is our architectural virtual world. Referring to our field, architectural representation is the privileged place where architectural thought and architectural construction meet. It is a kind of virtual test room where architectural models grow up, before becoming real architecture. Looking into this test room before and after the digital era might be a very interesting experience. In the analogue era, we could find drawings there and other various documents telling about the architectural space represented in the drawings where of course no interactions among those documents were allowed, and consequently, a lot of imagination was required to mentally figure out the three-dimensional features of the designed space, its physical properties, and the constructive processes from those heterogeneous materials. Nowadays, our test room, and especially BIM test room, shows very different features, it is comparable with an interactive virtual room where sophisticated dynamic simulations of architectural spaces as well as processes are possible, where changes and checks are possible in real time, and algorithms are at work in search of optimized solutions according to the given design requirements. The same approach can be employed if the subject is the virtual reconstruction of historical architectural buildings and environments.

Interesting consequences follow if we extend this idea to the whole world of knowledge, which is not difficult to imagine thanks to the internet. The image of a worldwide test room, or even better, a worldwide space of knowledge would then emerge, which, together with being a revolutionary picture, can also be seen, in continuity with history, as a new stage in the development of the long lasting dream of organizing knowledge in a colossal and perennially updated encyclopedic system. Back to our field, the advancements in BIM help to organize architecture as a unitary field, not only under an operational point of view, but also supporting an updated epistemological sensitivity. Classical distinctions among terms like space, shape, and form, which were recurring sources of discord, are nowadays more easily accepted as issues in relation to a more clearly perceivable unitary process. Trying a slogan, given the links between technique and epistemology, new epistemology is of course related to new technique. Not surprisingly BIM has also been defined as a state of mind (Race, 2013).

DIMENSIONS OF EDUCATION

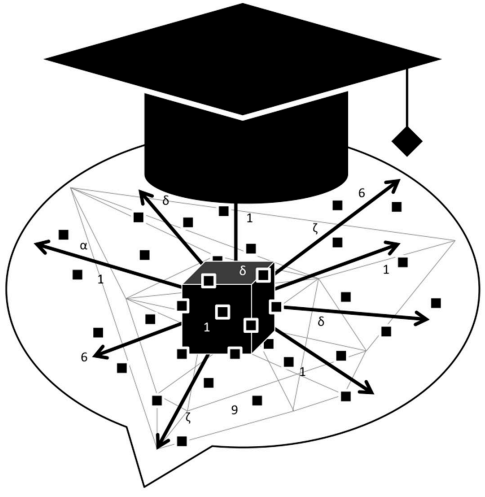

Figure 3_Metaphor of the many dimensions and codes of BIM in education (diagram by author).

Thus, BIM offers a powerful support to interdisciplinary bridges, bringing back, on new tangible bases, the issue of the centrality of Drawing in educating architects, already invoked some years ago by Massimo Scolari (let us claim a similar approach for engineers and designers education). That is, a kind of copernican revolution that would finally dissolve the many misunderstandings concerning our discipline and that calls into question our cultural contribution as educators, provided that we fill the gap due to the late academic acceptance of digital, which grew up for too many years as a stray phenomenon outside the University walls, as pointedly noted by Andrea Branzi. Moreover, it is also provided that we do not confuse digital skills and pedagogical competences, an issue about which the recent pervasive and uncontrolled entry of digital inside the academic world invites us to watch and reflect. The possibility to easily have at hand a digital menu, indeed, has generated the wrong illusion that no special education is nowadays necessary in the field of architectural representation, especially at the Uni-

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versity, which is our case, still in question.
But, after the initial digital binge over time from several disciplinary areas, first of all architectural composition, a claim to a revised educational approach in the fields of graphics is nowadays addressed to researchers and teachers working in the field of architectural representation. Based on all the abovementioned questions, it is clear that the basic point here is what does it mean teaching drawing nowadays? Similarly to the past, visual approach is undoubtedly confirmed as the main pillar of the process. Thus, already empowered by the three-dimensional and dynamic structure of the CAD programmes, visualization should be first of all more deeply connected with the millennial heritage of Geometry. Too often we see students struggling with any free-form configurations without any consciousness about their geometrical as well as constructive properties. Using attractiveness of digital programs, in our opinion, the first urgent step should be in the direction of giving again students solid background in geometrical modelling, based on a deeper education in Geometry (analogue and digital) provided in collaboration with mathematicians. Since we mentioned space as the essence of architecture, we would like to put emphasis on the role of Geometry in architectural education. To avoid the risk of naïve misunderstandings, although architecture is not made of Geometry, it can not be (not at all!) made without Geometry. Confidence with space and its properties can be achieved by using and integrating all the available tools and educational strategies; from traditional sketches, projective drawings, and maquette, to digital modelling and digital fabrication, as parts of a fundamental background supporting architectural education to design as well as to construction and restoration, like what grammar in literary education or math in science education does.
Even more interesting is the visual and interactive approach nowadays possible to traditionally demanding engineering disciplines like building physics, statics, mechanics of materials and structures, which can be more directly and fruitfully linked to architectural geometry, together with other sets of non-visual information belonging to other disciplinary fields. Therefore, our double educational task will be, at the same time, disciplinary on one hand, or based on enhancing digital education in our representational field, and interdisciplinary on the other hand, or focusing on the interplay with the many other related fields, taking advantage of the opportunities offered by digital means, including the impressive cognitive power of digital visualizations. In other words, integration of languages, knowledge, and procedures, seems to be a key open question for future education.
An advanced chapter in modern graphics education should of course concern computation, which is the technical base of BIM. Mastering parameters and understanding algorithms is in fact the modern way to enter disciplinary bodies and operate according to disciplinary criteria. Computational design is a way to focus on processes, making machines to work on what they do better, that is, executing calculation based on instructions and at the same time, keeping for us what we do better, that is, proposing hypotheses and evaluating results. In our opinion, in future architectural education, at least in the near future, it will be much more about on how to critically master digital processes than about how to enter the details of digital processes. Of course the basics of IT should be in the toolbox of any educational curriculum, at least in order to make users able to help software and system developers to increase the quality of tools and programs. Furthermore, compared to the traditional static transcription of knowledge through paper treatises, books, and manuals, the present dynamic parametric recording processes seem to considerably reduce the cognitive distance between theory and applications, and vice versa.
As even neurosciences are revealing, these and many other specificities of digital have already shown deep differences with the past, either in relation with the cognitive processes involved, or with reference to the didactical strategies and tools to set and carry forward, also in architectural education at University.

CONCLUSION

As we see, the many dimensions of BIM as a representational and operational system are strictly connected with the many dimensions of architectural space, thought, and education. BIM as a powerful connector of knowledge and interdisciplinary operator is also becoming a standard way of thinking according to the long lasting aim at incorporating knowledge in a new kind of worldwide, unitary, and interactive Encyclopedia, as well as a standard way of operating, according to the long lasting aim at facilitating the links between theory and praxis. To be actually effective, a virtuosic chain among technology, process, and policy is required.
Recently, in 2014, European Public Procurement Directive (EUPPD) has officially established a deadline for European countries to implement digital procedures in public administration. This directive takes root on a variegated international pattern, made of research and experience carried on in different countries. However, more than international collaboration, maybe software market will end up proposing the final standard. Based on the present conditions, in fact, market appears as the most powerful evolutionary selector for any product, activity, and vision, namely, hardware and software markets which are already offering us products tested and implicitly validated by wide communities of users. Anyway, as we know, in spite of globalization, digital tools and network are by definition flexible, therefore there is also room for developing customized BIM styles.
Looking at Italy, the search for a standard is actively going on. Based on this purpose, we would like to quickly mention an interesting cluster between Polytechnic Universities of Milan and Turin, in collaboration with other partners, namely the project INNOVance, aiming at creating a national data bank concerning technical, scientific, and economic information and data, in order to foster the dialogue among operators and institutions involved in the building construction chain. Other projects from other countries could be mentioned. Of course such projects require a shared communication code; the use of interoperable software programs, and a collaborative vision, which is maybe the most challenging goal to reach.
Education will be a key point on this way, not only University education, but also Secondary and High School education, as well as Post Graduate education (we are attentively working on it at the Polytechnic of Milan), and including dedicated Lifelong Learning Programmes which not only focuses on technical aspects, but also on more important questions, like the way BIM could help us in fostering environmental sustainability and beauty, achievable also thanks to a better understanding of building optimization and construction processes.

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However, considering present and expected benefits of BIM, as architects, we have to be alert. BIM is a technical tool, but Architecture is not only about Technique despite the fact that the word technique is the main root of the word architecture. Deviations towards mere technical jargons have to be avoided, consequently. Paradoxically, this does not mean that we need less technical skills but actually, even more in the same way poetry needs the most refined use of grammar techniques. We have to become familiar with BIM and new techniques, the same way traditional architects were familiar with pencil and the most advanced technical knowledge available at that time. However, difficult progress is expected in the fields of hardware and software programs and even more in the interface development, still too rigid nowadays.
But the most challenging goal will be in the ability to actively encourage and patronize the dialogue between our architectural culture and sensitivity, with the new design tools, aiming at obtaining from them the best help in enhancing our imagination, without missing our profound identity as architects in order to leave the best as possible architectural environment to the future generations.

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