Survey 4.0: the Challenge of Complexity

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Introduction

Over time, the scope of Survey had periods of greater or lesser consideration, but I would also say of mere attention of academic and non-academic scholars who confronted in the field of Drawing. This is due to the wide spectrum of cultural interests that are present in this sphere: from the geometry to the project, from the techniques to the systems. The considered focuses have an enormous variety of scale, from the object to the landscape.
The long history of the Survey itself represents such difficulty that has developed hand in hand with the history of man, his needs, his curiosity, the need to understand what is around him. On the one hand, the description of the surroundings as a need to understand the context in which it is located, on the other hand the inherent desire for inquiry and for an increasingly profound knowledge of what it meets. These considerations pushed man to deepen the analysis in all applications and methods aimed to investigate the elements that make the architecture, the city, the territory. The English terms of survey and inside summarize the same nature that drives a researcher to his task in each sector: but in the architectural field, it rises to a specificity that carries the Survey to be able to almost consider itself a discipline in its own.

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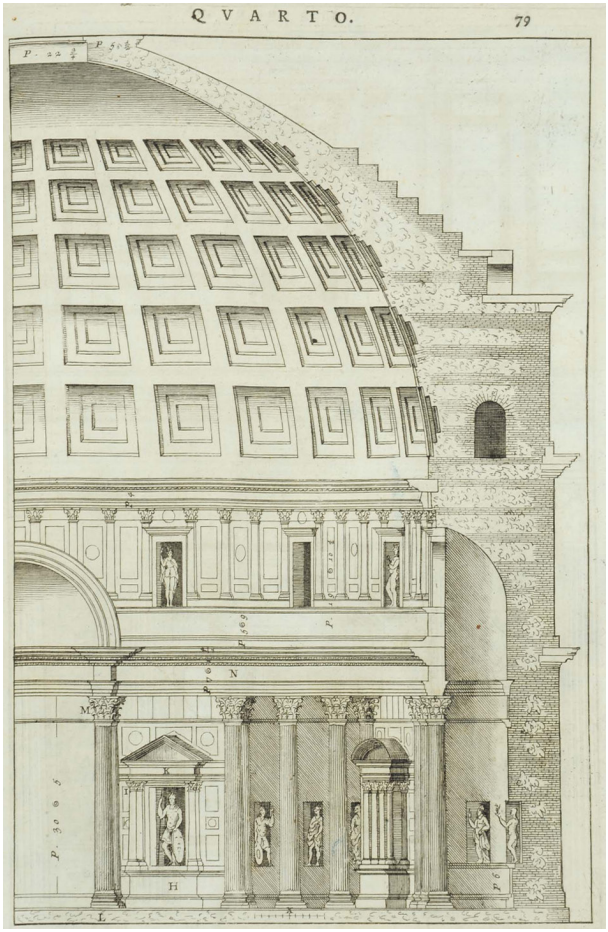


Fig. 1. Andrea Palladio, Drawing of the Pantheon, Rome [Palladio 1570, p. 81].

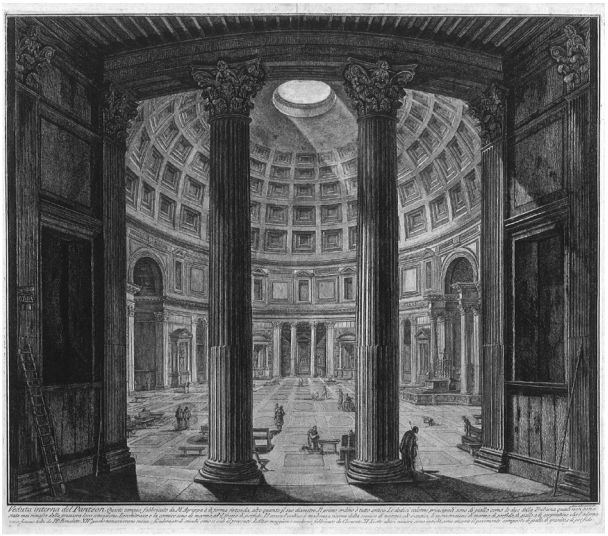
If in fact the scope of the 'description', as applied to the existing, falls within the definition of 'representation', the research on the built, and in particular the depth of the investigation itself exclusively relates to the field of Survey. Obviously guided by man, it will always maintain a representative subjectivity intended to explain the documented information, but it is no longer made only by graphic representation, but it extends its demonstrative amplitude to the various fields of the description of events and information, starting with, but not exhausting, from those expressed with graphic methods. In this sense, Survey assumes its own autonomy. The Representation begins and ends in itself and through itself, or autonomously (graphic representation, musical representation, theatrical representation, literary representation) using a specific and unique language to explain the subjective interpretation. In reverse, Survey starts from knowledge, from the information, from the analysis of the case study, and only through certain survey methods including the graphic one, it 'download' (restitute) again through the Representation its results: from the most superficial to the deeper ones.
Over time, Survey accentuated its distance from the representation and in particular the one of the surface: switching from the ancient but useful life drawing, to the acquisition of shape and measurement also through increasingly complex instruments, until the laser scans and photomodelling. It chased the accuracy of the physical-material component, but increased the description of a broader spectrum of information that goes beyond these aspects, to implement the deep knowledge of the object investigated. In order to do this, it necessarily had to follow the evolution of Science, which in particular in the last century has seen to undermine the constitutive paradigms that supported research for at least two centuries, from Newton to the present day.

From Survey 1.0 to 3.0

The traditional Drawing of the existent is realized through the critical and geometrical description of the architecture, perhaps with some graphical considerations about the technologies and of building materials and/or their conservative state. From Palladio to Piranesi, the Survey 1.0 especially increased the knowledge of form and dimension, through tools that pushed the Survey forward

from the second half of the 19th Century [1]. The wide use of mechanical, optical and photographic technologies applied to the survey field, different from the traditional tools of the Drawing, increased the quality of the description, but lengthened the distance between the Drawing as the sole instrument of investigation and the investigation itself as a place of competence of the Survey. The completeness was greater than the exhaustive aspects of the relationship between form and dimension. The progress made using those tools until the early 20th Century were evident [2].
The flanking of the of the non-contact survey to the direct one, with an enormous development of use of the last, definitely sanctioned a cultural transition whose effects have been very evident, precisely on how to conceive a survey (Survey 2.0). Progressively, the use of such tools increased the innovative-technological and methodological improvement: from the graphic description of architecture to photography / photogrammetry / stereo-photogrammetry, from levels and theodolites to mechanically and optically more and more refined and efficient instruments. Progressively, Survey reacted to the complexity required by the times, to the increase in the need for quality of the information restituted and more and more aimed at understanding the object, and not only at its description, but through a representation always more precise and reliable.
This passage corresponded to the parallel industrial development (Industry 2.0) which introduced industrial products, the 'machines', in all anthropic fields, from everyday life to scientific research. This spread caused a heated debate on the identity of the Drawing/Survey relationship, traceable in a wide bibliography by the detractors of this innovation, traditionally linked to the exclusivity of traditional techniques, against the 'modern reformists', strong of the actual results that these innovations brought in accuracy and coherence of the geometric information obtained [3].
In the second half of the 20th Century, the advent of information technology and the digital world provoked a further leap. As careful contemporary scholars pointed out, this responded to a need for a world that had to give faster and above all wider answers. 'Information' of increasingly different nature had to be linked, because their comparative reading gave answers to increasingly complex questions. The same definition of computer science placed emphasis on information, different from data. Of course, even more this approach developed the ability to investigate the phenomena in different sectors, in particular for those involved in research and knowledge aimed at understanding.
With the advent of computer science, the Survey 3.0 greatly expanded the field of investigative action, no longer focused on a purely mechanistic investigation regulated by cause and effect (measurement and drawing), but to a system that correlates information of various nature and of different origin than the previous geometric construction. The gap further expanded between investigation (survey) and description. In this case as well, the parallel transition was decisive from Industry 2.0 (the second industrial revolution) to 3.0 (the technological improvement) with the introduction of electronics, IT, telecommunications in the fields of knowledge and generally in everyday life.
In our field, the so-called CAD Computer Aided Drawing and therefore Survey, on the modernist line of the survey assisted by optical-mechanical instruments, more or less rapidly led to digital representation, 3D modelling, rendering, up to information systems, gene-

Fig. 2. Giovan Battista Piranesi, Perspective view of the interior of the Pantheon, Paris 1765-1768: <http://www.artnet.com/artists/giovanni-battista-piranesi/the-pantheon-interior-4TuI8P9OPaD2lCGvwFBexQ2> (accessed 2018, June 22).

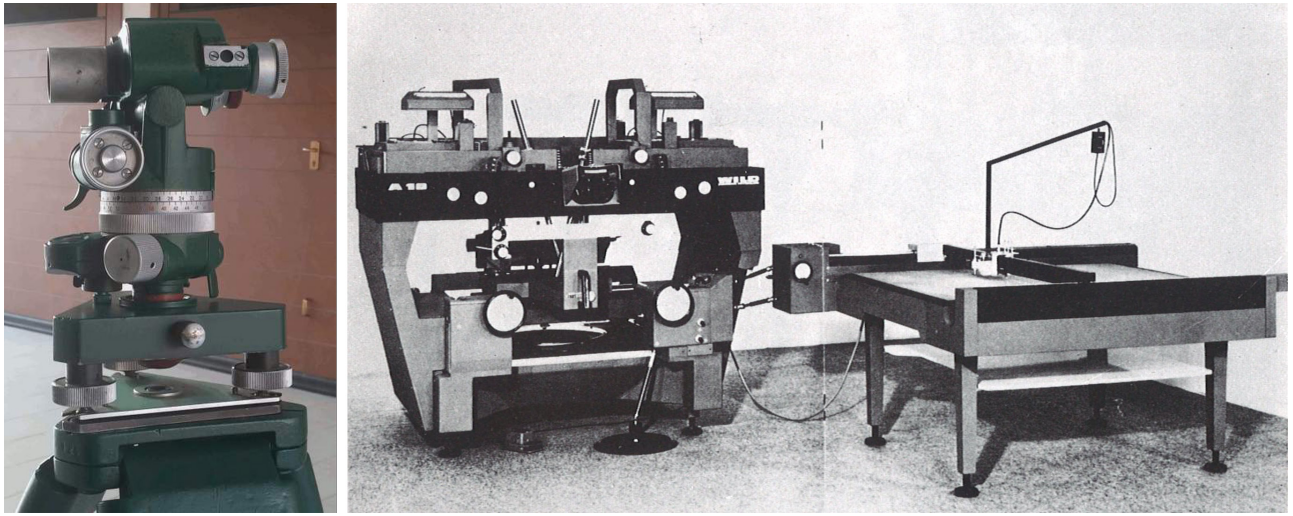


rating a new description/representation of the facts detected. We are not talking about the acquisition phase that, through measurements before from Total Station and then from Laser Scanner, implemented possibilities of precision where the indirect survey developed in the previous century become unavoidable. In fact, computerization allowed validating and strengthening Survey as a synonym of the general system of knowledge of the case study object, for architecture but not only. A complex of information from different sources (historical, structural, technological, artistic, performance, etc.) was holistically integrated on models that are increasingly geometrically precise and pervasive. They get an apparent comprehensive knowledge, which would allow little room for a further implementation [4].
Only ten years ago, a profound completeness (inside) of acquisition and management of information was thought to be reached. Instead, now almost paradoxically it poses continuous further questions, undermining the self-reference of the inquisitive process. Once, one would have said: 'The more I know, the more I realize I do not know'. The pace of innovation that these fields have shown in all directions demonstrates this: from CAD to BIM with a conceptual change of the 'representation/reconstruction' of architecture [5]; from digital stereo-photogrammetry to GIS, GPS, 3D capture technologies; from laser scanning to photomodelling [6]; from the introduction of the fourth dimension (time) to a hybridized representation through animation and cinematographic techniques; from the digital photomontage to Virtual and Augmented Reality. All this must be adaptable to the new Web that, with further complexity and with consequences on the representative process, from computers switch to tablet and smartphone [7].

To the Survey 4.0

This has had and still has a notable impact on the development of application and professional sectors: if once there was only a professional figure in the field of Survey (the 'surveyor', be it geometra, architect or engineer), today there are several actors. The specialization in the field of the metric acquisition almost never corresponds to the skills necessary for restitution and afterwards for 3D modelling, rendering and transferring the data into

Fig. 3. On the left, optical-mechanical theodolite; on the right, restorer Wild A10 with pantograph [Cundari 1983, fig. 40 p. 78].



a communicative and fascinating representation, able to increase the value of knowledge and dissemination. The specialists of information systems, especially on the ability/need to relate data and information from disparate sectors, usually have not the same skills of those who know how to work with BIM. Not to mention experts, like drone pilots or who digitize ancient documents, which are far away even if both aimed at understanding the same architecture. The fragmentation/separation of skills can be an opportunity for possible economic growth, jobs and qualification of professionals in the field, but it poses problems of connection and overall vision.
All these innovations approach the close relationship between academic discipline and professional practice, both in Drawing and Survey, up to fear the risk of slipping into pure application. This peril always menaced our disciplines and only the scientific approach to the reasons behind the operating procedure maintains the academic status necessary but not acknowledged by everyone. The know-how cannot be separated from how and why we do things and above all from the symbiotic correlation that they maintain with other disciplines that guarantee their validity and correctness (Descriptive Geometry in first place). However, the link with the professional aspects should absolutely not be underestimated, so that they spread and every day find their application and stimulate a constant innovative development.
It is also true that now, the disciplines with which Survey dialogues are increasingly almost all the possible, not only in the so-called 'technical' field. Today, a survey can support almost every field of knowledge and it can enhance its usefulness in linking all competences. Currently, Survey is apparently comprehensive of all possible knowledge, both on the physical and on the cultural level, not only for

Fig. 4. Digital restitution of survey: Tower 8, Damascus Citadel (graphic elaboration by: Gruppo di Rilievo, DICATeA Unipr).

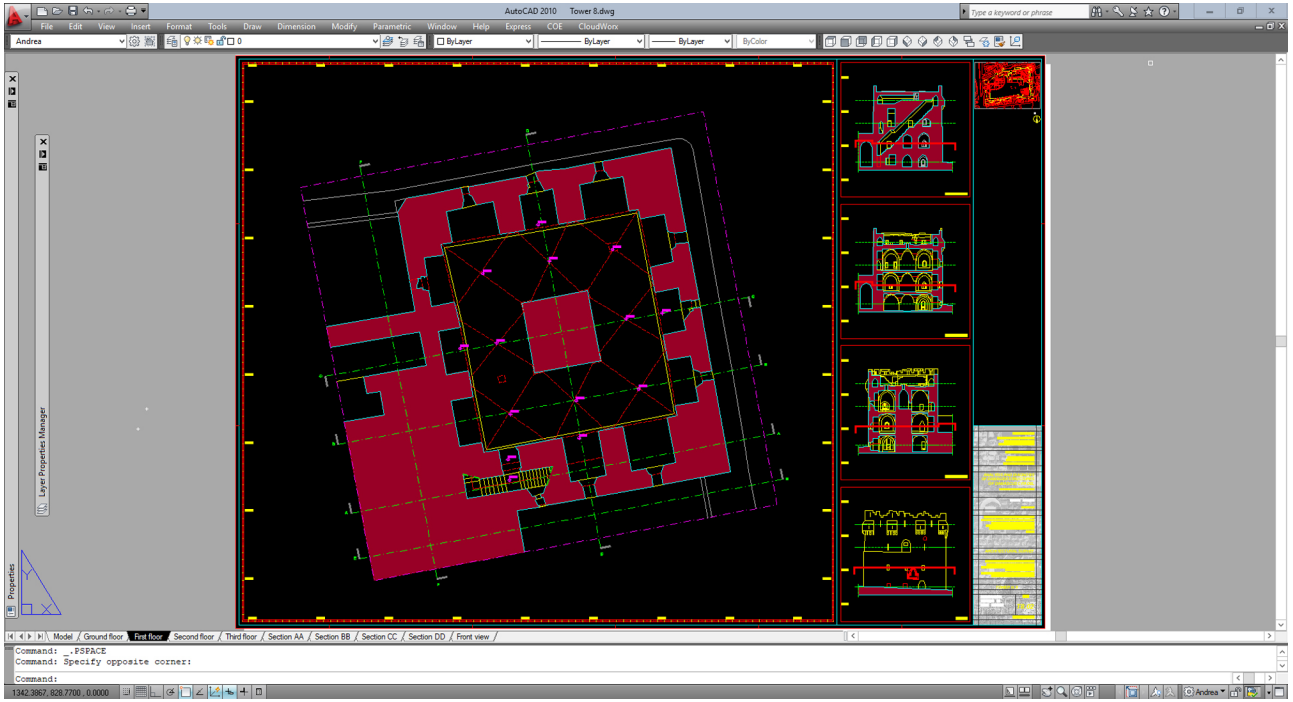


Fig. 5. 3D model of surveyed architecture: section of Pantheon, Paris (graphic elaboration by: Gruppo di Rilievo, DICATeA Unipr).

including data and information directly or indirectly acquired, but also for the specific and countless links applicable to the model. They lead to a theoretically infinite, multidimensional and multi-cognitive relationship context (i.e. hypertexts): "*Le scienze neo-meccanicistiche danno il colpo di grazia al concetto classico di oggetto singolo, sostituendolo con quello di sistema […] dove le indagini singole si spostano sulle relazioni che si instaurano tra elementi appunto di un sistema […] al posto dell'Uno, l'unitas-multiplex*" [Anselmo 2017, p. 20]. It is another cultural milestone.
According to Morin [8], the challenge of complexity is leading us from a world where the traditional knowledge faced problems whose factors obeyed the laws of classical logic (by their nature, they are for the most part measurable), to a new world in which the research itself is incalculable and boundless. The new frontier is the understanding of relationships rather than data, and a new organization of the knowledge. Survey 4.0 will adapt (maybe it is already beginning to do) to analyse the case study and the tools necessary for in-depth investigation, searching for the achievement of a deterministic, objective, definitive knowledge. It will also take into account and favour the relational aspects of the information itself, accepting a changing truth. This, through constant criticism, interrogation and dialogue. This is actually a huge step to take.

The challenge of complexity

Today we are able to document in a survey conducted with contemporary systems an extremely high quality and quantity of knowledge and it is clear to everyone how difficult it is to put it 'in order' and make it functional. Why? Because we are used to conceiving such a scattered order –a disorder– as a lack of our knowledge. Always, to understand we have been used to put things in hierarchical and pyramidal order. In front of such a mountain of information collected in different fields with different tools and increasingly moving beyond fields of competence of others, we are destabilized not only scientifically. It is highlighted the fragility of a method that instead should support and satisfy us, thanks to its pervasive deepening. The same principle of separability is vulnerable, according to which up to now it was necessary to break down a very complex problem into simple elements to solve it. This, despite the connection systems (information sy-

stems, GIS, BIM, etc.) are almost structured: at each subdivision, they leave on the field a gap of knowledge and a loss of relationship between the decomposed elements. By this time, an emblematic intellectual discomfort is almost physically felt [9].
The example of biological research shows: *"la scoperta della molecola convinti fosse l'elemento primario, ultimo ed indivisibile, per poi giungere invece alla scoperta dell'atomo, poi al suo nucleo, poi alla particella, per arrivare e giungere al quark di cui si è certi la particella sia composta ma che non può essere isolato materialmente, ma è solo postulato attraverso il calcolo"* [Anselmo 2017, p. 17]. Another example is the separation of disciplines in academia, where the continuous spasmodic pursuit of their singularity, specificity and identity has shown that the deviation from the very purpose of the application field causes more loss than gain. This applies to the human, medical, engineering, architectural sciences. The current attempt of a possible reconstruction of the whole is only a first sign of the intellectual discomfort that each of us feels [10]. Yet no one knows how to reassemble the fragments, without losing depth of expertise.
In the architectural field, the separation by nature of acquisition and origin of the information collected in a survey seems to disperse in a loss of the overall vision. The need to hold together the whole and the parts is fundamental as a mandatory condition for true knowledge. Even the reductionist process (through which a survey is conducted on smaller and smaller pieces, more and more in detail, seeking for accuracies at the limit of measurable) shows the fallibility of historicised method for which scientific is only what is measurable and quantifiable. The aforementioned case of the quantum physics demonstrated that the immeasurable is the frontier of the measurable and that any large, medium, small, very small or infinitesimal element find its true essence and meaning in its relationships and not in its composition/decomposition.
The basis of the encoded representation we use to graphically explain the architecture is the concept of the relationship between the signifier and the meaning. It leaves space to inductive, deductive and identifying systems, such as the icon, which today, paradoxically, seems to rediscover its intrinsic symbolic value in communication. It seems to have a greater capacity to show contemporary Truth, a truth no longer unique and determined, but changeable, conditioning, almost questionable. Already today, this changing truth testifies transformations, relationship, intangible values that architecture, the city, the landscape daily witness.
To give another example: how to detect the sociological effects of an architectural transformation in urban regeneration? The 'cultural' landscape, today so evoked and requested, is it detectable through the cataloguing of all the values present in the area? Would it be better to describe the impact it has on economy and on the development of the society, through the number of presences in terms of cultural heritage, employment, social inclusion or who knows what else? The incidence of the effects of that particular architectural/urban operation carried out in the city in transformation, is it detectable in order to be able to demonstrate a positiveness or negativity, as the local political debate perhaps requires?
The more we try to use the current methods of investigation and their representation, the more they appear arbitrary and lacking of sufficient completeness to produce a judgment that is not a factual data. How are these things measured? How are they represented? Assuming that we know how to investigate them, how can we transfer them through the Survey? We already know that this search, even if endowed with seemingly infinite technological innovative potentialities, it will appear absolutely incomplete and limited. Any relational critique, conducted

Fig. 6. Urban informative system: North avenues, Parma (graphic elaboration by: Gruppo di Rilievo, DICATeA Unipr).

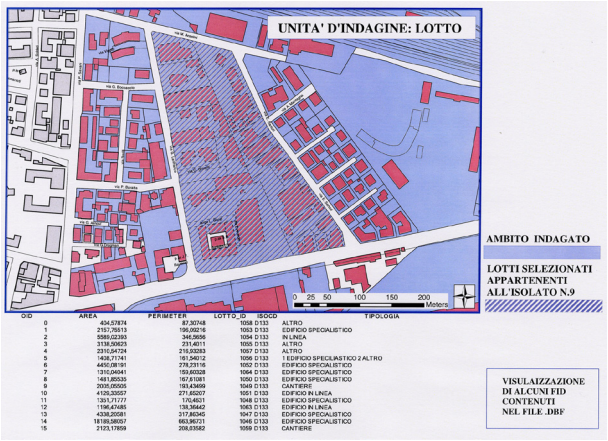
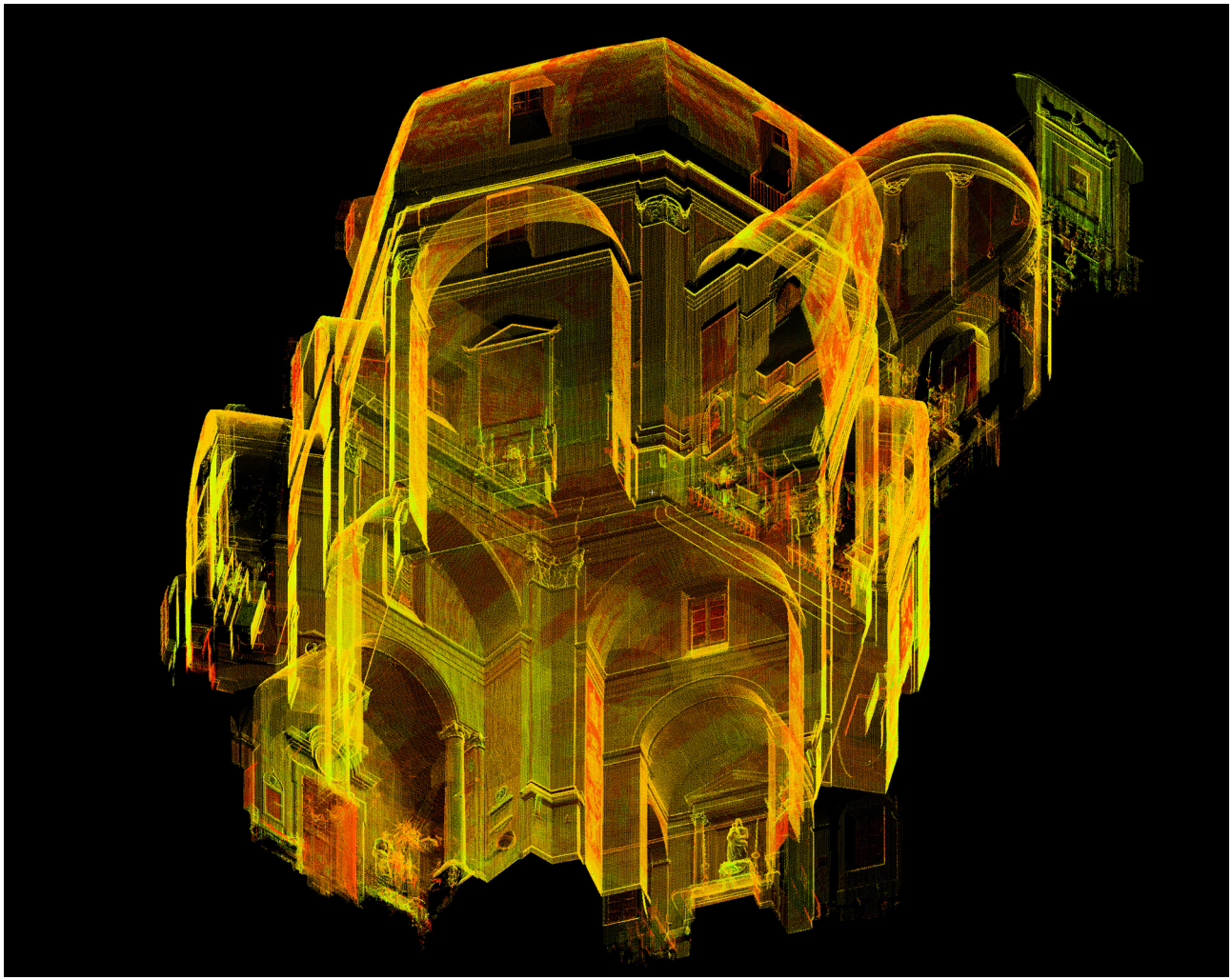


Fig. 7. Laser scan of architecture: Santa Maria del Quartiere, Parma (graphic elaboration by: Gruppo di Rilievo, DICATeA Unipr).



by an improvised commentator of contemporaneity in any television broadcast (the columnist), seems to have greater credibility.

Conclusion

Our investigations are so scientific and conducted in disparate disciplinary fields on the border of deterministic knowledge, but contradictions and uncertainties appears. This poses a new frontier, in which often the individual sensations, intuitions and presentiments can synthesize in empirical but appropriate way what appears elusive and indeterminate in the traditional methodology of serious thorough investigation.
A new challenge. A challenge for new generations. A vision of the future that should not scare, but on the contrary, it should fascinate for many positive implications, which could contaminate the technical and application Sciences with human Sciences, in order to pursue a path of *Virtute* e *Canoscenza*.

Notes

[1] The history of direct survey methods is widely described in: Docci, Maestri 1998.

[2] The chapter IV – *Strumenti e meraviglie* [Kemp 1990, pp. 187-244] is a very important compendium to understand the slow and inexorable progressive insertion of the machines in the drawing and survey of architecture and the city, in particular the evolution of stereoscopic photography from the end of the 1800s to the early 1900s.

[3] Cesare Cundari, introducing in 1983 his volume *Fotogrammetria architettonica*, intellectually registers the achieved overcoming of the "contrast between supporters of direct architectural survey and supporters of the instrumental one".

[4] From the mid-90s until the entire first decade of 2000, at the University of Parma the research group coordinated by the undersigned, was particularly involved in the search for a mature relationship between computerization of knowledge and Survey, from the modelling to the information system, both in architecture and urban environment. It can be found in some publications that progressively show the rapid change in attitude in the sector: Giandebiaggi 2007a; Giandebiaggi 2007b; Giandebiaggi 2006; Giandebiaggi, Zerbi 2005; Giandebiaggi 2003; Giandebiaggi et al. 2001a; Giandebiaggi et al. 2001b; Giandebiaggi, Melley, Zerbi 1999; Giandebiaggi, Ceiner 1997.

[5] The developments in the representation of Survey in the transition from CAD to BIM and up to Augmented Reality are extremely detailed in: Osello 2015.

[6] Considerations on the moment of transition that the Survey is experiencing in this historical moment are expressed in: Docci 2013; Bianchini 2014. For a complete knowledge of the theoretical geometrical and applicative passage from the passive and active 3D acquisition methodologies and the genesis of the 3D models in the fields of Design and also Architecture, see: Guidi, Russo, Beraldin 2010.

[7] The example of how the Survey has been completely pervaded by the digital age is extremely evident in the table of contents of the Italian research in the international arena, published in: Giandebiaggi, Zerbi 2014.

[8] The book by Edgard Morin was published for the first time in double version by the publisher Armando Siciliano from Messina in 2002 for the conferral of the Honorary Degree in Philosophy.

[9] See the chapter *La crisi della riduzione* e *la comparsa dell'inseparabilità nella separabilità*: Morin 2017, pp. 44-48.

[10] In recent years, the various reforms in the academic SSDs noticed the extreme and excessive fragmentation of the educational and scientific knowledge. They began a process of recomposition in a lower number and type of 'disciplines' and this path is still ongoing for a further regrouping in order to limit specialization without losing a holistic view of different knowledge.

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Fig. 8. Methodological process AR: AR media [Osello, Ugliotti 2017, figg. 8.8-12, p. 130].

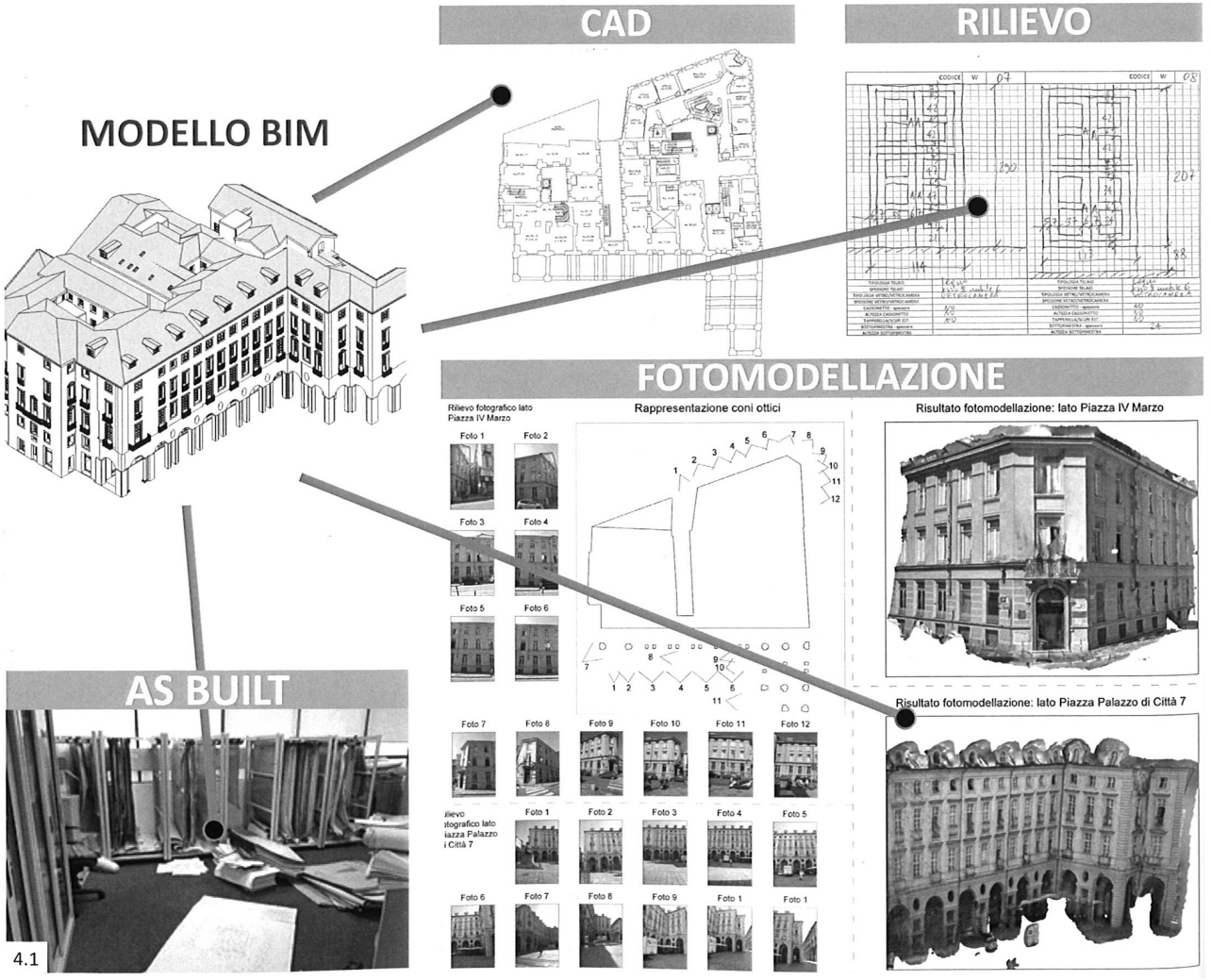
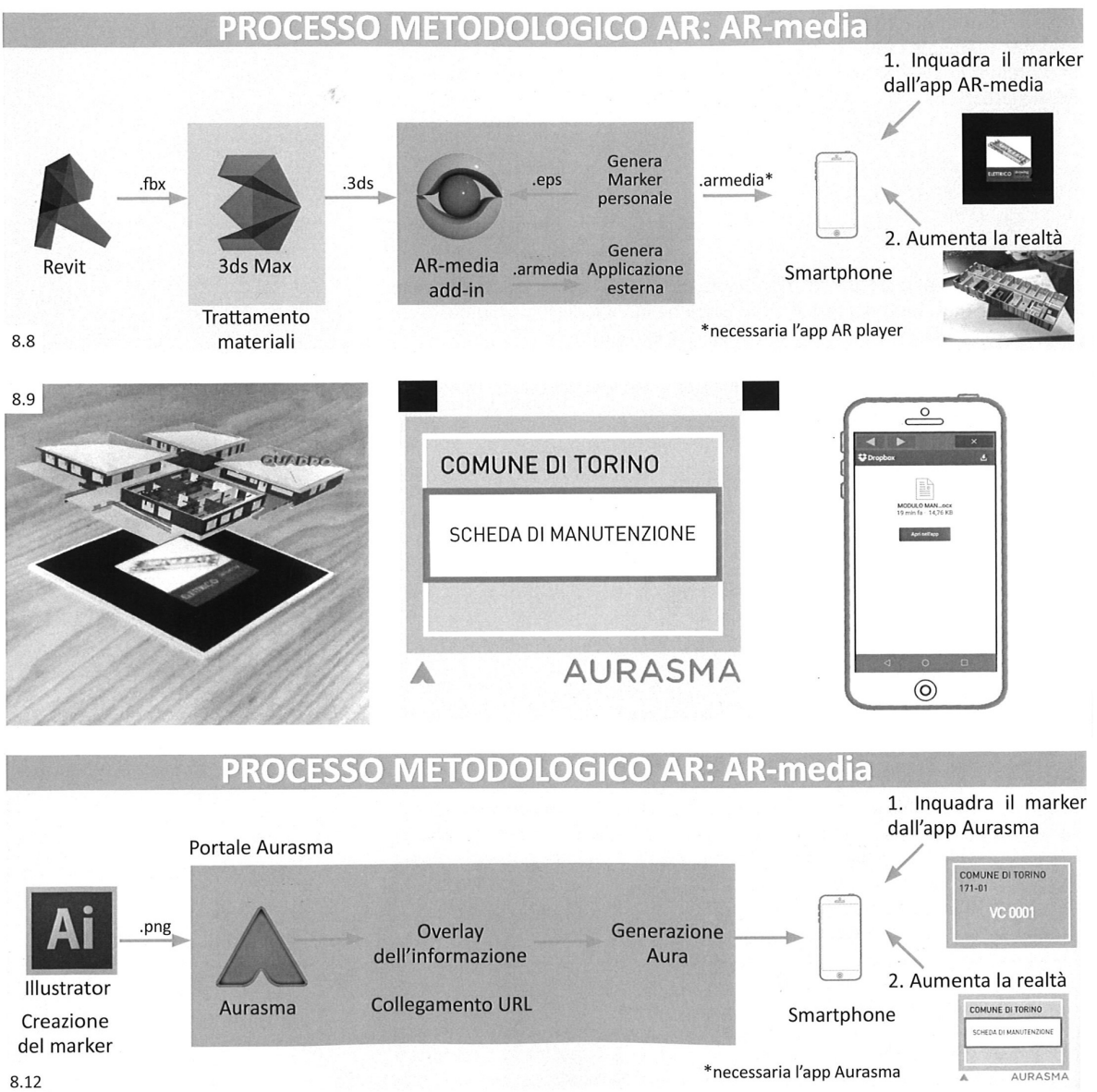


Fig. 9. BIM model and survey systems [Osello, Ugliotti 2017, fig.4.1, p. 46].



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