THE UTILITY OF GEODETIC SURVEY TECHNIQUES AND EQUIPMENTS IN ARCHITECTURAL HERITAGE DOCUMENTATION – AN ASSESSMENT OF RECENT APPROACHES IN TURKEY: THE DOCUMENTATION PROJECT OF THE OTTOMAN FORTRESSES OF SEDDULBAHIR AND KUMKALE

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ABSTRACT:

In this paper, the intersection of geodetic and architectural survey techniques are examined through the case study of the heritage documentation project of two Ottoman fortresses, Seddülbahir and Kumkale. During the five-year period of the survey, traditional as well as several new techniques for surveying and compiling architectural, historical and geodetic data were utilized, the results of the documentation project are now being processed and prepared for publication. The project was initiated as research on a specific topic; the most recent step in the documentation process has been the integration of all collected data into GIS. Threecomponents of heritage documentation that were used in this project are explained in this paper and compared to contemporaryapproaches in heritage documentation. This paper addresses the various challenges and choices that our team faced during the course of the project, both in terms of understanding and utilizing the most recent survey technologies available in Turkey and in working with a multi-disciplinary team in a heritage documentation project.

INTRODUCTION

In this paper, the intersections of geodetic and architectural survey methods are examined through the case study of a recent documentation project of two seventeenth century Ottoman fortresses located either side of the Dardanelles: Seddülbahir and Kumkale, the project was initiated in 1997 by the Department of History, Koç University and the Geodesy Division at Istanbul Technical University. Asst. Prof. Lucienne Thys-Şenocak from the Department of History in Koç University directed the architectural and historic research. The geodetic survey was directed by Assoc. Prof. Rahmi N. Çelik from Geodesy Division of Geodesy and Photogrammetry Department of Istanbul Technical University. The on site surveying was completed in July 2002 and now the results of the five year survey are being processed and prepared for publication. During the survey, traditional as well as several new techniques for surveying and compiling architectural, historical and geodetic data were utilized. The most recent step in the documentation process is the integration of various types of data into GIS (Geographical Information Systems) application.

In 1997, the aim of the project was twofold: first to document the existing remains of the fortress by generating the maps and architectural drawings of the structures on the site; second to bring together a vast array of data such as repair records from the Ottoman archives, European and Ottoman historical chronicles, drawings, engravings and archival photographs from various libraries' collections in order to assess the development of the fortresses and adjoining structures. The additional part of the project that developed in the 1999-2001 seasons at Seddülbahir and Kumkale was the oral history of the villages whose locations were within the parameters of the historical research and survey project. work. Meanwhile the historical research developed into a second and third project: the epigraphic documentation of remaining 287 Ottoman tombstones of the Kumkale cemetery and an oral history of the two villages of Seddulbahir and Kumkale. Parallel to this research, the precise geodetic and architectural survey of the fortresses and their immediate environs continued. As the project developed and research goals diversified, the collection of diverse types of data and the utilization of different measurement systems required a new platform to evaluate the data sets in an efficient, inexpensive and productive way.

After the first year of the survey our team decided that the optimum system for organizing the results of this type of project was GIS. We felt that GIS would be a more accommodating tool for our diverse research needs and would allow for scholars from the many disciplines that are involved in the project to interact and participate in the particular goals that are interested in while maintaining an understanding and appreciation of the larger research picture. The more flexible web like structure of the GIS allows for a less linear approach to data collection and problem solving. As a pilot study for our GIS we decided to begin with the simplest part of the physical survey: the Ottoman cemetery of Kumkale. In this smaller project we could better understand the challenges that would face us when applying GIS to the organization of the vast amount of data we had collected for the two fortifications. The results of this pilot project at the Kumkale cemetery has been discussed elsewhere and the results of some of the preliminary findings can be found on the project website.
(www.seddulbahir-kumkale.com)

The project that began as a rather narrow research project in 1997 has continued and developed in several new directions. During the course of the site survey new techniques were used and constantly evaluated along with the more traditional surveying methods. As the GIS became increasingly integrated into the project, the goals of the survey were reassessed and the data collection methods were reformed both theoretically and practically. Among the final goals of the project was the presentation of the data in a GIS. In the future we anticipate that all data we have collected, including historical, geodetic and architectural data will be visualized in the 3D GIS application of the project. One of the major benefits of our decision to use a GIS in our project was that it forced team members from various disciplines to have more intensive interaction and, as a result, a better understanding of the diverse needs and research results reached by all members of the project. Finally, because the use of GIS for cultural heritage projects is relatively new in Turkey, a final but not insignificant benefit of our research has been that all project members have become more familiar with this new tool and the growing field of data management of heritage documentation.

HERITAGE DOCUMENTATION

Essential to the success of any cultural heritage project is effective communication among all members of the team concerning the various goals and types of data collected during the process of surveying and documentation. Of equal importance is the ease with which specialists in different fields can use and interpret the collected data. Increasingly, successful and qualified cultural heritage documentation and management projects require newly developed technology to collect and process data. Particularly as GIS becomes more commonly used for data storing, organization, retrieving and inquiry in cultural heritage projects, the ability of specialists from diverse disciplines to communicate research needs and results becomes more important for project effectiveness. Closing the "information gap" is an essential aim. The members of a survey team who are involved in the research of historical data should be trained in a variety of disciplines: art and architectural history, cultural history, archaeology, geography, oral history, etc. Members of this team need to work closely with project members on generating the conceptual model, structure and database of the desired GIS application and ideally become familiar with GIS management so that the initial queries are drawing upon meaningful data. Ultimately, the dialogue between project members must be able to move beyond the project itself and present the results in an accessible and comprehensible format to the specialist and non-specialist audiences such as heritage administrators, experts, grant agencies, preservationists, and educators via a project web site transmitted over the world wide web . The main disciplines represented in our documentation and survey project for the Ottoman fortresses are art history, art and architectural history, archaeology, architecture and geodesy. Once the various methodologies of these different disciplines were coordinated and accommodated to the GIS , other more pragmatic aspects of the project must also be resolved. The availability of funds is of course an important element in the shaping of project goals and the additional " start-up" cost in terms of time and resources for GIS implementation must be accounted for along with other project costs. The project's aim, the survey system and the situation of the site directly shape the project organization. Inevitably the available financial resources, documentation expertise and the needs of the client, particularly if the project is conducted in the private sector, are all aspects which reform and reshape the aim and the expected research result. With the complex structure of documentation that a GIS provides, the feasibility of various inputs must be assessed, ideally at the beginning of the project. (Boehler, 2003; *Architectural Heritage: Inventory and Documentation Methods in Europe,* 1993)

To date, heritage documentation projects in Turkey have been conducted by governments and academicians. Recently with the new systems and more sophisticated technology that has become available for surveys and architectural documentation, both the traditional survey process and the digital data collection are being evaluated. But it is not just the viability of the newer technology and data systems which needs to be assessed by scholars undertaking survey projects in Turkey. Additionally the methodological approach that is being used in cultural heritage documentation projects must also be debated and developed so that an appropriate approach can be used for projects and for the particular conditions prevalent in Turkey.

In the "Seddülbahir and Kumkale Survey and Architectural Documentation Project", the methodology and the documentation approaches developed throughout the course of the project and as a result of trial and error experimentation. The three components of heritage documentation used in this project are explained below.

HISTORICAL RESEARCH

In any documentation and survey project the basic components of information are gathered either in the field or in archival houses, including libraries. The processes for gathering data from these different locals requires, in the initial phase of the project, close coordination and constant communication between project members. In addition to sharing research findings, the nature of different types of information must be understood. For example, topographical data gathered in the field has a quantifiable aspect to it that data collected from historical archives often does not possess. Historical information gathered in archives is subject to a much more subjective level of interpretation when compared to the physical data gathered in a site survey. Further, historical data is subject to multiple interpretations when compared to data collected during a physical survey. Fieldwork where oral history research has been conducted brings an additional set of challenges to the organization and structure of an historical documentation project. Ideally, all members of a project should have the opportunity to work in each facet of the project to facilitate communication among team members, but too often time and financial constraints are major factors which create a structure for a project and members are allowed to work only in areas where they have expertise. Initially, this if efficient, but ultimately, when we consider the use and application of data and research, the limited use of project members in their specialized areas reduces the impact that the research can make.

An essential part of the historical documentation process is extensive research of archives and libraries for historical

records of an existing site or structure. Historical documentation of a heritage site can be comprised of a wide range of sources, from original drawings to oral testimony of current residents. In our documentation project at the Ottoman fortresses of Seddulbahir and Kumkale we were fortunate to have a very rich and diverse range of archival material which allowed us to chart the architectural and historical development of the fortifications from the time of their construction in the mid seventeenth century, through several hundred years of the buildings' evolution. For example, the 1665 foundation deed, or vakfiyye, still exists for the two Ottoman fortresses and is located in the Suleymaniye Library in Istanbul. From this source we know that the fortresses at Kumkale and Seddulbahir were each to have within their grounds a bath, mosque, school and various barracks for the soldiers stationed at the fortress. From Ottoman repair records of the fortresses we have archival information about the different types of building material used for repairs in the 17th through the 19th centuries; in the 18th century there are extensive reports and drawings by French military advisors who had been invited by the sultan to modernize the military and fortifications in the Ottoman Empire. As both Seddulbahir and Kumkale were the sites of major battles during World War I's Gallipoli campaign, there are numerous photographs and sketches of the two strategic sites in the military archives of France, Britain, and Turkey. As Seddulbahir and Kumkale are situated at entrance to the Dardanelles and only a few kilometers from the archaeological sites of Troy and Eleaus, the two fortresses have been commented upon, described and sketched frequently by many travelers who passed through the famed waterway of the Dardanelles.

There is, in short, a great richness and diversity in the types of data that have been collected as part of the research into the historical and visual records for these two Ottoman fortresses. The challenge is to organize this data in an efficient and accessible way so that people other than the project members can understand it and make it available for queries that may not have been anticipated by those who initially conducted the archival research. The decision to use a GIS for storage and retrieval of this type of information has proved, to date, to be advantageous. One of the major benefits of the GIS is that the time component of a historical structure can be clearly mapped. In other words, we can chart and then layer the various physical changes that have occurred to a structure and coordinate these changes with the archival data we have collected for a particular section of a structure. Because the archival data is intermittent e.g. we do not have it for every year, or for every section of the building the research that continues by team members or others who are interested in the project, can gradually fill in many of the lacunae in our historical data and better coordinate it with the physical plan. Ultimately we achieve a fairly accurate idea of how the fortress developed and changed through several centuries of usage.

GEODETIC SURVEY

One of the most important tasks of the documentation of a historical site is the geodetic survey. Site documentation has to be layered upon the foundation of the geodetic data. Survey plans will require sufficient research to prepare a developmental history of the project area and to identify the contexts and associated property types. Reconnaissance survey of the area is required to gain an understanding of the variety, type, and location of historic properties. The final survey plan identifies several approaches for future surveying and describes specific objectives. Each approach or methodology should be assigned a priority ranking to assist in future decision making.

During the limited time of a campaign at an architectural or archaeological site enormous amount of data is acquired. This extensive set of initial data is necessary to determine the directions in which the project can develop. The high demands according to completeness, accuracy and reliability besides the limited resources of time and manpower require the use of modern techniques. The first task of the survey is to establish a geodetic network to take account of the distribution of the historical structures in the site. Thereafter all the measurements, even simple detail measurements, must be in the same coordinate system. The main problems like orientation, scale, relation can besolved automatically, even if transformation of data is required. The foundation of a modern campaign is the design, survey and signalizing of the geodetic network.
(http://cipa.icomos.org/papers/99w605.htm)

Determination of what measurement methods and instruments are going to be used in survey campaigns depends upon the target goals and expected accuracy of the project.The GPS survey method can be used in an outdoor survey; however TPS method will be necessary for indoor surveys. Disto tools can be used instead of steel tapes for easy and quick use. 3D Laser Scanning solution has some advantages on some surfaces, which have lots of essential details that must be measured; additionally this method provides 3D modelling at the same time. Surveyors provide data by using a wide variety of surveying techniques and computer equipment, including electronic distance measuring instruments, global positioning systems (GPS) and digital mapping systems to define and discover natural formations around a particular site. They process the data collected by GPS receivers and check for accuracy and efficiency. Surveyors attempt to determine the exact locations and relative positions of natural features and man-made structures on the historical site. The points of elevation in the land, contours and other important surveying features must be determined. For the precise surveying of building facades and interior spaces close range photogrammetry and TPS are the main survey methods. If control point coordinates are available, the orientation of the images can be done on site, and can demonstrate the need for additional control points or for marking appropriate tie points. Digital rectifications can be carried out on a laptop at the site, delivering an immediate result for the the researchers. Systematic coding of the measured points and other productions is also important. When the survey is completed and all appropriate data collected, the office work begins. This consists of analyzing the data and preparing drafts , drawings and maps from this information. If a well-considered point enumeration exists and an appropriate software package has been installed, a CAD model can be derived easily from the results of the adjustment program.

The on site cooperation between the geodesy engineers and the architects working on the project is essential for some of practical applications involved in drawing and surveying methods. Architectural or archaeological sketches are generally done analogously using traditional methods, but

newer technology provides digital solutions for practical site work. After completing the sketches surveyors and architects measure the objects together and at the end of a day of field work all detailed measurements are downloaded into the computer and processed in a CAD environment. Instead of preparing the sketches, preliminary drawings and maps on paper, another method using digital cameras and PDA or tabletPC or notebooks can be used in the field as they operate in a real time environment. The photographs of desired objects can be taken by digital camera, or the digital drawing of the surveyed area can be obtained and directly downloaded to the tabletPC via IR or serial or USB communication in the field. In this way the measured, desired or absent detail points can be marked on the screen-view of the photograph of the historical object. Many other measurements, apart from those gathered with a total station, can be used. The disto-steel type, any other type of measurement or attribute, can be marked on the screen view. In this way numerous digital sketches from different angles and heights can be prepared; these digital shots can then be stitched in graphicenvironment and eventually even a panoramic view can be produced. In this process the pattern samples of historical objects can be gathered in order to use in the production of 3D models for the objects. With the practical and effective usage of technology, the survey team and survey time will also decrease.

ARCHITECTURAL SURVEY

In architectural documentation, the process and the quality of the on site survey is generally formed and affected by the building conditions and the whole project process. The size and the scale of the built mass usually determines the survey method and techniques. The aim of the survey and post-survey process impact the choice of technique and equipment used. The traditional methods for the survey require architects to work on site in great detail for a long periods of time. This system used for the traditional survey is slow and labor intensive because most architectural details are recorded manually. This traditional process also requires many checks and controls because the data collection is being conducted by various individuals and the human error factor is therefore quite high. This extends the duration of the on site survey time and restricts the interaction between the actual survey and the final project. On the other hand, surveys of large scale architectural or archaeological complexes always risk being insufficiently documented because of there are frequently limitations of time and financial resources. With traditional methods, the architectural survey takes a very long time and is problematic because the trade off for accuracy versus the time and money consumed is often too high. In an interdisciplinary documentation such as the Ottoman fortification survey and documentation project we discovered that the traditional survey system was inadequate and did not satisfy the diverse research goals of the project. The newer technology for surveying and the development of several digital survey components allow different disciplines in a documentation project to function harmoniously and to realize goals in a more timely and feasible manner.

The methodology used in a survey is very important, it also effects the final products of the project. An architectural project is usually prepared and used by a definite and very limited group of people; it doesn't always attempt to be accessible to other colleagues or researchers in other professions. For this reason the collected data is rarely presented in a highly accessible format and is not made available to others. The survey completes its mission by gathering needed data for the limited goal of producing the project. Ideally, if both the survey and project were conducted in a more systematic way, the valuable information that had been collected could be made accessible to a much wider audience, perhaps even placed in the internet. Ultimately the use of the information in GIS on the web would present the collected data in a form that can be accessed by anyone who is interested in the documentation process of a particular site or structure. With the integration of the other disciplines and diverse facets of the project research, continuous data sharing is essential, and should generate a totally different systematic organization of data collection in architectural heritage projects. (*Architectural Heritage: Inventory and Documentation Methods in Europe,* 1993)

It is useful to examine how academics, architects and conservationists who share a concern about protecting the cultural heritage of a particular site or region, can develop a systematic, integrated, and efficient approach and process for the preservation, restoration and reconstruction of the historical structures. Information about the restoration procedures taken, what techniques worked and what did not, what historical or archival documentation exists for a particular structure is rarely shared. As a result numerous survey and documentation processes are often repeated needlessly; the 'wheel' reinvented several times. From this point of view, it is urgent to see where the disjuncture exists and how we are losing time and monetary resources because of the lack of a systematic methodological approach for heritage recording and a centralized database for information that is gathered by all working in the various fields that intersect with cultural heritage documentation.

Recently as a result of interdisciplinary interactions and research, the digital survey equipments being used by other professions such as electronic tacheometers, GPS (Global Positioning Systems), digital photogrammetric cameras have been tested and adapted in the architectural survey system. These equipments provide data in a short time period; generally decreasing the time involved in the on site survey process one-third . While the electronic tacheometers, GPS and aerial photogrammetry are used in the general survey of the mass and the deformation of the structure; TPS, the close range photogrammetry and scanners are used to document the facade details and texture. Any architect or engineer can use the collected data if it is gathered in proper way; the perception of the data is the same because of the high degree of accuracy. The practical usage of this digital equipments in architectural surveys and documentation projects has created a need for standardization and for techniques that can be used for both digital and non-digital measurements so that the documentation and further usage of the data can be better organized. Digital data storage has importance in architectural survey due to the subsequent steps which lead to preservation, restoration and reconstruction process. This standardization and methodology can differ due to the building scale and the particular processes involved in the realization of the project, but in historic documentation work there should be principle criteria in order to reuse and represent the survey data and the surveys of different periods which are used in the evaluation of the architecture.

Architectural heritage recording also includes the recent architectural examples of DOCOMOMO besides ICOMOS; this will generate various data related to buildings and sites digital or non-digital from the recent past. Meanwhile, the integration of these digital systems in architectural documentation will effect not only heritage recording, but many other project requirements. GIS usage in architecture will make the perception of these different processes in an architectural project comprehensible and accessible.

These opportunities have been known recently in Turkey but they are not widely used because the technique and equipment required are expensive and the digital technology needs specialists and technical training. The architectural survey techniques required to document cultural heritage structures are limited by the continuation of widely used traditional methods. At the present time in Turkey architectural documentation projects, the process and the quality of the site surveying, are generally shaped by the size of the building and the project budget. At the same time several projects that are conducted by governments, academicians and professionals are employing an assortment of different documentation systems and equipment (Aslan, 2001; Summers, 2001; Tanyeli, 2001; TAY).

Because of mostly the economical situation in Turkey, heritage documentation process develops in long period. The groups that are supervising and certifying architectural heritage documentation projects should define and require the proper documentation systems and create an appropriate methodology in order to receive qualified projects.

The architectural survey methodology that was used in Seddülbahir and Kumkale Documentation Project has been revised several times as the project diversified. The site survey of Seddulbahir in the preliminary years was concluded in 3 seasons; with the practical experience gathered from this first survey , the goals of the Kumkale survey were accomplished more efficiently. Recently after finishing the entire site survey and documentation database the problems encountered in the early years of the survey have helped us to determine more efficient techniques and a more sound methodology for future surveys.

THE INTEGRATION OF THESE DISCIPLINES IN THE GIS DATABASE

In this project GIS technology has been chosen as a pilot application for the documentation of historical sites. The GIS project was generated with a cross disciplinary approach which integrates information and research from a variety of other fields including geodesy, architecture history. It is quite possible to add to this information from other fields such as botany, geology, archaeology. A truly comprehensive GIS should be long term in its planning orientation and allow for data from fields other than the ones initially covered. Now that all digital survey data has been generated for the two sites and a substantial amount of historical information about the fortresses has been collected the layering of the historical data is beginning on the geodetic foundation. The application of the fortresses will be basically a three-step process. The first step is to create 3D digital map coverage of the site and the architectural plans of the historical structures. The second step is to gather all known information about each resource (historical attributes) related to spatial information and current information about the existing conditionsThe third step is to integrate the geormetrical data with these attributes mentioned above. The pilot project that haa been completed of the Kumkale cemetery, an 18th century Ottoman burial ground near the fortress, provides a good example of interdisciplinary work that is possible using GIS as an organizational tool. (For this see the project website: www.seddulbahir-kumkale.com)

The primary purpose for developing a GIS of the Ottoman fortresses is to facilitate the research in the project and make the questions and the answers asked of the collected data much more accessible, easy to visualize, and easy to retrieve. With this type of information and data management system both the present situation of the fortresses and the condition of the fortresses in the past can be recorded and the architectural changes from 17th century to present day can be determined more efficiently. GIS allows the user to quickly query a database of architectural plans or photographs in order to make stylistic comparisons and other types of analysis. For example, the specific plan of the entrance tower at Seddulbahir is not clearly known, but an examination through GIS based inquiry of several other entrance plans of Ottoman fortresses from the 15th century through the 18th century can be made to determine if there are any similar architectural components. This type of query can then be extended to include the entire plan of the fortress and make a comparative assessment of its design with examples of fortifications from the early modern Mediterranean region. Theoretically, as more cultural heritage projects turn to GIS for their data organizational needs, and put their data on the web, the power of this kind of system can be tremendous.

One of the essential requirements of GIS is accurate spatial data; hence, the geodetic network was designed and established to cover the entire area of the fortresses and their environs. Only with this comprehensive approach to the site could we produce a complete and accurate set of maps and architectural drawings and models of both fortresses. From the beginning two different types of geodetic measurement methods, which consisted of satellite and conventional measurements, have been used together to increase accuracy. These two techniques have supported each other, thus measurements can be accomplished in a shorter time and with fewer staff in order to complement the type of information gathered in the architectural survey. Finally, it is expected that in the future GIS will facilitate the development of the continuous process of site preservation at both fortresses.

CONCLUSION

In conclusion, in this project the necessity of integrating different disciplines within a cultural heritage documentation project is clearly observed. The main academic components of the project, geodesy, architecture, and history have share and understand the GIS digital database in order to use it to its maximum potential.

The alternative systems for architectural documentation and its integration with the interdisciplinary projects have been recently examined and used by both academicians and professional architects in Turkey. With the rich cultural heritage that our country possesses, while the extraction of some sites of heritage list in Turkey are being discussed, it is

urgent to determine and discuss the priorities, the need and feasibility of developing the proper methodologies for architectural heritage documentation. With more effective and productive usage of GIS, it is clear that both digital and non-digital architectural data must be collected, organized and presented in such as way as to make the enormous amount of effort. Financial resources that are currently expended in many architectural and documentation projects in Turkey can serve the information needs of a wide variety of users and be utilized for purposes that may be beyond the immediate needs of the original project participants and the first consumers of the data collected.

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