Urban Heritage: the role of recording, documentation and information systems

Urban Heritage: the role of recording, documentation and information systems.

G.Tucci, V.Bonora, A.Nobile, L.Bucalossi

Metric documentation of cultural heritage requires a thorough understanding and careful observation of the site and suitable graphic restitution of the data collected, as well as dimensional quantification using appropriate instruments.
Documentation projects are particularly important in cases where the heritage is, for whatever reason, in a precarious state. It is, therefore, important to collect documentation as thoroughly as possible: geomatic methods can be applied to generate permanent records from which information can be extracted (Fig. 1).

The complexity is an inspiring challenge and contingent difficulties constitute an effective stimulus towards finding better solutions and to improving research methods for urban heritage:
- as the preliminary knowledge of the sites is most of the time limited, we need a certain flexibility when setting up the on-site survey operations;
- environmental and climatic conditions often constrain the use of surveying instruments;
- the presence of experts from diverse fields may highlight different and new requirements for spatial data collection.

Recording is a key activity in the conservation management of cultural heritage. Conservation related information is usually obtained (certainly in the case of this project) from multi-disciplinary research activities.
In project teams with multi-disciplinary expertise, geomatic techniques can be used to construct a reference base that enables all members to meaningfully participate in both investigative procedures and project development and application.

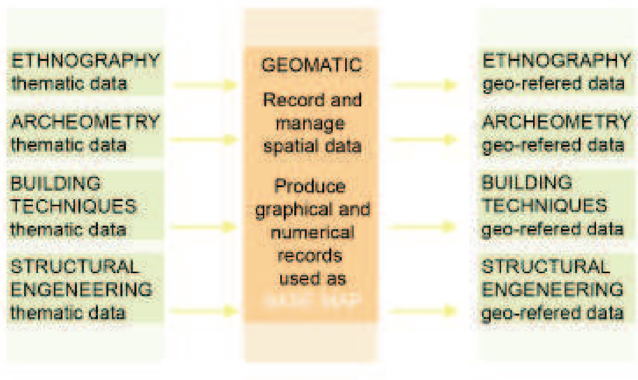

Fig. 1: Scheme of geomatic base map.

The management of spatial data

The management of spatial data often requires specialist skills making it difficult for experts in other fields to use raw data. So geomatics not only plays a vital role in the data acquisition phase but it is also important for data management and interpretation, acting as a 'filter' between raw data and graphical information (Fig. 2), has to be structured in such a way that experts in different fields with a basic or mid-level knowledge of CAD, image processing and new technologies can use it autonomously.

Recording spatial data requires, in the first instance, the collection of available materials, on the basis of which preliminary observations are made and further operations are planned. So there is initial off-site activity, followed by on-site verification and integration:

- Off-site: existing sources are generally available for smaller-scale documentation: small-scale topographic maps, satellite images, aerial photos and sometimes, architectural sketch drawings; satellite images are now available almost everywhere though their quality should always be checked (image resolution, cloud coverage, data acquisition, spectrum, etc.);
- On site: photos and instrumental survey: GPS, total station, photogrammetry, laser scanning, direct measurements.

The level of detail

Recording should be undertaken to a level of detail that provides the information required for appropriate and cost-effective planning and development.
The need to provide documentation at different scales highlights the usefulness of integrating the various levels of detail in the same project.

At the apex of the pyramid-shaped drawing (Fig. 3) are the inventories, the most basic form of documentation. They require 'identification': in our case the sites had to be first recognized, then georeferenced and memorised; sometimes other basic attributes were associated with a given position.

At the base of the pyramid drawing are the highly detailed 3D models, where the level of detail is such that even the texture of the constituent materials is described. The various operations undertaken in the sites of the Mare Nostrum project (Tartous and Tyre) occupy the middle area of the pyramid:

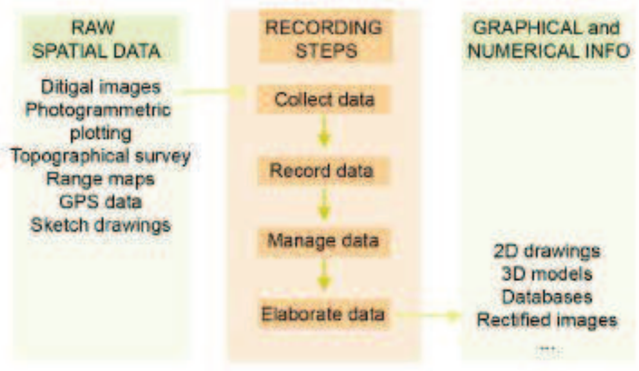

Fig. 2: From raw spatial data to information: recording improves understanding

Fig. 3: Pyramid scheme showing relations between graphical scale, data resolution, and level of detail.

The survey methods

Survey methods and the resulting documentation have to meet project requirements and objectives and be appropriate for the cultural context and the resources available.
Geomatic techniques are almost always not intrusive as remote sensing is deployed at a distance from the object being surveyed. This technique has the advantage of completely preserving the object but it can usually only be used on the external surfaces of the object.

In this context the term multi-resolution survey is appropriate because data density is gradually optimized by applying different instruments or by regulating the acquisition parameters: in this way the information density is correlated with the formal complexity of the object to be measured.
To obtain such results a possible approach is to combine different sensors, such as GPS, satellite imagery, total station, digital cameras, and laser scanners (Fig. 4).

The principle that can be derived from the above-described approach is the same as that which guides all correct survey procedures: it prescribes starting with general information and then proceeding to more specific detail, i.e. a very small number of points are ascertained with high precision (the number of points has to be kept as low as possible because operational costs increase proportionally to the degree of accuracy required).

A 'cascade' procedure utilizing measuring procedures that become increasingly simple is then adopted to determine the detail points that describe the form of the object.
A common reference system, usually defined by topographic parameters, makes it possible to acquire different objects and to highlight the relationship between them.
It is important that the data acquired in the various phases be subjected to quality controls, i.e. its usefulness and accuracy should be checked.

Fig. 5: Laser scanner surveying of the Promenade archeologique in Tyre, Lebanon

Fig. 6: 2D image of the total points model of the Systems of Gallery of the old city of Tartous, Syria

Rapid acquisition on-site is important when distance and inaccessible sites make long survey campaigns both difficult and expensive. Among the factors influencing the choice of instruments used in Syria and in Lebanon were portability and operational autonomy. A total station, a digital camera, and a laser scanner were used. (Fig. 5)

A common characteristic of all the data acquired is its numerical nature: information management is facilitated when digital heritage recordings are used and there are immediate benefits in terms of project planning, interdisciplinary communication and result evaluation. A digital model obtained using modern metric surveying techniques is always three-dimensional and it can provide structural and architectural outlines, profiles, cross-sections and contour lines and also detect features of interest and print a solid model.

Digital images

The simplest and most widely used technique for documenting cultural heritage is certainly photography: the content is richly informative (albeit exclusively qualitative) and easily acquired.
The use of digital images for metric surveying is well consolidated: photogrammetry and some scanning systems are classified as 'image-based' survey techniques.
Among the digital images used in the project for taking measurements were:
The synthesis image, another type of image that was widely used for the project, does not depict real objects but renders the views of models acquired using a laser scanner: a quite realistic texture can be achieved directly from the intensity value provided by the laser scanner as an attribute of each point.

The points model can be visualized with various degrees of shading and on different chromatic scales.
Efforts were made so the renders used in the project evoked black-and-white photographs as much as possible (Fig. 6). On the render it is possible to identify the pattern of the brickwork, recognize a wall built of the same-sized stone blocks, stones and earth or bricks (the difference between stone work and mud bricks can be perceived) and to ascertain the existence of plaster and its state of conservation.

All the sites have been documented using the most innovative digital techniques available (digital cameras and videos) to produce spherical panoramas, high resolution image mosaics and digital stereo images. The elaborated panoramas can be used in various ways: to enable the use of inter-connected virtual spaces on the internet or on CDs; to integrate chromatic information with the points cloud (Fig. 7); in pairs for photogrammetric restitution (spherical photogrammetry).

The panoramas of the most important archaeological and cultural sites (Fig. 8) will be connected and put on line and, in the future, meta-nodes will be used to do the same for the principal Phoenician Mediterranean ports.

Fig. 7: 2D Image of the total texturing point cloud model of the Promenade archeologique in Tyre, Lebanon

Fig. 8: Panoramic image of the archeological area in Tyre, Lebanon

List of References

- Bonora, V., Cruciani Fabozzi, G. & Tucci, G. 2008, 'The use of 3D Scanning and Rapid Prototyping for the Documentation, Conservation and Communication of Archaeological Remains: a Recent Experience in the Sanctuary of S. M. del Lavello (Lecco, Italy)', DMACH 2008 conference, 3 – 6 November 2008, Petra University, Amman, Jordan.
- Migliari, R. 2004, 'Per una teoria del rilievo architettonico', Disegno come Modello, Migliari R. (ed.), Roma. Rapoport, A. 1969, House Form and Culture, Milwaukee.
- Tucci, G., Bonora, V., Sacerdote, F., Costantino, F. & Ostuni, D. 2004, 'From the acquisition to the representation: quality evaluation of a close range model', XXth ISPRS Congress, Istanbul, vol. XXXV, part B5.
- Barber, D., Mills, J.: 3D Laser Scanning for Heritage. English Heritage Publishing (2007)
- Guarnieri, A., Vettore, A., El-Hakim, S., Gonzo, L.: Digital photogrammetry and laser scanning in cultural heritage survey. International Archives of Photogrammetry and Remote Sensing 35(5), 154–158 (2004)
- Haggrén, H., Junnilainen, H., Järvinen, J., Nuutinen, T., Laventob, M., Huotarib, M.: The use of panoramic images for 3D archaeological survey. International Archives of Photogrammetry and Remote Sensing 35(5), 958–963 (2004)
- Reulke, R., Scheibe, K., Wehr, A.: Integration of digital panoramic camera and laser scanner data. In: Proc. International Workshop on Recording, Modeling and Visualization of Cultural Heritage, Centro Stefano Franscini, Monte Verità, Ascona, Switzerland, May 22- 27 (2005)
- Torniai, C., Battle, S., Cayzer, S.: Sharing, Discovering and Browsing Geotagged Pictures on the Web. HPL-2007-73 (2007), http://www.hpl.hp.com/techreports/2007/HPL-2007-73.html {19-08-2010}
- Tucci, G., Bonora, V., Nobile, A.: Innovative survey methods for the digital documentation of vernacular architectural Heritage in Syria. In: 22nd CIPA Symposium, Kyoto, Japan, October 11-15 (2009).