Lecture Notes in Civil Engineering

Giuseppe Amoruso *Editor*

Putting Tradition into Practice: Heritage, Place and Design

Proceedings of 5th INTBAU International Annual Event

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Abstract. In December 2016 it was presented by the Joint Laboratory LS3D of Dicar - Department of Civil Engineering and Architecture, University of Pavia, the project "Productivity and Urban Renewal Programme in East Jerusalem (PURE)" promoted by United Nations. The project, developed in a year of activities and research carried out by the laboratory of Pavia in collaboration with University of Florence, has produced a three-dimensional database for the protection of historical heritage and a project for the architectural renovation of the complex system of buildings on the streets of Salah Eddin and Sultan Suleiman, adjacent to the walls of the historic city of Jerusalem. The project, funded by the European Union and by the Islamic Development Bank has covered, in addition to the measurement of a portion of the city and the monumental cemetery of Bab Azhar, a census of all the infrastructures, commercial activities and an analysis on the structural condition of buildings. The result is a virtual platform from which to assess the development of the historic city and through which give life to the city of the future.

Keywords: Integrated survey · 3D databases · 3D interactive models · Project of urban development · Jerusalem

1 Beyond Herod's Gate

Beyond the Herod Gate, out of the Old Town, it is possible to cross Sultan Suleiman, one of the main traffic ways of Jerusalem that connects the Damascus Gate on the Mount of Olives. The buildings facades, among which stylistic characteristics of the early twentieth century with Ottoman duotones are recognizable, are covered by all sorts of urban signs that invite to coffee bars, vegetable stands or clothing stores. It is the central hub of Salah Eddin Street market, the most important East Jerusalem's commercial area, which surrounds the hill of Bab Azhar, considered the Golgotha place by Protestants, where there are shops, mosques, bus stations and pedestrian traffic of those who enter inside the Old City by Herod's and Damascus gate.

The buildings that are close to the perimeter of the Holy hill, came from the sixties of the last century, built by the Consortium of the Merchants in order to create a new

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commercial sector, now considered the heart of East Jerusalem and thus a subject to renewal programs.

Observing historical photographs it is possible to understand what was the old image of those streets and what could be the architectural quality of the buildings, the great part of what today is uncontrollably hidden. This happen because of the addition of buildings or appendices that have altered the image of the fronts, but also compromised the structural stability of buildings and created places is used as a large open-air dumps. The incident in a Sultan Suleiman bar goes back to a little more than a decade, event in which 25 people died due to the collapse of a slab that occurred due to the failure of rotting pillars caused by saturation of the perimeter scannafosso close to the mountain (Fig. 1).

Fig. 1. The project area is shown in red, in relation to the access to the historic city and the Temple Mount of Jerusalem. On the left, comparing two images of Salah Eddin Street, one the present, one of the early 1950s. (Color figure online)

In this context the United Nations, within the Productivity Program and Urban Renewal Program in East Jerusalem (PURE) have developed a knowledge action for the intervention in complex valorization for the increasing of a further building economy plan of the neighborhood. The Laboratory LS3D won the international competition for the creation of a functional system documentary draft for the redevelopment of the entire area, taking care of the survey phases, documentation, creating

an interactive database and elaboration of design guidelines for the development of the competition for the final design[1].

The survey campaign, conducted in two phases, each with the duration of one month, involved the realization of the three-dimensional archive serving a basis for creation of a reliable drawing useful for the project.

The metric documentation has been integrated with information on the state of conservation and the structural analysis of buildings, useful to determine the interactive schedules values, by which bring out the necessary considerations for the project (Fig. 2).

Fig. 2. View of the laser scanner point cloud at the Herod's Gate and a view of Bab Azhar cemetery and the Minaret of the Mosque.

2 Creation of a Database for the Management of Historic City

The extraordinary increase of information and digital technologies introduces new questions about the research methodology for the documentation of historic town, and more generally for the development of actions to increase the knowledge and

[1] The research project managers are Stefano Bertocci, DIDA University of Florence, and Sandro Parrinello, DICAr University of Pavia; Scientific coordinator Sandro Parrinello; coordinators of each action: Francesca Picchio, DICAr - UNIPV, for the Survey and Documentation phase, Giovanni Minutoli, DIDA - UNIFI, for Structural Analysis and Michelangelo Pivetta, DIDA - UNIFI, the Concept and Desig project. To research project participated PhD, phD. Stud. Of University of Florence and University of Pavia, and technical stuff of the Joint Laboratory LS3D and of Dada Lab of Pavia University.

dissemination of traditional culture. In particular, the acquisition technologies and three-dimensional representation, such as computer vision, photogrammetry and laser scanning, developed information whose codes of representation are, despite numerous experiences produced, still being defined. Each model is a universe of discrete information that, contained in a digital ecosystem, is able to develop relationships, feedback and unforeseen and unpredictable interactions that alter the level of eco-informative awareness. Thanks to this the virtual reality is destined to become a real organism, made by artificial life and not preordained paths, and also that the cities of the future can already be visited and evaluated through the creation of simulation of the real space, from which define the management practices and administration of the territory, and for the realization of the project for the optimization of its functions and future infrastructures. Because the digital survey produces three-dimensional databases from which to obtain discrete information about real space, which can be put into a system with other information to build an interactive information system, talking about databases for architectural documentation concern the determination of the quantitative structure set of meaningful data about the condition of a context, but also concerns more properly a new face through which understand and interpret the architecture of the elements and the space. If even a few years ago databases were originally located with the architectural drawings and occupied towering bookshelves in the government offices, the drawings are today critical supports for understand the structure of the place, changing their shape to become themselves databases, containers of containers. Technological advances have moved, in the field of cultural heritage, all forms of documentation system towards the realization of digital platforms in which collect descriptive systems, useful for the development of more advanced forms of comparison for related information (Fig. 3).

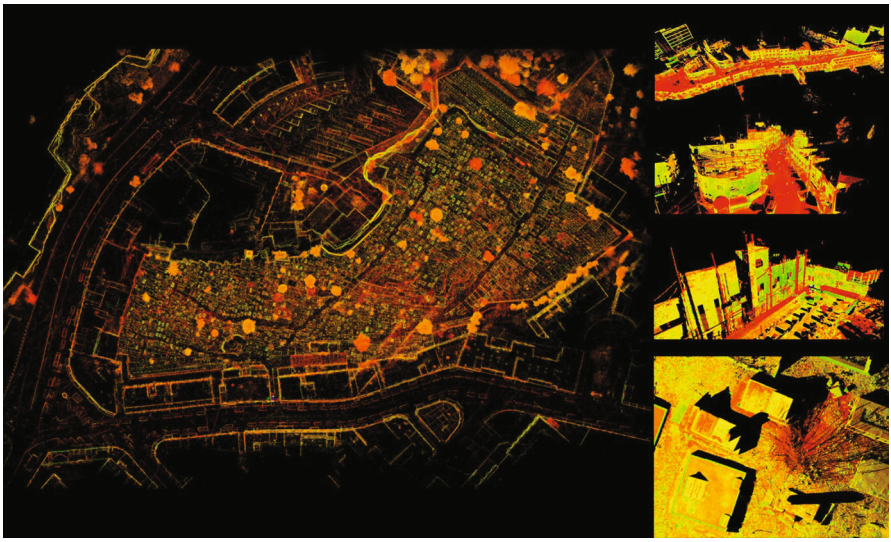

Fig. 3. Views of a 3D laser scanner point cloud and some details of the individual scans.

In parallel, the science of architectural, in all the connotations and various aspects from archaeological survey up to the urban one, it has been oriented on the development of methodologies which, using laser scanner instruments or cheaper photographic cameras, could produce point clouds, or databases of spatial vector coordinates. The result of this transposition of data from sign to code, is the transformation of any digital graphics processing in a database that must be processed and organized in both management and data maintenance aspects. The possibility of extend the architectural dimension in a digital space, creating three-dimensional shapes that could then be used as real spaces, is the basis of video games research and virtual simulations of the early '80s.

But what happens today as innovation of this virtualization process, is the absolute trust in metric and geometric data accuracy inside any digital space, and have begun to build more digital archives of our architectural heritage, in the hope of preserving the memory.

The digital space, dimensionally close, is represented as a discrete system thanks to the point cloud, in which every single portion of the surface looses its value if decontextualized, but placed in the whole of its nebula becomes able to describe not just the space, but all the place and the mutual relations of its elements.

In particular, these point clouds are constituted by dynamic formats, within which the spatiality is reintroduced in its three dimensions: the interaction with the virtual space allows to constantly change the point of view and to be able to interact with the place, with the object or with each element, improving learning and knowledge of the space.

The database on the measurement, as a result of a practical action, carried out on site of an automatic census of the points acquired by laser or photogrammetric procedures, is considered as the new starting point from which is possible to conduct innovative interpretation actions to process the drawing. This critical interpretation process of data has capable of re-acquire a new meaning of new database when it will have to "work" in terms of interactions within the virtual-digital system.

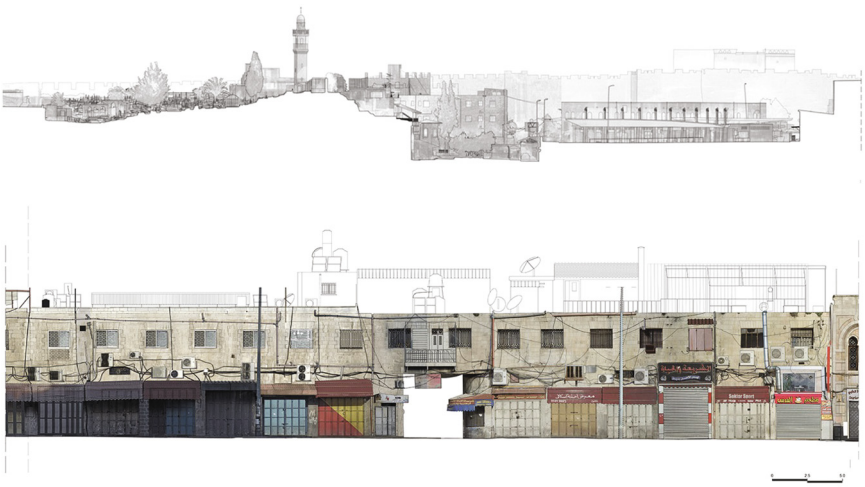

Fig. 4. Environmental sections and detail of photomapping of Sultan Suleiman.

The procedure for optimizing the digital models and export of databases in different formats that allow the manipulation, it is a revolution not just for the relationship with the places and heritage, but a different digital confidence which must be justified at least by definition of standardized methodological protocols and the use of safeguard certifications (Fig. 4).

3 Survey, Model and Design

The project performs the needs of some contemporary historical centers to became containers of multiple information, aims to be an interactive system that, through the use of a digital database, proves capable on the one side to enhance the urban center, and by other side to protect the Jerusalem area, subject of the investigation, by dangerous events that could compromise the persistence over time.

The interaction with the digital product offers the possibility to enjoy the city through a platform that can simulate virtually the urban space, eliminating all forms of physical and time limits. One of the objectives was to protect the image of the architectural heritage through detailed documentation, using innovative monitoring technologies and more aware methodologies, allow to give back to communities the symbolic value and identity of the place. The virtual model is able to transform the buildings and public space in information and multimedia containers, capable to give to the visitor the knowledge of the territory and of their city.

For the survey part, intended to restore a points database, satisfying the state of conservation of buildings in the area concerned, two main methodologies have been foreseen: *Range-based* data acquisition using a scanner laser instruments for the acquisition of metric data, and *Image-based* for the acquisition of colorimetric information related material and the quality appearance of the surfaces thanks to SFM photogrammetry methodologies. Such systems have allowed to acquire a high amount of information in a short time, ensuring the obtaining of highly reliable digital data banks. In relation to the census it has been decided to design a digital database schedule on which collect the nature of textual data, numeric and graphic, about the peculiar aspects of the historic architecture. The census also included the urban infrastructure, the plant network systems, as well as commercial activities and the uses of each property (Fig. 5).

To the management of the digital database and to the production of a documentary corpus, constituted by the state of conservation of each front and from the analysis of any degradations, has been followed a subsequent drafting operation of reflections about the structural stability of each building, using the 3D data obtained by digital survey and through the analysis of the state of deformation of wall hangings.

In addition to the complex database obtained by the use of digital instruments, has been related a three-dimensional model, formally very similar to reality, but implemented by communicative potentiality, capable of turning the space into a dynamic container of information, simulacrum of virtual images in which the city can be configured. Based on the information acquired by the survey, has been carried out, within the parameters of reliability and responsiveness to the real of architecture and historic aspects, a 3D model of public space, corresponding to the surveyed area.

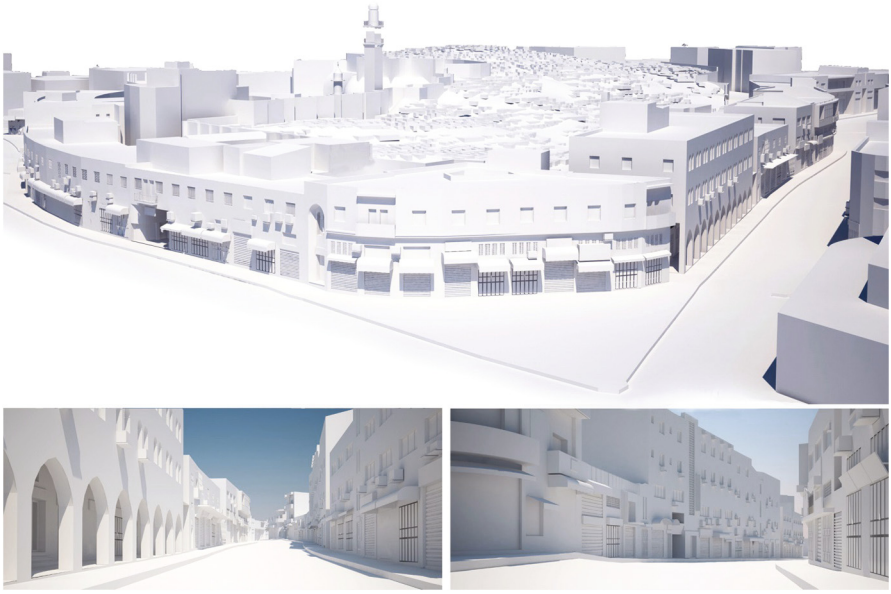

Fig. 5. View of the general three-dimensional model and the two streets of Sultan Suleiman and Salah Eddin.

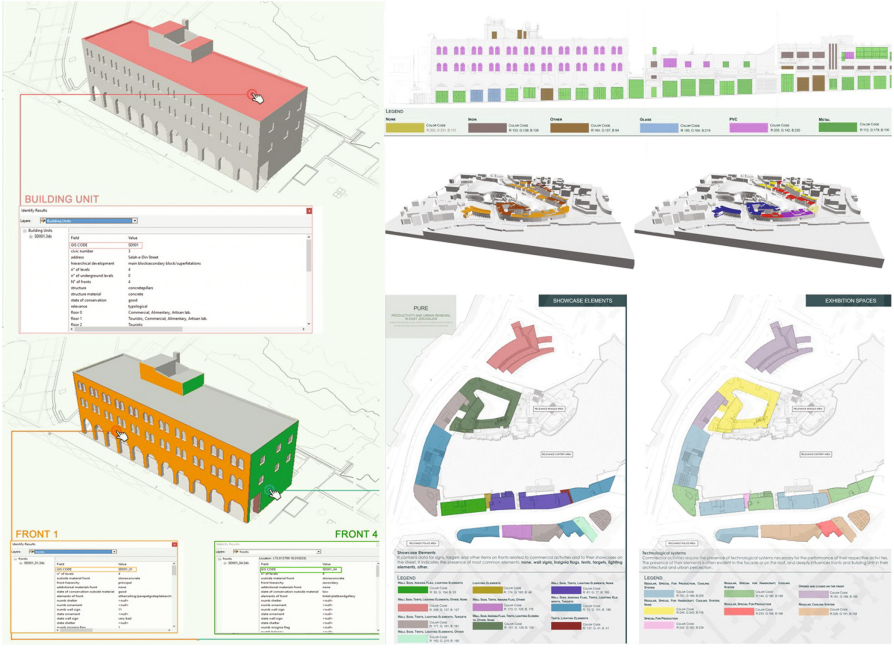

Fig. 6. Application of GIS digital archive to a single building unit and the urban front in the 3D interactive model.

Fig. 7. The city of the future and the architectural project within the model where you can browse and configure possible scenarios of urban development

4 Conclusions

The project grow up from the will to create a system of diffusion, sharing and exhaustive investigation of the many information on the "smart city" topic. Systems, applications and services, created in cities to satisfy the citizens and businesses are increasingly focused to the widespread and innovative use of information and communication technologies. The city acquires intelligence when from the integration and interaction of technologies is develop a virtual information system that takes the role of the brain of the urban system. This world of terminals, sensors, data, systems and applications has the goal of improving the quality of life of the person, offering an interconnected city, that is clean, attractive, comforting, efficient, open, collaborative, creative, digital (Fig. 6).

With the aim to simulate not only the form but also the performance of buildings, the 3D digital smart city becomes, at the same time, the showcase and the museum itself. The 3D digital city model can also become the spatial index of myriads of data information that are collected in many different databases. From the traditional ones, such as urban and planning, is possible to arrive to the land registry related to buildings, to cultural heritage, to those for underground technological networks. The information system product, will ensure the development of a great number of services for citizens. At the same time the graphical user interface will be an international attraction for the enhancement of the historic city. In particular they can be identified as beneficiaries or users of the product resulting from the research (Fig. 7).

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