EGE - Revista de Expresión Gráfica en la Edificación, Nº 11, 2019. ISSN: 2605-082X
https://doi.org/10.4995/ege.2019.12873
APEGA, UPV

DIGITAL SURVEY: FROM NEW TECHNOLOGY TO EVERYDAY USE, A KNOWLEDGE PATH AND CHALLENGE FOR SCHOLARS

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Abstract

Which is the meaning of researching and working in the field of the digital survey at the beginning of the XXIth century? Are the scholars and professionals planning procedures and strategies or just producing an enormous amount of digital data which destiny will be a colossal data loss? Starting from a reflection about "where we are" after 20 years of active digital survey for built heritage this article will try to trace some points about how to start and to plan digital survey intervention when the task is not merely professional and when the new survey bases are supposed to be used in a "liquid" context. From the massive machines and procedures of the XXth century, producing quite "light" amount of data, in the last two decades these tools passed to be lightweight in their hardware, while the amount of gathered data increased continuously, in what it seems an unstoppable process. But massive data gathering maybe it is not knowledge by itself and the information society, especially in its next evolutions, will need contents and versatile data to support and link our present to the heritage values. A specific reflection on the value of digital survey and procedures will be held here not in the pretention of finding a stable paradigm but in the will of stimulating the discussion in a field often tempted by simply technical solutions.

Keywords: Lasergrammetry; Photogrammetry; Santa Maria del Fiore Cathedral; Palazzo Vecchio; Firenze; Built Heritage.

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1. INTRODUCTION

Two main presences have ruled the digital survey scenario in the last twenty years: Lasergrammetry and Photogrammetry applications have been a more and more constant presence in every case studies and interventions on built, cultural and archaeological heritage. Their use alone, in combination, or even integrated by other kinds of data gathering have taken a large part of the attention in the technological renewal.

It is possible to consider them both as a part of the Information Technology Industrial revolution, included in the steps of the Industry 4.0 innovations (Bartodziej, 2016) and in the bases of the Society 5.0 concepts (Salgues, 2018). In a certain way, these two technologies have challenged each other in the field and in the preferences of the operators, producing benefits in the evolution of the state of the knowledge and excellent documentation and "digital twins" production (Auer Ram, 2019) for many elements of the Humanity's Patrimony.

But which is the present scenario with built heritage and digital survey? Considering the Gartner "Hype Cycle" (Fenn, Raskino, 2008), even with all its limits and contradictions, the 3D Laser Scanner (3DLS) -or "Lasergrammetry"- uses as well as the contemporary Photogrammetry should be in the so-called "Plateau of Productivity": for the uses of Lasergrammetry, they entered the Cycle from the "Technology Trigger" in 2012 and were at the beginning of the "Peak of Inflated Expectations" in 2013, just to pass quickly the "Trough of Disillusionment" and reached the "Slope of Enlightenment" in 2014 (Murphy & Topcon, 2015). For Photogrammetry, it seems there is no a specific position in between the subjects analysed by the Gartner's Cycles, but it should be possible to place its present position along the "Plateau of Productivity" close to Lasergrammetry, maybe with the terrestrial photogrammetry a little forward in front of the aerial UAV/Drone solutions. The continuous use of these solutions made them well integrated into the general approach and even if various personal preferences and behaviours may create a certain variety in the definition of the workflows between data gathering and post-processing, in general, the logic in the process appears well consolidated. The two different technologies can be considered as parallel starting from their measuring solution: on one side the "active" method of the 3D laser scanner: a specific signal allow the gathering of the point, with a procedure that now allows extremely massive captures.

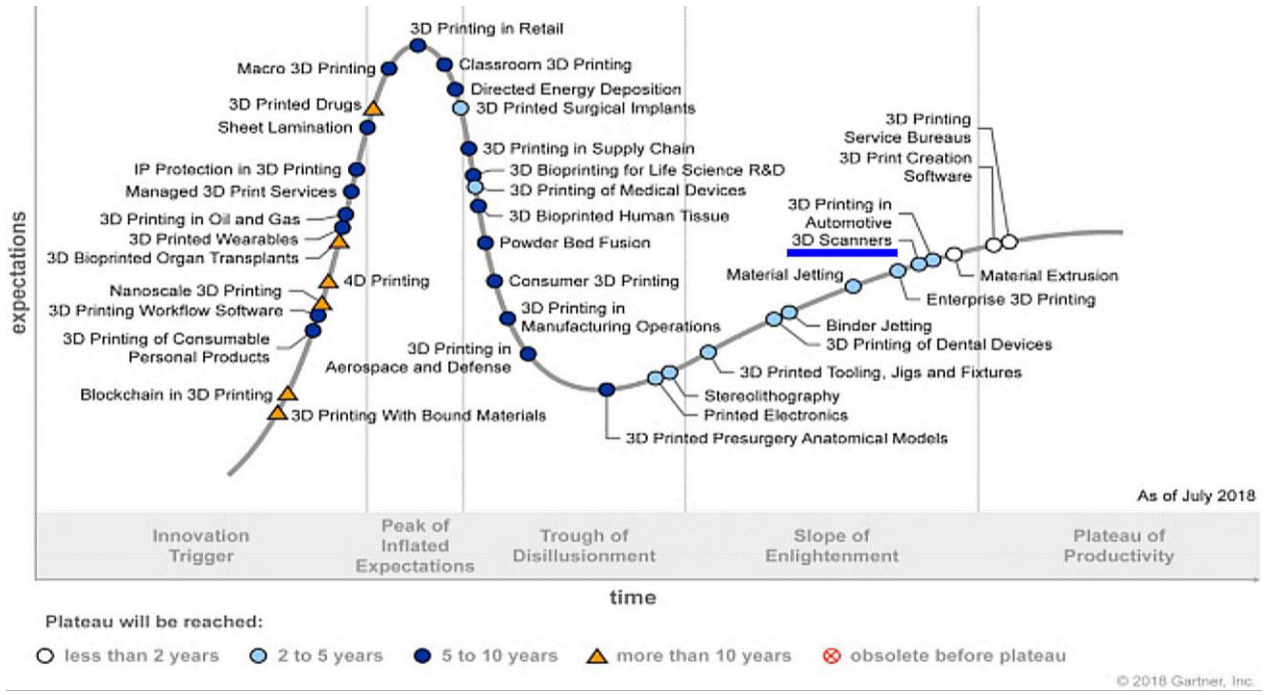

Fig. 1. Gartner's Hype Cycle for the emerging technologies: 3D Manufacturing, July 2018, the 3D Scanners are underlined in blue. (Source: www.gartners.com).

On the other side, the photogrammetry adopts a "passive" method, capturing the real without interfering with it and creating the digital model from pictures which technical quality directly influences the result (Stanco, Battiato, Gallo, 2017). These two sides of the digital survey have seen a significant evolution since their introduction on the field of built heritage (3DLS, main diffusion from the end of the 90s) or since their digital renewal (SfM/IM Photogrammetry, main diffusion from the second half of the 2000s).

For the 3DLS the more and more efficient "automatic alignment" procedure has shortened the time needed to register the point clouds in a single reference system, while the enhancements in the size, weight, autonomy, speed and accuracy of the laser units have made extremely simple to bring these tools around and face complex and long survey campaigns. At the same time, the latest tendency seems to be quite oriented to the production of extremely massive data, with high density, HDR/multi-coloured point clouds, excellent in the aspect and perfectly suitable for automatic procedures of alignment. Thus, the side effect of this quality is the "size" of the overall data, which makes easy the production of hundreds of Gigabytes of data in a single day of scanning. At the same time, the procedures for photogrammetry have seen a significant speed-up in the time needed for processing and model production, an enhancement not only linked to the better performance of the hardware, but to the better optimization of the software. The gradual integration of the support to point cloud data in the photogrammetric software have made simpler to integrate both the surveys in a single common result, with excellent benefits in the final quality of the resulting products.

At the state of the development of these technologies, it is worth to make some reflections and compare them to a couple of significant case studies to better understand challenges and "next moves" in the field of digital survey.

2. CONTINUOUS VS SAMPLED

The massive data gathering of the 3D laser scanners and the more and more high resolutions of the digital cameras push to some reflections and speculations about the parallel real/digital, from one side the high accuracy of the scanners allows to produce point clouds with point grids at minimal distances and then with an extremely accurate description of the shape of a surface. At the same time, in photogrammetry, the small size of the pixels on the object, the extremization of the Ground Sampling Distance ratio (GSD, originally defined for aerial digital photography, but then extended to all the situations) (Sanz-Ablanedo et Ali, 2018), has brought the possibility to produce 3D models with a level of details that goes quite beyond the common perception of the same object by the human eyesight. The possibility to explore from close-range to micro details the objects made particularly useful -and even fascinating- this complex work of reconstruction, opening new and interesting perspectives in the possibility of analysis, diagnostic and monitoring of various materials and artefacts. But it is worth to remember that any digital representation is necessarily made by a "finite" number of samples and that the creation of a digital twin needs a specific sampling of the object that brings necessarily to a reduction (even when beyond the human level of perception) of the complexity of the real. In a certain way, it is established a parallel between the "continuity" of the real and the "sampled version" of the digital, the results are excellent, but the limit of the possible level of detail exists.

For this it comes out naturally to consider the "appropriate" level of detail for each task, the restoration, the evaluation of the seismic risk, the production of multimedia or the study about virtual reconstructions, etc... all of them require a specific level of detail, when it comes "superior" to the needs the operators are simply "putting away" something useful for the future, but in the final preparation of the graphics boards, of the APP, of the digital 3D model, the extreme simplification will reduce to a fraction the entity of the original materials. Which think does not mean that all the people involved in the digital survey are called to produce only the exact amount of information needed for a single task. But that certain approach apparently guided by massive intentions may have to wait for a possible future use than being immediately useful.

At the same time the approach to digital as the "true representation of the real" may appear more like a fake myth than a real condition and depends on some misinterpretation of a logic process. Where the enthusiasm in technologies may replace an appropriate reading of the context.

Moving out from the digital survey scenario it is possible to find some parallel clarifying this concept, in an example: thinking about the digitalization of the sound. The sound in nature can be represented in form of a wave, which is defined by a continuous curve, the digitalization of the sound, samples this curve in a series of segments, the smaller the segment, the better the fidelity in the registration. The actual standards in digital registration and reproduction, with their high quality, may induce some weird convictions about the parallel between real and digital, like: “If you'd given Mozart a smartphone with his collected works on it, he would not have been able to believe his ears. What that thing does, to him would have suggested either magic or witchcraft. He would never have heard his music sound so clear, so pure, so perfectly produced in his entire short life.” (Hovestadt et Ali, 2017) where the high-quality reproduction of the real looks confused and considered superior to the real itself. The digital recording/reproduction is at now better than any similar previous solution, but cannot be compared to the quality and emphasis of the real (and at the time of Mozart there were no recordings tools), it is just a sampled version, a reduction to something portable that may leave stunned for the appreciable result, but not considered superior to a real orchestra, even for less trained ears than those of Mozart.

The same misunderstanding may happen in the digital approach to Cultural Heritage, considering the whole problem as merely linked to an accurate and mathematical/informatic accuracy, which thing should be not.

The digital part is only a step in a process of comprehension of the patrimony, the operation of guiding it to be “a little more” than the accuracy and quantity of the data should be a fundamental task for each scholar. The contents, the myriad of aspects, should be connected together, the real choice about quality, simplifications, post-processing, should take care about the contents of the specific subject, not treating it in a continuous replica of the same process, equal for a design object, a statue or a building, but oriented to valorise, optimize and enhance accordingly to the understanding and the final task of the interventions.

This comprehension has the option for creating a better bridge between the continuity of the real and the sampling of the digital, which can be enhanced not only by quantity but also by qualities. Such a choice and coherence can be the next step forward in considering the digital approach not as an “exceptional” event, but in perfect continuity with the tradition of the artists and craftsmen who made the built heritage itself.

3. THE FLORENTINE CATHEDRAL

The Cathedral of Florence represent a long story of transformations: the city moving from a medieval town to the Renaissance was giving itself a new large building, replacing the previous St. Reparata with a new church, large and rich, entitled to St. Mary of the Flower, clearly an allusion to the lily, the specific Florentine symbol. The construction of the Cathedral created a large courtyard, extended in space and time: from the early works from the 8 September 1296 to the completion of the Dome in 1434, to the consecration in 1436, to the Façade added in the XIIX century (Gurrieri, 1995).

This five-century long process defined the third largest Christian cathedral in the world, a monument that in our times brings important issues about management, tourism impact, a proper way of restoration and correct strategies in the intervention.

The “Opera di Santa Maria del Fiore”, the "Fabbriceria della Cattedrale di Firenze", or “Florence Cathedral Works”, was founded by the Florentine Republic in 1296 to oversee the construction of the Cathedral.

After all this time, the “Opera” is still managing restorations, accesses and interventions all over this huge building.

Since the early 2000s, to provide constant safety conditions to the numerous people moving all around the Cathedral every day and to avoid the risk of decay for some parts of the façades, the Opera started a continuous check of all the elements in the external walls of the Church, operating from the building and using large cranes periodically.

At the beginning of the second decade of the 2000s a digital system, mapping all the elements of the façades started to support the activity of architects, restorers and Cultural Heritage experts. In 2017 a new accurate survey was commissioned to update the state of knowledge

about the Cathedral with a completely new digital survey of all the façades. The commitment was assigned to Area3D Srl, Livorno, with the scientific coordination and in collaboration with the DiDALabs system of the Dipartimento di Architettura, University of Florence. The planning of the survey was articulated in two main sequences: one using a 3D laser scanner unit to capture the whole detailed model of the architecture and working as the main reference for all the architectural elements.

The second was based on the photogrammetric survey, aimed to produce a high detail image of the façade, integrated by the 3D laser scanner measurements and developed to be the main reference for all the details, from the statues to the minimal mosaics and marble elements.

In this way, all the possible issues caused by the extreme size and complexity of the façade were under proper control, with the benefit in having a global accurate survey based on 3D laser scanner and a level of detail capable to show cracks, spots, detachments, colour alterations, etc... Thanks to the complete photogrammetry.

The whole scanning work was done using a Cam/2 Faro Focus X330, which turned out as a well-working choice: the low weight/small size allowed to position the scanner anywhere in an easy way, like over the roof of the Baptistery, or in position reached using a crane, like all around the apsis; the long-range of this unit, capable to take points up to 330 metres of distance and the good accuracy of about two millimetres at ten metres of distance on normally reflective materials, allowed to have a global base ideal for preparing scaled drawings for the representation of all the fronts. No scanning was done directly from the crane, the presence of stable point of view from all the building around the Cathedral and an accurate planning of the scan stations all around the roofs and access in its top parts, allowed a complete coverage avoiding possible difficulties coming from the tilting of the crane arm and/or complex post-processing afflicting the final accuracy of the aligned point cloud.

This accurate digitalization by points was then used as a reference base for the photogrammetry. This part of the work was -and yet is- a great adventure for all the operators, in facts, at any occasion in which the crane is used for monitoring the Cathedral, a new area is covered by photogrammetry shots, this is also a challenge with the weather: in case of rain it is not possible to operate, the wind may reduce drastically the reachable height, the direct sun may cause unwanted shadows and chromatic dominants in the shots. The photogrammetry from the crane started in May 2017 and is now (November 2019) reaching the completion with the coverage of the southern front.

For the southern apse and a part of the eastern, there will be to wait for the restoration courtyard to be finished, while now it is covering all this part with scaffoldings. It is important to consider that the crane used for these tasks is not the typical small vehicle used for hanging around Christmas decorations. The various units involved in time for the monitoring are the large cranes with arms extending up to 114 metres (which correspond to the longest range available in Italy).

Fig. 2. May 2017, the first photogrammetry campaign of the Florentine Cathedral, operative unit, from the left: Stéphane Giraudeau, Filippo Giansanti, Paolo Formaglini from the DiDALabs System, Architecture Photographic Laboratory (LFA). (Source: own's, the author).

These extreme extensions are needed not only for the reachable heights but for the rich articulation of the arms, allowing to move all along a front, reaching difficult angles and making all these work from positions compliant with people traffic on the ground.

The possibility to have three photographers at time during the operations allowed a specific strategy: two full-frame cameras (Nikon D800) with the same lens (Nikkor 35mm F2) mounted on tripods, taking parallel shots from the two sides of the platform and a third camera (Sony Alpha 7r, mounting a Sigma Macro 50mm F2,8 or Pentax K1, mounting a Sigma 35mm F1,4), handheld and used to take angled, detail and specific shots accordingly to the area of intervention.

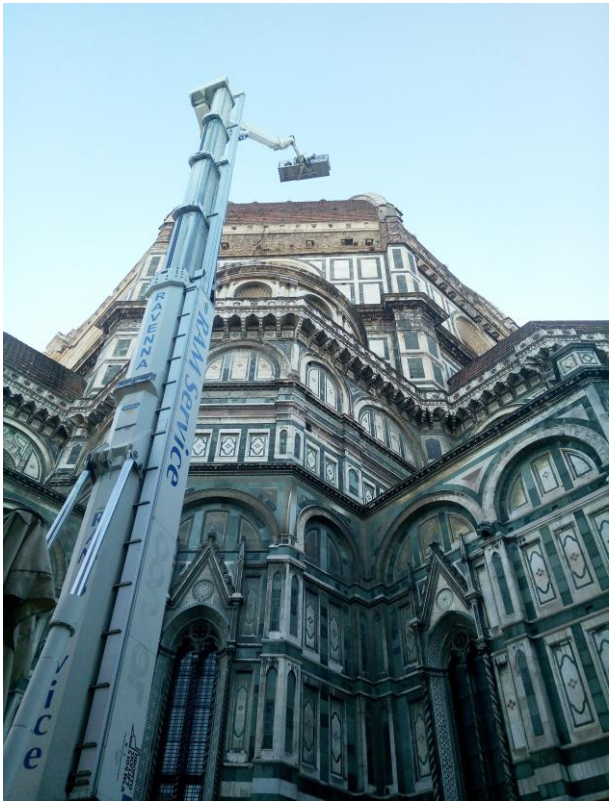

Fig. 3. November 2018, the photogrammetry campaign of the Florentine Cathedral: northern absis (Source: own's, the author).

The intensive shooting produced a wide set of images, that were later selected in terms of quality and proper overlapping, specific attention was given to the corners of the building and to the most difficult occlusion areas. Some adjustments and optimizations were brought on while the survey campaign was ongoing, both following the specific aspects of the building (passing from the West façade, rich of statues, to the Northern, characterized by large dark patina areas) and the changes/improvements in the equipment of the Architecture Photographic Laboratory. The order of the operations was: May 2017, Western and Northern Façades; November 2018, Northern apsis; May 2019, Giotto's Tower Bell; November 2019, Southern Façade. The photogrammetry operators/tools, the shooting/sub-selection and the main corresponding orthophotos were:

Western Façade, three operators, four FX sensor cameras with a resolution about 36 Mp, 3576 shots, sub-selection at 2.960 photos. Resulting polygonal mesh defined by about230 million triangles; final orthophoto 51.431x62.033 pixels, pixel sizes on the object 0,98 mm.

Northern Façade, four operators, four FX sensor cameras with a resolution about 36 Mp, 6.379 shots, sub-selection at 4.435 photos. Resulting polygonal mesh defined by about 410 million triangles; final orthophoto 152.536x86.070 pixels, pixel sizes on the object 0,6 mm.

Northern apsis, four operators, two FX sensor cameras with a resolution about 36 Mp, one FX sensor camera with a resolution about 47 Mp, one medium-format sensor camera with a resolution about 50 Mp, 11.700 shots, sub-selection of 6782 photos. Resulting polygonal mesh defined by about 2,1 billion triangles; final orthophoto divided into 19 planes of about 35.000x50.000 pixels, pixel sizes on the object 0,4 mm.

The whole set of operations, from the shooting from the platform to the treatment of all the pictures and the long days of calculations, was continuously aimed to the refining of the procedure, getting better quality and higher resolution results and adapting the process to the specific needs of the area/sector taken in processing. The darken colours caused by the patina, the richness of the statues or the articulation of the apsis required little different strategies. The results, exploiting to the maximum the resolution of the original shots produce impressing image documentation of all the fronts, where all the details are clearly recognizable in shape, colours, state of decay.

The following processing was aimed at the production of 2D drawings to enter the system of management of the façades. Each element was traced with a closed polyline to be later imported and described by all its attributes. The task of Area3D/DiDALabs so-called with the drawing production, all the further operations were brought on by the "Opera" officers.

Such a final use may look "a reduction" in the processing, while all the 3D data and high-resolution images are left behind the production of a "detailed" but "simple" drawing, but it simply

absolves the direct needs and creates a proper base for monitoring and managing the building. Otherwise, the richness of the bases is yet available documenting the state of the cathedral at the moment of the survey, remaining as a reference and usable for further studies and tentative in enhancing the procedures of management, visualization and virtualization of the whole monument. A simplified version of the materials produced during the Cathedral survey is visible and browsable in the Sketchfab.com community, in the profile of the DiDALabs Architecture Photographic Laboratory (sketchfab.com/L.f.A-DiDA-UNIFI).

Fig. 4. Northern Front of the Florentine Cathedral, final processing of the photo plane, orthographic projection, original resolution: 152.536x86.070 pixels. (Source: Laboratorio Fotografico Architettura, DiDALabs, Paolo Formaglini, Filippo Giansanti, Alessandro Giacomelli, Stéphane Giraudeau, 2018).

4. PALAZZO VECCHIO

Palazzo Vecchio is an incredible collection of transformation and overlaid interventions. Since its foundation, it has seen a continuous courtyard of adaptations and expansions, growing to fill the whole block in its nearby areas, while the inside changed its shape and aspects many times. It covers the previous roman structures of various buildings, with the former Amphitheatre recently opened to the public for visits. In the past centuries, various studies documented this ever-transforming building (Rastrelli, 1792; Francini, 2007; Bruttini, 2013), in an extreme attempt of resuming the reason for such intense transformations it can be argued that its origins and development as the core of the Florentine governance forced continuously the needs of changing and adapting. The main interventions can be focalized in the early medieval definition of the so-called “Arnolfo’s Cube”; the large Renaissance restoration and transformation with all the interventions by Giorgio Vasari; the later expansion and “completion” by Battista del Tasso e Bernardo Buontalenti. In recent times, being at the same time the place of the Florentine Municipality and a large museum, it has received numerous interventions to adapt the building to technical needs: plumbing, piping, elevators, electric and aeration systems. The result of centuries of growing and changing is a very complex structure, expanded, connected and often carved, extremely rich of artworks and weird remains. In such a context, the request for defining the “seismic risk” brought to understand the need for a detailed survey.

In facts, the previous works (Bartoli, 2007) were offering appreciable drawing and description of the building, but they all resulted of too simplified or too partial to support the seismic study with proper accuracy in the definition of walls,

interstices, openings and “holes”. This condition pushed the municipality to decide on a new global survey of the whole building. In the will of such an advance in the level of details and knowledge in the survey of Palazzo Vecchio, the work was obviously monumental. The strategy adopted was to operate with multiple 3D laser scanner units, accordingly to the specifics of the unit to get the best possible benefit about the accuracy, coverage, speed.

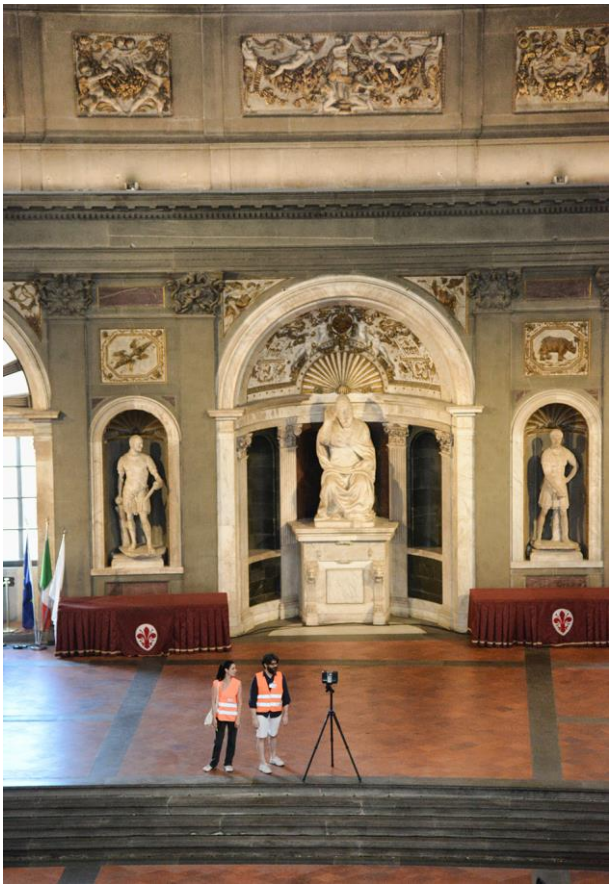

Fig. 5. July 2019, the Lasergrammetry of the “Salone dei Cinquecento” in Palazzo Vecchio, Florence. (Source: own’s, the author).

The scanners in use were of five different models, often working with two at time: Cam/2 Faro Focus X330 (360x320° capture field, two mm accuracy at 10 metres, range up to 330 metres, weight 5 Kgs), Cam/2 Faro Focus 70s (360x320° capture field, 1mm accuracy at 10 metres, range up to 70 metres, weight five Kgs), Leica BLK360 (360x320° capture field, 6mm accuracy at 10 metres, range up to 60 metres, weight one Kg), Leica RTC (360x320° capture field, one mm accuracy at 10 metres, range up to 150 metres, weight six Kgs), Z+F Imager 5016 (360x320° capture field, two mm accuracy at 10 metres, range up to 380 metres, weight 7,5 Kgs). In this way, the long-range scanners were used for all the external parts, while the smaller and light weighted scanners were used in the interiors, with significant benefits in the small spaces, like extrados, narrow staircases, interstices, etc…

Accordingly, to the aims of the survey, the needed data were the simple geometry of the spaces, without the need for texturing, so, no integrative photogrammetry was done. The whole survey was completed in about three weeks, with four working groups exchanging their turns and allowing a very heavy timetable (7.00 am – 10.00 pm or 9.00 am – 00.00 pm) with the start at the end of July 2019 and all the main surveys done by the first week of August and in the later campaign at the beginning of September. Some integrations were done in November 2019. The full coverage of the building was completed in 4660 scans. The logic in the planning of the survey was aimed to produce an appropriate level of details for all the walls, vaults, staircases, pits, voids, etc… But at the same time, specific attention was dedicated to parts showing interesting potentiality for further studies/researches. In this sense specific photogrammetry was taken for the statues in the “Salone dei Cinquecento” and various integrative scanning were done in the most detailed parts, like for the halls “dei Gigli”, “Delle Udienze” e del “Mappamondo”. The whole scanning work was aligned in a series of “groups”, registering a coherent sequence of scans and later combining the parts together. The alignment was brought from the beginning to the end using Autodesk Recap. The idea to bring on such a complex alignment in Autodesk Recap was due to various reasons, first of all for practical needs, this software is offered in free license to academic institutions and students, which means that any following study will be able to exploit the global point cloud without the need of commercial license, then it is a well promising package, with excellent options in terms of possible evolution and enhancements, it is having an extremely fast diffusion, due to the robust link with other Autodesk product, like Autocad, Revit and 3D Studio Max.

Fig. 6. Palazzo Vecchio, Lasergrammetry: Ceiling of “Sala dei Gigli”, Leica Geosystem RTC 360 scanner unit (Source: own’s, the author).

At the moment of the writing the reconstruction of the final, first, a global point cloud of Palazzo Vecchio is yet ongoing. The processing of assembling large areas to postpone the reunion to a final moment seems to work fine accordingly to the intention to use Autodesk Recap for the above-mentioned reasons. The following operations, the creation of 2d drawings and 3d parametric models as the bases for the seismic study will produce an extreme simplification on the general level of details, but all the data will remain in the "original" dataset for further use. The identification of a series of worthy subjects is gradually bringing on specific studies and a line of master’s degree thesis in Architecture.

The survey base, once again as a first digital twin that is just the first knot in a network of knowledge and experience.

5. CONCLUSIONS

In the last twenty years, the progressive improvement of digital survey techniques has made possible the documentation, with a level of accuracy and detail previously unthinkable, of every kind of architecture. The relationship between the subject detected and the result obtained immediately assumed a specific key, an effect that could be defined as "the greater complexity of an object compared to traditional survey techniques corresponds to a greater benefit, practicality and advantage in the use of digital techniques ".

Figg. 7-8. July and September 2019, the Lasergrammetry of Palazzo Vecchio, Florence, internal and external views of the aligned point clouds. (Source: own’s, the author).

An apparently obvious and acceptable concept, but not always fully grasped by all operators in the general field of Built and Cultural Heritage. A certain technological gap linked to the training of the operators and the modest presence of an attempt to trivialize the solutions of the digital survey, linked to the lack of understanding of the progressive establishment of the "Digital Heritage" field have contributed to a lack of success in a full acquisition of some processes.

Which according to the specific UNESCO definition: “Digital heritage is made up of computer-based materials of enduring value that should be kept for future generations. Digital heritage emanates from different communities, industries, sectors and regions. The description of a widespread and articulated entity that is now an objective and constantly evolving presence” [UNESCO, 2003; Berry, 2012].

The digital survey is characterized by a scenario of technological transformation, with a behaviour perhaps comparable to the dawn of photography and that could see the same progressive popularization of tools and methods, since, wanting to continue with this parallel, at the moment we could find ourselves in a phase equivalent to the one that saw the passage from the heavy “view cameras”, difficult to transport and very complicated to use, to the entering of the first medium format cameras with their technically simplified operations.

What many of the operators of the digital survey have in common with the past photographers is the fact of being professionals of their own time, orienting themselves towards solving complex cases using what is available, with an acute interest for novelties and innovations, but always balancing it with practical needs. They follow technologies getting all the possible benefits for their work. The fact is that every "high level" survey, whose object is a valuable architecture, and any situation worth of being considered as a real challenge, have always contributed to the definition of clear solutions with well-defined goals, which were inspiring for following experience, they were the demonstration that it was possible “to be done” and they also showed, possibilities, solutions, strategies. The results of these works, when released, leave the possibility of appreciating the versatility of the products while increasing the state of the art and knowledge about the subject of the activity.

The scenario described in this paper may offer more open challenges than “conclusions”, for this, in this closing, it is preferred to open one more “front” in the “digital approach to everything”, which is less impressive, less capable to capture curiosity, unless its missing or failure come out with dramatic aspects and it is the front of the “digital repositories”. The place where all the digital data produced are supposed “to go” when that survey work or project or workshop is completed. If the digital technologies in themselves, are positive and often became quickly practical even when they enter inside well-consolidated environments and force their renewal, their capacity to be correctly managed by operators to produce complete and reliable digital twins of the real is just the first step in an extended scenario of digital data efficiency. In it, it would be possible to imagine complete inclusion of all the data gathered and processed entering permanent archives and allowing the full benefit in time from this kind of solution. But the fragmentation and the limited competencies in some passage in the present digital process may put at risk and slow down the possibility to reach fully the positive effects of this massive digitalization. The request for “results” intended as “the final passage only” of a whole process may put at risk of losing the option about having all the original data stored somewhere for further access, checking and verification. In this, the challenge against data obsolescence and decay is more than impressive.

The digital twin seems to ask immediately for similar attentions than its real origin: preservation, periodical maintenance, attention, clear procedures and approach.

The irreversible passage from traditional paper boards production and storage to the electronic archives may look like a solution to the size and the accessibility of the information but will not free people from the need of care and preservation of the repositories. It is possible to imagine this condition like a crossroad in the approach to archiving, with one way going towards the great efforts needed in the attempt about preserving everything, one another road going toward some sort of “biological mind” approach, where only some more important and influencing parts are preserved; and a third road based on casualties and where both the other roads are mixed. Surprisingly, or not so

surprisingly, this third one seems at now the closest to the present approach.

The incredible increase of knowledge and data production brings the need for extending the capacities and the skills about preservation, correct archiving and sharing. Whatever it will be the next future of survey and production of digital twins: the need for extending and refining the approach to archives will be an ever-growing presence. Most of all it is something to be considered as a part of the tasks in the overall digital strategy in survey and modelling operations.

ACKNOWLEDGEMENTS

The digital survey of the Santa Maria del Fiore Cathedral in Florence is a collaborative activity between Area3D Livorno, coordinators: Alessandro Peruzzi and Massimo Gualandi, Opera di Santa Maria del Fiore Firenze, coordinator: Samuele Caciagli and Dipartimento di Architettura, coordinator: Giorgio Verdiani, Operative group: Paolo Formaglini, Alessandro Giacomelli, Filippo Giansanti, Stéphane Giraudeau, CAD drawing and post processing: Tatiana Pignatale, Ilenia Tramentozzi, Anna Raffoni, Riccardo Crosara, Daniele Fedeli.

The digital survey of Palazzo Vecchio was operated during a research agreement between the Comune di Firenze, Fabbrica di Palazzo Vecchio, coordinator: Paolo Ferrara and the Dipartimento di Architettura, University of Florence, agreement coordinator: Mario De Stefano, survey coordinator: Giorgio Verdiani, sampling and data integration coordinator: Marco Tanganelli; operative survey team: Mattia Faiulo, Alexia Charalambous, Giulia Emilio, Andrea Guazzoni, Federico Nannini, Gaia Vannucci, Francesca Meli, Ilaria Bencini, Yelenia Ricci, Andrea Pasquali, Annalivia Ciuffreda, with the collaboration of Paolo Capraro.

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How to cite this article / Citation
Verdiani, G. 2019. " Digital Survey: from new technology to everyday use, a knowledge path and challenge for scholars", *EGE Revista de Expresión Gráfica en la Edificación*, Nº 11, Valencia: Universitat Politècnica de València. pp. 94 - 105. https://doi.org/10.4995/ege.2019.12873.