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The Application of New Survey and Documentation Technologies for Cultural

Heritage Sites:

Case Study Analyses of the Digital Statue of Liberty, New York City and

the Ottoman Fortress of Seddülbahir, Gallipoli Peninsula

by

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ABSTRACT

In this thesis, the process of generating architectural drawings, models and other products from laser scanning data is examined and some solutions for bridging the gap that currently exists between the technology and its application are investigated. This investigation is done by evaluating and comparing two important heritage documentation projects which have utilized laser scanning as the major technological tool for documentation: The Documentation and Restoration Project of the Ottoman Fortress of Seddülbahir, on the Gallipoli Peninsula of Turkey and the Digital Statue of Liberty Project, on the Liberty Island, New York City, USA.

The advances in surveying technology have seen parallel developments with architectural documentation processes. However the recent and very rapid changes in surveying and documentation technology are creating a situation where it is increasingly difficult for the heritage professional to learn, adapt and integrate in an effective manner new documentation technology. The knowledge gap and the insufficient connection between the documentation process and the surveying technology often lead to undesirable results. Therefore a serious need has arisen: to bridge the gap that now exists between the data collected by the laser scanner and the way in which that data is used by architects in the documentation project to produce more effective final products.

This thesis examines the current state of documentation and surveying technologies being utilized in Turkey and internationally. It works towards establishing a methodology for laser scanning projects which are conducted in the heritage sector and constitutes a step towards closing the gap that now exists between the digital surveying technologies and architectural documentation.

Keywords: the Seddülbahir Project, the Digital Statue of Liberty project, documentation of cultural heritage, restoration, architectural documentation, surveying, digital surveying technologies, laser scanner, methodology, the RecorDIM Initiative

ÖZET

Bu tez çalışmasında, lazer tarayıcı verisi kullanılarak meydana getirilen mimari çizimler, modeller ve diğer ürünlerin oluşum süreci incelenmiş; bu teknoloji ve teknolojinin uygulanması arasındaki kopukluk araştırılmıştır. Bu araştırma, belgeleme aşamasında, lazer taramayı ana teknolojik araç olarak kullanan iki önemli kültürel miras projenin incelenmesi ve karşılaştırılmasını kapsamaktadır: Seddülbahir Osmanlı Kalesi'nin Belgeleme ve Restorasyon Projesi, Gelibolu Yarımadası, Türkiye; Dijital Özgürlük Heykeli Projesi, Özgürlük Adası, New York şehri, Amerika Birleşik Devletleri.

Rölöve teknolojisindeki ilerlemeler mimari belgeleme sürecinde de paralellikler görmektedir. Ancak, rölöve ve belgeleme teknolojisindeki bu güncel ve hızlı değişiklikler beraberinde öyle bir durum yaratmaktadır ki, kültürel miras profesyonellerinin bu teknolojileri öğrenmesi, uyarlaması ve belgeleme teknolojisini projeye efektif bir biçimde entegre etmesini zorlaştırmaktadır. Bilgi eksikliği, belgeleme ve rölöve teknolojileri arasındaki yetersiz iletişim olumsuz sonuçlara yol açmaktadır. Bu yüzden çok önemli bir ihtiyaç doğmuştur: lazer tarayıcıdan elde edilen veri ile bu veriyi işleyecek mimarlar arasındaki bu boşluğu yok etmek ve daha efektif ürünler elde etmek.

Bu tez çalışması, Türkiye ve dünyada kullanılan belgeleme ve rölöve tekniklerini incelemektedir. Bu çalışma, kültürel miras projelerinde lazer tarayıcının kullanılmasına ilişkin bir metodolojinin oluşturulmasına ve dijital rölöve teknikleri ile mimari belgeleme projeleri arasında mevcut olan kopukluğun aşılmasına çalışmaktadır.

Anahtar kelimeler: Seddülbahir Projesi, Dijital Özgürlük Heykeli Projesi, kültürel mirasın belgelenmesi, restorasyon, mimari belgeleme, rölöve, dijital rölöve teknikleri, lazer tarayıcı, metodoloji, RecordIM Girişimi

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Chapter 1

Introduction

Documentation can be defined as a systematic examination and analysis of individual historic resources to produce a compilation of data about a site, structure or object of a subject. Its purpose is to collect, organize, explain and illustrate information that is relevant to our understanding of the past and present of the entity in question. For example, an exhibition consisting of historic pictures of the historic peninsula of İstanbul is an attempt to document the different time phases of the city, or a collection of Ottoman scripts dating to the 18th century can also be considered as an attempt at documentation. As for architectural documentation, it is a compilation of both graphic and written records that explain and illustrate the significant characteristics of a historic building, site, structure, or object (Burns 1).¹

Since the 19th century various countries have created an institutionalized framework in which to scientifically document the national architectural resources. The formal systematic and institutionalized process of architectural documentation for archival purposes began in the United Kingdom in the late 19th century; thereafter the Royal Commission on Historical Monuments was created in 1908 and charged with the compilation of inventories; it has continued today as the National Monuments Record (Warden & Woodcock 111). The Historic American Buildings Survey

¹ LeBlanc and Eppich defines documentation of the cultural heritage as an integration of two main activities:

1. the capture of information regarding monuments, buildings, and sites, including their physical characteristics, history, and problems
2. the process of organizing, interpreting, and managing that information.

LeBlanc, F; Eppich, R. "Documenting Our Past for Future". *GCI Newsletter* 20.3 Fall 2005. 25 April 2007, <<http://www.getty.edu/pf/PF>>.

(HABS) was created in 1933, after the Great Depression, and was one of the early recovery programs initiated by President Roosevelt. The HABS sought out unemployed young architects, asked them to record the historic U.S. building stock with simple measuring tools. In four months 882 buildings had been recorded. In 1934, this initial success in surveying was formalized by transferring the management of HABS to the National Park Service. Since then HABS with its organizations HAER (Historic American Engineering Record) and HALS (Historic American Landscape Survey) has been working extensively and are now the main documentation organization in the USA (Cliver et. al. 31; Warden & Woodcock 111).

In Turkey, the formal process of surveying for preservation purposes began in the late 19th century before the establishment of the Turkish Republic. In the Ottoman Empire, the first systematic surveys were undertaken by Montani Efendi and his colleagues for the International Vienna Exhibition in 1873; the Ottoman architectural features were collected in the volume called “Usul-ü Mimari-i Osmani-L’Architecture Ottomane” (Uluengin 11). The attempts to record the Ottoman built heritage were undertaken during the “Balkans War” (1912-1913), “World War I”

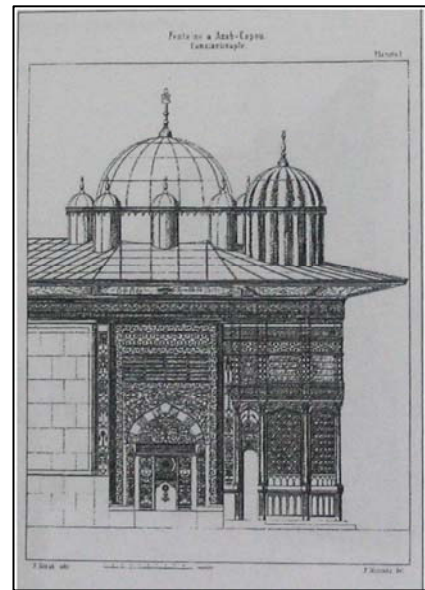


Fig. 1.1. The measured drawing of the Azapkapı Fountain, İstanbul; drawn by Montani Efendi for the Vienna Exhibition, 1873; Uluengin.

(1914-1918) and the subsequent Independence War of the Turks. When the Turkish Republic was founded in 1923, due to the fact that the new government was dealing with the political and economical problems of the country, no budget could be

allocated for the preservation of the Ottoman built heritage. It was not until 1931, the “Anıtlar Koruma Komisyonu” (Commission for the Conservation of Monuments) was founded; and a considerable amount in the budget was assigned for the restoration and registration of monuments, and the preparations for the surveying² were initiated. Grants for scientific papers, joint ventures with tourism oriented organizations, and grants for the travel of international scholars to restore the monuments were organized by the Anıtlar Koruma Komisyonu. In 1936, these recording attempts were formalized with the establishment a “Rölöve Bürosu” (Surveying Bureau) in the Turkish government. In 1944 “Eski Eserler ve Müzeler Umum Müdürlüğü” (Historic Art Works and Administration of Museums) replaced the previous bureau. In 1951 the “Gayrimenkul Eski Eserler ve Anıtlar Yüksek Kurulu” (Council of Real Estate, Historic Art Works and Monuments) was founded as a pioneering council whose concerns were not only documentation and preservation of historic monuments but also the preservation of the vernacular architecture. In 1983 this council was converted into the “Kültür ve Tabiat Varlıklarını Koruma Kurulu” (Council of Conservation of Cultural and Natural Properties). Since then, this council has established 17 branches in Turkey and has been responsible for overseeing all the conservation in Turkey (Uluengin 14-15).

In the 19th and the beginning of the 20th century when there were several urban renewal movements in the US, Europe and Turkey, the initial reason and motivation for documenting and recording structures was because it was believed that if they

² *Surveying* is a measurement collection system to represent a 3D existing structure with 2D measured drawings such as the plans, elevations, and sections. These measured drawings are different from the original construction drawings. Measured drawings correspond to the existing conditions of the structure during the surveying phase. Therefore, particularly, the new alterations should be indicated in the measured drawings. Uluengin, Bülent M. Rölöve. İstanbul:Yapı Endüstri Merkezi Yayınları, 2002, p.21.

were demolished one day, the records of the structure should be preserved for the future. Gradually, the importance of conservation was recognized and the process of documentation also began to be recognized as a prior phase to conservation³. Documentation activities were generally undertaken by a restricted group of people: architects or people who had some formal training in art and architecture. Documentation teams have therefore traditionally been comprised of professionals from academic disciplines such as architecture, archaeology and civil engineering and have used the basic documentation tools to both compile, and when necessary, to generate written documents, photographs and measured drawings.

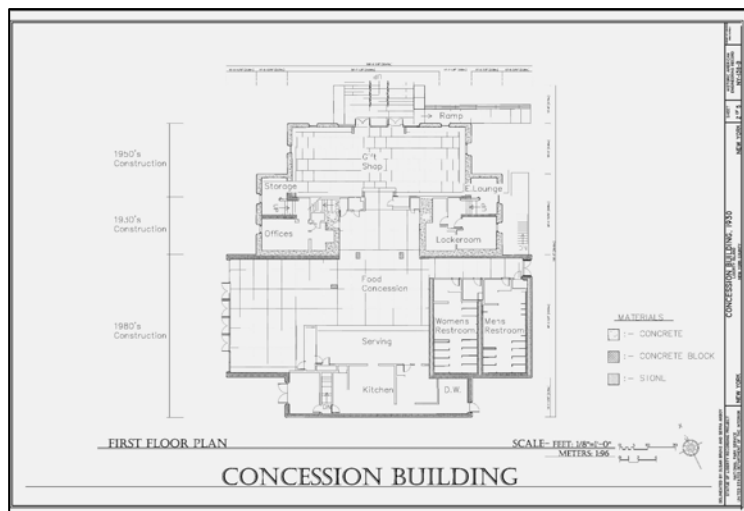
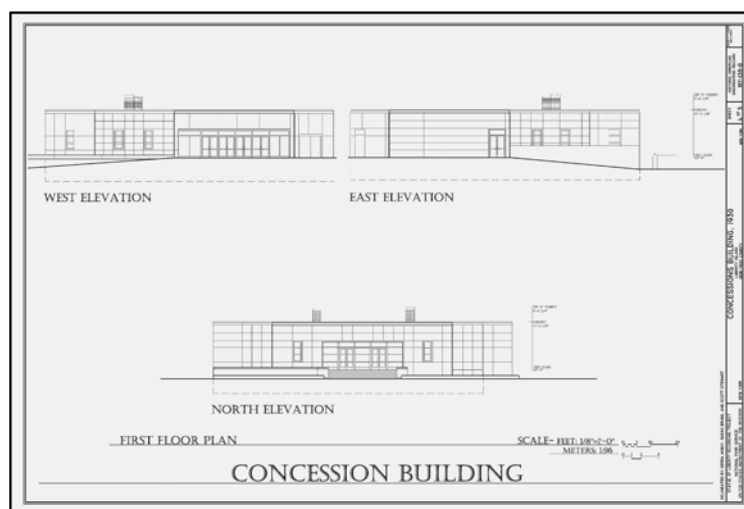


Fig. 1.2. Measured drawings of the Concession Building, the Liberty Island, NYC, DSOL, August 2006.



³ Venice Charter. "International Charter for the Conservation and Restoration of Documents". 1964. 30 April 2007, <http://www.icomos.org/venice_charter.html>.

However, new concepts about the purposes of documentation and new advances in documentation technology have triggered a reassessment of both the theoretical and practical aspects of architectural documentation in the past two decades. On one hand the process and concept of architectural documentation still resembles the goals of traditional documentation efforts and takes advantage of the earlier technology and processes. In a conceptual manner, architectural documentation continues to be the basis for safeguarding historical structures and must therefore be conducted as a primary step in the process of conservation. It still emphasizes the importance of written documentation and measured drawings. On the other hand the definition of what constitutes documentation has now evolved to include a much greater diversity of disciplines and new conceptualizations are included. The waves of these changes have been expanding to encompass a bigger world, and a much more diverse range of architectural, archaeological, historical, social, cultural and economic data now informs our understanding of historical structures. Similarly a diversity of new tools is now employed to provide and organize our data. As an example in the Seddülbahir Fortress; Survey, Documentation, Restitution, Restoration & Reusage Project⁴, the documentation process is no longer the purview of only archaeologists, architects and historians.⁵ The new documentation approach includes important roles for engineers, computer programmers, sociologists and business administrators among others. Now, the documentation projects are a multi member partnership from

⁴ “The Seddülbahir Fortress Site; Survey, Documentation, Restitution, Restoration & Reusage Project” is referred to as “the Seddülbahir Project” in this thesis.

⁵ For instance, the Seddülbahir Project represents a good example of the intensive interactions between the diversified professions in a post modern documentation project. The project includes disciplines as architecture, archaeology, history, art history, architectural history, cultural history, oral history, cultural heritage management, geography, geodesy, photogrammetry, and engineering. A. Ozsavaşçı; L. Thys-Şenocak. “New Survey Technologies in Architectural Heritage Documentation and the Project Process: The Role of the Architect and the Analysis of the Interdisciplinary Approach”. Forum UNESCO: University and Heritage, 11th International Seminar. Documentation for Conservation and Development: New Heritage and Strategies for the Future. 11-16th Sept. 2006 Florence, Italy. p.4.

different disciplines, working toward similar objectives. In order to achieve the various goals, project participants from different disciplines have imported their tools to document, produce and analyze knowledge and information about a site. The computer programmer is producing new software which is compatible with the needs of the heritage industry, the sociologist and oral historian are implementing new surveying techniques in the community to discover the significance of the site, the business administrator is examining the organization and maintenance of the site and assessing its sustainability and the cultural heritage manager is involved in preparing a site management plan to insure proper usage and sustainable development of the historical resource.

1.1. The importance of documentation in architecture

Regardless of the different fields in which people are involved in the documentation process there is a general consensus that architectural documentation is an essential and important step to a deeper understanding of our past. One author from the United States has remarked,

“Architectural and engineering documentation broadens our experience of American history. Historic structures are frequently the only tangible evidence of history. They can open new doors to understanding the past. They can be significant for their characteristics and features, as well as for their association with people and events. As artifacts, they can provide insights into past cultures and activities, events and people (Burns 8).”

Not only can architectural documentation provide information for a diversity of academic studies and pave the way to new insights, but also it supplies information for future generations of structures which have vanished. The structures are lost due to a diversity of reasons: developments, technical or functional obsolescence, neglect, fire, natural disaster and war. Needless to say architectural documentation can mitigate the loss by providing graphic and written records (Burns 9). These permanent records will transmit the knowledge of these historic structures and thus “documentation can help keep the heritage from being destroyed or forgotten, and it serves to communicate, not only to conservation professionals but to the public at large, the character, value and significance of heritage (LeBlanc & Eppich 2)”.

Although Burns’ statements are still the backbone of architectural documentation and the notions of providing knowledge about the past and recording it for archival reasons are still fundamental, there are other issues surrounding the process of documentation. Architectural documentation has always been crucial for the development of architectural thought, architectural training, and a general awareness about the architectural legacy which we have inherited. For instance if Andrea Palladio and other architects of the past had not been inspired by structures from Greek and Roman antiquity, and carefully measured and studied the antique architecture, Renaissance architectural development would not have emerged as it did (Warden & Woodcock 111). In Turkey, in the second half of the 19th century, the rise of nationalism impacted architectural developments. European architectural features were abandoned and a Neo-Classical Ottoman style emerged which promoted a reintroduction of classical Ottoman architectural features into the contemporary building vocabulary. The utilization of classical Ottoman features required an

extensive observation, recording and study of the classical Ottoman built heritage as evidenced by architects, such as Mimar Kemalettin Bey, Mimar Vedat Bey, who were so formative in the 1st nationalistic movement in Turkey and developed this style through their documentation of classical Ottoman structures (Uluengin 11).

As for the vital role of documentation as a component of various aspects of architectural training, documentation projects that involve architecture students help the students to develop skills of observation. They facilitate the transformation between the 2D architectural drawings (plans, sections and elevations) and the 3D models. Also the ‘deconstruction’ of a structure enables the student of architecture to know the spatial circulation, construction materials, deterioration phases as well as several other features of a site. (Warden & Woodcock 111).

Preferably in most of the documentation projects, students are hired to work in teams under a professional supervisor. For example most of the HABS/HAER (Historic American Buildings Survey/Historic American’s Engineering Record) documentation is produced during the summer months with the assistance of these teams. I participated in the second phase of the Statue of Liberty project while an ICOMOS intern and worked with the HAER summer team during the summer of 2006 and benefited greatly from the project. From an architectural point of view the field work was a tremendous help to develop skills to observe and form a connection between the structure and the drawings.

1.2. Conservation and documentation

Besides the assessment of its vital role for the development of architectural thought, training and education, documentation is an important component of conservation. Although it can be conducted independently from a project to gather data for archival needs and research projects, most of the time projects requiring documentation are directly connected to conservation purposes and the documentation phase is the first step in compiling data for the conservation project.

“Once conservation begins, those involved in the process need access to comprehensive information about the site. This information -obtained through documentation- allows conservation professionals to record current conditions, consider appropriate conservation options, plan interventions, apply treatments, and, finally measure the results of their efforts (LeBlanc & Eppich 3).”

However, documentation does not stop when the conservation project starts and even after the conservation phase, documentation provides the basis for monitoring, management and routine maintenance of a site (LeBlanc & Eppich 3). As it is mentioned in the Venice Charter, documentation is a continuing process even during the conservation process and data continues to be accumulated according to the scale and scope of the project (Article 16).

The vital role of documentation as a preliminary phase was stated in the Venice Charter in 1964 as follows:

“In all works of preservation, conservation, or excavation, there should always be precise documentation in the form of analytical and critical reports, illustrated with drawings and photographs. Every stage of the work of cleaning, consolidation, rearrangement, and integration, as well as technical and formal features identified during the course of the work, should be included. This record should be placed in the archives of a public institution and made available to research workers. It is recommended that the report be published.” (Article 16)

The postwar Venice Charter was addressing documentation as a phase where architectural, archaeological, historical data should be provided. However the linkage between conservation and documentation has come to the point that documentation is crucial not only to gather the architectural, archaeological and historical data; but also to investigate social, cultural and geographical knowledge and determine the tangible and intangible values ascribed to the heritage.

Conservation can be defined as “all actions or processes that are aimed at safeguarding the character defining elements of a cultural resource so as to retain its heritage value and extend its physical life.”⁶ Fundamentally, it is concerned with the transmission of cultural heritage, with its significant messages intact, and made accessible to the greatest degree possible (Letellier & Gray 8).

⁶ Conservation may involve presentation, rehabilitation, restoration or a combination of these actions or processes.

Preservation is the action or process of protecting, maintaining, and/or stabilizing the existing materials, form, and integrity of a historic place or of an individual component, while protecting its heritage value.

These definitions are taken from

Parks Canada. Standards and Guidelines for the Conservation of Historic Places in Canada. Canada: Delta Printing, 2003, p. int. 2.

The conceptualization of conservation after the 19th century defines it as a scientific discipline focused on the physical context of the present structure or the site and its particular conditions of aging and survival (Matero 17). Unlike the earlier traditional definition as a static process grounded in a particular moment or an act of the built heritage, the post-modern approach to conservation does not conceptualize it as a mere preservation of the built heritage anymore. The understanding of what conservation is now has shifted to a definition which sees heritage as a living and evolving environment in which preservation is only one aspect. Besides the fundamental concerns of conservation, evaluating and interpreting cultural heritage for its preservation and safeguarding it to the future, new questions have emerged: Who determines the decision of what to conserve and how do they implement these decisions? All these questions are a product of contemporary values and beliefs about the past's relationship to the present.

Values have always been associated with conservation; they used to be defined in terms of material “authenticity” and integrity”. However, now, “value” has taken on the additional more complex characteristics attributed to the heritage objects and places by legislation, governing authorities and stakeholders (Torre 4).

Consequently, the value based conservation consists of interpretations of a diversity of values which can be defined as the aesthetic, historic, scientific, cultural, social or spiritual importance or significance for past, present or future generations. The heritage value of a historic place is embodied in its character-defining materials, forms, location, spatial configurations, uses and cultural associations or meanings.⁷

⁷ Parks Canada, int. 2.

There are several examples of how new definitions of values are being used to guide various documentation aspects of conservation projects. Among the case studies presented here are the “Rapid Ethnographic Assessment Procedure Access to Ellis Island Project”, in New Jersey and New York and the “Seddülbahir Project” on the Gallipoli Peninsula in Turkey. Before physical documentation processes started the NPS conducted research about Ellis Island in 1994-1995. This research evaluated access alternatives, identified the stakeholders, community and the local users, and thereby elicited the values attributed to the site as a way to understand the meanings that the site held for local residents and visitors. The study gave a voice to their needs of the stakeholders. The studies showed that Ellis Island did not represent the immigration past of many of the surrounding neighborhoods, because the community does not have easy access to the island due to the expensive fee. The neighborhoods can not benefit from Ellis Island in terms of recreation (Low 47-64, 31-49).⁸ A second case study is the project at the 17th Ottoman fortress of Seddülbahir. The Oral History Project at Seddülbahir that was undertaken between 1999 and 2001 serves as a good example for how the values in the local community can be documented and understood. The Oral History project not only gathered diverse conceptualizations of Seddülbahir through interviews with members of the community, revealed the collective memory of the community but also provided physical information about the site and structures that was not evident before, i.e., the study showed that the site had a special place for the local stakeholders because there had been people among the community who had actually served their military service in the fortress, and who had lived and worked on its premises in the past. Further, this oral history project provided

⁸ For further studies: Low, S. Social Sustainability. Managing Change: Sustainable Approaches to the Conservation of the Built Environment. Getty Publications 2003, 47-64.

Low, S. “Anthropological-Ethnographic Methods for the Assessment of Cultural Values in Heritage Conservation”. Assessing the Values of Cultural Heritage. Getty Publications. 2002. 31-49

a forum where the community voiced their suggestions about the potentials of the site and the further projects.⁹

As the preliminary phase of conservation, the definition of documentation is widened to include research into existing community values and these values are crucial to establish further projects such as the conservation.¹⁰ “Good documentation of a site allows for a better understanding of its value-historical, scientific, aesthetic, social, and economic. Recognition of a site’s value and significance is often the first step towards its conservation (LeBlanc & Eppich 3)”.

Besides the richer interpretation of values that have been brought into the increasing complex definition of heritage documentation, a wider and more multi-disciplinary array of decision makers are now involved in the decision making process about a site. The challenge is to assess these diverse values held by different stakeholders and incorporate them into a conservation project. It is important because the assessment of values among the conservation project enables the stakeholders to identify the project from their own view point and consequently contributes to an increased sustainability of the project goals. For example in the Seddülbahir Project, there is a diversity of stakeholders. From a historian’s point of view, the fortress reveals the historic facts of several certain time periods from the 17th to the 21st century. The fortress is unique because of the architectural patronage of a valide

⁹ Kale Takımı. The Architectural Survey and Documentation Project of Seddülbahir and Kumkale Fortresses. Kale Takımı Project Report 2002. 30 April 2007. <www.seddulbahir-kumkale.org>

¹⁰Exploration of values requires a different methodology than traditional surveying techniques such as anthropological and ethnographic tools. The recent studies in the Getty Institute, have been especially addressing the assessment of the values and the implementation of these values in the conservation project and the site management. For more information, <www.getty.edu> , Assessing the Values of Cultural Heritage. Los Angeles: Getty Publications, 2002, Heritage Values in Site Management: Four Case Studies. Los Angeles: Getty Publications, 2005.

sultan (regent queen), Hatice Turhan Sultan. From an architect's point of view, the fortress is a refined example of a military structure. As for the archaeologists, the site is located near to an area where the mythical Trojan War took place. It is also important for the history of Turkey because the site had a central role during the Gallipoli campaign and World War I and many people lost their lives during the war. Most importantly the fortress is important for the community who is living next to the site, because they are the people who are directly connected to Seddülbahir. Presumably all these stakeholders have different interests in the project. Their views should be considered in the conservation project and the management plan and be voiced. An inclusive documentation project is a great tool to identify these stakeholders and prepare a basis for all of these different demands.

Value based conservation is not a merely the preservation of the heritage; it is not simply a technical and scientific act. The context of conservation has shifted to encompass a host of concerns about social, cultural, economic, geographical and administrative aspects. Therefore not a single methodology can be employed to understand the diverse issues. A combination of different methods from different disciplines is essential. The expansion of the conceptualization of conservation in terms of theory and application, places documentation at a more central place than ever. The basic definition of documentation as the information units acquired over time through heritage recording and other research means, and the creation of a knowledge base for particular sites and objects, has expanded now to reflect these new concerns and definitions of heritage recording.¹¹

¹¹ The definition is taken from Lettellier, R; Gray, C. "The Heritage Recording, Documentation, Information Management Guidelines for World Heritage Sites". Bridging the Gap between Information Users and Providers, California: Getty Publications. 2002. p.8.

The developments in both the technical and theoretical aspects of conservation have had an inevitable impact on documentation projects. Briefly, the expansion of the term of conservation to include the interpretation of values and the involvement of different bodies and stakeholders are now impacting the way documentation is conceptualized and implemented.

Besides the conceptualization of conservation, the advances in technology have brought new challenges to the heritage documentation. The recent and rapid changes in surveying and documentation technology are creating a situation where it is increasingly difficult for the heritage professional to learn, adapt and integrate in an effective manner new documentation technology. The knowledge gap and the insufficient connection between the documentation process and the surveying technology can cause undesirable results such as inefficient final products, further demolition of the heritage and waste of time and money. In 2002, the International Council on Monuments and Sites (ICOMOS), the Getty Conservation Institute (GCI) and the International Committee for Architectural Photogrammetry (CIPA) created the RecorDIM (for Heritage Recording, Documentation and Information Management) Initiative partnership to bridge this gap between the information providers and the information users.¹² The RecorDIM initiative highlights its fundamentals as follows: “The purpose of the initiative is to bring information users and providers together to identify the nature of the gaps between them, to develop strategies to close the gaps and to recommend a framework for action to be coordinated by the RecorDIM Initiative over the coming five years.”¹³ Since 2002, RecorDIM has been working to

¹² Information users: research, inventories, initial studies, conservation planning, project management, maintenance, monitoring; information providers: photography, photogrammetry, surveying, GPS, GIS, 3D laser scanning, 3D modeling, geophysical prospection, etc. Ibid. p.3

¹³ Ibid. p.2.

bridge the information gap by organizing symposiums, i.e. New Perspectives to Save Cultural Heritage, CIPA 2003 XIXth International Symposium, Antalya, Turkey; International Cooperation to Save the World's Cultural Heritage, CIPA 2005, XX International Symposium, Torino, Italy. RecorDIM has not been only devoted to the improvements of the integration of the digital surveying technologies with heritage documentation, but also has been seriously emphasizing the importance of documentation. For instance, in March 2002, an international group of information users contributed their experiences regarding "heritage recording, documentation and information management" in a roundtable discussion where they addressed major areas to analyze the situation between the information providers and users, identify the needs and propose solutions.¹⁴ These discussions voiced significant remarks such as: the lack of definition and roles in the documentation projects; the absence of an established terminology; deficiency of communication between the information provides and users and thus a lack of information and technology exchange; the need for standards and guidelines; the necessity of multi faceted training for both young and mid career professionals; more emphasis on the importance of documentation in conservation, heritage and information management; and the cost benefit methodologies, etc.¹⁵

The Seddülbahir Project and the Digital Statue of Liberty Project are from different parts of the world belonging to diverse architectural settings and possessing

¹⁴ 1. To improve perception and communication in recording, documentation and information management,

2. To integrate recording, documentation and information management activities into the conservation process,

3. To increase resources for documentation,

4. To define, develop and promote documentation tools,

5. To disseminate information,

6. To make available specific RecorDIM Training / Learning Programs", Ibid., p.2.

¹⁵ Ibid. p.15-16.

varied scope and scale. However, both projects have been struggling with similar technical, practical and theoretical challenges and these general challenges had been addressed in the RecorDIM Initiative. Therefore, it is very important to examine these two case studies in terms of architectural documentation practice and thus propose a comparative methodology including the general approach as well as distinctive features of the projects. Both projects have benefited from advanced surveying technologies to document their respective sites and are discussed as case studies in this thesis. This thesis is primarily concerned with the new processes of physical documentation and investigations for methodological approach of laser scanning in heritage documentation. Due to the fact that both projects are recent¹⁶, there is tremendous amount of data that has not been published yet. Therefore one aspect of the methodology of the thesis is interviews with the team members. These verbal inputs are a valuable part of this study along with published articles, papers and further studies regarding the projects.

¹⁶ In the Seddülbahir Project, the site was scanned during the fieldwork in 2005 and the architectural drawings were finished by August 2006; in the DSOL, the site was scanned in June 2006 and the team has been still working on the architectural drawings.

Chapter 2

A Brief History of the Architectural Documentation Practices from Traditional Methods to Contemporary Ones

Recording the physical feature of an object/structure/site is one of the main points of documentation which can be defined as the capture of information which describes the physical configuration, condition and use of monuments, groups of buildings and sites, at points in time.

2.1. Traditional Recording Techniques

Traditional recording techniques are made of a diversity of formats addressing different documentation needs. For instance measured drawings register accurate dimensions of the features and the spaces of buildings. Photography records scenes of information including general outlines, lighting quality, and the appearance of different materials. Sketching records a view/detail in a more subjective format. As

we can see in Fig.2.1., a physical model represents the three-dimensional aspects of a building. In addition, video records and especially photogrammetry, which has an extensive history in

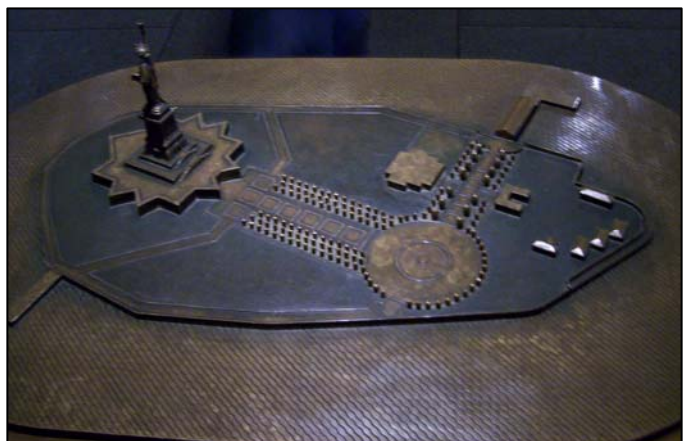


Fig.2.1. The physical model of the Liberty Island gives information to the visitors before they enter the museum in the pedestal. DSOL, June 2006.

documentation, can be also considered now as a traditional recording technique. Videos and sound recordings record a live visit to a place that includes a series of scenes and even the sound of a place.

2.1.1. Hand Survey

Traditional recording techniques consist of hand measurements which are mostly based on human assessment and simple tools. For example everybody can document their dwelling with just a tape, ruler, pen and paper. All around the world, every student in historic preservation departments are taught as the first step into the diverse world of architectural documentation with the help of these basic devices. While the digital surveying



Fig. 2. 2. Hand surveying in the field, Seddülbahir, 2005.

technologies gradually have substituted the old ones, hand measurements are still a major part of the documentation project. Pen, paper, ruler, tape, steel tape, plump line, water balance, theodolite, molding profile etc. are still fundamental tools to have in the field. Although both the Digital Statue of Liberty and the Seddülbahir Project used the latest digital documentation, surveying technology was also used.

2.1.2. Sketching

Producing sketches in the field is a major part of the documentation project. Hand made drawings simulate what the human eye sees. Even though digital surveying technologies supply tremendous data, a humble sketch of a little detail of the structure provides meticulous insights about

the structure and thus facilitates the conversion from the raw data to the measured drawings. In both the Digital Statue of Liberty and the Seddülbahir Project, alongside the advanced

digital technologies, hand measurements were used at the field extensively. In Seddülbahir, for example, 1500 pages of hand made sketches were made during the 2005 field work (Özsavaşçı & Thys-Şenocak, 3).



Fig.2.3 The author, producing sketches in the field, DSOL June 2006.

2.1.3. Photography

Photography has had a substantial role in documentation and always has complemented the other methods used in the project. Taking a photograph is one of the cheapest, easiest and fastest ways to document. Further, the wide use of digital cameras has made photography a more extensive tool because the interaction between documentation and photography is more intensive than ever. As we can see in Fig. 2.4., a photograph can convey three-dimensional qualities, spatial relationships, current conditions, texture and context in an objective manner. Occasionally, a pattern may be too difficult to depict, or a crack may be too small to draw. In that case

a photograph taken from the right vantage point¹⁷ can be added to the documentation file and the photograph substitutes for the measured drawing (Lebovich 70).



Fig.2.4. Photo of the excavation undertaken for the construction of the American Museum of Immigration, 1961 Photograph Collection of the American Museum of Immigration, Liberty Island, U.S., Department of the Interior, NPS.

Besides the conventional way of utilizing photography for documentation purposes, there are two major techniques when using photography for documentation purposes: Orthophotography and rectified photography.

2.1.3.1. Orthophotography

Orthophotography is employed during the utilization of photography in order to avoid distortions of the image. Although, even if a picture is taken absolutely ‘square on’ to a flat plane with the assumption that the entire image is in the same scale, it is impossible to prevent the distortions in images of vast land and colossal building façades. Therefore correcting the image is required for a true scale

¹⁷ *Vantage point* is the location of the instrument which the architect/engineer designates in order to get more data of the structure.

photograph. First, a 3D surface model of the subject structure must be created.¹⁸ Once the surface model is complete, the image is manipulated to fit, creating a true scale photograph. Also bonding the adjacent images provides a faultless product and therefore it is critical for documentation purposes.¹⁹

2.1.3.2. Rectified Photography

Rectified photography is used when building façades have elaborate or subtle details that are difficult to capture. For the application of this type of photography, the façade needs to contain one or more well defined planes to identify control points. First a photograph is taken and then scanned at a high resolution²⁰. During the rectification, the identification of the control points on the images enables a seamless mosaic to be created from all the images and planes involved. Finally, the rectified images are converted to CAD drawings by scaling and positioning the image with a grid and a sheet format.²¹

2.1.4. Theodolite

¹⁸ Photogrammetry has an automated process in the software to carry out the production of a 3D model.

¹⁹Downland Survey and Measurement. "Orthophotography". Technical Glossary. 2003. 03 October 2007. <<http://www.exactsurvey.com/orthophotography.html>>.

²⁰ Resolution: A relative, rather than an absolute, value, usually expressed as the density of elements, such as pixels, within a specific distance, most commonly an inch. Besser, H. et al."Glossary". Introduction to Imaging. Revised Edition. California: Getty Publications. 2003. p.16.

²¹Downland Survey and Measurement. "Rectified Photography". 2003. Technical Glossary. 03 October 2007. <<http://www.exactsurvey.com/rectifiedphotography.html>>.

The theodolite has had a considerable function in surveying. Although theodolite (transit) was developed in the early 19th century as an important instrument for a telescope that could transit the scope to allow easy back-sighting and doubling of angles for error reduction, it is a key tool in surveying at present which determines both horizontal and vertical angles.²² The theodolite is a useful instrument for surveying not only large geographic distances, i.e., distances to the tops of distant mountains but also shorter distances.²³

2.1.5. Total Station

Total station, as seen in Fig.2.5., is an optical instrument used in surveying which includes an electronic theodolite (transit), an electronic distance measuring device (EDM) and software running on an external computer. Unlike the theodolite which only determines angles, total station measures angles and distances from the instrument to the points to be surveyed. Furthermore it calculates the actual positions of surveyed points or the position of the instrument from known points. The data can be



Fig.2.5. A reflectorless Total Station, LEICA TCR702, DSOL, June 2006.

downloaded from the theodolite to the computer and the application software generates a map of the surveyed area. Some total stations are compatible with GPS

²² "Theodolite". Encyclopedia Britannica Online. 2006. Encyclopedia Britannica. 03 October 2006. <<http://www.britannica.com/eb/article-9071993/theodolite>>.

²³ Pouzzner, Daniel. "Universal Theodolite Rangefinding". 31 May 2006. 30 April 2007. <<http://www.mega.nu/theodolite.html>>

and thus the combination of these two technologies benefits from the advantages of both and reduces the disadvantages.²⁴

2.1.6. Photogrammetry²⁵

Photogrammetry is a measurement technology in which the three-dimensional coordinates of points on an object are determined by measurements made in two or more photographic images taken from different positions.²⁶ In a few words, it is the art and science to obtain reliable measurements and scaled drawings from photographs. Since its invention in the late nineteenth century, science has developed extensively and at present photogrammetry has played a significant role in a diversity of disciplines such as topographic mapping, architecture, engineering, geology, archaeology, police investigation. Photogrammetry has had a wide use in topographical mapping, ranging from mapping the whole surface of the world, to civil and military mapping, to large engineering surveys. Apart from the topographical use, photogrammetry has played an important role in engineering, architectural and

²⁴The total stations which are compatible with GPS take advantage of these two technologies. For example, in GPS, line of sight is not required between measured points and this is a benefit during surveying. Moreover, when compared with GPS, traditional total station acquires high precision measurement especially in the vertical axis. In addition to these, the combination of the total station and GPS reduces the disadvantages such as the poor accuracy in the vertical axis and lower accuracy without long occupation periods. Total station org. "Total Station". Total station guide. 03 June 2007. <<http://totalstation.org/>>.

²⁵ There are different kinds of photogrammetry methods such as aerial photogrammetry, industrial photogrammetry, close range photogrammetry. In this thesis when I discuss photogrammetry as an architectural documentation technique, I refer to close range photogrammetry.

²⁶The Institute for Prehistory and Protohistory of the University of Vienna. "Introduction to Photogrammetry". The Aerial Archive. 1999. 03 June 2007. <<http://www.univie.ac.at/Luftbildarchiv/wgv/intro.htm>>.

heritage projects. The examples are as diversified from bridge surveys to plant modelings to elevation and plan surveys.²⁷

2.2. Advanced Surveying Technologies

As surveying technology advances new tools have been added to the traditional ones. Now the handheld laser distancing devices (laser tapes) calculate the distant to the target by sensing the amount of time required for a laser pulse to return from it. Laser levels provide an efficient means of establishing a datum line to which floor or ceiling variations can be measured; tablet computers in the field facilitate the transmission of the data instantly to the computer. A diversity of photogrammetric softwares exist which analyze survey images for a wide array of applications; cameras are manufactured for documentation procedures, laser scanners that collect survey 3D Cartesian data send a stream of laser pulses toward a target and calculate the exact distance to that point using time of flight (Bingaman 93-103).

In addition to these diverse instruments that facilitate the recording process and enable a precise architectural documentation project of the subject object/structure/site, all the structures at the site can easily be located by a satellite with GPS (Global Positioning Systems), and all the historical, architectural, geographical etc. data that is gathered through documentation can be archived in a GIS (Geographical Information System) which combines layers of information (Thys-Şenocak 19).

²⁷ Downland Survey and Measurement. "Photogrammetry". 2003. Technical Glossary. 03 October 2007. <<http://www.exactsurvey.com/photogrammetry.html>>.

2.2.1. GPS

Developed by the United States Department of Defense, it is officially named NAVSTAR GPS (Navigation Satellite Timing and Ranging Global Positioning System). GPS is a requisite aid for navigation all around the world, indispensable instrument for map making and land surveying. Through GPS, the users can reach to any 3D position, navigation and time information without any time and place constraints (Güney et al. 6). GPS is currently the only fully-functional Global Navigation Satellite System (GNSS). Since the first experimental satellite was launched in 1978, more than two dozen GPS satellites are in medium Earth orbit now, transmitting signals allowing GPS receivers to determine the receiver's location, speed and direction.²⁸



Fig. 2.6. The GPS satellite determines the time and location

²⁸Total station org. Total station guide. 03 June 2007. <<http://totalstation.org/>>.

2.2.2. Laser Scanner

The laser scanner is a new but a very important tool in the surveyors' armory. Laser scanning is "a technology that captures the digital shape of physical objects".²⁹ Concisely, the operational principle of the scanner in a survey is based on scanning over an area at a predetermined speed and increment and



Fig.2.7. Laser scanner in the field, DSOL, June 2006.

recording a closely spaced collection of 3D points.³⁰ The most beneficial use of the scanner is its capability of recording measurements at a distance and with a high degree of precision. Owing to its +2 to +6³¹ accuracy level at 100 meters, the laser scanner offered excellent results during the surveying of monumental projects such as the Digital Statue of Liberty and the Ottoman Fortress of Seddülbahir.³²

2.3. GIS

GIS³³ is an information management tool which enables integrating, storing, editing, analyzing, sharing and displaying geographically-referenced information. In other words it functions as a modern archiving method where a diversity of data can

²⁹ Laser Design. "Technology Overview- 3D Laser Scanning Technology". 2006. 03 October 2006. < <http://www.laserdesign.com/> >.

³⁰ Downland Survey and Measurement. "Laser Scanning". 2003. Technical Glossary. 03 October 2007. <<http://www.exactsurvey.com/laserscanning.html>>.

³¹ 2mm to 6mm accuracy level

³² The use of laser scanner and the related issues are briefly mentioned here. The subject is dealt more extensively in chapter 3.

³³ GIS (Geographic Information System) is also referred to as Geospatial Information System or Geographic Information Science.

be integrated (Thys-Şenocak et al. 19). This system allows the convergence of layers of information such as topography, planimetric data (monuments, roads, trees, seacoast), architectural data (the 2D and 3D drawings), land use (residential, agricultural, plants), utilities (water and sewer installations, heat system), cadastral data (ownership), historical data (art history, written history, oral history), archaeological data and past illustrations (historic maps, drawings), residential, natural reserves and defensive considerations (Thys-Şenocak et al. 19-20). GIS permits the users to create interactive queries, analyze the spatial information, edit data, and present the results. Consequently, this technology has had a wide use in scientific investigations, resource management, asset management, environmental impact assessment, urban planning, cartography, criminology, history, sales, marketing and route planning.³⁴

2.4. Categorizing Surveying Devices

As the surveying techniques have diversified and the technology has advanced, new challenges arise in terms of implementations and methodologies. The complexity of using these new survey devices in the field is a major topic which will be addressed in the following chapters. However the difficulty of conceptualizing survey techniques is also a significant issue to be addressed particularly with newer technology by those who are using its products. Accordingly the basic definitions of the surveying technologies given previously, a basic categorization can further facilitate our understanding of the new technologies.

³⁴ ESRI. "What is GIS?". The Guide to Geographic Systems. 04 April 2007. 03 June 2007. <<http://www.gis.com/whatisgis/index.html>>.

Surveying technologies can be classified in accordance with non-image and image based considerations and remote sensing. “Non-image based” surveying indicates direct interaction with the structure whereas “Image based” is considered as a surveying technique where the image of the structure is taken into account. In this context, hand survey, theodolite/RDEM survey, GPS are components of the non-image sect whereas rectified photography, panoramic imaging, photogrammetry and laser scanning belong to the indirect one. Remote sensing means the acquisition of information concerning objects and phenomena, using devices that are remote from the object of study. From this point of view remote sensing includes laser scanning, aerial photography, thermal imaging, orbital imaging, ground-based remote sensing, archaeological geophysics, LIDAR.³⁵

³⁵*Aerial photography* is the taking of photographs from the air with a camera mounted, or hand held, on an aircraft, helicopter, balloon, rocket, kite, skydiver or similar vehicle.

Thermal imaging, or *thermography* is a type of infrared imaging. Thermographic cameras detect radiation in the infrared range of the electromagnetic spectrum approximately 900–14,000 nanometers. Infrared Thermography is a picture of heat.

Orbital imaging: Orbit is the path of an object that is moving around a second object or point and orbital imaging means surveying or getting images of the planet by the satellite that has been launched on the planet’s orbital path. Nasa. “Imagine the Universe Dictionary”. 28 January 2004. 28 March 2007. <<http://imagine.gsfc.nasa.gov/docs/dictionary.html#O>>.

Ground based remote sensing: Remote sensing is the science of deriving information about the earth's land and water areas from images acquired at a distance through a ground based device. It usually relies upon measurement of electromagnetic energy reflected or emitted from the features of interest.

TWG-GIS. “Glossary of GIS and Remote Sensing Terms”. 28 March 2007. <<http://fwie.fw.vt.edu/tws-gis/glossary.htm#G>>.

Archaeological geophysics most often refers to geophysical survey techniques used for archaeological imaging or mapping. More broadly defined, the term could refer to any geophysical techniques applied to archaeology.

LIDAR (Light Detection and Ranging; or Laser Imaging Detection and Ranging) is an optical remote sensing technology which measures properties of scattered light to find range and/or other information of a distant target. The prevalent method to determine distance to an object or surface is to use laser pulses. Like the similar radar technology, which uses radio waves instead of light, the range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal. LIDAR technology has application in geology, engineering geology, seismology, remote sensing and atmospheric physics. NASA. “LIDAR”. LIDAR Tutorial. 2 Augus 1999. 31 May 2007. <http://www.ghcc.msfc.nasa.gov/sparcle/sparcle_tutorial.html>.

Chapter 3

Laser Scanner

3.1. What is a Laser Scanner?

The laser scanner is considered to be any device that collects three dimensional (3D) ³⁶ coordinates of a given region of an object surface automatically and in a systematic pattern at a high rate (hundreds or thousands per second) achieving the results in (near) real time and thus captures the digital shape of physical objects without interacting with the object.

3.2. Evolution of the Scanner from Laser Tacheometri to Laser Scanner

Tacheometric measurements are the combination of measured distances and angles from one station. Tacheometric measurement systems are being used extensively and these systems include tacheometer, binocular, laser tracker, laser radar and laser scanner (Staiger 2). The laser scanning technology has been preferred due to its fast, accurate and automated data acquisition in a very short time at varied distances from less than a meter to few kilometers. The laser scanners, capture the digital image of the object through getting 3D coordinates plus the intensity (called as the fourth dimension) of the points.

The laser scanners can be divided to three different groups:

³⁶ 3D means having three dimensions, characterized by Cartesian (x,y,z) coordinates.

- **Camera Scanner:** These scanners have a limited field of view, i.e., 40X40° and optimized to scan a view of the object. Therefore a long range distance measurement device is useful. CYRA 2500 (LEICA) and ILRIS 3D (OPTECH) are examples of the camera scanners.
- **Panorama Scanner:** These scanners have an unlimited field of view only restricted by the base of the scanner (incl. the tripod) which are designed for indoor purposes. Imager 5003 (ZOLLER & FRÖHLICH) or CALLIDUS (CALIDUS PRECISION) are examples of panorama scanners.
- **Hybrid Scanner:** These scanners have one rotation axis without any restrictions (usually the horizontal axis) and the second rotation one is limited (i.e. 60°) due to the mirrors of the scanner. GS 200 (MENSI), LMS Z 360 (RIEGL) and HDS 3000 (LEICA) belong to this group (Staiger 4).

3.3. How Does the Laser Scanner Work?

3.3.1. Triangulation Method

Basically, in the optical triangulation technique a focused beam of light is emitted to the surface of the object illuminating the spot and a camera records the spot. The rest is based on elementary mathematics. The center pixel³⁷ of the spot can be computed, and the line of sight through pixel can be traced until it intersects with the illumination beam at a point on the surface of the object. This method supplies

³⁷ *Pixel*: From picture element. The smallest programmed unit of a bitmapped image, similar to grain in a photograph or a dot in a halftone prints. Pixel size, frequency, and color determine the accuracy with which photographic images can be represented. The greater a pixel's bit depth, the greater the number of different shades or colors it can represent. The larger or fewer the pixels within an image, the more likely "pixilation"-where individual pixels become apparent and break the illusion of continue tone-is to occur.

Besser, H. et al. "Glossary". p.15.

only a single range point, so the professionals have developed other triangulation methods to provide the whole scan of the object. In the first method, the light spot on the surface is scanned by using mirrors, and in the second method the laser beam is fanned into a laser plane where this plane casts a light stripe on the surface of the object and is then captured by a camera. Each camera scanline can be treated differently. The center of the imaged light is found, and intersects the line of sight with the laser plane. As a result, ranging profiles of the object can be achieved by sweeping the light over the object. Although these two methods do not suffer from any ambiguity, the main drawback of triangulation is the limitation of the captured surface. The researchers have developed multi-stripe systems which scan thick stripes to capture as much shape as possible (Curless 2).

Triangulation techniques are useful for small objects and work at distances ranging from one half meter to few meters. Short range scanners operate according to this principle. They provide extremely high resolution data for small objects; their measurement accuracy is below one tenth of one mm and the uncertainty lies between fifty and two hundred μm (Guidi et. al.350).

3.3.2. Time-of-Flight Method (Ranging scanners; Pulsed Scanners)

In the time-of-flight method the distance to the objects is calculated with the help of the laser beam. Basically, the scanner emits a pulse of laser light to the object and waits for its return. The time it takes to reach to the object and come back is calculated by the sensor in the scanner and it provides the distance to the object from the scanner (Curless 2).

“The “time of flight” or “ranging” scanners have a laser diode that sends a pulsed laser beam to the scanned object. The pulsed laser beam moves through a rapidly changing elevation and azimuth angle of a mirror inside the instrument. The pulse is diffusely reflected by the surface of the scene or object and part of the light returns to the receiver. The time that needs to travel from the laser diode to the object surface and return is precisely measured. Knowing the speed of light, the distance from the scanner to the object and the azimuth and angle of the beam, the position of each point where the beam is reflected can be calculated (Slob & Hack 179).”

Louden, further articulates the working principles of the long range scanner as:

“The high-energy photon beam is pulsed out of the scanner head at a rate of up to 800 separate beams per second. When the beam hits any solid surface, it bounces back, dispersing in many directions. Some of that returning light is captured by the mirrors inside the scanner head and sent to the laptop computer via a cross-talk cable. The timing devices within the scanner head records coordinate locations that lie on the surface of the object.”³⁸

The user only has to determine some crucial points via the operating software program: the scan area, point spacing, scene distance and point density.³⁹ Also the user has to know the specifications of the required final products for predetermining the accuracy and the resolution during the scanning process.⁴⁰

³⁸ Loudon, Elizabeth, “Presentation to HABS 70th Anniversary Symposium: Technology and Architectural Documentation on November 15, 2003” <http://www.aia.org/nwsltr_hrc.cfm?pagename=hrc_031215_HABS2003_louden>, 15 September 2006.

³⁹ *Scan area* is the area the user designates for scanning.

Point spacing is the distance between points in the x, y, z coordinate system.

Scene distance is the distance between the scanner and the structure to be scanned.

Point density is the amount of points in an area.

These definitions are taken from a conversation with Karen Hughes during the Documentation Project of the Memorial Temple of Ramses II, Western Thebes, Luxor, Upper Egypt, architect, 10 January 2007.

⁴⁰ “Accuracy relates directly to the scanned object’s optical qualities or reflectivity. High gloss surfaces excessively disperse the beam creating ‘noise’ in the scan or in cases such as the gilded torch on the

After the scanning, the 3D coordinated raw data (point cloud)⁴¹ that has been collected by the scanner can be modified with specialized point-cloud processing software. “The end result typically is a grid of measurement points limited by the size and power of the laser beam and the distance to the object.”⁴²

Time of flight method allows for larger distances to be covered, up to few kilometers. Long range scanners function according to this principle and are utilized outdoors for geodetic surveying and measuring large structures. Although the accuracy remains very high, the disadvantage of these scanners is the loss of precision which goes down to several millimeters. This loss of precision is not a problem during documenting large structures, however it is a drawback if the structure is highly detailed and has small features to be captured (Slob & Hack 179; Guidi et. al.350).

Statue of Liberty, no information at all can be collected. Resolution, on the other hand, is the smallest increment of distance that the timing devices are capable of detecting.”

Louden, Elizabeth, “Presentation to HABS 70th Anniversary Symposium: Technology and Architectural Documentation on November 15, 2003”
<http://www.aia.org/nwsltr_hrc.cfm?pagename=hrc_031215_HABS2003_louden>, 15 September 2006.

⁴¹ “The scanner records thousands of points per second and each point has intelligence, or location coordinates and elevation information. All of these points are placed into the same local coordinate system to make up a *point cloud* which represents the area, building, or object being scanned in a 3D space.” Klimoski, Sam. “Using 3D Terrestrial Laser Scanning to Model the Interior of an Abandoned Theater for Renovation Purposes”. Vol 8, Papers in Resource Analysis. Saint Mary’s University of Minnesota Central Services Press. Winona, MN. 27 December 2006.
<[http://www.gis.smumn.edu/Pages/Graduate Projects.htm](http://www.gis.smumn.edu/Pages/Graduate%20Projects.htm)>.

“The laser dots in a scan or registered scans shape like a *point cloud* in which each dot indicates the x, y, and z coordinate of a point. A *point cloud* represents a collection of geometric data, which are allocated on an object’s surface and therefore can be used to show its appearance and profile. In database, *point clouds* are represented as *scanworlds* or scans and can be exported by x, y, z coordinates and attributes such as intensity or RGB values of color.” Shih et. al. “3D scan for the digital preservation of a historical temple in Taiwan”, Advances in Engineering Software, 2006, p.3. 22 December 2006. <<http://www.elsevier.com/located/advengsoft.com>>.

⁴² Louden, Elizabeth, “Presentation to HABS 70th Anniversary Symposium: Technology and Architectural Documentation on November 15, 2003”
<http://www.aia.org/nwsltr_hrc.cfm?pagename=hrc_031215_HABS2003_louden>. 15 September 2006.

3.3.3. Laser Radar Method (Amplitude Modulation, AM imaging radar)

Laser radar technique is based on calculating the phase difference of the emitted and reflected power signals and hence designating the distance of the object. “In this case, the laser is operating continuously, but the power of the beam is being modulated sinusoidally over time. After bouncing off an object and returning the sensor, the reflected light still has sinusoidal power variation with time, but it is now out of phase with the emitted light. By computing the phase difference between the emitted and reflected power signals, we can again compute roundtrip distance to the surface (Curless 2.)”

Although, generally, short range scanners are utilized for documenting small artifacts, i.e., sculptures, objects, and long range scanners are employed outdoors for geodetic surveying and documenting big structures, in some cases neither of these scanners is compatible for capturing the measurements of the artifact and specialized scanners have been developed for a diversity of purposes, i.e. tunnelling where data has to be obtained from a distance (up to 30m) like long range scanners; but with a higher detail and accuracy like short range scanners (Guidi et. al.351).

Chapter 4

Literature Review

In this chapter, a vast array of laser scanner applications is briefly examined. The chapter is organized chronologically, beginning from the earlier examples of scanning projects to the most recent ones to show the diverse use and change in technology as well as methodology used during the course of few years. Although the examples are chosen from diverse projects, and thus different kind of scanners and accompanying software was utilized, a comparative analysis of these projects for the conceptualization of laser scanning and designation of applications, techniques and problems is useful and important to understand.

4.1. History of Laser Scanner

The laser scanner is an instrument that captures a massive number of coordinates of ground points in 3D with high velocity and accuracy. The scanner was initially used in the late 1980's for mobile robot navigation, and it was developed to enable the robot vehicle to perceive obstructions in its path and to determine the three dimensional shape of its environment with high accuracy (Singh & West 1). In the 1990's, the scanner began to be used in industrial projects where it was used for surveys of industrial facilities, piping and equipment systems. The engineers would utilize the scanner for deformation monitoring and producing fabrication fit-ups (Hughes & Loudon 37). Then heritage professionals realized the advantages of the

scanner such as capturing large amount of accurate data in a very short time. They first used the scanner to construct metric scaled 3D models of the artifacts, i.e. sculptures, to visualize record and undertake metric analyses on the virtual models (Blais & Beraldin 395). As the technology developed, the maximum distance of the laser improved and allowed the professionals to survey increasingly larger surfaces. Subsequently, the scanner was utilized in various applications of architectural, archaeological and topographical research and documentation. When the preservation industry began to use scanners in their projects, they took advantage of the laser technology to measure surfaces, and gather interior and exterior data on buildings and monuments (Hughes & Loudon 37). Recently, the scanner has also been employed to determine the character and to monitor natural hazards such as volcanoes and rock fall studies (Hunter et. al. 204; Abellán et.al 137).

4.2. First Applications of Scanning in Industrial Projects

The laser scanner is a device that collects data in near real time to produce the digital shape of an object. Consequently this technology has been used extensively in the field of industry since 1990's. Surveyors benefited from the collected data to produce 3D models for a diversity of engineering applications. For example, engineers have utilized the scanner to survey large industrial facilities, in order to monitor the infrastructure/materials and calculate the measurements and dimensions of the deteriorated materials that they needed replacement creating compatible pieces for the piping and equipment systems was among the early application of the laser scanner. The scan data is accurate enough to give the exact dimensions of the needed

material; hence it made it easier to retrofit the new parts by extruding, fitting and overlaying them onto the scan data. The utilization of the scanner for large industrial infrastructures still continues and develops with the new advances in the scanning technology (Hughes & Loudon 37). Increasingly, the utilization of the scanner has intensified in various applications of diversified disciplines such as engineering geological practice and research; volume analysis and monitoring, detailed and large scaled topographic mapping, tunneling, rock surface surveying, and digital outcrop mapping (Slob & Hack 179).⁴³ It is useful to examine several of these case studies even if they do not relate directly to architectural documentation projects as the successful or failure of the different application in other fields provides insight into potential uses in the future for diverse types of architecture and landscape.

Volcanology and geothermal research is one of the fields in which professionals have recently utilized the scanner. Monitoring activities play a substantial role in this field. Detailed laser surveys of volcanoes have determined invaluable information about magma movement in the upper parts of volcanoes, volumetric changes after emplacement and more information on changes in the summit region during periods of growth and collapse. Even though traditional measurements and documentation equipments such as the total station and GPS surveys have been utilized in these surveys, these techniques have been unreliable

⁴³Other than these practices, different versions of laser scanner have also become a vital instrument in a diversity of important disciplines:

For instance, in forensic medicine, in which the examination of accidents is imperative, the laser scanner is not only employed to determine the internal findings but also to interpret the collision between the vehicles and pedestrians during an accident and to visualize the accident.

Buck, U. et al., "Application of 3D Documentation and Geometric Reconstruction in Traffic Accident Analysis: With High Resolution Surface Scanning, Radiological MSCT/MRI Scanning and Real Data Base Animation". Forensic Science International 2006.

Laser scanners are also used by entertainment industry during the production process of movies, games, etc. When a real world equivalent model is required, the real scene is scanned and integrated into the production. This procedure is faster than creating the scene by software programs manually.

during eruptions due to safety reasons and rapid changes in the topography (Hunter et. al 203).⁴⁴

In 2000, a team of scholars from varied disciplines scanned Mount Etna to evaluate the potential of the scanner for monitoring ground surface changes.⁴⁵ A long range reflector-less laser scanner (3DLM LR1) seen here in Fig. 4.1 can measure distances up to 2km with an accuracy of ± 25 mm was used with a 360° horizontal and 150° vertical field view and measurement rates range from 1 point per second at 2 km to 4



Fig. 4.1. 3DLM LR1, long range scanner, Mount Etna 2000.

points at 10m (Hunter et. al 203-204). Riegl Laser Measurement Systems invented the software (TerraScan) and 3D Laser Mapping Ltd. developed and provided the application supports. The latter, also participated in the scanning trials at Mount Etna in 2000 to determine the practical operating limitations on volcanoes and to evaluate the value of the scientific data collected (Hunter et. al 204). In the trials, a large number of sites were scanned to test the scanner under different conditions such as a small quarry near to Tre Levelli which contains three lava flow units. The South East

⁴⁴ “The ideal eruption surveying system should be capable of measuring the following from a safe distance:

1. Volumetric changes of lava flow fields
2. Proximal pyroclastic accumulation rates
3. Cone and dome growth rates and dimensions.”

Hunter et.al. “The Application of a Long-range Laser Scanner for Monitoring Volcanic Activity on Mount Etna”. *Journal of Volcanology and Geothermal Research*, 123, 2003, p.1

⁴⁵ 3D mapping Ltd.; Environmental Science Department, Lancaster University; Istituto Internazionale di Vulconologia, Consiglio Nazionale delle Ricerche.

(SE) cone which has been one of the major centers of activity and North East (NE) cone to illustrate the effect of volcanic gas (Hunter et. al 205-208).

In the first case study, the team scanned the quarry at a 20m distance and generated precise topographic data and an intensity image (Hunter et. al 206).⁴⁶ The raw data captured by the scanner contains information about range, intensity, vertical angle and horizontal angle and this data was generated as 3D CAD software package where it was possible to draw sections, perspectives (Hunter et. al 206-207). The second case study, SE Cone, has been one of the main centers of activity since 1998. Investigating SE cone was crucial because the larger instabilities and numerous collapses had occurred there during the

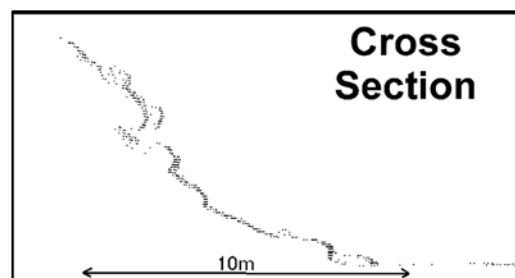
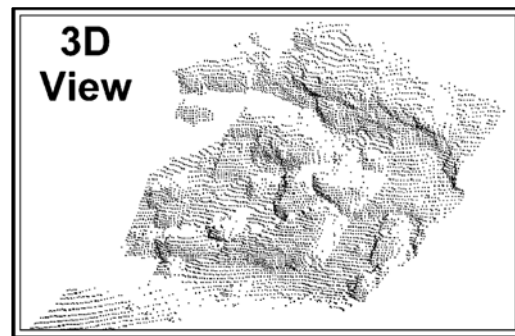


Fig. 4.2. a) photo of the Tre Quarry, b) 3D View (point cloud), c) Cross Section (point cloud), Mount Etna 2000.

eruptions and there could have been another large scale collapse (Hunter et. al 207). The team scanned the SE cone from a distance of 1150m. The data collected during the survey has been used to generate a terrain map of the ground surface, an intensity image, a detailed contour map and a cross section through the centre of the SE cone. If this area is monitored for a longer term and regularly scanned during eruption, then it would be possible to detect precursory movements before serious collapses (Hunter

⁴⁶ The intensity image generated by the raw data was so accurate that it has closely resembled the actual photograph of the subject quarry. Hunter et. al. p. 206.

et. al 208). The third case study conducted in this scanning project was of the NE cone which was partially obscured by gas. This case study was important because it determined the operational limitations of the scanner under volcanic gas (water vapor and carbon dioxide). During the survey, the scanner captured the reflections of the gas cloud and approximately 20% of the point clouds were affected by gas. During the data processing, the effects of the gas were removed with the help of filtering software (Hunter et. al 208).

During the laser scanning application on Mount Etna, one of the main limitations was the obscuration of gas which was blocking the field view of the scanner and was subsequently removed during the processing. Also the laser scanner is a very bulky instrument and moving it around Mount Etna for long distances was very challenging. These three case studies undertaken on Mount Etna proved that the laser scanner is a useful tool for surveying and monitoring the topographic changes of active volcanoes and reaffirmed that the distinctive features of the laser scanner, such as scanning from a distance and collecting a tremendous amount of data at such a short time, are particularly advantageous in this type of work (Hunter et. al 206).⁴⁷

A second application of the laser scanner was in 2002 and supplies us with additional insight into potentially diverse usages for this technology. A consequence of the Quecreek mine accident in Pennsylvania, which was caused by inaccurate maps

⁴⁷ The scanner emits infrared light to the subject structure and records the reflected light for each point. This reflectivity corresponds to the intensity images and helps the operator to determine different material types in an individual scan. Ibid., p. 206.

of the mine, a group of scholars were given the opportunity to demonstrate the mapping quality of the scanner in an underground coal mine (Huber & Vandapel 7).⁴⁸

Mapping mines is intrinsically different from terrain mapping or modeling building exteriors and interiors where airborne sensors enable good vantage points and GPS eliminates the need to register the data from different viewpoints. In the underground corridors of a mine neither of these is available. Furthermore, the narrow corridors of the mine limit the viewing distance and impede registering multiple scans (Huber & Vandapel 8). In the process of modeling buildings, documentation systems which model the environment using planar surfaces and simple geometric primitive are being used, however during the process of mapping mines this approach does not allow for the creation of accurate maps. Further the scanning of most historic buildings is based upon common features such as a door or a window, whereas in the cramped underground corridors these common features are not obtainable (Huber & Vandapel 8). Again, the scanning processes of underground mines may seem unrelated to the kind of work that surveyors of historical architectural structures are grappling with, but in fact, the lessons learned from the scanning of these kinds of difficult-to-access spaces can be extremely useful when spaces such as fortification tunnels or underground chambers and storage areas need to be documented.

⁴⁸ The scholars are from The Robotics Institute, Carnegie Mellon University. Huber & Vandapel. "Automatic Three-Dimensional Underground Mine Mapping", The International Journal of Robotics Research, Vol.25, No.1, January 2006, p. 7.

In the mine project, the team utilized a high resolution 3D laser scanner seen here in Fig. 4.3. (a Zoller and Fröhlich LARA 25200, Z+F) mounted on a cart with a 360° horizontal and 70° vertical view with a range of 22.5 m (Huber & Vandapel 8).⁴⁹



Fig. 4.3 Zoller and Fröhlich LARA 25200, Z+F, The Quecreek mine, 2002.

“The mine consists of a network of several km. in length. Corridors had a low ceiling (approximately 2m high), variable width, and railroad tracks running down the center. The walls were coated non-uniformly with a white, waterproofing material, but in many places, bare coal was exposed. The roof was reinforced with metallic netting, and the environment contained numerous metallic objects, such as pipes and rails. Furthermore, regions of the walls and ceilings were wet and dripping water (Huber & Vandapel 8).”

The team took 23 scans at 3-5 m intervals tracking the loop trajectory⁵⁰ for four sequent hallways. The cart stopped at each location for 90 seconds to capture the scan which generated a surface containing 400, 000 points and 800,000 triangles and covered a 10m section of a corridor.⁵¹ The field work took approximately 3 hours including the setup and disassembly of the equipment.⁵²

⁴⁹ “The scanner produces 8000X1400 pixel range and reflectance images with millimeter-level accuracy. The scan head was inclined to allow higher density of scanning of the floor and ceiling near the scanning platform. Unfortunately, in some regions, the low roof was actually too close to the scan head for the sensor to fully scan the ceiling.” Ibid. p. 8-9.

⁵⁰ *Loop trajectory*: The circle road in the mine that the workers are using.

⁵¹ The team has not recorded the position or the altitude of the cart due to the algorithm system they were using. Ibid., p. 9.

⁵² The cart was pulled manually. The team is working on the development of the pulling system that in a further mine scanning project, the cart can be navigated by an autonomous robot. Ibid., p. 9.

During the field work the team had two main concerns: “the level of noise⁵³ and bias⁵⁴ in range measurements when scanning scenes with widely ranging surface albedo⁵⁵” and “the effect of scanning targets, such as bituminous coal (which is relatively shiny) or wet surfaces” (Huber & Vandapel 9; Huber & Vandapel 10). For the noise issue, the team detected that the noise and bias using a calibration target has had a patch of six different colors including black and white. The team has collected 11 identical scans from the same target and distance (7.5 m) to test the repeatability of the measurement. As a result, the level of noise of the black target was larger than the white target.⁵⁶ However even the worst-case noise (black target) has been valid for mine mapping application (Huber & Vandapel 9). Another concern was about the scanning materials that had a different reflectivity. The team maintained controlled tests on coal samples and scanned the same coal separately when it was wet and dry. Again, the samples were scanned at the same distance (7.5m) 11 times. As a result, the dry sample produced an erroneous range of measurements with reflections; alternatively, the wet sample, reduced the frequency of erroneous measurements (Huber & Vandapel 10).

The team developed a system that automated the modeling-from-reality⁵⁷ process and utilized this system (multi-view surface matching) to register scans. This automatic modeling-from-reality has been crucial for the data processing phase

⁵³ *Noise*: Unwanted data or imperfections in a file that are somehow developed in the course of scanning, processing or data transfer. Besser, H. et al. “Glossary”. p.14.

⁵⁴ *Bias*: The bias of an estimator is the difference between an estimator's expectation and the true value of the parameter being estimated.

⁵⁵ *Albedo*: Albedo is the ratio of reflected to incident electromagnetic radiation. It is a unitless measure indicative of a surface's or body's diffuse reflectivity. The word is derived from albus, a Latin word for "white".

⁵⁶ For the black target the the level of noise was ($\sigma = 5.80$ mm) and for the white one it was ($\sigma = 3.54$ mm). Huber & Vandapel p. 9.

⁵⁷ Modeling-from-reality is the process of creating digital 3D models of real-world scenes from 3D views as obtained, for example, from range sensors or stereo camera systems. Ibid., p. 10.

because the program had automatically registered the multiple 3D data sets (scans) without requiring any knowledge of the viewpoints from which the data was obtained. Therefore, in the field the team did not record the position or the altitude of the cart nor did they survey the scan locations, and additionally they did not even require the order of scanning (Huber & Vandapel 10).

This mine study was among the pioneer works initiated to utilize scanning for mine mapping and been very important for future applications. The final products and highly accurate 3D maps in the project have proved that scanning is an extremely useful instrument for mapping. Also the utilization of the multi-view surface matching has been very advantageous considering the conditions and the scope of the project. This project's approach did not require any additional external sensing requirements', GPS, so the cost and complexity of the project was less in this respect. The team has been developing further advances and alterations of this system for future mine mapping (Huber & Vandapel 16).

In 2004, a group of scholars used a long range scanner in a small test zone in Vall de Núria, Eastern Pyrennes which was chosen due the frequent rockfalls and subsequent damage to the railway nearby (Abellán et.al 137). The team utilized a long range scanner (Iiris3D from OPTECH) because this equipment provided the advantage of measuring large above-surface volumes from a long distance with high velocity and accuracy.⁵⁸ The Iiris3D seen here in Fig. 4.4 can reach to +4 accuracy⁵⁹ at a distance of 100m and collect 2000 points per second (Abellán et.al 137-138).⁶⁰

⁵⁸ Iiris 3D consists of a LCD (Liquid Crystal Display) where the visualization of the scan takes place. The user can issue the necessary parameters (spacing between points, dimensions of the scan area...) by a PDA (Personal Digital Assistant) connected to the computer. Abellán et.al. "Application of a Long



Fig. 4.4 The Iris 3D from OPTECH, Vall de Núria, 2004.

To scan the test area three stations and a total of eight scans were undertaken in less than 2 hours (Abellán et.al 139). To process the data, Polyworks software program was utilized to unite the relevant scans. Due to the limited scanning experience of the team, two of the scans were unsuccessful because of the insufficient overlapping areas of the scans. For this reason, the control points in the point clouds and in the photographs were identified and subsequent acquisition of coordinates was achieved with a reflectorless total station, Leica TRC 705 (Abellán et.al 140). As a consequence of the visualization, the team detected some scanned areas which had no 3D data (shaded areas; void). This shortcoming could have been avoided by scanning at different positions and heights and combining different surveying techniques together (Abellán et.al 140).

Range Terrestrial Laser Scanner to a Detailed Rockfall Study at Vall de Núria”.Engineering Geology, 88, 2006, p.138.

⁵⁹ 4mm accuracy

⁶⁰ The maximum range depends on the reflectivity of the surface and the angle of incidence. The range is 1500 m for the surfaces which have a reflectivity of 80%. However the maximum range of the natural slopes is 1000m due to low reflectivity of the ground. Ibid.

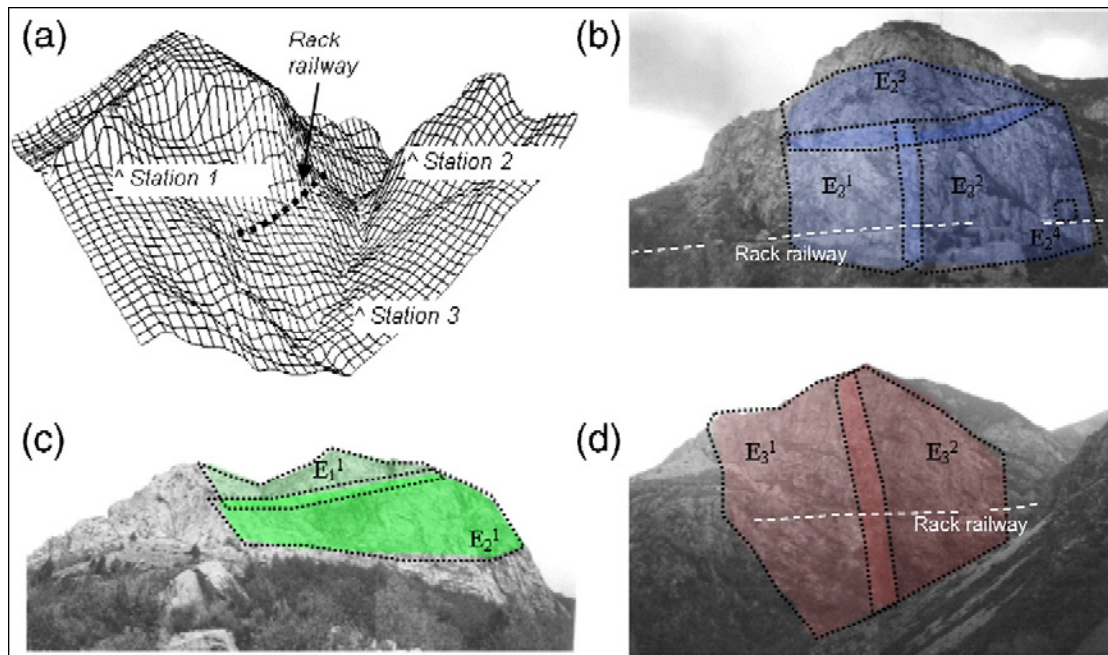


Fig. 4.5. a)The study area; b,c,d) A total of 8 scans were performed from 3 stations, Vall de Núria 2004.

One of the main problems regarding scanning data processing is to deal with the huge point cloud data. For this reason a balance needs to be struck between the data which the scanner has the technical potential to collect and the data which is required for the project; it is important to determine the required data and accurately to obtain a level of the most useful final products (Abellán et.al 140).⁶¹

The team gathered approximately 4 million 3D points, and with this data the team has produced a superficial geometry of the slopes (DEM) and the geometry of the joints in the rocks. The team has used the CAD software to visualize the slope in 3D⁶², and these visualizations from the 3D point cloud or DEM renders have provided

⁶¹ The Ilris3D maintains a preliminary reading of the mean distance to the surface of the slope with the aim of identifying point spacing and the team has used this feature to determine the optimum point spacing according to the needs of the final product. The team has selected point spacing from 6cm to 20cm. To generate a DEM for rockfall simulation, point spacing from 10cm to 20 has been enough, on the other hand the highest density of points in E corresponds with the regular rockfalls in the region and has been required to be studies extensively.

Ibid., p.140.

⁶² In the CAD software, to get a better visualization, the point cloud can be rotated along the axis, zoomed in or moved away from a specific detail.

more accurate data than a conventional topographic map. For example, by using the point cloud, the team has determined bedrock outcrops, potentially unstable rocks, indicators of recent rockfalls etc. (Abellán et.al 140).⁶³

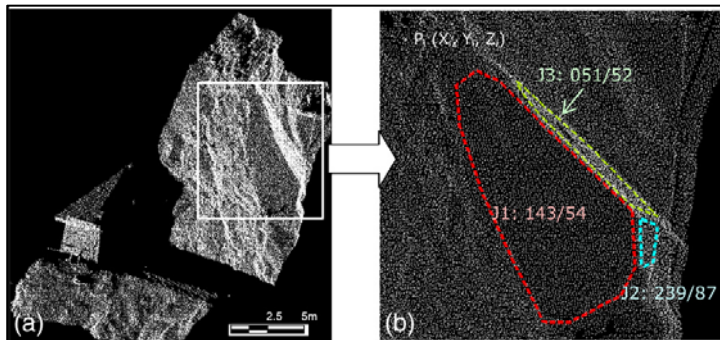


Fig. 4.6. a) Point cloud data, b) Modelling joint geometry, Vall de Núria 2004.

The laser scanner was a useful instrument in this project owing to its ability to collect data with high velocity and accuracy. In addition to this, the long range scanner had the advantage of scanning from a long distance, totally 870m. This feature was vital considering that scanning mountainous areas is dangerous fieldwork and direct contact between the operator and the rock façade should be avoided. Also the scanner allowed the team to produce an accurate Digital Elevation Model (DEM) and obtain a detailed inventory of the rockfalls and a better understanding of the rock fall phenomena. The point cloud provided highly accurate information on the detachment location, joint orientation, volume of detached blocks and characterization of rockfall trajectories and energies. One of the problems during the project which emerged during the data acquisition was that the shadow areas occurred in the point cloud, especially in the case of the horizontal surfaces, the rockslope. This deficiency can be resolved by combining terrestrial and air measures. Another problem

⁶³ The geometry of the slope and height of the source area were obtained with greater accuracy using the point cloud than with a conventional topographic map (1:5000), the back. Ibid., 141.

encountered was the huge point cloud which hampered the data processing work. Further case studies are needed to overcome this problem. For now the best solution is to determine the optimal data density for the estimated final products (Abellán et.al 146).

These varied scanning examples from a diversity of disciplines have indicated that surveyors have extensively benefited from the laser scanner for different purposes. The utilization of the scanner has shifted to architectural documentation, heritage professionals have been examining the diverse case studies which are not directly related to architectural documentation in order to better assess the different challenges that they may face in the field and in the processing phase of a project which utilizes laser scanning technology.

4.3. Early Applications of Laser Scanning in Heritage Projects

Since the scanner was first initiated in the early 1990s, it has gained a tremendous momentum in the heritage industry. Unlike the applications of the scanner in industry or the field of geology which was of large scale industrial structures or landscape features like the volcanoes or underground mines, the use of the laser scanner to document in the museum heritage industry began with the scanning of sculptures and smaller interior spaces. When the University of Ferrara in Italy purchased CyraX 2004 in 1998 and started to experiment with the scanner on historic structures, no one would have guessed the extensive use of scanners in the field today (Hughes & Loudon 39). When Lockett was writing his professional practices on

recording industrial sites with CAD technologies in 2000, he mentioned the laser scanner as a promising device to gather 3D data in field, yet extremely expensive (41). A lot of changes have occurred since these initial expectations. Now an immense body of literature is devoted to the use of the scanner in the heritage industry and everyday brings new practices.

In heritage projects, the laser scanner was first utilized on artifacts, i.e. sculptures. For example, one of the pioneering uses of the laser scanner in a heritage project was the Digital Michelangelo project undertaken by scholars from Stanford University and the University of Washington.⁶⁴ A team consisting of 30 people, faculty, staff and students spent the 1998-99 academic year scanning Michelangelo's sculptures and artifacts, including the David, the Unfinished Slaves (Atlas, Awakening, Bearded, and Youthful), the St. Matthew, the four allegorical statues from the Medici Tombs (Night, Day, Dawn, and Dusk), the architectural interior of the Tribune del David in the Galleria dell'Accademia, and the architectural interior of Michelangelo's New Sacristy in the Medici Chapels. The project aims were research oriented, scholarly and educational. The team initially wanted to produce a 3D archive of Michelangelo's works, capture and record his chisel marks due to a request from the museum curators.⁶⁵

⁶⁴ Levoy, Marc. "The Digital Michelangelo Project". Computer Science Development Stanford University November 2003. 11 September 2006. <<http://www.graphics.stanford.edu/projects/mich/book/book.html>>, and also

Levoy et.al. "The Digital Michelangelo Project: 3D Scanning of Large Statues." Proc Siggraph, 2000. p.1-14.

⁶⁵ Levoy, Marc. "The Digital Michelangelo Project". Computer Science Development Stanford University November 2003. 11 September 2006. <<http://www.graphics.stanford.edu/projects/mich/book/book.html>>.

The team used two scanners and a software program. The main scanner seen here in Fig. 4.7 was manufactured by Cyberware Inc. of Monterey, California according to the team's requirements. To process the data, software and a special algorithm was developed at Stanford University by the team to align and combine the scans, to fill the holes⁶⁶ and to process the range⁶⁷ and color data.⁶⁸

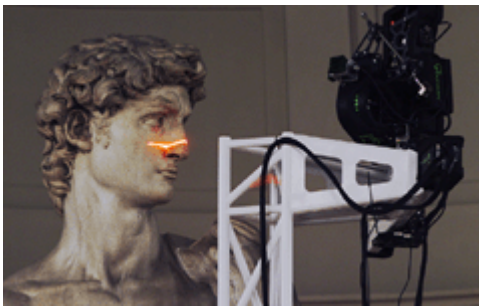


Fig. 4.7. The scanner working, the Michelangelo Project 1998-99.

The two main problems the team faced during the scanning were the enormous data set collected and insuring the safety of the statues.⁶⁹ Even the data set for the statue of David –occupied the largest data set among the whole project- consists of 400 individual scans, 2 billion polygons and 7000 color images. Altogether it occupied 60 gigabytes of computer storage. This immense data set unfortunately made it impossible to manipulate the data easily. The challenge of insuring safety for the statues during scanning was another issue that the team had faced. Although scanning is fundamentally a non-contact digitization method, positioning a scanner too close to a precious artwork, may cause accidental collisions. To prevent collisions,

⁶⁶ When the team combined all the scans together, they came across holes in the scan data which emerged due to the lack of an automated scan planning. They filled the holes by processing the data.

⁶⁷ *Range image*: During the scanning, by sweeping the laser stripe across the object, a full record of the three-dimensional shape of the object is obtained, at least as seen from one side. The resulting data takes the form of a grid of points in three-dimensional space, sometimes called a *range image*. Ibid.

⁶⁸ Ibid.

⁶⁹ Ibid.

the team used a long standoff distance and pressure-sensitive motion cutoff switches. Safe operating procedures and extensive training of the scanning crew were also undertaken. To reduce the chance of damage in case of inadvertent contact, the scan head was encased in foam rubber.⁷⁰

The final products of this project are to be used for a variety of purposes. In addition to making replicas of the artifacts for restoration and educational purposes, the project has provided answers to varied questions such as what are the number of teeth in the chisels employed in the carving of the Unfinished Slaves or what is the smallest size block from which each of the allegories in the Medici Chapel could have been carved; or is the giant statue of David well balanced over his ankles. Furthermore the scan data itself has offered new view points of the objects. For instance, in addition to the accustomed viewpoint of David from the ground up, the scan data has provided new viewpoints, i.e., with the scan data now it is possible to observe David from the face level rather than from below. Further, from the education point of view, the interactive viewing computer models offer tremendous virtual experiences and the digital models of the artifacts can be accessed anywhere without time or budget constraints. Viewing art in this digital medium has shifted the viewer's role from a more passive act where there is limited access to an artifact to a much more active journey.⁷¹

⁷⁰ Ibid.

⁷¹ Ibid.

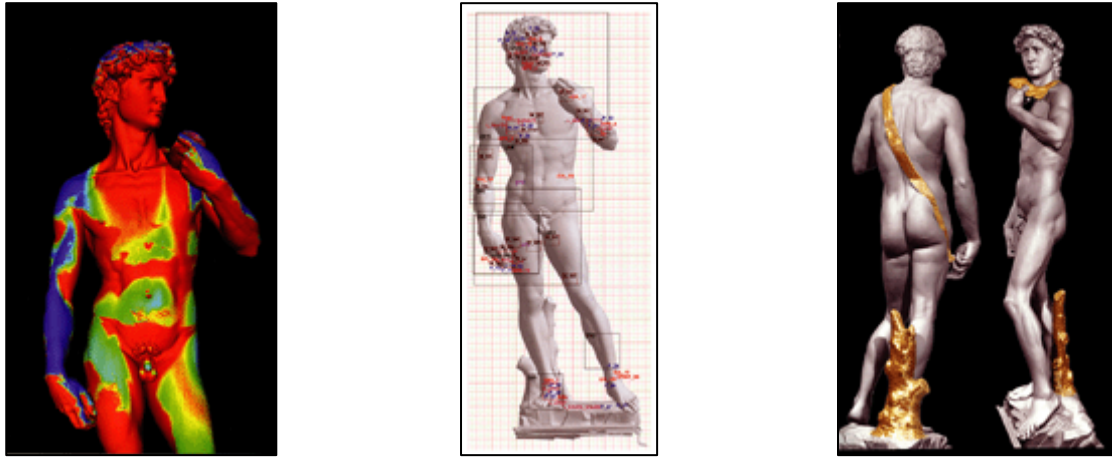


Fig. 4.8. Some images created using the 3D model.

Exposure of the statue surface to nearly vertical (± 5 degrees) deposition of rainwater, dust, and other contaminants (left)

Locations of analyses carried out on the statue surface (middle)

Hypothetical placement of gilding reported to have been applied in the 16th century (right)
The Michelangelo Project,

The documentation project of German Emperor Maximilian's Tomb is another example which has utilized scanning for heritage recording. The tomb was completed in 1568 and no documentation of it had been done since then. In 2002, the scanning team was commissioned to document it as part of the preservation and restoration plans for the tombs (Boehler et. al 1).



Fig. 4.9. The tomb of German Emperor Maximilian, 2002.

The tomb is located in the center of the nave of the Hofkirche Church, State of Tyrol as seen in Fig. 4.9. The tomb is 3m X 5m and has 24 white marble reliefs embedded on a black marble structure with bronze decorations. For centuries the tomb was separated from the visitors by wrought iron lattice and all the reliefs were covered

with glass plates. During the restoration of the cenotaph⁷², after the restoration of the right wing, the procedure was conducted on the other side and it was the first time that the tomb was accessible from all sides and unwrapped from all the lattice and plates. This was the time that the complete documentation and the measurement work was conducted (Boehler et. al. 1).

“Both, close range photogrammetry and 3D scanning techniques were used. A common geodetic control point system was installed for both methods. Photogrammetric work consisted of stereo points and separate color images. 3D scanning was accomplished with a MENSİ S25 for the overall structure and a GOM ATOS II at high resolution for the relief plates (Boehler et. al 1)”.⁷³

MENSİ S25, captured the complete scan of the entire cenotaph with a point density 2mm. and from 20 vantage points, approximately 10 million points were achieved in 60 hours scanning time (Boehler et. al 2).⁷⁴ Additionally, the GOM ATOS II was utilized to scan the fine marble reliefs on the cenotaph with high precision. 12 scans were obtained for each relief; the raw data for a single relief was between 450-700Mbytes (Boehler et. al 3).

⁷² *Cenotaph* means empty tomb.

⁷³ The setting of tasks was not clearly defined before the project. Therefore, the team decided to undertake a combination of geodetic methods to benefit of this rare opportunity when the four sides of the tomb was accessible. Thus they produced the detailed drawings. A photogrammetry stereo model does not provide a precise representation of the object. However a 3D visualization technique, i.e., laser scanning, can achieve a more accurate model with more intricate details. The classical close range photogrammetry was used for the complete measurement of the cenotaph whereas the 3D documentation was carried out by the scanners. Boehler et al. “Documentation of German Emperor Maximilian I’s Tomb”. *CIPA 2003, International Symposium, Working Group 6*. Antalya, Turkey. p.1.

⁷⁴ If the scanning range is not surpassed, the scanner has a point accuracy of better than 1mm. Ibid., p.2.

As for processing the scans Raindrop Geomagic Studio software program (version 4.1 and 5) was employed (Boehler et. al 3). Before the project different programs were tested for the processing phase and the Raindrop Geomagic Studio was decided upon as the most compatible with the project. It was impossible to deal with the immense data and even to run all the steps to complete a model for an 82cm X 55cm dimensioned single relief. Therefore the solution was: all the points outside the scan area and 35-45% of the total points were deleted to reduce the point density (Boehler et. al 3). The 3D model of the overall cenotaph has been coarse compared to the individual relief models (Boehler et. al 6).

The experiences of the Maximilian Tomb Project serve as a cautionary lesson to heritage planners. In this project even though the laser scanner provided a high quality of data in terms of accuracy and efficiency, the processing phase consumed too much time and effort. Additionally, this project suffered from incompetent software and inadequate hardware to deal with the immense data sets.



Fig.4.10.Coarse resolution model (shaded view of point cloud) of the tomb, 2002.

A combination of all scanned and meshed information was not brought together and there is little doubt that it will be accomplished in the near future. It is possible, if the rapid advances in the scanner technology continue, that results can be acquired since everything is archived but the proper decision making at the outset of the project is crucial, as this team has learned (Boehler, et. al 6).

Another very interesting application of laser scanning documentation in the heritage industry has been the “Digital Preservation of Ancient Cuneiform Tablets Using 3D Scanning”, conducted by John Hopkins University. Cuneiform is the world’s oldest known writing system and cuneiform tablets are one of the oldest documents of mankind (Kumar et. al. 1). These tablets have been scattered in various museums all around the world and this has impeded the scholars to access the complete corpus of tablets. To date, only 10% of the tablets have been deciphered (Kumar et. al. 1).



Fig. 4.11. 3D scan of a “micro tablet” in the John Hopkins arch. collection.

Traditionally, cuneiformists and the archivists have used 2D photography, hand drawn copies to document the tablets. However these techniques have been inadequate to represent an accurate and extensive documentation of the tablets (Kumar et. al. 2). In 2003, scholars initiated a project to scan the tablets in order to provide accurate, high resolution 3D models for the scholars’ use and digital preservation of the tablets (Kumar et. al. 1).

The team obtained the scanners from the Canadian National Research Council. Furthermore, for the registration software, unlike the other algorithms that generated holes or incorrect triangulation in the under-sampled areas, the team developed an algorithm which detected holes in a scan automatically to guide the operator in planning the next scan (Kumar et. al. 4). Due to the large amount of tablets to be

scanned, the manual registration methods consumed too much time and effort, so an automatic registration procedure was substituted for the manual ones. The team has been working on perfecting this aspect of the project (Kumar et. al. 4). Owing to the fact that the tablets are fragile and invaluable artifacts they had to be handled carefully and the physical contact with the objects was kept at minimum. To eliminate any damage to the tablets, any physical fiducial⁷⁵ marks were avoided. During the scanning, the team maintained a scheme where the approximate fiducial markers were placed near the object using pointing pins attached to flexible arms. The fiducial arms were not attached to the object but moved with it. In this way, the team manipulated the movement of the scanner and the object but limited the need to reposition the object (Kumar et. al. 4).

This project served as the initiative step of a wider one of scanning hundreds of thousand cuneiform tablets with high accuracy and high resolution to develop a digital library for research purposes. Therefore the scanner has to be manipulated in the field easily; it to be light, fast and largely automated. The team has been also working on scan-planning and automated scanner placement, and has developed more appropriate algorithms which they continue to work on perfecting (Kumar et. al. 7). In general, the 3D visualization is an instrument which the project director sees will allow “the virtual autopsy of the cuneiform tablets”⁷⁶ and will increasingly lead to new alterations regarding these studies. The digital replicas and the archival copies of the cuneiform tablets will be broadly available, facilitating the scholar to study without expensive travel grants or time constraints (Kumar et. al. 2). Also the limited physical contact with the actual object will enhance the preservation attempts.

⁷⁵ In applications of augmented reality or virtual reality, "fiducials" are often manually applied to objects in the scenery to recognize these objects in images of the scenery.

⁷⁶ Kumar et. al. 2.

Another promising application of a short-range scanner for heritage documentation is the scanning project of the Egyptian Tomb of Seti I in the Valley of the Kings. In 2001, Factum Arte was commissioned to carry out the research and develop a procedure to produce the replica of the 16m² section of the burial chamber of the tomb (Ahmon 112).⁷⁷ Unfortunately, the tomb of Seti has suffered from the destruction by human hands since its discovery in the 19th century by “squeezing where an impression of the relief is taken in wet paper, plaster or wax, removing much of the paint layer in the process (Ahmon 114)”. Also, movements in the rock strata, graffiti, vandalism, and losses caused structural problems in the tomb. Furthermore, the tomb of Seti, has suffered from visitors as even, a small number of visitors can bring a substantial threat due to uneven fluctuations in temperature and humidity. Moreover, accidental damage is an immense risk factor considering the cramped spaces, uneven floors and low level of lighting. Due to the threats a decision was made in the 1980s to close the tomb to visitors (Ahmon 112). Therefore a construction of a replica of the tomb would not only enable visitors to experience the tomb once again, but also would facilitate aid research projects (Ahmon 112).⁷⁸ The concept of replacing the original object at risk with the replica is not a new approach and it is controversial but most of the heritage experts agree that if a substantial risk exists to a site or an object with continuous exposure to the threat, an acknowledged and clearly labeled replica of the site or an object is an acceptable course of action. The replacement of Michelangelo’s masterpiece David is one famous example among many. More

⁷⁷ The lavishly decorated burial chamber is over 6m high and the wall surfaces are approximately 2000m².

Ahmon, Jess. “The Application of Short-Range 3D Laser Scanning for Archeological Replica Production: The Egyptian Tomb of Seti I.” *The Photogrammetric Record*. 19 (106). p.112.

⁷⁸ The replica of the burial chamber was exhibited at the Museo Arqueológico Nacional in Madrid in November 2002.

Ibid., p.113.

recently the Lascaux II and the Neocave at the Altamira Museum have used replicas of entire caves as a virtual substitute for visitors (Ahmon 112).

3D digitization, has the advantage of being a non-contact method of gathering data, and eliminates further damage unlike the alternative methods of replication (copying by hand, moulding, and casting). In this context, the project's distinctive purpose is to create an archaeological replica of the tomb with laser scanning, digital photography and industrial fabrication techniques (Ahmon 112). The project suggests the utilization of laser scanner and digital photography to record the tomb at the highest possible resolution and then to output the data as a 3D relief using industrial techniques. Additionally, during the production of the replica of the tomb, the team emphasized the importance of utilizing materials and methods similar to the ancient Egyptians were using (Ahmon 113-114).

Factum Arte and 3D Scanners (UK) developed a scanner (the Seti Scanner) particularly for this project which “is robust and simple enough to make it easy to set up and maintain” and “capable of functioning in very dusty and hot



Fig. 4.12. The Seti scanner working, Tomb of Seti I, 2001.

conditions as temperatures are, on average over 30° (Ahmon 115)”. The Seti scanner uses the accompanying Riscan software to capture and display data and in addition to

this additional software was developed by Factum Arte (Ahmon 115).⁷⁹ In addition to the Seti scanner, a second scanner, the Model Maker X, was tested successfully during the project although the data from this scanner has not been utilized in the project. The second scanner was a manual hand-held scanner and needed because it could scan around the corners and underneath ledges (Ahmon 117).⁸⁰ The Seti Scanner has a Reversa 25H scanning head, vertically mounted onto XYZ linear guides. A Computer Numerical Control machine controls the movement of the head (Ahmon 114).⁸¹

“Once the Seti Scanner has been set up and calibrated it scans a series of horizontal passes. The laser strip passes across the surface of the wall as the scanning head moves along the linear guide. The data comes up on the computer screen in real time so that errors can be detected and corrected straight away. The scanning head can scan a tile up to 52x52cm² before being repositioned by the scanning operator to scan the adjacent tile. The guides are tall enough to enable a vertical strip of up to six tiles to be scanned before the system must be moved (Ahmon 114).”

⁷⁹ The Riscan software has special features such as a color-coded display to indicate the relief, merging features, gap filling and data cleaning. Also Factum Arte developed additional software to run the computer numerical control and merge the data after each pass. Ibid., 115.

⁸⁰ The Model Maker X operates according to the triangulation principle. “Model Maker X is a hand-held system consisting of a scanning head, very similar to the Reversa head, mounted on an articulated arm which has six degrees of freedom, attached to a tripod. The scanning head is held in the hand so the path of the laser strip is controlled manually. It is therefore more flexible than the Seti scanner and can be used to scan around the corners and underneath ledges. The Model Maker X, has a potential maximum resolution of 200µm. In practice the quality of the data is dependent on the skill of the operator. The processes data has a maximum resolution of 200µm. (Ahmon 117).”

⁸¹ 3D Scanners UK supplied the Reversa head. Ibid., p. 117.

The relief data that was scanned and captured at a resolution of 100 μ m was stored directly onto CD and 3D data file. One tile required 650mb (Ahmon 114- 115).

Due to the mechanization of the system, the system generated points that were positioned in a regular, orthogonal grid which precluded any further processing such as meshing, triangulation and optimizing. Unlike the random point cloud which needs interpolation, the system utilized in this project does not require any of this processing and thus improves the accuracy of the data, lessens the time of the processing and eventually

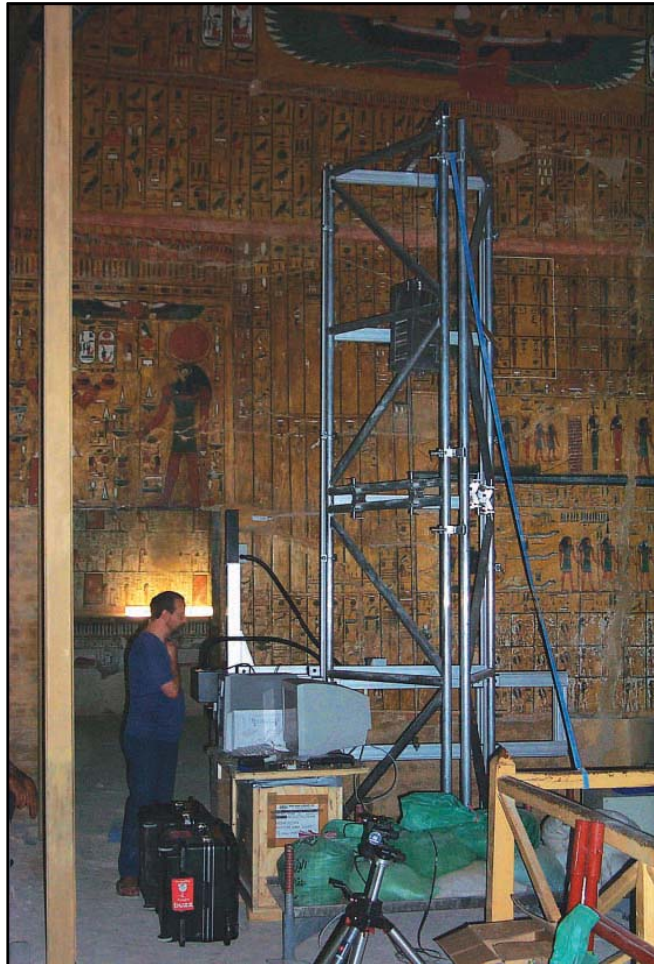


Fig. 4.13. The Seti scanner working in the burial chamber Tomb of Seti I, 2001.

reduces the cost. Furthermore, the elimination of post-processing the scan data means that the replica is made of the actual data instead of processed data and thus this is a breathtaking advance considering the processes involved in making a replica: there is no transition phase or processing needed to acquire the replica anymore (Ahmon 115). In addition to scanning, digital photograph records were taken with a Hasselblad camera with a Phase One H20 instant capture back and specially designed units

(Ahmon 117). Also, selected colors from the reliefs were recorded on paper with gouache paint⁸² to ensure the accuracy of the colors when printing (Ahmon 118).

“The scanned data was cut as a 3D relief by industrial milling techniques. This was then cast in materials resembling the original tomb and printed in full color, using the digital color data, on a specially modified flat-bed printer (Ahmon 113).”⁸³

All the digital data was given to the Supreme Council of Antiquities of Egypt. From the documentation point of view, the data is all available for further studies and applications. From the conservation point of view, the scanning project of the tomb of Seti and the replica provides further hope for the heritage at risk (Ahmon 122).

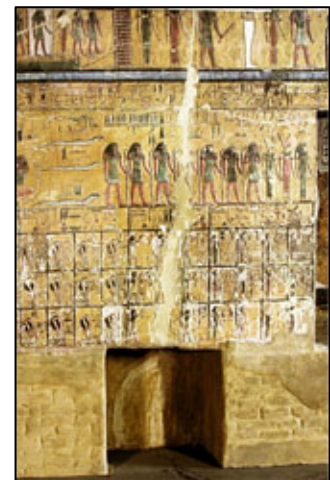


Fig. 4.14. The replica of the burial chamber of Tomb of Seti I, 2001.

In 2005, “3D Scan for the Digital Preservation of a Historical Temple in Taiwan”, a promising application of a long range scanner in heritage documentation was undertaken. The main hall of Pao-An temple in Taiwan was scanned, a digital recording of the temple was undertaken as an extension of a project to record Chinese architecture. This project is the first project in Taiwan to employ the 3D scanner to record the main hall of a temple inside out (Shih et. al 2).

⁸² *Gouache paint* is a type of paint consisting of pigments in water.

⁸³ The production of the replica and all the milling was carried out by Delcam UK in Birmingham using a three axis machine. The scan data was cleaned and prepared to be used by Delcam’s Power Mill NC software. Each 52x52cm square tile was cut using advanced cutting tools which consists of ball-nosed and conical cutters. The cutting tool was 0.6mm and thus it took 24 hours to cut each tile. The tiles were milled from high-density polyurethane board. Silicon moulds were made out of these plastic panels. Eventually the replica was built from these moulds (Ahmon 118-119).

The first temple at the site of PaO-An Temple was a small one, made of wood which was constructed between AD 1775 and 1760. The existing structure was constructed between AD 1805 and 1830. It is an opulent wooden structure exhibiting a gorgeous combination of religion, architecture, and art related creations. Basically, it has three main halls (the entrance hall, the main hall, and the back hall) on the south, and two side rooms on the east and west. In the main hall is a section of the temple which is a masterpiece with its double-eave mountain styled roofs. Four dragon pillars are in front of the temple and serve as important relics dating from the initial founding stage of the temple (Shih et. al 2). Even though the constructions and renovations of the temple have been recorded in 2D drawings for over 170 years, these records have not been enough to identify the fascinating details of the structure such as its free forms and curves, abundant 3D decoration, the interrelation between the interior and exterior and the immense double eave mountain style structure. The former documentation efforts consist of manual measurements; hence compared to the digital surveying technologies, they were not sufficient to record the distinct features of the temple (Shih et. al 1). Furthermore, in this project it was anticipated that the new scan data and the old drawings could be compared for accuracy (Shih et. al 2).

The Cyrax 2500, a 3D long range laser scanner (50-150m) was employed to retrieve the data. The Cyrax seen in Fig. 4.15 operates according to the time of flight⁸⁴. It is suitable for large outdoor structures such as this temple or landscapes.⁸⁵ The scanner was utilized



Fig. 2.15. The Cyrax 2500 working in the Pa0-An temple, 2005.

with the accompanying software, Cyclone 3.2/4.0 to control the scanner, process the data. The temple was recorded with 1958 exterior and interior scans out of 131 scanworlds^{86, 87}. Beside the scans of the overall structure scans, additional ones were made to the detailed components and curves (114 scans from 34 scanworlds) and decorative components such wood frames, dragon columns, roofs and sculptures. The overall field work took 308 man-hours (Shih et. al 3).

⁸⁴ “The “time of flight” or “ranging” scanners have a laser diode that sends a pulsed laser beam to the scanned object. The pulsed laser beam moves through a rapidly changing elevation and azimuth angle of a mirror inside the instrument. The pulse is diffusely reflected by the surface of the scene or object and part of the light returns to the receiver. The time that needs to travel from the laser diode to the object surface and return is precisely measured. Knowing the speed of light, the distance from the scanner to the object and the azimuth and angle of the beam, the position of each point where the beam is reflected can be calculated.” Slob, S.; Hack, R. “3D Terrestrial Laser Scanning as a New Field Measurement and Monitoring Technique”. Engineering Geology for Infrastructure Planning in Europe Perspective. Lecture Notes in Earth Sciences. Vol.104. p. 179.

⁸⁵ The main hall is about 20m long, 18 m wide and 16m high. Moreover, the distance between the scanner and the highest point of the temple fell within the best range of 50m. Shih, Naai-Jung et.al. “3D Scan For The Digital Preservation of a Historical Temple in Taiwan”. Advances in Engineering Software. September 2006. p.3.

⁸⁶ “A scanworld is a sort of a database which constitutes of more than one scan. Every time a new scan location or angle is determined, another scanworld is designated. In a scanworld the total amount of points can reach to 10 millions. However due to the browsing and modeling efficiency, the number of points in a cloud should be reduced to 50.000 or 200.000 points” Ibid., p.4.

⁸⁷ Among these 1958 scans, 253 of them (out of 83 scanworlds) were made by original scans and the rest were created along the registration process. Ibid., p.4.

During the scanning the team encountered some problems. Due to the size of the structures in the site, such as the back hall of the temple and the surrounding buildings which were higher than the main hall, it was not possible to get scans of the eave roofs of the temple



Fig. 4.16. The interior of the main hall of the temple, 2005.

from these locations. However, the open spaces around the temple were very narrow for wide angle scans and impeded the reference views to combine the interior and exterior scans. Furthermore, the scanner had a limited field of view (40° horizontal and 40° vertical), so it was moved around the temple to accomplish the exterior scans segment by segment. Accordingly, a scanning scheme had to be developed to combine the scans of the temple from the ground level with the bird's eye scans from the street for the exterior appearance in conjunction with the interior scans to produce the overall structure (Shih et. al 2). Besides, the exterior and interior scans were dramatically different due to the fact that few reference scans could be made through the limited openings of the temple. The final scans were carefully determined and included part of the temple roof, interior cabinets, and walls as references (Shih et. al 5). Also determining the scan positions in the field became a problem. If the scanner is to scan an artifact, the object would be rotated to retrieve different positions of the object. On the other hand if a structure/landscape is to be scanned, different scan positions and angles available in the site would prevent visual obstructions. In the case of Pao-An Temple, the team came across many visual obstructions due to the distinct structure of the temple, the centralized table layout and the hanging lamps which were not supposed to be moved away. Therefore the team had to visit the

temple frequently to have more scans of the obstructed areas from other directions (Shih et. al 5).

As a result of the complicated and challenging scanning experiences encountered in the field, the project team had to develop a methodology for scanning this type of structure. It is as follows:

- “Pre-scan: the planning of scan resolution, machine circulation paths, power supply, registration locations, time schedule, manpower, weather, etc.
- On-site scan: the planning of scan locations and registration reference schemes. The data management system creates an interface for researchers to input operation-related information, such as date, scan number, scan project number, weather, number of people involved, scan type, scan location, target description, registration type, the number of points, starting time, operation hours etc. Researchers can examine individual scan and registered scans through this interface. On-site scans are made using the following steps:
 - Omni scans: the larger area scans define the relative locations of parts within the whole temple configuration
 - Focus scans: the small area scans to define the shape of individual object like a dragon column or the wood components under the roof
 - Post scan: data manipulation, such as file back-up, scan registration, polygon creation, shape comparison, drawing production and web design (Shih, Wang et. al 4)”.

Cyclone software provided auto-registration function to register the clouds. Three or more reference points inside each scan had to be tied together and the selected points were not linear or allocated to a small region. This approach resulted

in less than 2 cm error in tolerance. Furthermore, during the scanning in the field, additional registration instruments were used such as spheres and theodolite. However due to the narrow spatial dimensions of the temple, most of the time spheres did not work and most of the time the team preferred the auto-registration method (Shih et. al 5).

Beside the basic advantages of the scanner such as the speed of data acquisition, amount of data, outreach to the inaccessible places, due to the distinct features of the structure, e.g. built free forms, curves, the scanner enabled the documentation of the 3D features that were impossible to define with the hand measurements. Also during the course of the project, the comparison between the original drawings and the scan data indicated the higher level of accuracy of the digital data. The comparison not only was undertaken by overlapping the digital data with the point cloud, but also employing a theodolite to check the reference points of the scan data. Once again, the digital data proved to be accurate. Furthermore, the team applied a straightforward cross check method where they took a slice of point cloud data on the roof to make sure all the cloud sets were seamlessly registered. This method also reaffirmed the accuracy of the digital data (Shih et. al 9).

web. However as the project continued the maintenance of metadata became a vital concern⁸⁸. Because not only the overall 3D structure, but also the parts (roof, body, base...) were registered and hence all the scanned components were categorized by name, alias, material, finishes, dimension, description, location, date of creation, modification date, creator, photos, related 3D point cloud and surface model. Therefore the classification process for the temple should be undertaken according to the metadata of the webpage so that a user can utilize the project and website efficiently using the same keywords (Shih, Wang et. al 7).

During the project, the team encountered some other problems: the interference of obscuring objects in the field which would be alleviated by scanning from other directions or utilizing a hand held camera; the weight and size of the scanner which impeded the navigation of the scanner around the site; the high budget of the scanning which makes the projects with smaller budgets unable to utilize the scanner (Shih et. al 11). Overall, scan data was useful and a more efficient way to represent the as-built geometric information of the temple when compared to the traditional recording methods. Also this digital data is very promising for the further chronological comparisons and to discover possible configuration changes. The scope of the project will shift from the temple to street blocks in the near future and the scans for the individual building can be included as part of the urban scenes to provide a more precise description of as-built environments for building design and planning control (Shih, Wang et. al 12).

⁸⁸ *Metadata*: Commonly defined as “structured data about data”, or data captured in specific categories or elements. Metadata can include data associated with either an information system or a data object or set of objects for purposes of description, administration, preservation the documentation of legal requirements, technical functionality, use and usage, and so forth. Besser, et.al. p.12.

The documentation project of Shubert Theater in Minneapolis, Minnesota in 2006 was another example of utilization of a long range laser scanner in architectural documentation. The project was undertaken to produce a model of the interior of the abandoned theater for renovation purposes. The Miller Dunwiddie Architecture commissioned Martinez Corporation to produce the drawings of the theater. Scanning was determined to be the most efficient method to obtain a model of the existing condition of the theater; the conventional surveying problems such as line of sight, accuracy and time constraints would be alleviated by the utilization of a scanner and a renovation project would be produced directly based on the digital 3D data.

The theater had been abandoned since the early 1980s and the building had been physically moved to its present location in 1998. Owing to the years it was abandoned and the shift of its location of approximately a block away, substantial damage happened to the theater. Some of walls and ceilings had deteriorated in such a way that in some areas of the ceiling the steel girders were exposed, some of the ornate plaster on the balcony and columns were in an advanced state of disrepair, and overall the theater was in a bad condition (Klimoski 3). Therefore the architectural firm's initial interest was to obtain all the accurate data of the theater at present to monitor and hence to produce the renovation project. Additionally, the firm wanted to tie the scan data to a real world coordinate system with which the existing CAD drawings of the surrounding area could be used in conjunction, and thus this final product could be used in the creation of renovation plans and public presentations about the theater (Klimoski 1).

In order to accomplish all these tasks a Leica HDS 3000 laser scanner (Fig. 4.18) was employed with the accompanying Cyclone software to operate the scanner and process the data (Klimoski 4).

Before scanning the theater, an outline of the scanner positions or scan worlds were estimated to capture all the data needed. Due to the great amount of sight obstructions inside the theater, twenty six scan worlds were required. The remaining seats, debris, hallway turns etc. required more scans

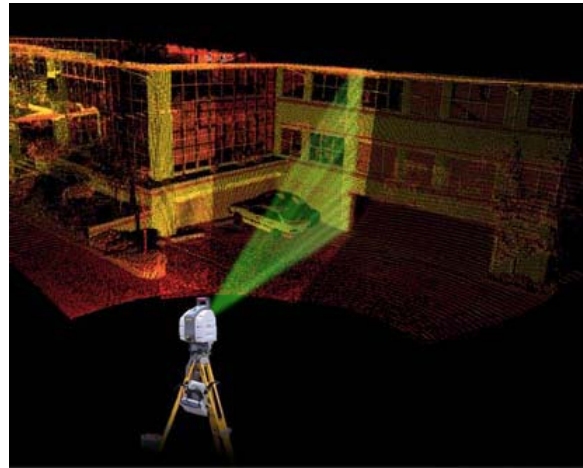


Fig. 4.18. The HDS3000 surveying interior of the Shubert Theatre, 2006.

to articulate the interior of the theater. In addition to these, two of the scanworlds were determined from the vantage points to hit through the theater windows in order to tie the interior with the existing surveys that had been conducted of the surrounding area (Klimoski 4).

“The first step the scanner takes is to take a digital image of the area from each setup. This image shows the entire 360 degree view from each setup. This image shows the entire is then to highlight areas that are to be scanned. The option to scan the entire field of view is available as well. Therefore, once the image is taken, the scanner operator uses the image as a reference for what will be scanned. These scans can all be set up to run in a script so there is no operator intervention once the scans are scripted (Klimoski 4)”.⁸⁹

⁸⁹ *Scan script*: the sequence of the numerous scans one after another.

The Cyclone software allows the user to set the scan density, scan area of the scans, set up the scan scripts and provide a view of the point cloud in the field during the scanning. At each scanworld the scanner was mounted on a tripod and set at to provide a 360° of the scan area from that vantage point at a low density. While HD3000 was undertaken this initial illustrative scan, the scan script was used to estimate the

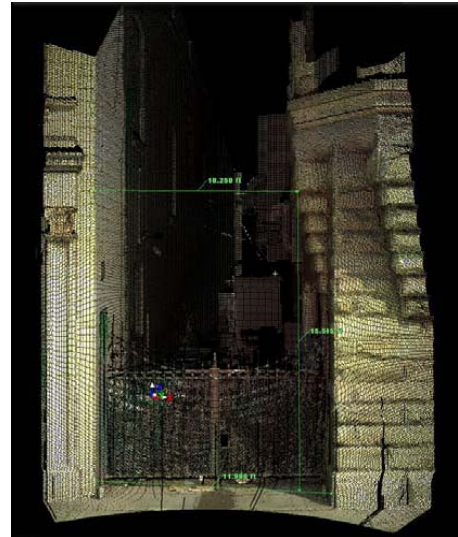


Fig. 4.19. Point cloud data obtained by HDS 3000, Shubert Theater, 2006.

areas which required higher density scanning such as the balcony façades, columns within the theater, detailed terra cotta on the façade, certain areas of the ceiling. These areas were either identified by the architect or the operator who thought it would need further point density (Klimoski 4).⁹⁰

To register the scanworlds, seventeen targets were set up around the theater before the scanning. Cyclone was utilized to scan the targets at high detail.⁹¹ Once the scanning was finished, the scanworlds were registered using these targets. “Differences in control point location resulted in the generation of some residual error. This error corresponds to the accuracy of the scanner (Klimoski 5).” Furthermore, coordinate

⁹⁰ Processing, manipulating and interpreting the immense data that is made of million of points (pointclouds) is very hard with typical mapping software’s such as ArcGIS, AutoCAD and Microstation. Therefore lines and polygons representing the structure of the theater are needed to be extracted from the point cloud by using Cyclone. Higher point densities, facilitates the extraction of lines, TIN’s and planar surfaces from the point cloud for the designated model to be drawn. Then these are to be used to make up the model of the theater (Klimoski 5).

Klimoski, Sam. “Using 3D Terrestrial Laser Scanning to Model the Interior of an Abandoned Theater for Renovation Purposes”. Vol 8, Papers in Resource Analysis. Saint Mary’s University of Minnesota Central Services Press. Winona, MN. <http://www.gis.smumn.edu/Pages/Graduate_Projects.htm>, 12.27.2006. p.5-6.

⁹¹ The targets have a reflective center point on them that the algorithm in Cyclone detects and scans. Once Cyclone scans a target, the software places a control point in the target within the point cloud automatically.

Ibid.

locations around the exterior of the theatre were collected by a survey team and then these points were put into the point cloud using Cyclone. From the point cloud the control points at the same location were chosen manually as the survey points. Again the registration of the scanworlds was performed and error was generated for each control point. Like the local registration, the error of the fixed coordinate system represented the accuracy of the scanner (Klimoski 5).

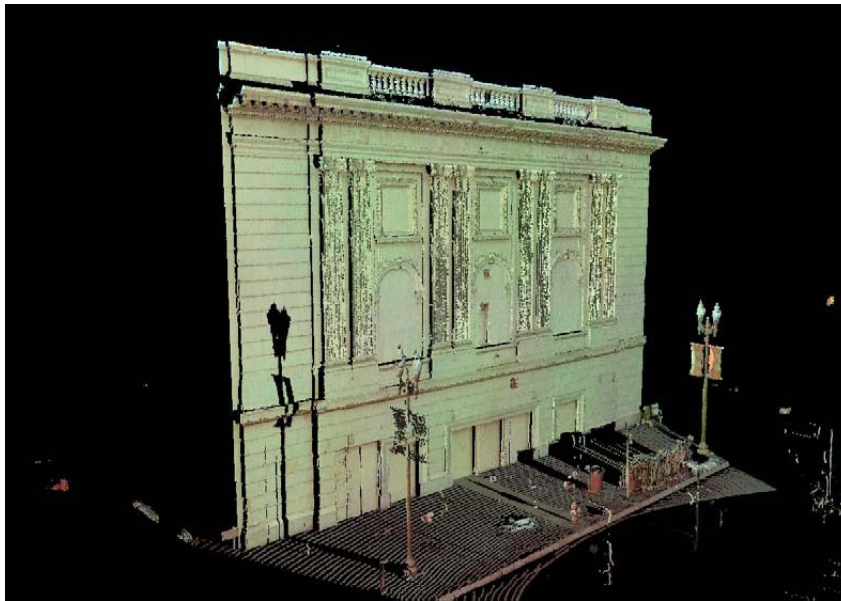


Fig. 4.20. Point cloud image of the façade of the theatre, 2006.

In this context, this project was important for the analyses of the registration process and thus assessment of the mean value. The project attempted to compare the local (relative) and fixed registration. Relative registration means registering the point clouds to one another and thus these values represent the differences in coordinate values for each control point between all the scan worlds. The total mean error for the relative registration was 0.008 feet.⁹² On the other hand, fixed registration is considered as registering the point cloud to a known coordinate system and it provides

⁹² 0.008 feet= 0.24384cm

mean values for the fixed coordinate system outside of the theater which was 0.086⁹³ feet in this project and it represents the differences in coordinate values between the survey and the scans of the surrounding area of the theater (Klimoski 7). If the project would have been undertaken by a group of student interns, it would have taken approximately twelve weeks with four to five people. The manual measurements would have been from 0.08 feet⁹⁴, in some cases up to 100 feet⁹⁵ and this application would be limited by access to different areas regarding safety issues and it would be very difficult to measure across the large gaps. However with the scanner, this application only took two weeks with two people and the error in the model that was created was 0.008 feet which exceeded the ¼ inch accuracy the architect was looking for (Klimoski 8-9).⁹⁶

This project is one of the illustrative examples that indicate the benefits of laser scanning in heritage documentation. The team benefited from the speed of data acquisition, the richness, accuracy and high density of data which created a base for the advanced renovation project. The employment of a scanner reduced the time in the field and left a considerable amount of time to work on the actual renovation of the theater.

4.4. The Utilization of the Laser Scanner in Heritage Documentation in Turkey

The laser scanner has become an increasingly useful tool for the heritage documentation in the world and the wide use of scanner has inevitably shifted to

⁹³ 0.086 feet= 2.62128cm

⁹⁴ 0.08 feet= 2.4384 cm

⁹⁵ 100 feet= 3848 cm

⁹⁶ ¼ inch = 0.635 cm

Turkey. Although the history of this promising device in Turkey is limited comparing to the vast use in the world, the Turkish heritage industry has been acknowledging the application of the laser scanner and has been gradually integrating this technology into documentation projects. On the other hand, even though there are these kinds of projects, it is very difficult to find any extensive information regarding the utilization of the scanner. For example, in Turkey there are approximately twenty scanners owned by both the state universities and private sector.⁹⁷ Various structures have been documented e.g. the Ayasofya Museum, the Land Walls in İstanbul, Tekfur Palace in İstanbul, several mosques in İstanbul (Nusretiye Mosque, etc.).⁹⁸ However, at the time of writing this thesis, there has been no further information about these projects, their applications and the results of the data. There are some projects which are internationally new projects in Turkey in which the laser scanner has been applied and some degree of information can be obtained about the application and the further use of the data.

In 2003, one of the initial laser scanner applications was undertaken in Turkey. One of the important Neolithic sites of Turkey, “Çatalhöyük” was scanned during the

⁹⁷ The state universities such as Yıldız Technical University, Selçuk University and İnönü University own scanners. Further, the private Bimtaş firm working cooperatively with the İstanbul Great Municipality owns nine scanners which have been utilized extensively in the surveying and restoration projects in the Eminönü region. Also some private firms such as the Sistem A.Ş.-Leica have scanners. This firm has been leasing the laser scanner in diversified heritage projects such as the Seddülbahir Project, the surveying project of the Kars Antique City founded by the Ministry of Culture, Global Heritage Fund Laser Scanning of Kars Ani Project, the surveying project of the 1000 years old ship wreck in Marmaray, Yenikapı, the surveying project of the Eminönü Vefa Library. “Correspondence with Bora Sayın, geodesy team, the Seddülbahir Project, 17 May 2007.”

⁹⁸ From the conversation with Arzu Özsvaşıcı İTÜ, supervisor of the architectural team, the Seddülbahir Project, in 17 April 2007; interview with Rahmi N. Çelik, İTÜ, director of the project and responsible of the geodesy team in 26 April 2007 and interview with Gülsün Tanyeli, İTÜ, project consultant, in 27 April 2007. I was using a digital recorder during the interviews. When I was interviewing Gülsün Tanyeli, due to a mobile phone next to the digital recorder, the recording suffered, was cracked and unfortunately could not be retrieved, so this interview with Dr. Tanyeli is based on my notes.

excavation season. A portable Cyrax 2500 3D laser scanner⁹⁹ as seen in Fig.4.21 was used to scan a significant portion of the structures in the South Area, “collecting millions of sub-centimetrically accurate 3 dimensional points on the surfaces of the walls, floors and features within the Neolithic structures”.¹⁰⁰ All the scanned data was incorporated with all the other spatial information at Çatalhöyük as it was referenced to the same project-wide coordinate system.¹⁰¹



Fig. 4.21. Cyrax 2500 3D laser scanner in the field, Çatalhöyük 2003.

The project team took advantage of the scanner’s high accuracy-at-range, adjustable scan density, scanning speed, adjustable field-of-view, and ease-of-use. All this greatly enhanced the recording of the Neolithic buildings which could be accomplished with a greater resolution.¹⁰² The scan data was processed into rendered triangulated computer models and these models became accurate representatives of the undulating, irregular surfaces of the structures. Moreover, after processing the data, the greater resolution of the data helped scholars interpret the function and use patterns of the houses. The project team has been thinking of enlarging the scanner application from these houses to the entire settlement with the hope that it can provide new dimensions to the studies in Çatalhöyük such as it would be possible to view the site from different view points.¹⁰³

⁹⁹ The scanners equipment was loaned by Cyra Technologies through their parent company Leica Geosystems and the professional geomatic expertise was provided by Plowman Craven & Associates, UK. Lees, Duncan. “Geomatics”. Çatalhöyük 2003 Archive Report, 2003. January 2007 <http://www.catalhoyuk.com/archive_reports/2003/ar03_18.html>.

¹⁰⁰ Ibid.

¹⁰¹ Ibid.

¹⁰² Ibid.

¹⁰³ Ibid.

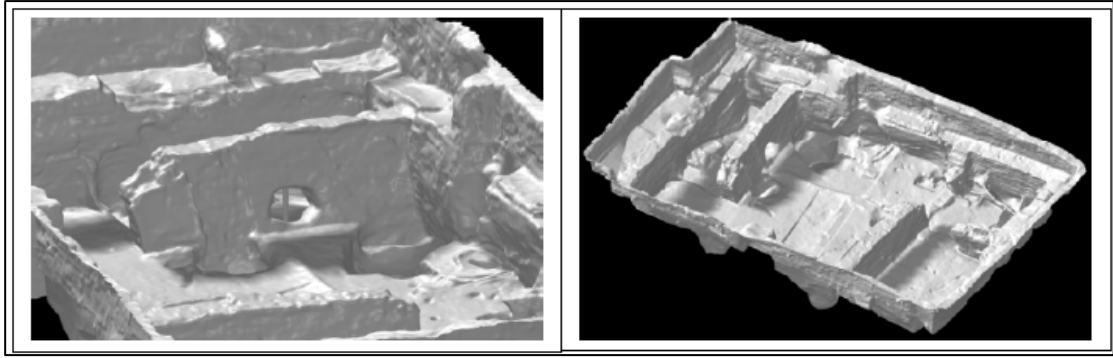


Fig. 4.22. Rendered triangulated mesh, Çatalhöyük, 2003.

Another project utilizing the laser scanner in the documentation of archaeological sites is the Zeugma Project in Gaziantep. There the laser scanning was undertaken as a part of the excavation. In September 2006, two houses in the Zeugma archaeological site, Dionysos and Danae, were documented with RIEGL-2 360 which was tested at Zeugma for first time in the world.¹⁰⁴ The scanner had a 360° horizontal and an 80° vertical field of view and was able to capture 2000 points as far as 400m distance in three working days.¹⁰⁵ The data processing phase has just finished in March 2007, and the team obtained the 3D point cloud models.¹⁰⁶ The scan data will be utilized in primarily restoration and conservation projects and consequently in restitution projects. Moreover, the scan data will be used in commercials regarding the Gaziantep Archaeological Museum and Turkey.¹⁰⁷ The scan data is stored in a CD-ROM and was submitted to the Gaziantep Archaeological Museum and was shared with the public on the 18 May 2007, during the first day of the Museums' opening week. The visitors were expected to be able to observe the digital model of Zeugma

¹⁰⁴ Gaziantep Sanayi Odası. "Zeugma'nın Görüntüleri Hazır". Gaziantep A.A. 19 April 2007. 30 April 2007. <<http://www.zeugmaweb.com/>>

¹⁰⁵ This project is sponsored by the Ministry of Culture and private firms. Gaziantep 27 net. "Zeugma'da ilk modellemeler çıktı". 30 April 2007. <<http://www.gaziantep.net/detay.php?id=1968>>

¹⁰⁶ Gaziantep Sanayi Odası, Ibid.

¹⁰⁷ Ibid.

while enjoying the artifacts in the museum that were obtained from the Zeugma archaeological site.¹⁰⁸

These examples indicate that the utilization of the laser scanner in heritage projects in Turkey has been increasing both in the commercial and private sector. However, due to the recent popularity in the international heritage industry of the laser scanner for documentation purposes the heritage professionals in Turkey are often importing this technology without any further consideration or anticipation and expectation of what measures will be needed to process and analyze this data. In some cases, the scanner is utilized just to scan the structure and since there is no qualified staff that can operate the scanner and interpret the scan data, the final products are just point clouds gathered carelessly and actually impeding the efficiency of the future work.¹⁰⁹ On the other hand, although there are successful documentation projects in Turkey where the scanner has been utilized, these experiences have not been shared with the heritage industry and it is very hard to access this kind of information unless one is personally involved in the project.

¹⁰⁸Ibid.

¹⁰⁹Conversation with Arzu Özsağcı, İTÜ, supervisor of the architectural team, Seddülbahir Project, in 17 April 2007.

Chapter 5: Case Study One

Seddülbahir Fortress Site

Survey - Documentation - Restitution - Restoration & Reusage Project

Architectural documentation has frequently taken advantage of digital surveying technologies. Beside the traditional hand surveying techniques, a diversity of digital techniques, for example, GPS, laser scanner, GIS have increasingly been employed in the field. In Turkey, although there are several documentation projects where these techniques have been utilized, there are few projects which have benefited extensively. The Ottoman Fortress of Seddülbahir Project is among these few projects which has used new documentation technologies extensively. In this chapter, the context, infrastructure and mission of the project is investigated broadly and the problems encountered in the field are addressed.



Fig.5.1. The Ottoman Fortress of Seddülbahir, the “Dam of the Sea”, view of south section of Seddülbahir and wall walk. From Sultan Abdülhamid II’s photograph album (IRCICA, İstanbul)

The Ottoman Fortress of Seddülbahir, “the Dam of the Sea” was built in the mid 17th century on the European side of Dardanelles by the queen mother (*valide sultan*) Hadice Turhan Sultan. Along with the fortress of Kumkale on the Asian side

of the Dardanelles, Turhan Sultan commissioned these two military structures as a defense against the Venetian naval attacks during the long war over Crete and the eastern Aegean. Additionally the Dardanelles located, at the entrance to the Aegean Sea, has had a strategically important role for the protection of the Çanakkale Straits, the Bosphorus and the Ottoman capital Istanbul. As a result, Seddülbahir has played an instrumental role first for the Ottoman and then Turkish defense. During World War I, the fortress of Seddülbahir was a major target in the Gallipoli campaign and was damaged severely by the Allied artillery fire. After the removal of the Australian, British, French and New Zealand troops from the region, the fortress was returned to the Turkish government and maintained as a Turkish naval base until 1997. The surveying project conducted by ITU and Koç University was initiated after the military left the fortress in 1997(Thys-Şenocak 10; Özsavaşçı & Thys-Şenocak, 2).

The Ottoman Fortress of Seddülbahir Project was initially started as a research project by Lucienne Thys-Şenocak from Koç University as a part of a doctorate thesis on the architectural patronage of imperial Ottoman women such as Hadice Turhan Sultan. In 1997, an official protocol was signed between the History Department of Koç University and the Geodesy Division of the Geodesy and Photogrammetry Department of Istanbul Technical University in order to facilitate a survey. However, as the project continued, it was evident that a detailed geodetic and architectural survey was required. Subsequently, the project evolved from a research oriented project into an extensive documentation project and finally in March 2005 into a conservation and a restoration project. In the winter of 2006, the team (Kaletakımı) submitted the multi disciplinary documentation project to the Council of Monuments

in Çanakkale and all parts of the restoration project were approved by the Highest Monument Council in Ankara in April 2007.

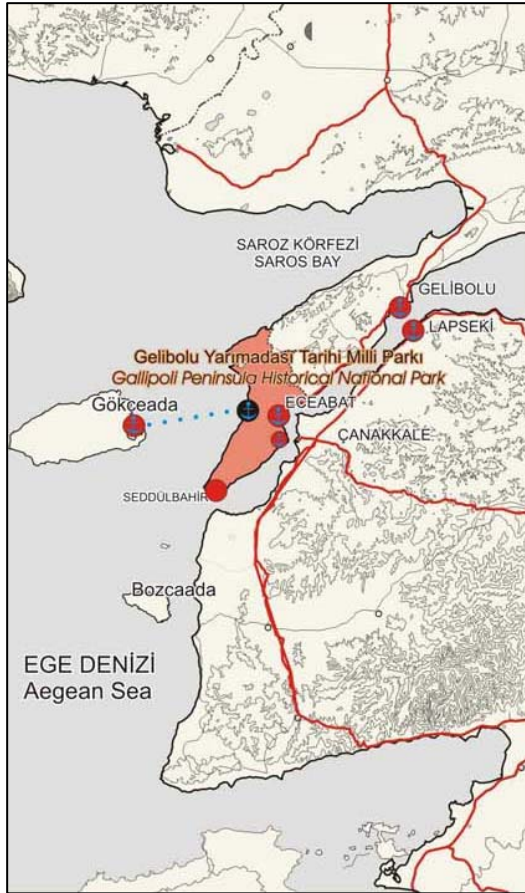


Fig.5.2. Gallipoli Peninsula Historical National Park and the location of Seddülbahir (left), site view of Seddülbahir (below).



The project has been shaped by two major goals since its beginning in 1997. First a precise geodetic and architectural survey was initiated at that time; second an elaborate archival research project was maintained for over a decade. Research included the investigation of repair records from the Ottoman archives, European and Ottoman historical chronicles, engravings and archival photographs from a diversity of collections and libraries (Thys-Şenocak 3). Since 1997, these varied studies and the project archive has been maintained in the office at the Geodesy Division of Geodesy and Photogrammetry Department of Istanbul Technical University, Maslak, İstanbul. Here the team assesses archival research, processes raw data, and produces the geodetic, architectural drawings and models required for various aspects of the project (Özsavaşçı & Thys-Şenocak, 3). The products of the project such as the research, architectural drawings, and geodetic studies have been presented in various conferences and publications since 1998.¹¹⁰

The Seddülbahir Fortress Project has been an example in Turkey in terms of the benefits of a team of diversified professions using a multidisciplinary approach. Kaletakımı consists of approximately 30 faculty and students from the two universities (Thys-Şenocak 10). Koç University has contributed to the project with expertise in history, art history, archaeology, cultural heritage management; İstanbul Technical University has provided architectural, geodesy and photogrammetric engineering expertise (Özsavaşçı & Thys-Şenocak, 2). Accordingly, the team members have represented a rich range of disciplines such as architecture, archaeology, history, geology, photogrammetry, art and architectural history, cultural

¹¹⁰ All this information is accessible from the website of the project. Kale Takımı. 17th Century Ottoman Fortresses on the Dardanelles. <<http://www.seddulbahir-kumkale.org>>.

history, oral history, geography, geodesy, heritage management (Özsavaşçı & Thys-Şenocak, 4).

5.1. Project Management

Kaletakımı is a university based team acquiring its expertise from scholars belonging to diversified disciplines. The team is managed by two directors: Lucienne Thys-Şenocak, Koç U. is the project director and also responsible for the historical research of the project; Rahmi N. Çelik, İTÜ is the other project director and is in charge of the geodesy team. Additionally, Arzu Özsavaşçı, İTÜ manages the architectural team and Carolyn Aslan, Koç U. supervises the archaeology team. Gülsün Tanyeli, İTÜ is the project consultant. Moreover, scholars, professionals and students have been involved in the project since 1997 and thus they have taken advantage of learning the recent developments in digital surveying technologies and the conceptualization of multidisciplinary approach in documentation projects.

5.2. Architectural Survey

In the process of architectural documentation, the architectural survey is undertaken in order to provide detailed drawings of existing and selected structures on the site (Özlüdemir et. al 5). In view of that, the survey is generally shaped by structures located on the site, the condition of the structures, the number and size of the built mass. Other factors such as economic constraints, research goals, client's

needs are also a part of the decision making process. Further, the goal of the survey and the intended results of the survey have a great impact on determining type of the surveying techniques that will be employed (Özsavaşçı et. al 4).

The traditional recording techniques have always had a major role in architectural documentation, but there are some drawbacks to these techniques. Traditional techniques are mostly applied manually and therefore they are highly dependant on human factors; further they require more time in the field. A project may not have a sufficient budget to afford such a long surveying season and may have limitations. Therefore a survey that uses traditional documentation techniques may be limited by financial and time constraints (Özsavaşçı et. al 4). In large scaled documentation projects such as the project of Seddülbahir, traditional techniques were used but consumed a considerable amount of time. Digital techniques on the other hand gave more precise results in a shorter time. As the project is based in two universities, one of the goals of the project was to experiment with new digital technologies and train the team members to utilize this technology. Due to the varied disciplines of members of the team and the interdisciplinary interactions and research, advanced technology and techniques from other disciplines have been integrated in the project such as GPS, GIS, digital photogrammetric cameras, hand-held distance measurement tools (Disto), laser scanner.

5.3. GIS

As the Seddülbahir Project developed and research goals diversified, not only was the application of different surveying systems required, but also a new platform had to be utilized in order to integrate the diversified studies. In 1998, after the first year of the project, the Kaletakımı realized that a Geographic Information System (GIS) would be the most appropriate tool for the diversified research needs of the team, and also would facilitate the collection and organization of all the historic, geographic and architectural data that had been generated. GIS was the most appropriate tool to create an easier interaction between the team members who had different backgrounds. Utilization of GIS not only allowed the team members to participate in the localized goals efficiently, but also enabled them to become more involved in the larger conceptual goals of the project (Özsavaşçı et. al. 1).

In 2000, the initial utilization of GIS for the fortresses of Kumkale and Seddülbahir was undertaken with a pilot project (Fig. 5.3.) at the Ottoman cemetery of Kumkale located 750 meters from the fortress of Kumkale. This pilot project provided information about basic

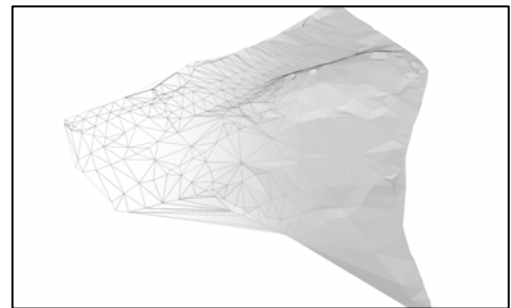


Fig. 5.3.3D model of the Kumkale cemetery in GIS, the Seddülbahir Project 2000.

application principles and allowed the GIS designers to evaluate shortcomings for larger applications and future challenges (Özsavaşçı et. al. 1). As GIS became a prominent part of the project, the surveying methods had to be reevaluated. Although traditional surveying techniques had always been a part of the project, the new digital

surveying technologies had to be compatibly assessed for the GIS progress (Özsavaşçı et. al. 2).¹¹¹

In the Seddülbahir Project, GIS in addition to serving as a platform where all data could be stored and integrated, also facilitated the processes through which team members from various academic disciplines could interact, and become acquainted not only with the particular goals, but also the overall goals of the project, and the overall conceptual framework.

5.4. Geodetic Survey

In the project of Seddülbahir, the geodetic survey was undertaken in order to obtain highly accurate topographical maps of the remaining structures on the site, the architectural plans of existing structures and the archaeological remains (Özlüdemir et. al 6). In addition to these purposes, geodetic surveys were undertaken in conjunction with architectural surveys in order to get precise results. The process of surveying involved the following: “As infrastructure for the geodetic measurements, control networks covering the entire area of the fortresses were established. The control networks in the Seddülbahir and Kumkale fortresses consist of 4 and 6 points, respectively.

¹¹¹In the case of the Seddülbahir Project, the integration of all the historical, archaeological, architectural and geographical data to GIS has indicated the significance of developing a GIS strategy. The team had to generate a strategy to collect, manipulate and archive the data for GIS and undertook the documentation project according to this plan. Therefore, the data to be collected had to be reassessed in view of GIS and adequate surveying methods were utilized. For instance, the team utilized a laser scanner because not only it provides a highly accurate 3D model of the structure, but also enables the professional to generate architectural drawings, restoration projects, deformation analyses, etc. and these products can be easily integrated into GIS where the professional can compare these products with the other data regarding the project. For instance, when the professional mesh the recent architectural drawings, topographical maps and the old maps and pictures of the site in GIS, he/she can trace the transformations of the site.

These networks were then made denser by the inclusion of traverse points. Beginning from the first measurement campaign in 1997, both conventional techniques and GPS technology has been used together.” (Özlüdemir et. al 6).

At the beginning of the project in 1997, all the network points were located in the “World Geodetic System 1984 (WGS84)” because of the absence of the Turkish coordinate system; later, in 2001, when Turkey’s national coordinate system had been more fully developed, the “Turkish National Fundamental GPS Network (TUTGA)”

was used. This network system is International

Terrestrial Reference Frame-Epoch 1996 (ITRF96) (Özlüdemir et. al 6; Çelik et.al 2).

A TUTGA point near the Kumkale Fortress was used as a reference point.¹¹² When the geodetic measurements were finished, Digital Terrain Models (DTM) of the fortresses and their surroundings, as well as 3D architectural drawings were produced as seen in Fig 5.4. As the project developed into a restoration and conservation project, more measurements were needed such as exact measurements of individual sections and stones of the architectural remains. Therefore, during the 2005 season, in addition to using geodetic measurements, a laser scanner was employed to obtain more detailed data of the elevations and the interiors of the Seddülbahir fortress (Çelik et. al 5). In the summer of 2005, as a part of the Seddülbahir Project,

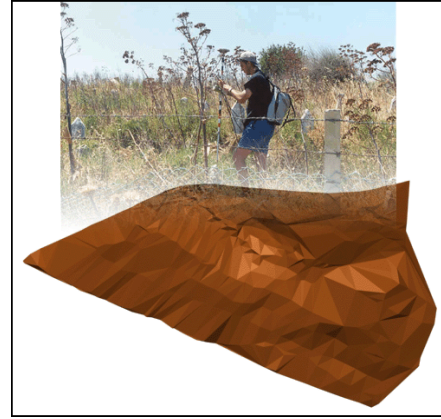


Fig. 5.4. Digital Terrain Model (DTM) of the Kumkale Cemetery, the Seddülbahir Project.

¹¹² The Kaletakımı team explains the working principle of the coordinate points and TUTGA as this: “TUTGA coordinates of the control points were obtained and these coordinates were switched into grid coordinates in ITRF96 with a “Transverse Mercator” projection set with 3° zone width and 27° central meridian.” Özlüdemir, et. al. “Roadmap for a Multidisciplinary Project: The Historical Documentation of Two Ottoman Fortresses on the Dardanelles: Seddülbahir & Kumkale”. WSA3, *Spatial Information Systems for Archaeology-Workshop Archaeological Surveys*. FIG Working Week 2004. Athens, Greece. May 22-27, 2004.

Kaletakımı undertook 55 days of field work; 19 days were allocated for laser scanning. This application is very important because laser scanner was utilized for the first time at a large scale archaeological site in Turkey; the fortress of Seddülbahir is approximately 24.000m² and encompasses a building mass of nearly 4.200m² (Özsavaşçı & Thys-Şenocak 3).

5.5. Data Acquisition at Seddülbahir

At Seddülbahir, a Leica HDS 3000 laser scanner and a Leica TCR407 Power reflectorless Total Station were employed in the field to maintain the digital surveying of the site.

All the fortress walls, entire interiors and some of the topography were scanned by the HDS 3000 with +5 accuracy¹¹³. The scanner provided satisfactory results due to its ability to capture a 360° horizontal and 270° vertical field of view and its ability to scan 1800 points in a second (Çelik et. al 5). This vast field of view and extensive point capacity in such a short time enabled the team to obtain data with fewer vantage points and thus shortened the time spent in the field. For the entire site, 45 vantage points were designated; five of these vantage points were located in the interior of the fortress (Çelik et. al 5). Due to the working principles of the scanner, it was also possible to use the scanner at night to scan the interior of the fortress towers. Thus during the day, other activities dependant on maximum daylight took place on the site (Çelik et. al 5). At the end of the scanning period, 8 GB laser point data -the

¹¹³ 5 mm accuracy

point cloud data- consisting of approximately 350 million points had been collected (Özsavaşçı et. al 2). Registration of the scans was maintained by Cyclone, the accompanying software for the Leica HDS 3000; the post-processing of data was undertaken with Cloudworks software.

While the HDS 3000 scanner was used for the majority of the scanning operation at Seddülbahir and generated most of the needed data, a Leica TCR407 Power reflectorless Total Station was also used with the scanner in order to crosscheck the point-cloud accuracy. This use of both the scanner and total station allowed the team to fill in the missing parts (Özsavaşçı & Thys-Şenocak 3). For instance, in the interior of the fortress, the scanner missed some details; the total station was then used to capture these missed points. The entire site, including the walls and the interiors of the fortress and the complete topography was also surveyed with the total station and thus these measurements were used as base templates for the scan data. As the 2005 campaign was a more intensive restoration project, during the summer 2005, approximately 20.000 points were collected with the total station; in the previous years of field work, approximately 9000 points had been obtained (Özsavaşçı et. al 2).



Fig. 5.5.Data acquisition in the field with digital technologies, HDS 3000 laser scanner in the front, TCR407 Total station in the back, the Seddülbahir project, 2005.

5.6. Processing the Scan Data¹¹⁴

In the beginning of the 2005 season, two months were allocated to surveying in the field whereas sixteen months were devoted to process the data, including the registration of the scans, digital documentation of the fortress and the site with the point cloud, topographical maps of the remaining structures on the site, 3D models and architectural drawings of the existing structures and the archaeological remains. Registration¹¹⁵ and surface reconstruction¹¹⁶ of the scans were maintained by Cyclone, and the processing of the scan data was undertaken with Cloudworks software. The scan data modified in Cloudworks was transferred to AutoCAD to support the 2D and 3D architectural drawings. During registration and the surface reconstruction, the total station data continued to play a substantial role. Even though the laser scanner supplied millions of accurate points, the total station data had to be utilized to specify the reference points and thus facilitate the drawing of this gigantic amount of scan data. For instance, throughout the registration the total station was employed to georeference¹¹⁷ the captured points. Furthermore, in the surface

¹¹⁴ “Processing the scan data” encompasses all the phases after data acquisition in the field including registration and reconstruction of the point clouds, producing drawings, 3D models, animations, etc. However, engineers usually refer to this phase as post processing whereas architects usually prefer processing the data, scan processing etc. This is an important terminology confusion between the architects and engineers. In this thesis, I prefer “processing the scan data” to indicate all the stages after the actual data acquisition stage in the field.

¹¹⁵ *Registration*: The fusion of several point clouds in one coordinate system. Staiger p.6.

¹¹⁶ *Surface reconstruction*: The conversion of the irregularly distributed point cloud data into 3D surface information to analyse the character and shape of the object. From the reconstructed 3D surfaces, it is possible to generate 2D profiles, elevation contour lines, etc. Slob & Hack, p.181.

¹¹⁷ “*Georeference*”: The geometric alignment of the separate data set into a common reference frame. Georeferencing has certain advantages in comparison to registration in an arbitrary local coordinate system. Today a large variety of pre-georeferenced geodata is available as standard products, for example digital maps, ground maps, digital terrain models and others. Georeferencing the measurements transforms the simple sensor data into geodata and thereby opens the opportunity for an almost unlimited number of combinations with other geodata.” Schuhmacher, Sara; Böhm, Jan.

reconstruction some errors were encountered. Although the scan data was accurate within the individual scan/scanworlds, when the architectural team tried to merge relevant scanworlds together, some gaps existed between the scans/scanworlds. Thus the total station data facilitated aligning the relevant scans/scanworlds so there were no errors or inaccuracies in the final drawings. Additionally, to produce accurate architectural drawings, the data provided by the total station was employed as a basis for the scan data. The process was as follows: first the outline of the drawings were prepared with the total station data in AutoCAD; then the scan data was layered into this foundation data; finally the team could undertake the detailed drawings of various sections of this structure. The team began by drawing the plans of the structures and then continued to generate the sequence of sections and elevations.



Fig. 5. 6. From the scan data to the CAD drawings, the Seddülbahir Project.

During the drawing process, the architectural team struggled with the gigantic amount of point cloud data and frequent problems were encountered with the computer hardware because of the processing demands placed on the computers. For instance, tracing the stones of the fortress walls from the point cloud data not only consumed much time and effort, but also grew difficult with the software. Consequently, the team recorded the locations of each of the stones in the elevations and worked section

“Georeferencing of Terrestrial Laser Scanner Data for Applications in Architectural Modelling”. Proceedings of the ISPRS Working Group V/4 Workshop 3D-ARCH 2005: “Virtual Reconstruction and Visualization of Complex Architectures” Mestre-Venice, Italy, 22-24 August, 2005. Commission V, Working Group V/4. <www.commission5.isprs.org/3darch05/pdf/15.pdf>

by section to produce the 2D drawings. In some places the team used photographs to draw the stones as this was faster than deciphering the point cloud data and then determining the specific focus of the stones. The scan data did facilitate drawing of the sections where varied section slices would be extracted from the point cloud easily, accurately and with a diversity of profiles.¹¹⁸

When the team was registering the circle planned towers, some problems emerged during processing the scan data. Owing to the fact that the towers do not have any perpendicular edges and the angle of the walls change consistently, the minor points had to be skipped and the optimum points had to be selected for the registration phase. The total station data was essential at this point, since this data was used to perform the cross check points and to represent the basic forms. After the template was produced, the scan data was integrated into the total station data and thus the drawings for the fortress could be accomplished.¹¹⁹ When the tower data was converted to CAD drawings, the team had problems representing the tower because of the lack of edges on the structure and it was difficult to distinguish the proximity of the layers and the perspective views. The team depicted the back layers of the tower by perspective views that were drawn in 3D in the CAD software.¹²⁰ Additionally, photos were traced when the scan data was not sharp enough to represent the stones.

In the end of the project, the team produced diversified survey maps, 3D drawings, 2D architectural drawings including the plans, sections, elevations and a variety of detailed drawings of the fortress. The team submitted 1/50 and 1/20 scaled

¹¹⁸ Interview with Umut Almaç, İTÜ, architectural team, in 13 April, 2007.

¹¹⁹ Conversation with Arzu Özsavaşçı, İTÜ, supervisor of the architectural team, the Seddülbahir Project, in 24 April 2007

¹²⁰ Interview with Umut Almaç, İTÜ, architectural team, the Seddülbahir Project, in 13 April, 2007.

drawings to the Council of Monuments of Çanakkale in August 2006.¹²¹ Among this wide range of drawings, the team allocated a substantial amount of time to process the x, y, z coordinate point cloud data and generate the 2D architectural drawings because the team were preparing the restoration project of the entire site. The restoration project should include all the 2D plans, sections, elevations and details of the structure depicting the existing conditions. These measured drawings should be precise enough to serve as a basis for the conservation projects, undertake the further repairs, constructions. Further, the Council of Monuments in Turkey strictly regulates the formats of these measured drawings.¹²² Overall, through both the total station and the laser scanner process, the team obtained such a large amount of data with such high accuracy that if the fortress is ever damaged or destroyed by a natural disaster such as an earthquake an extremely accurate restitution could be accomplished.

¹²¹ Conversation with Arzu Özsavaşçı, İTÜ, supervisor of the architectural team, the Seddülbahir Project, in 24 April 2007

¹²² The Council of Monuments in Turkey recognizes only 2D measured drawings as the official architectural documentation project. These projects are strictly legalized by regulations. Therefore, making some alterations in the architectural documentation regulations involves mutual bureaucratic procedures. For now, the council legally accepts total station technology utilizations in architectural documentation since they are familiar with this technology and can crosscheck the total station data. However the laser scanner technology has been a recent technological advance and requires more time to improve the weaknesses of the system such as the high cost, sophisticated expertise, computer maintenance. Consequently, for now it is impossible for the Council of Monuments to accept the mere point cloud data in the project brief. However as the scanning examples in Turkey have been varied, the technology has been improved, this technology gradually will be recognized by the Council of Monuments and the scan data will be a part of the project brief.
Interview with Gülsün Tanyeli, İTÜ, project consultant, the Seddülbahir Project, in 27 April 2007.

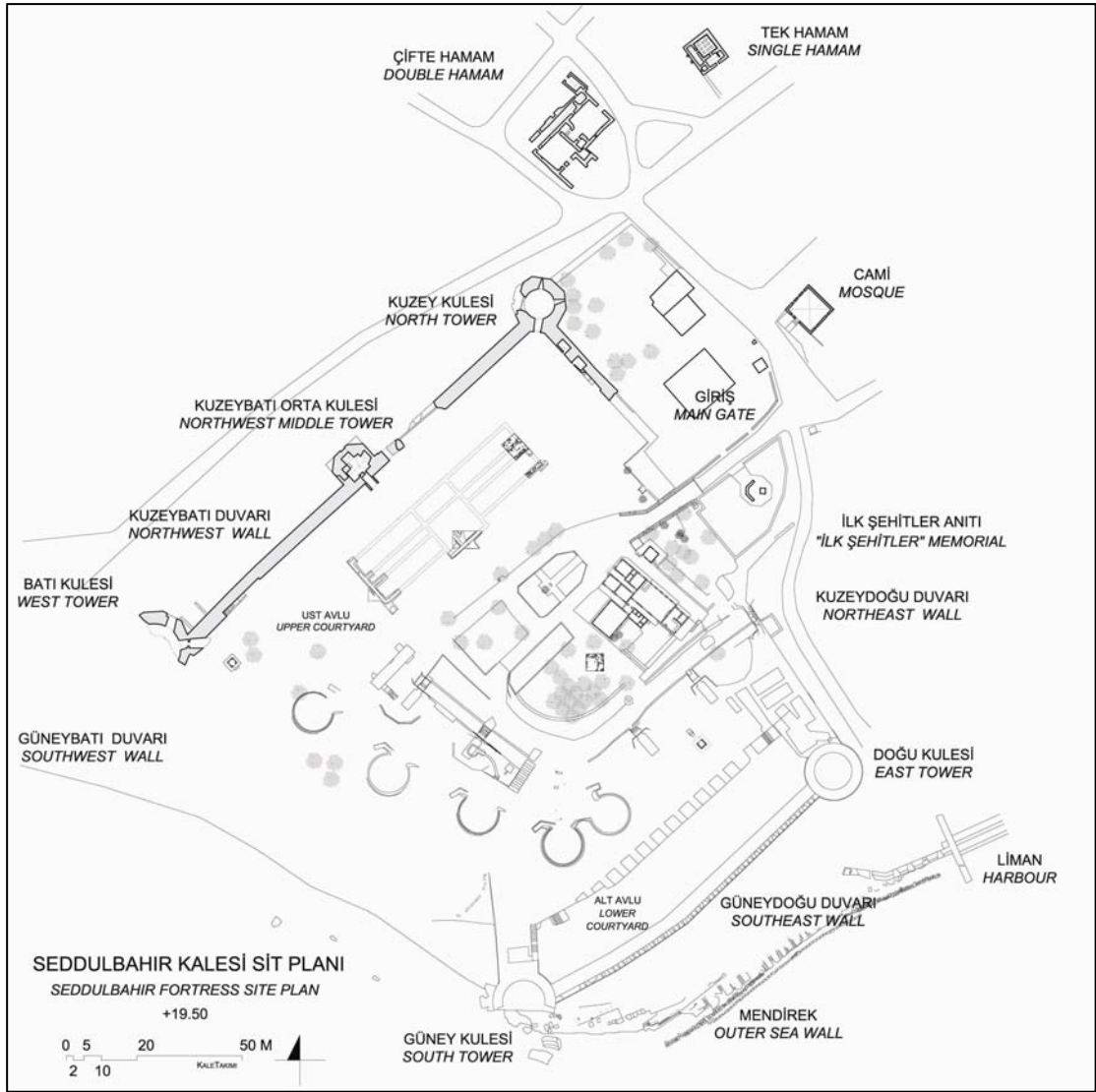


Fig. 5.7. Seddülbahir Fortress Site Plan, the Seddülbahir Project 2006.

Although the laser scanner provided a huge amount of accurate data with millions of points in such a short time in the field, the quantity of data was a challenge in the processing phase. The processing work took sixteen months. The team was working with high configured computers, but these workstations could frequently not handle the vast amount of scan data. Especially, towards the end of the project, due to the growing amount of data, the collapse of the computers became a regular phenomenon. The advances in the gathering of data in laser technology have

not been followed by similar advances in the computer hardware and software programs, so this type of problem will continue until there are advances in technology.¹²³

5.7. Conclusion

When Kaletakımı used the laser scanner in the Seddülbahir Project in 2005, the laser scanner was utilized for the first time at a large scale site stated for restoration in Turkey. Kaletakımı encountered many problems throughout the process regarding not only the technical aspects of the laser scanner application in the field, but also had to cope with the conceptualization of this new technology in architectural documentation.

Since the Kaletakımı had not utilized the scanner before 2005, they were experimenting with this technology for the first time. Additional time constraints were faced because the private firm which had given the scanner for this experimental project was not sure when they needed the scanner back; they could not therefore follow an exact pre determined scanning routine per day. Therefore, they worked ceaselessly (15-16 hours per day) to accomplish the scanning and eliminate any data voids which could have occurred. Due to the absence of adequate teaching tools, guidelines, etc. the Kaletakımı had to anticipate diversified variables during the scanning in the field and also processing the scan data. The Kaletakımı is not the only team that is coming across new technological practices and experiencing the lack of

¹²³ Conversation with Arzu Özsavaşçı, İTÜ, supervisor of the architectural team, the Seddülbahir Project, in 29 March 2007.

any guidance tools to navigate the team throughout the project. The RecorDIM Initiative has been highlighting the point that the heritage professionals in the world have been struggling with the same problem and this organization has been working towards establishing a methodology to incorporate the digital technologies in documentation in an effective way. Part of this methodology is to provide principles, standards, guidelines, teaching tools, etc. to the heritage professionals to facilitate the documentation. For instance, in 2003, the participants of the RecorDIM organization attended a workshop to discuss “Recording, Documentation and Information Management Guidelines and Handbooks”.¹²⁴ As a consensus, the importance of generating handbooks for heritage professionals to provide detailed information about specific documentation techniques applied to heritage preservation was emphasized and diversified task groups¹²⁵ were allocated to generate these tools.¹²⁶

The utilization of digital surveying technologies in architectural documentation is relatively new in Turkey. Therefore there is a great need for

¹²⁴ Cancino, C.; Hardy, M.; LeBlanc M. “RecorDIM Initiative Principles & Guidelines and Handbook Workshop Los Angeles, CA, USA 27-29 May, 2003 Meeting Notes”. 2003. 05 June 2007. <http://www.getty.edu/conservation/publications/pdf_publications/recordim_workshop_052703.pdf>.

¹²⁵ For example, *Task Group 1: Training: Metric Survey Skills in Conservation*; *Task Group 4a: Recording, Documentation and Information Management for the conservation of Cultural Heritage Places - Principles and Guidelines*; *Task Group 4b: Recording, Documentation and Information Management for the conservation of Cultural Heritage Places – Illustrated Examples*; *Task Group 7: Guidelines for documentation of Historic Properties of India*; *Task Group 9: Generic Template for the Management of Heritage Places*, etc. Lettellier, R. “2005-6 Report (draft)”. *RecorDIM 2006 Partners Meeting-5*. Rome, Italy. May 14-16, 2006. 03 June 2007. <http://extranet.getty.edu/gci/recordim/pdf/lunnon_progressrpt06.pdf>.

¹²⁶ The target audiences were categorized as this: *target audiences for principles* should outline the reasons why documentation is crucial for the preservation of cultural heritage, the document should introduce the strategic thinking behind the use of documentation in preservation policies and should be oriented towards policy makers; *the target audience for guidelines* should aim to help decision makers establish goals and use appropriate methods to better integrate recording and documentation into preservation processes, the guidelines, primarily oriented to heritage managers, could also benefit a wider audience of professionals working in the field of preservation of cultural heritage; *target audiences for handbooks* will provide detailed information about specific documentation techniques applied to heritage preservation, the handbooks should be primarily oriented to professionals but could also benefit a wider audience of people working in the field of preservation of cultural heritage. Ibid.

qualified staff both to conduct the scanning operations in the field and for restoration architects to do the data processing. Similar as the scanning projects in the world and thus which are discussed by RecorDIM, this scarcity in qualified and the number of staff trained to work with this new technology is disregarded and few professionals involved in the documentation process are also involved in digital technologies.¹²⁷ A temporary solution in Turkey has been to bring in architects from abroad to undertake these scanning projects rather than investing in upgrading local architectural skills and human resources. Contrary to this model, the project at Seddülbahir, in addition to producing the final restoration project with this technology, also functioned as a school where the team members have intensively worked together to better understand with the digital technologies. This kind of education is extremely significant for further documentation projects in Turkey. Now, the team members of the Kaletakımı have the required expertise to contribute to future laser scanning projects in Turkey.

Further, the extensive collaboration between the team members has led to an important exchange of knowledge between the team members and this exchange has highlighted the importance of how team members must be trained in different disciplines in order to sustain the dialogue that must occur for a project to have satisfactory results. Since each team member has their own specialization and expertise, the members have different point of views and these different approaches not only provide varied products but also may lead to various frictions during the project. Therefore, certain aspects of a documentation project such as the basic

¹²⁷ Lack of training/education of heritage professionals is one of the major gaps that RecorDIM indicates. According to RecorDIM there is a great need for manuals, handbooks; courses, seminars that take a multidisciplinary approach; to include mid-career specialists and management in training. Letellier & Gray, p.16.

principles of GIS and an understanding of how new digital technologies are impacting the documentation process must be understood by all team members. (Özsavaşçı et. al. 2). The importance of this multidisciplinary approach was also highlighted in the RecorDIM Initiative. “Heritage conservation is a complex activity that requires exchange of ideas and information and the integration of diverse skills and knowledge (Letellier & Gray 9).” Therefore, to improve the communication between these diversified heritage professionals, these professionals should be trained in a multi disciplinary approach and supplied with courses, seminars, etc. from varied disciplines (Letellier & Gray 16).

New digital surveying technologies have made headway in Turkey, and these technologies are now attracting the attention of the Turkish architecture academy.¹²⁸ However, due to the lack of the qualified staff who know how to interpret the scan data, little of the data from these other projects has been processed to produce the required architectural drawings. As a result of these initial projects, the viability of laser technology has been debated. However, this new technology has proven to be extremely useful in projects such as Seddülbahir in Turkey, as well as several international examples. Further, the shortcomings of the utilization of digital technologies in architectural documentation are improving rapidly. In a decade, these technologies will inevitably be substituted for traditional surveying technologies. In this context, rather than discussing the viability of digital technologies in architectural documentation, the creation of a solid methodology which can maximize the efficiency of the new laser scanning process must be a priority (Özsavaşçı et. al 2). In

¹²⁸ For instance, the Tekfur Palace, the Ayasofya Museum, the Land Walls and several mosques (Nusretiye mosque etc.) in İstanbul, Ani Harabeleri in Kars, Çatalhöyük and Zeugma archaeological sites were recently surveyed with the laser scanner technology. However, in most of the cases no finalized architectural drawings or further studies were done. Conversation with Arzu Özsavaşçı, İTÜ, supervisor of the architectural team, the Seddülbahir Project, 17 April 2007.

the Seddülbahir project, the Kaletakımı has been working to develop a methodology which fits the needs of the project but which can also be utilized in other projects.

Since the Seddülbahir project is a university based project, Kaletakımı consists of diversified scholars from different disciplines, and the team has always benefited from its academic context. The team has had many advantages, i.e., utilization of the most advanced technologies available to test the capacity, feasibility, accuracy etc. in documentation practice where these types of experiments are not always possible in the heritage sector regarding the high cost, limited budget and time. For example, the universities have excelled in the long term documentation projects which have research and developed as a strong component because the commercial sector has not preferred to undertake work of this nature for such a long period. In the architectural documentation projects, surveying activities are directly related to the long term cost efficiency and effectiveness. Even though the utilization of laser scanning in the documentation projects may require more initial budget compared to the other techniques, in the long run the scanner has more benefits; once the scan data is obtained, it is a gigantic amount of high accuracy data eliminating the further surveying trips to the site and providing the data archive to utilize even if the project goals have changed. For example, in the long term projects such as the Seddülbahir Project, the laser scanning in the field (only 19 days) provided all the data that the team required for their project. Not only did this application save the team from long procedures such as applying to the Ministry of Culture for getting permission for additional surveying in the site, but also this data archive allowed the team to make further modifications in the project even if the requirements have changed in the restoration project or questions coming from members of the team in the different

disciplines changed.¹²⁹ Further, as discussed in the RecorDIM Initiative, the contribution of the documentation tools to the “quality of the conservation research, analysis, design, and maintenance and monitoring” should be evaluated and then they should be chosen (Lettellier & Gray 19)

The RecorDIM Initiative has observed that the larger documentation and conservation practices are usually sponsored by governmental bodies.¹³⁰ Similar to this understanding, the Seddülbahir Project has been sponsored by the Turkish Forest Ministry (T.C. Çevre ve Orman Bakanlığı) and the Vehbi Koç Foundation and this project is important to illustrate the different communication levels between diversified organizational bodies in a heritage project. The Forest Ministry is responsible of the National Parks in Turkey including the Gallipoli Peninsula which the Seddülbahir Fortress is located.¹³¹ Regarding the protocol made with the Forest Ministry, the Kaletakımı not only has to collaborate with the Ministry consistently, and but also notify the Ministry about every decision concerning the project. These intensive notifications bring forward bureaucratic problems and thus delays in the project procedures. Further, due to the fact that the Ministry has not had experience in restoration and conservation projects, most of the time the team has had to navigate the Ministry through these procedures. These attempts to determine the adequate procedures for the project have been problematic throughout the project.¹³² Nevertheless, the general positive attitude of the Forest Ministry towards the

¹²⁹ Interview with Lucienne Thys-Şenocak, KU, Project director, Seddülbahir Project, 05 June 2007.

¹³⁰ Lettellier & Gray p.9.

¹³¹ The ministry is conducting numerous restoration projects. For example, regarding the Akseki İbradı Region Cultural Development Cooperation Protocole, the Forest Ministry has been sponsoring restoration projects such as the project of the Old Mosque, and surveying projects of the houses in the village. ÇEKÜL. “Akseki Süleymaniye’de ‘Akseki-Ibradi Havzasi Çevre ve Kültür Değerleri Araştırma ve Uygulama Merkezi’ ne Doğru”. Çekül Vakfı web site. 2006. 05 June 2006. <http://www.cevreorman.gov.tr/site_03.asp>.

¹³² Interview with Lucienne Thys-Şenocak, KU, Project director, Seddülbahir Project, 05 June 2007.

Seddülbahir Project and the concerned officials in the Ministry has maintained the project within the adequate borders. The Kaletakımı has had to cooperate intensively with another governmental body, the Council of Monuments of Çanakkale, throughout the project due to the fact that the team had to submit the project to this council in August 2006 including the restoration drawings and all the surveying and research reports. However, owing to the official alterations among the commissioned personnel in the Çanakkale Council, the entitled authorities have been changed and these transformations in the Çanakkale Council led to misunderstandings between the Kaletakımı and the Council and delays in the approval of the project which was finally passed by the Higher Mounument Council in Ankara in April 2007, almost one year after being submitted to the Çanakkale Monument Council.¹³³

In Turkey, the future of architectural documentation with new technology is at a crossroad. The Seddülbahir project has highlighted the necessity of integrating digital surveying technologies with traditional approaches to architectural documentation and building up the expertise of members of different disciplines in a team. The evaluation of the Seddülbahir project demonstrates the challenges of embracing new perspectives in the process of architectural documentation. These assessments not only have been important for the heritage industry in Turkey, but also have been addressing similar challenges that the heritage professionals in the world have been encountering. For example, this project has highlighted issues which are also being discussed by international heritage professionals, such as the importance of training of the qualified staff in digital technologies, the benefits of a multidisciplinary approach in the documentation project and the level of

¹³³ Ibid.

communication between the team members, the role of architectural documentation in conservation projects and thus decision making processes, the cost-benefits of recording and its long term effectiveness, etc.¹³⁴

¹³⁴ According to RecorDIM the gaps in heritage documentation can be classified as communication (perception), tools, training/education, process, resources. Since 2002, RecorDIM has been working towards improving perception and communication in heritage recording, documentation, and information management; making available training and learning programs in recording and documentation; integrating recording, documentation and information management activities into the conservation process; to increase resources for documentation; defining, developing and promoting documentation tools. Letellier & Gray p.9-11

Chapter 6: Case Study Two

Digital Statue of Liberty Project

Proper documentation of historic structures is essential for American historical architecture and “measuring and documenting historic structures with a high level of accuracy has been a mandate of the federal department of the Interior since 1935” (Louden 29)¹³⁵. Since the establishment of HABS in 1933, more than thirty four thousand of historic structures have been surveyed through traditional surveying techniques (Cliver et. al 31). Although these techniques, i.e., hand measurements, photography, photogrammetry, etc. have had a substantial role in surveying, digital surveying technologies have been increasingly substituted for the conventional ones. The Digital Statue of the Liberty Project has been a pioneering one, utilizing the laser scanner to capture curvilinear forms on a monumental scale (Louden 32).

The Statue of Liberty located in New York Harbor is one of the distinguished historic structures in the American history being a symbol of the ideals of freedom and liberty. She was designed by French sculptor Bartholdi in recognition of the friendship established between France and United States during the American Revolution. In 1886, the statue was



Fig.6.1. An old photo of the Liberty Island. Photograph Collection of the American Museum of Immigration, Liberty Island, U.S., Department of the Interior. NPS.

¹³⁵ The Historic Sites, Buildings and Antiquities Act of 1935.
Cliver et.al. “HABS/HAER at the Millennium: Advancing Architectural and Engineering Documentation”. APT Bulletin. Vol.29. No.3/4. Thirtieth-Anniversary Issue. 1998. p.31.

erected on top of a granite pedestal¹³⁶ which was built inside the courtyard of star shaped Fort Walls¹³⁷. Since then she has welcomed millions of immigrants to the United States. In 1924, a Presidential Proclamation declared Fort Wood and the Statue of Liberty within as a National Monument.¹³⁸ In 1984, the statue became a world heritage site.¹³⁹ Although the Statue of Liberty has had an outstanding place in the American history and architecture, there are no architectural drawings due to the fact that the statue was built on scaled models rather than architectural drawings.¹⁴⁰

In 2001, NPS contracted Texas Tech University College of Architecture to demonstrate the feasibility of using a laser scanner to provide highly accurate documentation of the skin of the Statue, to monitor the patina and thus supply a plan for the maintenance and operation of the Statue.¹⁴¹ “The scaled drawings would be used to monitor and preserve the statue and will eventually become a part of a small-scale GIS that will enhance maintenance and management of the landmark structure (Louden 38).” At that point, the Digital Statue of Liberty Project was initiated by scholars from Texas Tech University and on the subject of investigating the utilization of scanning technologies

¹³⁶ Richard Morris Hunt, a famous Chicago architect of that time designed the pedestal. Louden, Elizabeth. “Digital Liberty: 3-D Lidar Scanning of the Statue of Liberty”. *Insight*. Vol 3. 2003. p.50.

¹³⁷ The Fort walls were built for the War of 1812. National Park Service. “History & Culture”. Statue of Liberty National Monument. August 14, 2006. April 12, 2007. <<http://www.nps.gov/stli/historyculture/history/index.htm>>.

¹³⁸ Ibid.

¹³⁹ The statue was inscribed as a world heritage site in 1984 under criteria C(i) and (vi). National Park Service. “Statue of Liberty National Monument of New York”. U.S. World Heritage Sites. August 14, 2006. <<http://www.cr.nps.gov/worldheritage/liberty.htm>>, April 12, 2007.

¹⁴⁰ Bartholdi, initiated his work for the Statue by working on clay study models and bronze castings. He gradually transferred his studies to successive larger models. Eventually he finalized his investigation of the design by building one quarter the size of the proposed final art work. He divided this plaster model into 300 sections and then enlarged each piece four times. The original design was conveyed to laminate wooden forms which used as a template for the proposed copper panels. Sheet metal was molded onto these wooden pieces. This shell altogether weighs 31 tons and each sheet is 2.5mm thick. Additionally, Gustave Eiffel designed the 125 ton steel skeleton of the statue. Bartholdi first merged all the pieces together in his studio in France, then disassembled all the parts, numbered them and shipped them to the States to the Statue’s permanent location.

Louden p.48-51.

¹⁴¹ Conversation with Dana Lockett, NPS, Project consultant, DSOL, in 20 April 2007.

for nonlinear colossal structures and examining the data conversion requirements (Louden 38).

6.1. Project Management

The Digital Statue of Liberty Project is a university based project and consists of scholars mainly with architectural backgrounds. The research team consists of Elizabeth I. Louden who is responsible for all the project supervision, John P. White as the project consultant and Glenn E. Hill who is in charge of the technological aspects of the project (Louden 32). Further, Dana Lockett from NPS (National Park Service) supervises the project. The team has taken advantage of being in a College of Architecture and has been employing several undergraduate students, graduate students, research assistants and interns since the project initiative. Thus, these young students and professionals have been gaining experience in an important documentation project, and becoming familiar with the digital surveying techniques in addition to prepare themselves for future laser scanning projects.

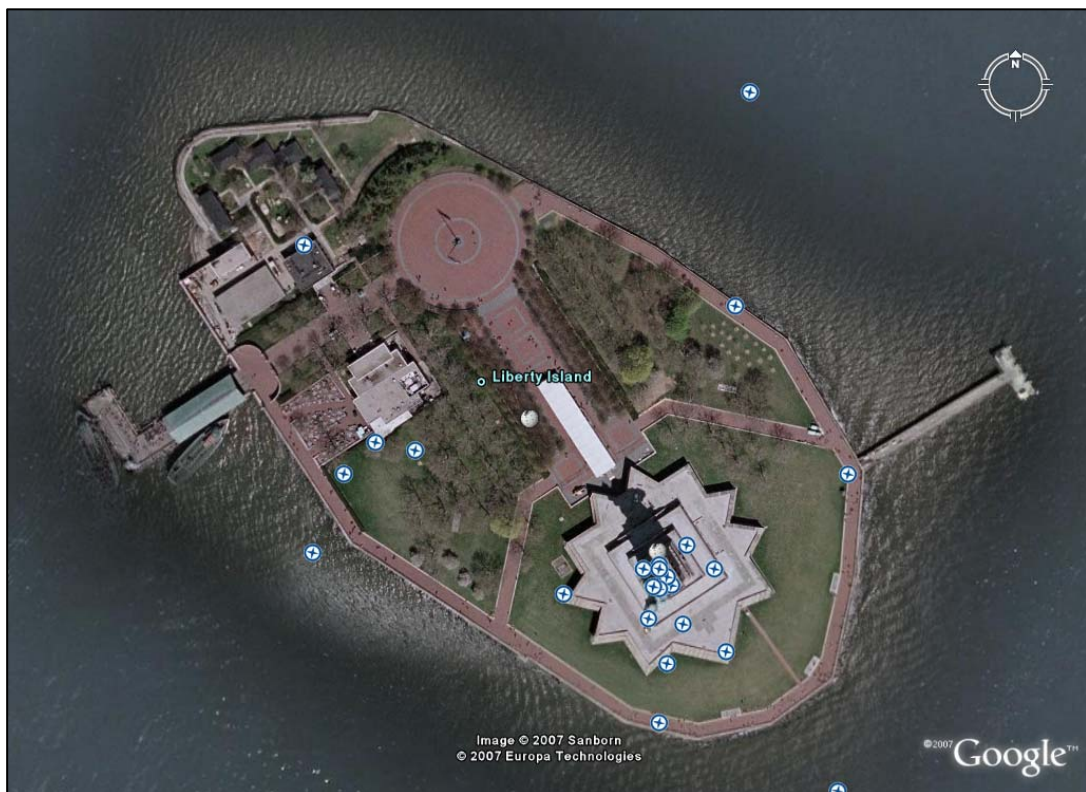


Fig.6.2. The Liberty Island, its location within New York City, (above); the Liberty Island (below), Google Earth, 11 May 2007.

6.2. Phase I

6.2.1. Data Acquisition

In March 2001, a university team, NPS (HABS) officials and a representative from Cyra Corporation went to the Liberty Island to experiment with the scanning system of the statue and determine the logistical challenges (Louden 38). The team summarizes the objectives of the Phase I of the Digital Statue of Liberty as follows: “collect point cloud data to test the accuracy of the scanning technology at undocumented distances; to understand the potential and limitations of the scanner equipment under site conditions; to gather information on the logistical complexities of working at the statue; and to determine a process and procedure for conversion of non-uniform data sets into historical documentation.”¹⁴²

The team utilized a Cyrax 2500 laser scanner¹⁴³ accompanied by a reflectorless Leica TCR702 total station. The team tested the scanner only on the statue while the HABS team surveyed the location of registration targets using the total station which provided the data to measure and analyze distances between targets, crosscheck the accuracy of the scan data and to tie the scans together (Louden 39). Through this first trip, the team could determine the optimal scanning platform which turned out to be the Fort Wood promenade level. Although the scanner would give accurate data, due

¹⁴² Phase One, Work Plan.

Digital Statue of Liberty. 2006. Texas Tech University. October 2006. <http://www.arch.ttu.edu/digital_liberty/>, April 12, 2007.

¹⁴³The scanner has a 40x40 field of view.

“The scanner’s optics includes dual mirrors controlled by random access timing devices. A metal housing and precision glass lens shield the internal mechanism. The video targeting supports a 480 x 480 color resolution. The laser type is a green, pulsed, proprietary microchip that is a safety Class II (ref. CFR 1040) eye safe-except in the event of direct long term exposure.”
Louden, E. “Mapping Miss Liberty”. Geospatial Solutions. September 2002. p.40.

to the monument's size, long transmittal distances exceeded the manufacturers' specifications. In order to scan the statue (151 feet and 1 inch high)¹⁴⁴ from the promenade level, the scanner had to send vertical beams to the statue and the pedestal (altogether 305 feet 1 inch¹⁴⁵ high) which were to travel more than 400 feet¹⁴⁶. To minimize this vertical angle during the scanning of the uppermost parts of the statue, the team concluded that the scanning process would require scanning from more than a dozen different positions from the apex of each point on the promenade level on top of the Fort Wood in order to overlap the data (Louden 39).

After two days of field work the team got back to Texas Tech, Lubbock and worked on the data they obtained. The measurements captured from the total station and the laser scanner were compared in order to determine the sequence of the project. The accuracy of the data showed potential for future documentation work, the utilization of the scanner alleviated accessibility and safety concerns in the field.¹⁴⁷ Thus, after two months of procedure planning, the team went back in August 2001 to the Liberty Island to document the statue (Louden 39).

The team placed 32 targets around the statue, including the torch, crown, and pedestal, on the crenellation, crown and small balcony surrounding the torch, to register the data between the different 13 scan locations and for the triangulation required over the vertical and horizontal distances (Louden 39). The precise location

¹⁴⁴ 151 feet and 1 inch= 4605.02 cm

¹⁴⁵ 305 feet 1 inch = 9298.94cm

¹⁴⁶ 400 feet = 12192cm

¹⁴⁷ For the reflective targets outside the crown of Miss Liberty and the pedestal, the accuracy was set for .25", but for the distance discrepancies (up to 2.5") regarding the other targets, the team attributed these errors to the sway of the statue's arm and the torch caused by the wind. Louden p.36.

The traditional documentation methods are not efficiently applicable to record the colossal Miss Liberty, these methods, i.e., scaffolding, can be dangerous due to the size of the monument. Also the high flow of visitors is a problem during documentation.

of these targets was surveyed by utilization of a reflectorless total station within one tenth of an inch¹⁴⁸.

After the total station survey, the scanner was moved to the predetermined points on the promenade one after another, and the statue was scanned from head to toe. The data was captured at 0.375 inch¹⁴⁹ resolution in grids of 1,000 x 1, 000 points. From the 13 targets at the base of the statue the team, produced 43 different scans. In four days the team gathered more than ninety four million data points and the data collection covered approximately 70% of the statue, leaving just the top of the head, torch and some areas around the torch unscanned as the scanner could not see and record. The team returned to Texas Tech University, Lubbock to process all the data they had captured in four days (Louden 40).

6.2.2. Processing the Scan Data

At Texas Tech University, the team started to download and investigate the point cloud data. However all the attempts to register the scan data failed due to the incompetent computer power and the gigantic quantity of the scan data. The team purchased new computers to overcome this problem¹⁵⁰, but still they could not accomplish to combine the data together. They realized that the movement of the arm and the torch were causing a large problem for the target registration. Hence, they eliminated the torch targets from the combination of the scan data and completed a 3D point cloud model. Still the 3D model was an enormous file to process. Therefore the

¹⁴⁸ 1/10 inch = 0.254cm

¹⁴⁹ 0.375 inch = 0.9525cm

¹⁵⁰ Dual 1.8 GHz processors, a 1-GB RDRAM video card and two 80-GB hard drives.

team divided the 3D model into smaller portions and processing continued. The scanned data was used to create a polymesh¹⁵¹. The polymesh was smoothed and the holes were filled, and then the final polymesh was converted to NURBS¹⁵² (Louden 39&41).

At the end of Phase I, the team submitted a preliminary drawing of the horizontal sections of the statue, a grid of 4" x 4" squares with an elevation on the left that showed where the section cuts were, and as a visual reference the elevation data of the pedestal (in registered point cloud) was given to NPS.¹⁵³

6.3. Phase II

When Louden envisioned the future phase of the project in 2003, she indicated the importance of “the production of a complete, interactive 3-D model of the statue and comprehensive architectural drawings of the entire site, including the visitor center, fort, pedestal, and the auxiliary buildings” (45). In 2006, the NPS again contracted with TTU to provide an architectural documentation project of the entire island and provide more extensive drawings of the statue.

¹⁵¹ *Polymesh*: Three connected straight lines define a triangular surface or a simple polygon. This process continues until a polygonal mesh of triangles is created from the points (x, y, z coordinates in space in the cloud. Louden p.42.

¹⁵² *NURBS (Non uniform rational B-spline)*: NURBS model is produced by breaking the point cloud into manageable sections. A NURBS model reduces the file size considerably, since the computer will, in essence, be dealing with a single 3-D curved surface rather than millions of line segments. Louden p.42.

¹⁵³ Conversation with Elizabeth I. Louden, TTU, project director, DSOL, in 15 April 2007.

6.3.1. Data Acquisition

In June 2006, the TTU team and the NPS team went to the Liberty Island to undertake the architectural documentation of the entire island. Not only would the team utilize the latest digital surveying technologies, but also decided they would hand measure the interior and exterior of each structure in the site. This was done, so survey data obtained by conventional technologies and the digital one could be mutually cross checked for accuracy.

The team utilized a HDS 3000 laser scanner with the accompanying software Cyclone in the field. The laser scanner was utilized to capture information covering the entire island and the buildings: the exteriors of all the administration buildings, concession buildings, and both the exteriors and interiors of the pedestal, Fort Wood, and the statue. The team worked methodically around the island to ensure good coverage of the buildings, and placed the targets all over the island accordingly to provide for adequate overlap (20%), and to establish sightlines to the maximum amount of targets from the scanner positions. The team scanned the island landscape at approximately 1 inch spacing, the statue at a combination of 0.50 inch and 0.75 inch spacing between points and the details at a tighter resolution of 0.25 inch.¹⁵⁴

During the field work, a reflectorless total station Leica TCR702 accompanied the scanner. This instrument was employed to survey the island and determine the targets for the scanner. The team placed the targets around the island so that from

¹⁵⁴ 1 inch = 2.54cm
0.50inch = 1.27cm
0.75inch = 1.905cm
0.25inch = 0.635cm

each scan location they could see at least 4 overlapping targets.¹⁵⁵ Further, throughout the scanning phase of the buildings on the site (admission and the concession building), these targets were also registered as GPS points. This procedure of multi-equipment use resulted in an accurate and an unproblematic registration process, and thus prevented any errors which could have occurred during the registration and consequently in the results of the processed scan data. However, the targets could not be tied to the GPS in the statue because there were visitors always moving the precise surveying equipment. As a result, the registration products of the statue were not as accurate as those from the buildings on the island.¹⁵⁶

6.3.2. GIS

HAER and the Northeast Regional Office of the NPS have been working on the GIS project of the data from the Digital Statue of Liberty and the Ellis Island. The NE Regional Office of NPS has collected the required GPS data for the GIS application. This GIS project has not been implemented yet.¹⁵⁷

¹⁵⁵ Although only three overlapping targets are enough for the registration, it is smart to have more than this to have some extra choices during the registration process. Conversation with Karen Hughes, 30 April 2007.

¹⁵⁶ Conversation with Karen Hughes during the the Documentation Project of the Memorial Temple of Ramses II, Western Thebes, Luxor, Upper Egypt, architect, 12 January 2007.

¹⁵⁷ Conversation with Dana Lockett , NPS, project supervisor, DSOL, in 18 April 2007.

6.3.3. Processing the Scan Data

After the field work was accomplished in two weeks, the team turned back to TTU, Lubbock in the end of June 2006 to undertake the processing of the data. It was anticipated that the drawings would be completed in August 2006 and include a survey map of the entire Liberty Island, plans, sections and elevations of the entire buildings on the site (concession building and admission building), Fort Wood, pedestal and the statue. Also a 3D model of the interior of the statue encompassing the rotund staircase was expected to be drawn by this time. The Cyclone software was used to do the registration and surface reconstruction and Cloudworks software was applied to transfer the point cloud data to AutoCAD to support the 2D and 3D architectural drawings.

When the drawing team including three students and two interns initiated the office work, the drawing team was given a course on manipulating the point cloud data in Cyclone and transferring this data to the CAD drawings.

Although the registration of the scans had been started by a team member while the field work was being undertaken on the Liberty Island, the attainment of the registration of the entire island and the structures would consume tremendous time. Since, all the exteriors and the interiors of the structures on the island including the administration building, concession building, Fort Wood and pedestal were also hand measured during the surveying on the Liberty Island, the team started to process this hand measure data immediately to prevent any loss of time once they began the office work. During the drawing session the team members tried to circulate the drawings

between themselves as much as possible to prevent errors and to crosscheck the accuracy of the drawings. By the time the drawing team obtained the initial registered point cloud data, they had already finished most of the drawings of the administration building, concession building and plans of the pedestal. The team crosschecked all the drawings they had done with the cloud data and rectified the mismatches'. At the same time, some team members initiated the Fort Wood drawings and the rest of the Pedestal drawings by utilizing the point cloud data.

In June, the NPS supervisor¹⁵⁸ came to TTU to check the drawings' advancement. After the NPS representative left, the team proceeded with the drawings and submitted a land survey of the entire island, and plans, sections and elevations of all the structures (admission building, concession building, Fort Wood, pedestal, and statue) in the 1:8 and 1:16 scale by date of August 2006. The NPS supervisor and the TTU research team crosschecked all the drawings, and discussed how to improve the drawings. The work on the drawings has continued since then, and a graduate student from TTU is working on these as well as a 3D animation of the interior of the statue.

From an architect's point of view who had a very traditional architectural training, working with the laser scanner data was a different challenge for me. Until then, I used to survey with traditional techniques such as hand measurements, sketches and photographs and then convert the data to architectural drawings either by hand drawings or AutoCAD software depending on the project. Therefore, when NPS hired me to work in the DSOL project during the summer of 2006, and revealed the fact that the entire island was going to be scanned and then all the scan data was going

¹⁵⁸ Dana Lockett, Architectural Project Manager, National Park Service.

to be converted into CAD drawings. I was amazed by the idea of learning an advanced surveying method. Although throughout the field work I helped the team to scan the island and in several occasions I scanned numerous scenes, I did not know that the entire adventure was about to start after the field work while we were processing the scan data. The initial disappointment of processing the scan data was to experience the similar set of methods as with the traditional surveying techniques. For instance, if the project was undertaken by traditional methods e.g., hand survey, sketches, photography, the survey data would have been converted to architectural drawings point by point, crosschecking consistently with the other hand measurements and photography. Even though the scan data is superlative to the data quality gathered by hand survey because millions of points are supplied in a scene and the architect can trace these million of points to produce architectural drawings; the architect still has to be careful, just as in a traditional documentation project, carefully processing the scan data, extracting the information he/she needs from the this data, producing the drawings point by point and always cross checking the drawings with other survey measurements, photographs, etc. Further, even though the scan data is much more precise in terms of milimetric accuracy, the final products continued to be highly subjective because they must still be interpreted by the architect who is selecting a group of points from millions of points. Moreover, although the scan data provides a highly accurately entire model of the structure, there might be occasions where data voids¹⁵⁹ occur and no information can be found at all. In that case, the architect who is processing the scan data should consult his/her own personal surveying experience in the field, but also take into account the information from photographs and the other survey data in the field. Therefore, although the scan data

¹⁵⁹ *Data void*: Sections within the point cloud, more than twice the point cloud density of the scan in size, which contain no data despite surface information on the object itself.

is offering millions of points and many details in a single scan and this data is superlative to the other surveying techniques, it is still the architect who processes the scan data and converts it to the 2D drawings that are required by National Monuments Boards. For that reason, the architectural training of the architect is pivotal both in acquiring data in the field, processing this data and producing adequate architectural drawings.

The TTU team encountered other drawbacks as well while working with the point cloud data such as the tardiness of the computer in processing the large amount of data such as the data set for Fort Walls, the pedestal and the statue. Therefore the team subdivided the work areas throughout the processing and worked on the issued drawings one by one. The team especially encountered difficulty when dealing with the stones of the Fort Walls (Fig. 6.3.). The Fort Wall elevations were full of individual stones and this slowed down the manipulation of the data significantly, so the team preferred to subdivide the individual Fort Wood elevations and trace the stones locally, similar to the method used by the Seddülbahir team.

Similar to the team of Seddülbahir, another major difficulty the team came across were break downs of the software and the hardware. Although Cyclone is compatible with the CAD software, the system crashed frequently due to the massive point cloud data. However since the office work was undertaken in a university facility, there was a permanent CIT employee maintaining the computer infrastructure and eliminating the work delay as much as possible.

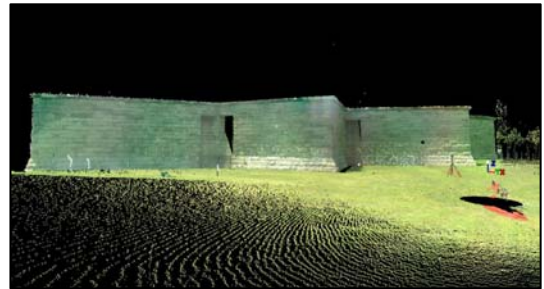
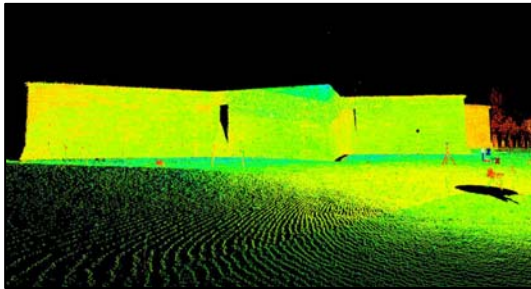
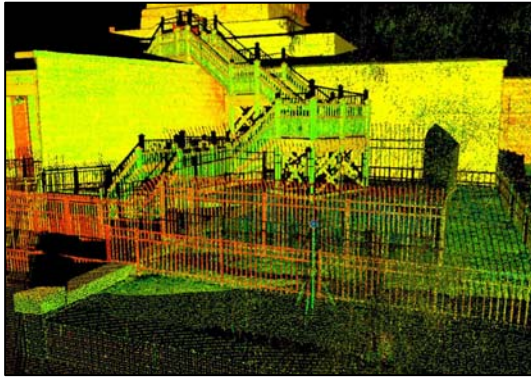


Fig. 6.3. The drawing team had difficulties drawing the stones on the Fort Walls, not only the stones slowed down the manipulation of the data, but in some parts the scan data was poor in details.

The south west wooden staircase in the Fort Wood, point cloud image (above left)

The south west wooden staircase in the Fort Wood, point cloud with global mapping (above right)

The east elevation of the Fort Wood, point cloud image (below left)

The east elevation of the Fort Wood, point cloud image with global mapping (below right)



Fig. 6.4. Point cloud image of view of Statue's face (top); the tablet (middle); the statue form the pedestal (below).

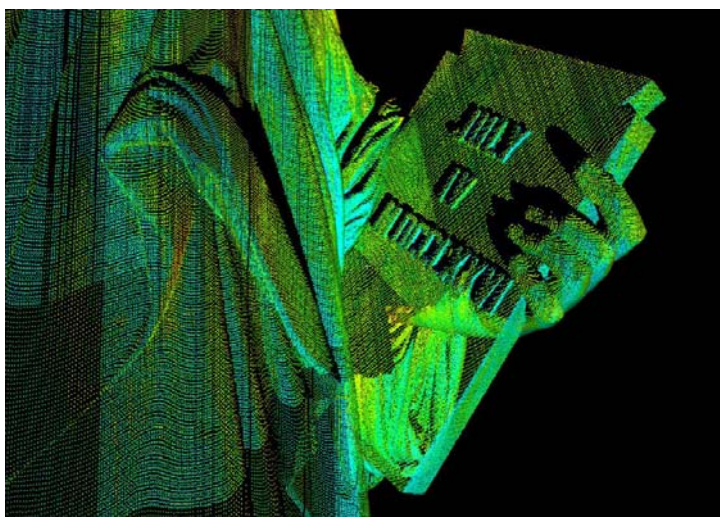




Fig. 6.5. The south elevation of the Statue, DSOL, 2006.

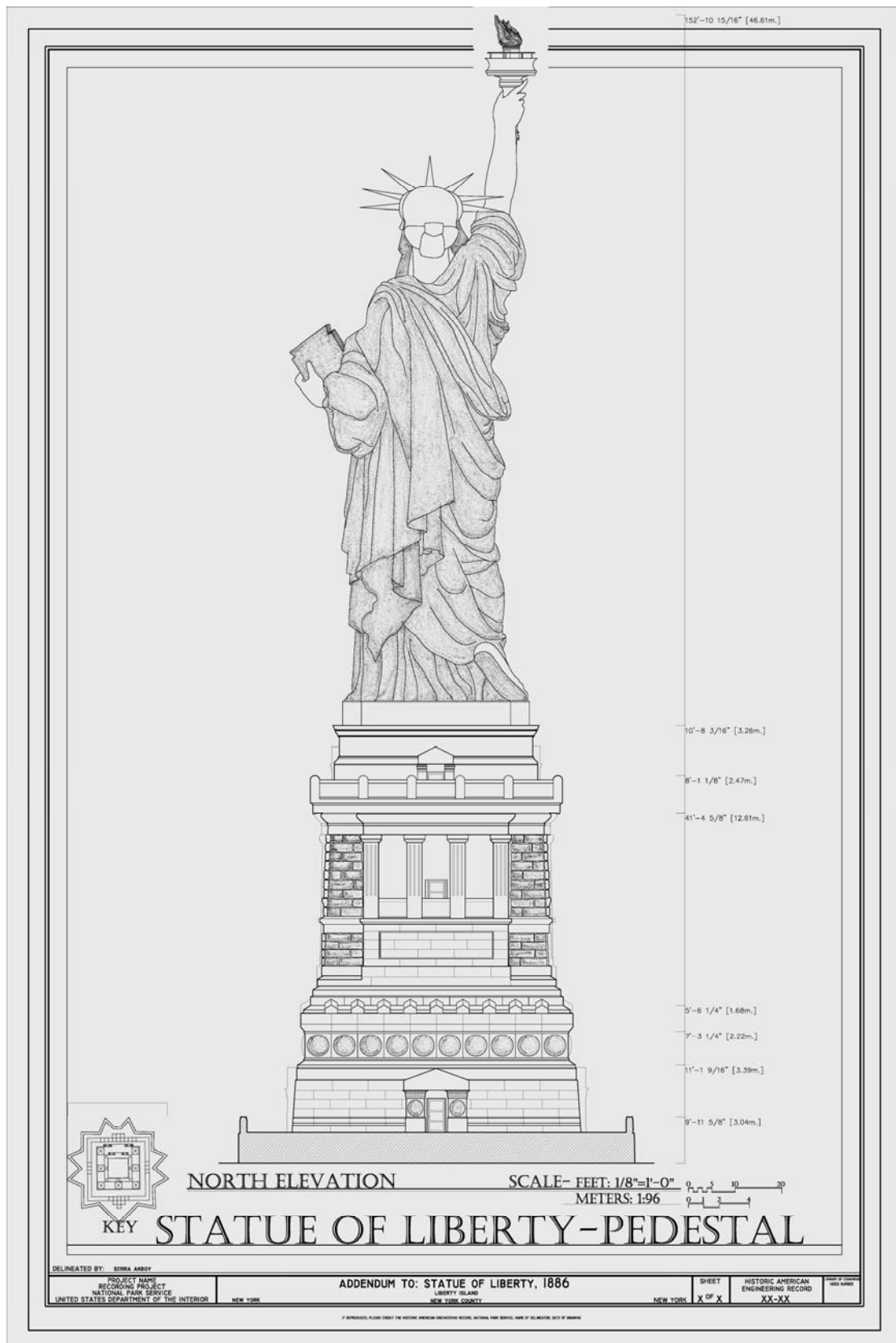


Fig. 6.6. The north elevation of the statue, DSOL, 2006.

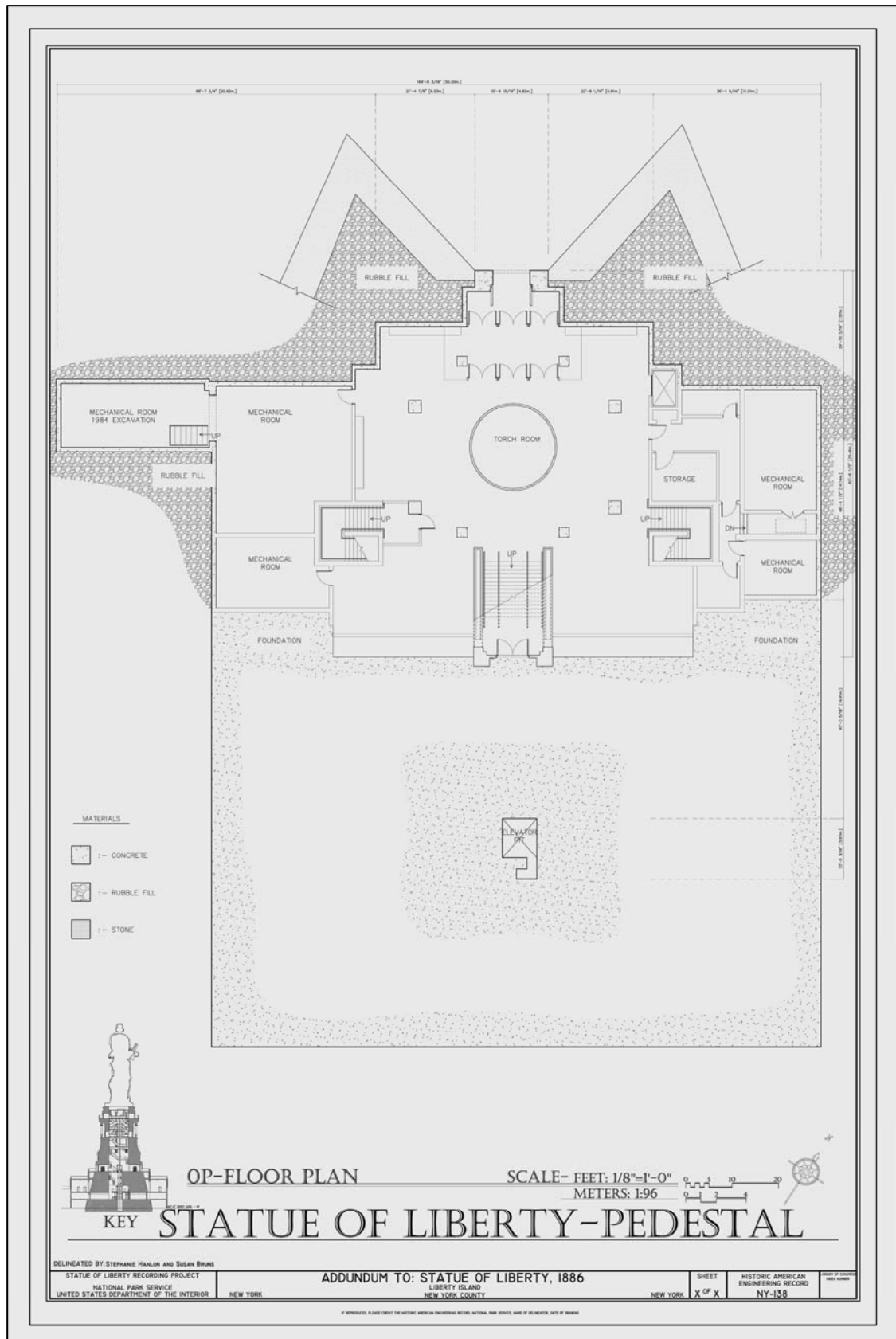


Fig.6.7. The OP-Floor Plan of the Pedestal, DSOL, 2006.

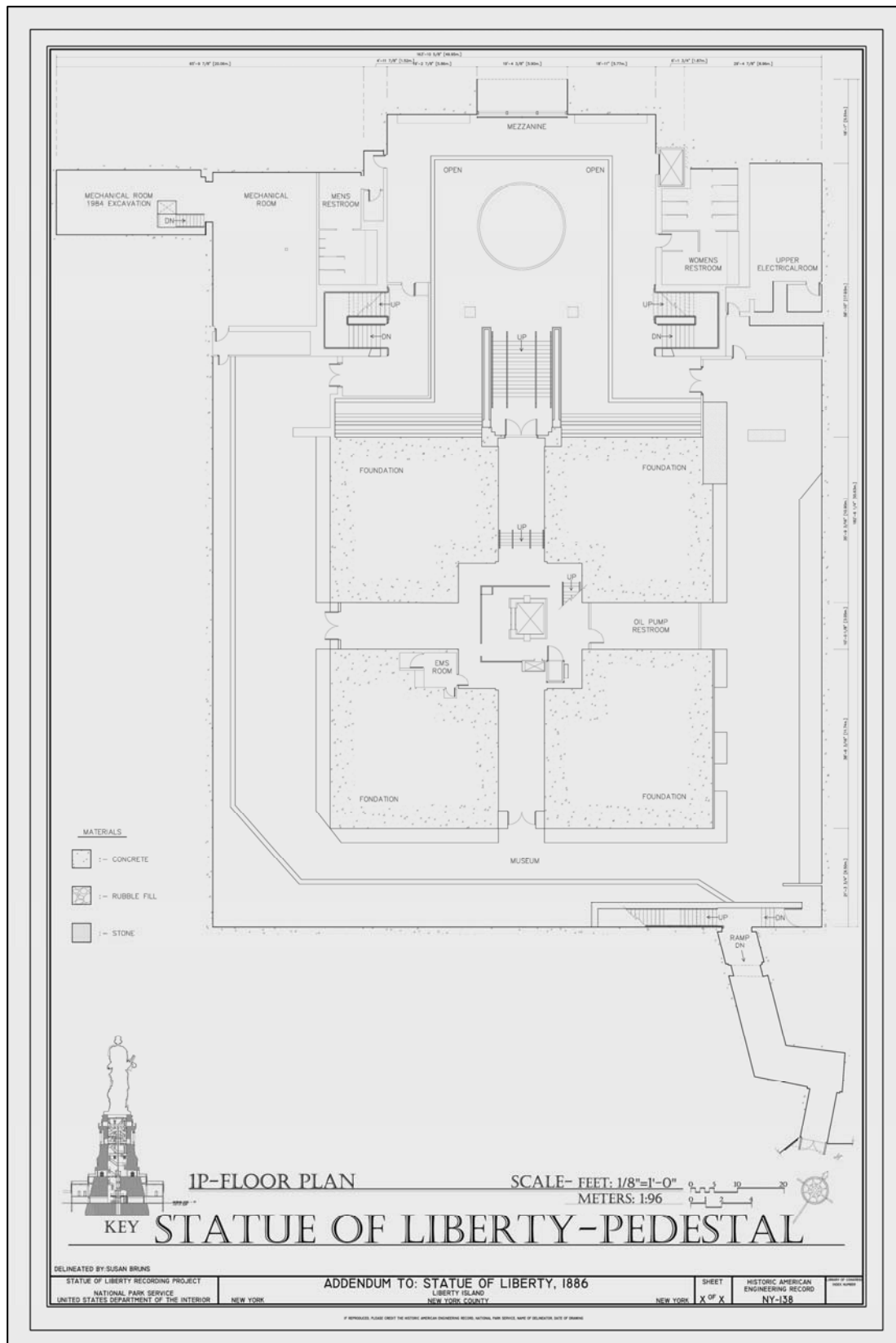


Fig.6.8. The 1P-Floor Plan of the Pedestal, DSOL, 2006.

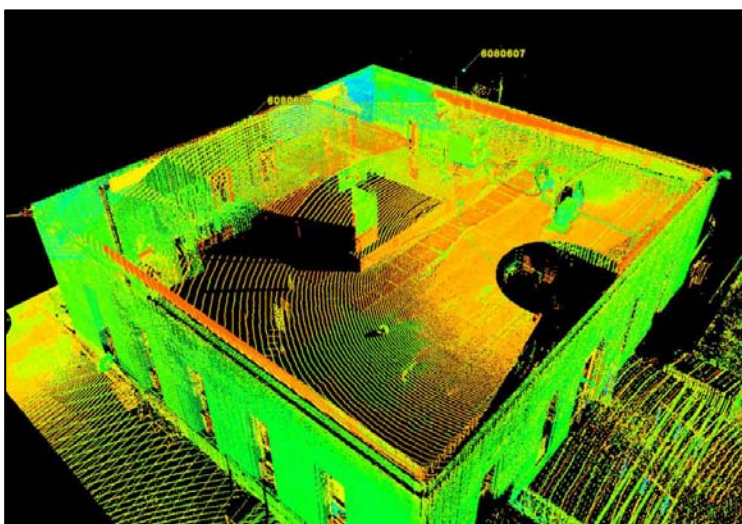
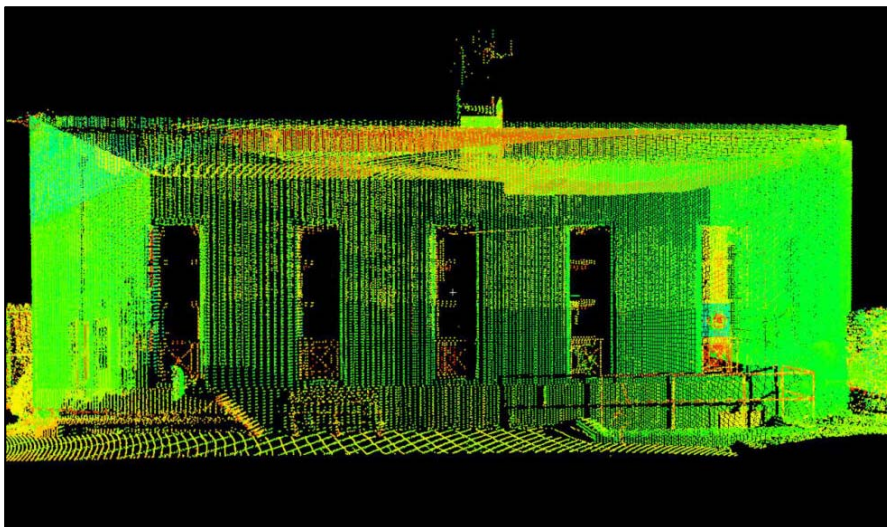
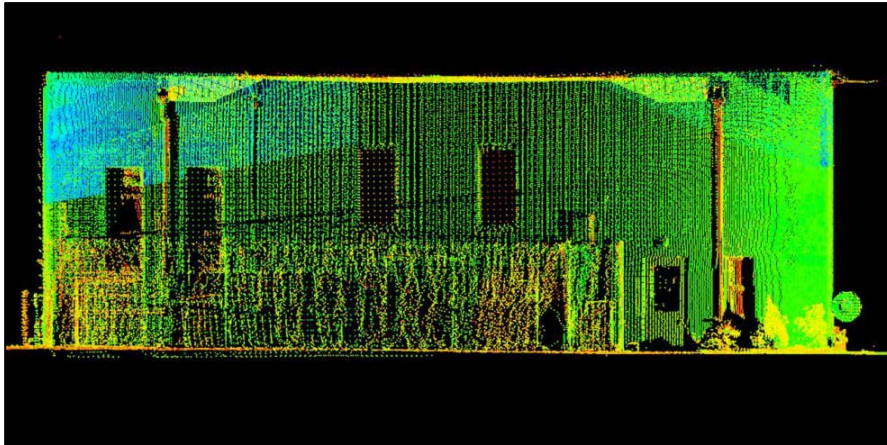


Fig. 6.9. Point cloud image of the Admission building, north elevation (above), west elevation (middle), roof of the building (below), DSOL 2006.

6.3.4. Conclusion

The utilization of digital surveying technologies in heritage documentation is not new in the USA; these technologies have been used in architectural documentation projects since the 1990s.¹⁶⁰ Further, TTU employed the laser scanner in various projects before the Digital Statue of Liberty.¹⁶¹ However, the Digital Statue of Liberty is pivotal in the scanning literature because not only has the project been devoted to the new experiments¹⁶² with the laser scanner technology in architectural documentation, but it has also underlined some gaps in the utilization of these technologies in these large scale documentation projects.

The Statue of Liberty and the Liberty Island is under the jurisdiction of NPS. The Digital Statue of Liberty Project is not only a university based project, but also a government instituted one which has been founded by NPS.¹⁶³ Therefore, the management scheme of the project is more structured than a commercial heritage project. For instance, although the TTU team undertook the scanning of the island and

¹⁶⁰ The earlier utilization of the laser scanner in architectural documentation includes scanning the Kansas State Capitol, the U.S. Capitol, and the Wilson Automobile Plant in Kansas etc. Hughes, K. & Loudon, E. "Bridging the Gap: Using 3D Laser Scanning in Historic-Building Documentation". APT Bulletin. Vol. XXXVI. No.2-3. 2005. p.39.

¹⁶¹ TTU has been investigating the laser scanning technology in architectural documentation for nearly a decade. One of the projects is the documentation project of Continental Grain Company, Brownwood Texas where TTU scanned the site with the Texas Department of Transportation (TxDoT) with a 2500 Cyrax laser scanner in 2002. Following this project, TTU scanned Bluff Dale Bridge, Bluff Dale Texas. In 2004, TTU and TxDoT worked together to document three road-side parks and several objects at eight other parks stretching across 1200 miles of Texas. Ibid., 41-43.

¹⁶² Examinations of how curvilinear forms of historic structures can be recorded by the utilization of laser scanner.

¹⁶³ Unlike the Seddülbahir project, where Kaletakımı has undertaken all the archaeological, historical, geodesic investigations, in the Digital Statue of Liberty case TTU is in charge of the digital architectural documentation of the island and NPS has been conducting various other projects in the department regarding the island. For instance, NPS conducted archaeological excavations on the island which have shed light the history of the island before the construction of the Statue of Liberty. In the last century the island was used as food collection station, a privately owned island with a house and garden, a quarantine station, a fortification, a signaling station, and only recently, home to Auguste Bartholdi's statue of Liberty Enlightening the World. More information can be found in NPS. "The Ground Beneath Her Feet: The Archeology of Liberty Island". 1999. April 25 2007. <<http://www.cr.nps.gov/archeology/IforA/caseLibertyIsland.htm>>.

processing the scan data, the NPS supervisor of the project¹⁶⁴ was consistently cooperating with the team, monitoring the project both in the field and in the office, helping the drawings to meet the NPS standards. Further, the team leaders and the NPS supervisor were frequently communicating to maintain the project along with the predetermined goals and making alterations if needed. Therefore this project is an important example of the significance of good communication channels between different organizational bodies within a heritage project.

The Digital Statue of Liberty project has always benefited from its academic context. Like the Seddülbahir Project, the team has had various benefits compared to other projects in the heritage documentation. The project focused on experimenting with digital technologies which is not possible most of the time because of budget and time constraints. For instance, the Digital Statue of the Liberty project officially started in 2001 and has continued since that year. This is quite an unfeasibly long process for most commercial projects due to strict deadlines. Further, the utilization of digital surveying technologies requires maintenance of the processing and employment of qualified staff which add tremendous cost to the project budget. However, the project could only emerge and devote itself to the investigation of different technologies as a result of its academic base of support. Hence, the Digital Statue of Liberty is very important when compared to other scanning projects in the States because a substantial part of the project has been dedicated to educating architectural students about digital surveying technologies.

¹⁶⁴Dana Lockett, Architectural Project Manager, National Park Service.

Although the utilization of the laser scanner has a great impact for the initial project budget, the contributions of this expensive surveying tool for the long term cost efficiency and effectiveness of the project should be considered extensively.¹⁶⁵ The same observations are highlighted in RecorDIM Initiative, “It is important to offset the current perception of the high cost of recording tools with an understanding of how they contribute in the long term to cost efficiency and effectiveness (Lettellier & Gray 19).” For example, the initial intention of the NPS was to document Miss Liberty accurately and monitor the patina effects on the skin of the statue. Now, however the NPS has a data archive to use for further multi purposed projects such as monitoring the entire island, improving the security infrastructure, developing transportation options to the island, producing preservation and restoration projects, etc.

The kind of problems that the team encountered throughout processing the scan data, such as the drawbacks during the conversion of the scan data and the failures of the computers are indicating that gaps exist between the digital surveying technologies and the architectural documentation. Although, the world of documentation has been acquainted with the digital surveying technologies and laser scanning technology, there is still a scarcity in the qualified staff that can operate the scanner and interpret the scan data.¹⁶⁶ While, the scanner has been increasingly

¹⁶⁵ Further, even though it is true that the employment of the laser scanner has a direct impact on the initial project budget; it should also be considered that the entire island was scanned in approximately two weeks which is not possible if traditional surveying techniques were used. The utilization of traditional surveying techniques not only would have taken a longer field work, but also it would have included more expenses such as the accommodation of the team in Manhattan for a longer time. Also there would be more human errors in the surveying data.

¹⁶⁶ TxDoT has been contracting TTU for most of their scanning projects. However, rather than investing in upgrading architectural skills and human resources, TxDoT prefers to hire scanning professionals. This approach contradicts the need for training students in scanning projects. On the other hand, TTU has been employing as many students as possible with the project budget and scale. Conversation with Loudon, TTU, project director, DSOL, during the Documentation Project of the Memorial Temple of Ramses II, Western Thebes, Luxor, Upper Egypt, 9 January 2007.

utilized by documentation professionals, rather than investing in the education of new staff, professionals who have been involved with scanning previously have been chosen because it is assumed they will more efficient. The RecorDIM Initiative has been also indicating the same problems and highlighting the importance of bridging the gap by providing adequate education facilities to both young heritage professionals as well as mid-career ones. For instance, one of the partnerships of the RecorDIM Initiative, the English Heritage (RecorDIM Task Group 1) has been working on improving “Metric Survey Skills in Conservation” by providing teaching guides on utilizing digital surveying technologies and drawing this survey data. This kind of investigation is important because it will help the heritage professional to anticipate the final products and increase the quality and quantity of the documentation standards.¹⁶⁷ Further, due to the fact that the digital technologies have been relatively new in architectural documentation, these systems have still had irregularities during the implementation such as the difficulties during scanning and processing the non linear edges, the failures of the interface softwares throughout the transition of the scan data from the laser scanner to the AutoCAD. RecorDIM has also been proclaiming the importance of bringing together the information providers such as the programmers and the information users such as the heritage professionals. For example, RecorDIM Task 9 is working towards the development of a common GIS tool for cultural heritage purposes.¹⁶⁸

¹⁶⁷ These teaching guidelines should provide an accessible teaching resource, inform selection of techniques, enable users to anticipate the difficulty of survey processes by methods, improve quality control through informed briefs, improve applications of user driven tools. English Heritage. “Training: Metric Survey Skills in Conservation”. RecorDIM 2006 Partners Meeting-5. Rome, Italy. May 14-16, 2006. 2005-6 Report (draft). Task Group 1. 03 June 2007.

http://extranet.getty.edu/gci/recordim/pdf/lunnon_progressrpt06.pdf

¹⁶⁸ Rinaudo, Fulvio & Bilgin, Güliz. “Generic Template for the Management of Heritage Places”. RecorDIM 2006 Partners Meeting-5. Rome, Italy. May 14-16, 2006. 2005-6 Report (draft). Task Group 9. 03 June 2007. http://extranet.getty.edu/gci/recordim/pdf/lunnon_progressrpt06.pdf

The Digital Statue of Liberty is a key project which has utilized the laser scanner in architectural documentation. The project distinguishes itself from the contemporary scanning projects because of its large scale, scope and the organizational scheme between the university and government. The assessments of the team's experiences in the project will help the heritage professionals in the international context, to find solutions to the gaps regarding training facilities, the collaboration between universities and government bodies in heritage documentation, the cost effects analyses of the scanner in the long term, etc.

Chapter 7

Laser Scanner in the Field

The Seddülbahir Project and the Digital Statue of Liberty are two documentation projects from different parts of the world. One is a stone structure from Gallipoli, Turkey, involving an Ottoman fortress and the surrounding site, which has witnessed many significant historical events since the 17th century including the bombardments of World War I. The DSOL is located in New York City, USA, built in the 19th century on Liberty Island, and is an important site and symbol for American history. Hence, the scale and the scope of the projects are different. The project in Turkey was initiated as a research project, and then developed past the initial phase to become a restoration and reusage project of the entire site. The latter project in New York City set out to document the skin of the Statue of Liberty to monitor the patina effects. The intentions and goals of this project also changed from its initial intentions to become a wider documentation project including the entire Liberty Island. However both projects, share some similar goals. Owing to the fact that they are university based, both the Seddülbahir Project and the DSOL have not hesitated to test new technologies for the sake of heritage, documentation and research. For instance, in 2004, when the aim of the Seddülbahir Project shifted from that of a documentation project to a restoration project which required more precisely measured drawings, although there were other methods available at a lower cost to capture the precise measured drawings, i.e., photogrammetry, Kaletakımı preferred

the laser scanner technology to acquire the data.¹⁶⁹ Since the scanning technology had not been attempted in Turkey on such a large scale, the team took the chance to experiment with this technology and ascertain the final products. On the other hand, before the Digital Statue of Liberty began, the TTU team had already been using the laser scanning technology in heritage projects. However, when NPS asked TTU to provide the scan data of the skin of the statue in 2001, the TTU team took advantage of this opportunity to experiment with the problems of dealing with this type of scanning technology on curvilinear forms and to investigate the data conversion. Therefore, both projects have been undertaken for practical as well as scholarly reassess, and have examined new technologies and their impact and challenges in heritage documentation. Additionally, from a pedagogic point of view, both projects provided an infrastructure to young colleagues, i.e., architecture students, engineering students, interns, etc. who worked throughout the projects and gained valuable experience by acquiring a deeper understanding of the conceptualization of documentation and the digital technologies.

In this chapter, the two projects are explored according to their field work from a surveying point of view. The predetermined schemes and their outcomes are investigated. The problems which were encountered in the field are addressed and their solutions are discussed.

7.1. The Seddülbahir Project

¹⁶⁹ Also, photogrammetry was not a good alternative because this technology could not have documented all the details that the project required. Conversation with Lucienne Thys-Şenocak, Koç University, project director, the Seddülbahir Project, in 14 June 2007.

The Seddülbahir site is located on the southern shore of the Gallipoli Peninsula, in the Seddülbahir Village; the fortress is located on the shore of the village exposed to the Dardanelles. The geodetic location is $26^{\circ}.199$ E_{ITRF} and $41^{\circ}.006$ N_{ITRF}. Although the village is on the road to a major monument which commemorates the Turkish and Allied dead in the Gallipoli battles, the fortress is only visible from the sea and the memorial at Cape Hellas. Therefore, although the Seddülbahir fortress is easily accessible from the village, it is not visited by many of the tourists heading to the war memorials. The Kaletakımı received permission to close off the entire site to the public while the surveying project and excavation was underway. It is again opened to the public in the spring 2007 although the site has many dangers and unstable structures. Unfortunately when the National Park has reopened the site to the public, no safety provisions were made as the fortress awaits restoration.¹⁷⁰

The Seddülbahir site was closed during the fieldwork so Kaletakımı could undertake the surveying without any external obstructions. Also it was the recommendation of the team to close the site because of the unsafe environment that existed at Seddülbahir due to so many unstable structures. Additionally, the security guards at the site helped the team to maintain the operations. During the fieldwork, the team could work without any external interruptions; however when the team was working on the measurements outside the site, to the team members' surprise, rather than the local villagers, the summer residents would come and ask questions about the on going work.¹⁷¹

¹⁷⁰ Conservation with Lucienne Thys-Şenocak, Koç University, project director, the Seddülbahir Project, in 14 May 2007.

¹⁷¹ Conversation with Arzu Özsavasçı, İTÜ, supervisor of the architectural team, the Seddülbahir Project, in 24 April 2007.

Before the field work in 2005, the team anticipated approximately a two week campaign for scanning in the field. They were loaned the laser scanner and the operator from the Sistem Bilgisayar ve Teknik Hizmetler Sanayi AŞ - Leica for the work. However, during the first days of the fieldwork, the firm requested the scanner back due to another scanning project and the team had to hasten scanning in the field. They even worked 15-16 hours per day which was very tiring.¹⁷² Moreover, charging the batteries of the scanner and the lap top computer became a major problem during the scanning campaign. The batteries were not enough to maintain a scan script; therefore they had to be charged constantly. In some occasions, the team had to stop scanning until the batteries were full, which delayed the field work.¹⁷³

Throughout the scanning of the interiors of the fortress, the team discovered the importance of illumination. Although, the scanner can operate independently from light conditions, light has a great impact on the quality of the scan data determining the intensity image (color value) of the structure. This color value enables the architect to ascertain the 3D details and different materials of the structure and thus facilitates the drawing phase. In the case of the HDS 3000, this scanner has an integrated facility of taking pictures of the scanned area. These pictures were crucial since the scanner captures the color information in these pictures and adds the color information to the 3D vectorel image¹⁷⁴ (point cloud data). However due to the fact that the scanner did not have an illumination system integrated to the camera, the

¹⁷² Interview with Rahmi N. Çelik, İTÜ, project director, Seddülbahir Project in April 26 2007. Also, Bora Sayın, geodesy team, the Seddülbahir Project, complained about the same problem. Due to the restricted time in the field, the team had to scan rapidly. Communicative email, 17 May 2007.

¹⁷³ Correspondence with Bora Sayın, geodesy team, the Seddülbahir Project, 17 May 2007.

¹⁷⁴ *Vector graphic*: An image composed of mathematically described elements such as lines, arcs, and points (vectors), plotted in two or three dimensional space. The use of mathematical formulas to describe an image, instead of pixels, means vector graphics are not constrained by resolution, allowing them to be output at any size without loss of detail or other artifacts of pixel-based processing.

team had to artificially light the environment to maintain the high level of point cloud quality and obtain clearly defined details of the structure when they were scanning the interiors of the fortress, i.e. dome, or working at night.¹⁷⁵

Considering the whole scanning process in the field, the Kaletakımı did not come across major difficulties except the long hours of scanning.¹⁷⁶ They maintained the power supply of the scanning by charging the batteries of the scanner and the laptop frequently.¹⁷⁷ Further, when they utilized the operation system of the scanner and the integrated camera within, they generated more successful scans.

7.2. The Digital Statue of Liberty

The Liberty Island is located in the New York Harbor, and the only transportation system linking the island to the mainland is a ferry departing from Battery Park and New Jersey on the regular basis. The Statue is one of the major tourist spots of New York City and the island welcomes many tourists all day long.

¹⁷⁵ Further, during the field work, the team experienced a few important lessons, when they were working in the interior of the fortress. While the scanner was taking pictures of the dome, the team realized that a small can had been left on the floor obstructing the field of view of the scanner, so they removed the can. However the scanner had already taken a picture of that detail and when the scanner was scanning that view point, the can was still in the point cloud data like a black shadow. With this experience the team recognized the technical relation between the photos of the scanner and the scan data and the importance of cleaning all obstructing objects before commencing the scanning. Interview with Rahmi N. Çelik, İTÜ, project director, Seddülbahir Project in April 26 2007.

¹⁷⁶ Actually, the long hours of scanning can be referred as a general characteristic of all the scanning projects in the field. Since there are always time and budget constraints and scanning a site practically consumes more time than scanning an artifact in the museum due to the varied dynamics in the site, e.g. the configuration of the structures in the site, the accessibility to the structures, the topography, the lack of a solid maintenance system (power supply, etc); working long hours in the field is an inevitable fact of scanning. In the DSOL, we were scanning sometimes fifteen hours a day. Also in the Documentation Project of the Memorial Temple of Ramses II, Western Thebes, Luxor, Upper Egypt we would start scanning 6:30 in the morning and continue scanning until the site was closed at 6:30 pm. Only this way, we could have scanned the entire site and the massive structure in five days.

¹⁷⁷ In the DSOL the team not only used the electrical system of the island, but also had additional batteries for the scanners to facilitate the fieldwork.

Further, after the terrorist attack on World Trade Center in the 11th September 2001, the island has become one of the major places where security procedures have increased tremendously. Therefore the visitor circulation and the strict security regulations on the island were major concerns of the team during the field work.¹⁷⁸

The tourist groups arrive on the island (Fig.7.1.), proceed to the Fort Walls where the statue is located, take pictures and look at the souvenirs while awaiting the huge line to enter. They precede through several security spots, enter the pedestal, and visit the Museum accompanied by a park ranger. Eventually, after all these procedures, they use the elevator in the pedestal to climb up to the “promenade” level where they can observe the interior of the statue by looking from the glass ceilings under the statue.¹⁷⁹ After they experienced the statue

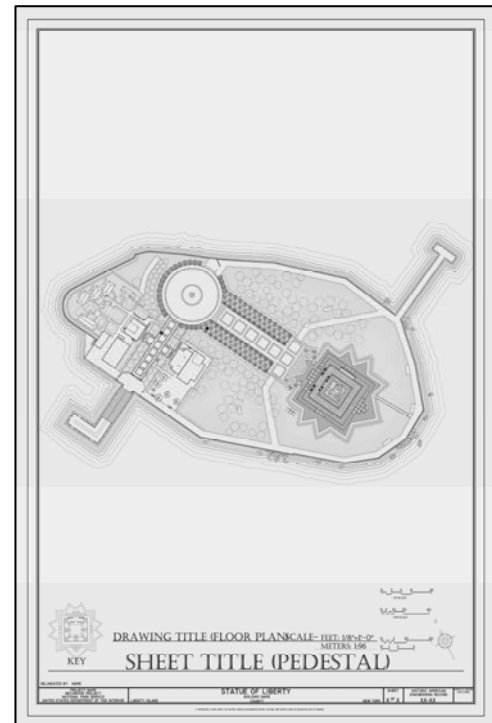


Fig. 7.1. The site plan of the Liberty Island, DSOL 2006.

and enjoy the view of Manhattan from the Observation Deck, they proceed up to the stairs to go down and exit from the pedestal. After that, they would stroll through the

¹⁷⁸ The visitor circulation and security regulations are frequent problems that the heritage professional encounter in the field. For example in the Documentation Project of the Memorial Temple of Ramses II, we came across to the similar problems. The site was located near to the Valley of the Kings, so it was on the route of the tourists. However, since the site was not so popular (compared to the Valley of the Kings, Karnak, etc.) the tourists prefer to visit the temple as a secondary choice. Therefore, only a few tourist groups visited the temple in the morning and they were not impeding the scanning in the field. This facilitated our work. However, due to the Egyptian regulations, the site was open during the official working hours and working in the field after the working hours was strictly forbidden. As a result we had to work during the day ceaselessly.

¹⁷⁹ The visitors are not allowed to enter the Statue after 9/11. Glass ceilings were built in the observation deck where the visitors can examine the inside of the statue.

island, take pictures, have some snacks and then leave the island with a lot of unique memories.

During the morning field work, the pedestal and seashores and thus the statue was fairly empty since the visitors were proceeding through the security points and then heading to the Statue. However in the afternoon, right after noon, not only was the island packed with tourists but also the statue was crowded. Towards the end of the afternoon, the island became quite empty due to the last ferry departure at 18.30.



Fig. 7.2. The team suffered from the high visitor flow, DSOL June, 2006.

The presence of the visitors became a major constraint since from the first day of the field work and required a solid time management scheme. The huge crowds of tourists were everywhere impeding the surveying on the island. Not only did they slow down the hand measurements, but also obscured the field of view of the scanner, sometimes approaching the precise surveying instruments and removing the targets. As a result, the team had to adjust the surveying time according to the circulation of the tourists. For instance, the team chose to survey the favorite targets of the tourists very early in the morning (From 6.30 AM to midday and from late afternoon to 21.30

Pm). Also, the team entered the statue to scan the interior of the statue, after the last tourist group left the island (after 18.30 PM) since the visitors are not allowed to enter the statue, the National Park Officials did not want to offend them with a view of surveying and working in the statue. Further, the team preferred to hand measure major tourist spots, i.e., the souvenir shop, café, etc., in the early morning since they could do hand measuring of the secondary spots, i.e. administration building, kitchen, depot, etc., throughout the day. Although, this strict time management eliminated most of the surveying delays encountered indoors, it did not work so efficiently outdoors for the places where the tourists frequented often, i.e., the entrance of the concession building (Fig.7.3.). As a result, although the obstructions by people in the scan data were cleaned during the registration, in some cases such as the scan of the entrance of the concession building, the data had some missing details which were filled with the help of the photos while producing the CAD drawings.

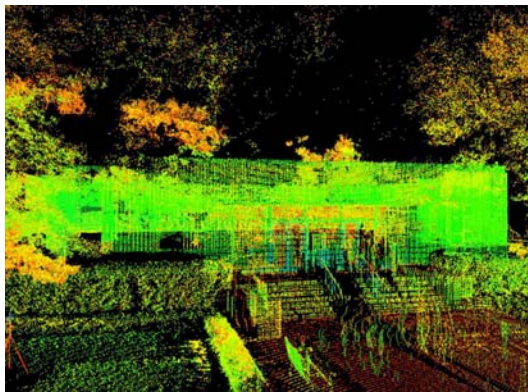


Fig.7.3. The Cyclone views of the Concession building, the entrance of the buildings were always crowded with tourists
North Elevation, point cloud model (top)
Entry from patio, point cloud model (below)

The other challenge to the team was the strict security regulations.¹⁸⁰ The public order on the island is maintained by security guards who are armed. In addition to this, an official helicopter flies over the island frequently. The visitors are subjected to a series of security check points where they are put through a diversity security tests before entering the island and then proceeding to the statue.

The team had also to consider these security regulations during the surveying. The team not only had to cooperate with the security guards, but also had to follow all the security regulations. For instance, especially, while entering the pedestal, the team members were subjected to the same security check points as the visitors and had to repeat the sequence each time they left the pedestal. It became a burden to carry all the surveying equipment through the gates repeatedly. To eliminate this waste of time and effort, the team members used the vacant pylon (the old museum) in the pedestal as their base and kept all the equipment there. This way the team maintained the contact between the members while surveying the interior of the pedestal and the statue¹⁸¹.

The cooperation with the security guards was not always successful either. In one occasion, Loudon experienced a conflict with a security guard who refused to let the team inside the statue, claiming that no one is allowed to enter the statue. The

¹⁸⁰ On the island, there are two types of officials: the park rangers and the security guards. The park rangers work for the NPS and are responsible from all the administration and the utilization of the island whereas the security guards are employed by the NPS and all in charge of all the security of the island. A park ranger always assisted the team throughout all the field work.

¹⁸¹ The team used the vacant house on the island as their main base and kept all the equipment and maintained the computer information.

disagreement was solved when the guard called the superior NPS official and learned that the TTU team had the full authority to pursue the scanning of the statue.¹⁸²

During the field work, the team had some internal miscoordinations due to the large number people (12) in the team. Although there were two scanners and thus two scanner teams, there were times when the communication between the teams was inefficient to determine the scanned and unscanned portions. At the end of the field work, the entire island had been documented but the scan work could have been done more efficiently and faster if the level of communication between the two teams had been better.¹⁸³

Owing to the fact that the statue is made of copper, the team anticipated reflectivity problems during the scanning and was concerned they may have had to pursue different procedures. However, since the copper sheath had oxidized, they did not have any such reflectivity problems regarding the statue. Nonetheless, they had a reflectivity problem with the glaring torch (Fig.7.4.). They could not get any images of the torch. Instead they had panoramic images. As a result, they scanned the old torch that is in the pedestal to record the shape of the present torch.¹⁸⁴

¹⁸² Conversation with Elizabeth I. Loudon, TTU, project director, DSOL, during the Documentation Project of the Memorial Temple of Ramses II, Western Thebes, Luxor, Upper Egypt, 9 January 2007.

¹⁸³ Conversation with Elizabeth I. Loudon, TTU, project director, DSOL, in 19 April 2007.

¹⁸⁴ During the restoration campaign in 1986, the original torch was replaced by a replica which has gold plating applied to the exterior of the "flame," The 1886 torch was put in the pedestal which can be seen entering the statue. During the fieldwork, the team had problems scanning the glaring torch at present and could not get any images, so they scanned the original torch in the pedestal and integrated it into the pointcloud of the statue.

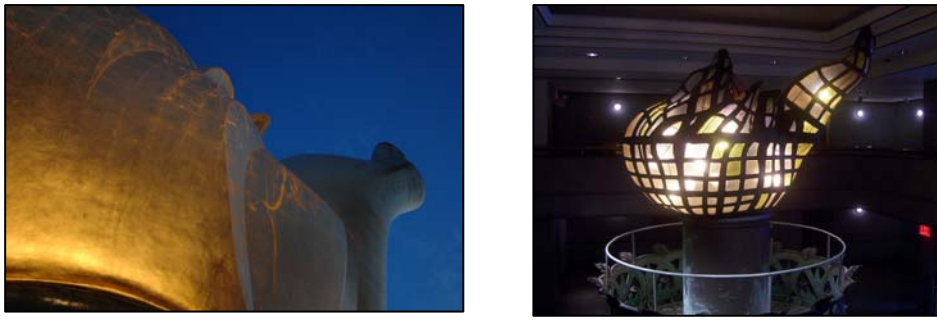


Fig. 7.4. The team had a problem with the reflective nature of the torch (left), they could not get any scan data; so they integrated the old one (right)

The other challenge regarding the application of the scanner emerged due to the fact that the scanner captures volumes precisely but can not detect the edges. Therefore the team had problems scanning the round corners and determining the edges of the curves similar of to the problems encountered at Seddülbahir. Finally, while processing the scan data, when the team was drawing the stones on the Fort Walls and the curves of the Statue, the scan data was not sharp enough to represent the edges, and the pictures were used to obtain additional data.

Overall, apart from the peak tourist flows, strict security regulations and some miscoordination of errors between the team members, the team did not encounter serious difficulties while scanning the site. The only major problem encountered the reflectivity of the torch was solved by during the processing phase of the scan data by substituting the old torch for the torch that had too much reflectivity to capture accurate scans.

Chapter 8

An Overview of the Utilization of the Laser Scanner in Heritage Documentation and a Proposal for its Methodology

The utilization of scanning technologies in documentation projects began about a decade ago. As a result, the documentation professionals have not only been implementing their personal surveying experience in the application of the laser scanner, but also have undertaken the scanning technologies with trials and errors.¹⁸⁵ The procedures for scanning a fortress, statue or a small artifact and thus generating the drawings and models are intrinsically different; however the general approach is similar and there is an urgent need to produce a general methodology for the recommended practices for the laser scanning technology and the standards for which the point cloud data should meet in diversified documentation projects.¹⁸⁶ In this chapter, first the utilization of the laser scanner in heritage documentation is evaluated and then a methodology for this utilization is proposed in view of the diversified case studies that have been presented in the previous chapters and the Seddülbahir Project and the Digital Statue of Liberty.

¹⁸⁵ As a result, in the research of laser scanning procedures and final products, organizations such as the International Committee for Architectural Photogrammetry (CIPA), the International Council on Monuments and Sites (ICOMOS), the Getty Conservation Institute (GCI) these three organizations created the RecordIM initiative in 2002), National Park Service (NPS), ICCROM and English Heritage (EH) have been working toward improvement in the documentation field.

¹⁸⁶ Mills, J.; Barber, D. "An Addendum to the Metric Survey Specifications for English Heritage". English Heritage. 2003. p.2.

8.1. An Overview of the Utilization of the Laser Scanner in Heritage Documentation

8.1.2. The Operational Scheme

The use of the laser scanner can be roughly categorized into two groups: the information providers and the information users. Conservators, archaeologists, architects, engineers, historians, planners, the general public, surveyors, graphics artist etc. can be considered as the information users (end users) who are working to produce a record of at-risk sites, to monitor projects, to make 3D digital replicas, to serve educated purposes, documentation and interpretation. Essentially, they are trying to determine various questions such as: what does the object/structure/site look like, how big it is, how it has changed, where is the maintenance work required, does it have subtle features that were not previously noticed. The information providers consist of photographers, photogrammetrists, GPS, GIS, laser scanner professionals who have mastered the recording tools. Although this rigid categorization does not indicate in exact terms the overlap between the providers and the users due to the interdisciplinary nature of the documentation, it draws a picture of the fundamental phases and provides some distinctions between the groups of the related professions who are involved in the scanning process.

8.1.3. The Advantages and Disadvantages of the Laser Scanner in the Field

In view of the case studies presented in the previous chapters, the advantages of using the laser scanner in the field can be generally outlined. In support of laser scanner technology:

- it is applicable to all 2D and 3D surfaces
- it can produce very detailed, accurate, sub millimetric data
- it captures data very fast in (near)real time
- it produces portable/customizable 3D data
- it captures a tremendous amount of data with a high accuracy rate and eliminates further surveying trips to the field to procure any missing data
- it has an ability to visualize non-visible features that are located in inaccessible places with its capacity for generating 3D models
- it is ideal for modeling and visualization
- it has an important educational/interpretational value

On the other hand, the laser scanner has some disadvantages in the field which should be considered before utilization,

- Both the hardware and sophisticated software needed to process the data is still very expensive
- it produces very large data sets which are often very difficult to view and manipulate

- it requires specialist processing and extensive training of architectural staff
- its final product still requires manual digitization
- it is used with other surveying and documenting tools such as total station, GPS, photogrammetry for cross-checks and inaccurate points.

8.2. Methodology and the RecorDIM Initiative

Methodology is defined as “a set or system of methods, principles, and rules for regulating a given discipline, as in the arts or sciences”.¹⁸⁷ Further, methodology can be assessed as an interchangeably broad approach including the analysis and development of these methods and principles of the discipline. Moreover, even agreeing upon the rules, tools and terminology within a discipline can be evaluated as adopting a methodology. Methodology is often confused with method. However, “method is a particular way of doing something”.¹⁸⁸ Therefore, methods along with other tools such as identification of the terminology, standards, policies, rules, practices constitute a part of a broader methodology. For example, both in the Seddülbahir Project and DSOL, the methodology was to document a historic site and produce architectural drawings, conduct deformation analyses with experimenting new technologies and involving students in the project. An additional part of the methodology was to discuss and disseminate the findings and final products by

¹⁸⁷ “Methodology”. Dictionary.com. Definitions from Dictionary.com. 2007. 29 May 2007. <<http://dictionary.reference.com/browse/methodology>>.

¹⁸⁸ “Method”. Essential English Dictionary. London, Glasgow: William Collins Sons & Co. Ltd. 1990. p.490.

submitting papers, articles and further studies. Hence, both of the projects utilized a laser scanner as a method to accomplish this methodology.

In this context, the RecorDIM Initiative offers a methodology “to develop strategies to close the gaps between information user and provider and improve conservation recording practice” (Letellier & Gray 2). This methodology includes:

- organize roundtable discussions to define the gaps between information users and providers
- publish guidelines for heritage recording, documentation and information management
- develop how-to handbooks for recording
- create a Web presence on these subjects
- develop training opportunities and materials and
- develop further partnerships with appropriate and committed organizations (Letellier & Gray 5)

A methodology should be simple, clear to everybody and reflect a general approach such as the RecorDIM which offers a general methodology for the heritage professionals in the international context by expressing common problems and solutions in the field in a comprehensible manner.

A methodology is not a mere compilation of methods, but it highlights the underlying principles of the discipline, emphasizes the philosophical assumptions and then analyzes the principles, and finally offers solutions. This requires professionals from diverse disciplines, sharing their experiences and knowledge and examining the

present circumstances, and then offering adequate methods. For instance, since 2002, the RecorDIM Initiative, has been emphasizing the significance of the constant idea exchange between the diversified heritage professionals and the collaboration of diversified varied disciplines by organizing roundtable sessions,¹⁸⁹ symposiums,¹⁹⁰ and workshops.¹⁹¹ As part of the common goal of these meetings, the Initiative assesses the present circumstances and determines the tasks to be done according to a schedule.¹⁹²

“RecorDIM activities are largely based on self-motivation in that generally those creating a RecorDIM task group do it to resolve a gap that exists within their own organization / country. This motivation grows with the understanding that task groups will get input from the other RecorDIM Partners that represent organizations with similar needs, but from different countries with complementary experiences (Letellier 1)”¹⁹³.

These task groups are aimed at examining the different gaps in the heritage field and documentation practices in respective countries. They propose solutions for

¹⁸⁹ The roundtable sessions such as RecorDIM 2005 Partners Meeting-4, May 8-10, 2005, Paris, France; RecorDIM 2004 Partners Meeting -3, April 25-27, Leuven, Belgium, etc.

¹⁹⁰ The symposiums such as International Cooperation to Save the World's Cultural Heritage, CIPA 2005, XX International Symposium, Torino, Italy; New Perspectives to Save Cultural Heritage, CIPA 2003 XIXth International Symposium, Antalya, Turkey, etc.

¹⁹¹ These are workshops such as RecorDIM Initiative, Principles & Guidelines and Handbook Workshop Los Angeles, CA, USA, 27-29 May, 2003, etc.

¹⁹² For instance during the first RecorDIM roundtable discussion session on March 4-5, 2002, Getty Conservation Institute, Los Angeles, California, the professionals discussed the conceptualization of documentation in conservation, the importance of governmental bodies and commercial organizations in the process of documentation and conservation, the problems between the information providers and users including the terminology confusions and communication problems. They concluded these six statements as a base for the solutions of the problems at present. Then, the Initiative allocated these statements to more than fifteen task groups ranging from “Guidelines for documentation of Historic Properties of India”, to “Training: Metric Survey Skills in Conservation”, “Documentation for World Heritage Nominations and Monitoring”, “Documentation and support of restoration of the traditional architecture in Nias, Indonesia”, “Technical Monitoring of Large Archaeological Sites”, etc.

Letellier & Gray p.2; Letellier p.3-4.

¹⁹³ Letellier, R. “What is RecorDIM”. CIPA 2005 XX International Symposium, 26 September – 01 October, 2005, Torino, Italy.

the international context. Although, this attitude is justified for voicing the general needs in an international platform, from a regional point of view, this methodology often too general and has to be reinforced with more information from the local and national level. For example, every country such as Turkey has problems similar to what RecorDIM brought up, such as the lack of definition of roles and responsibilities of heritage professionals, unclear terminology, a lack of understanding the role of documentation within the conservation process, training tools, guidelines and standardization. However, because Turkey has not been well represented in the case studies, as well as in the task groups, the implementation of this methodology in the Turkish case becomes problematic.¹⁹⁴ Therefore, although, the implementation of this methodology is an initial step towards bridging the gap in the international platform, in the local cases such as the Turkish one, each country has to assess position and improve the tools according to local needs. The Turkish heritage professionals have to assess the RecorDIM methodology according to their own experiences rather than accepting the tools without any criticism. It is unfair to expect that the RecorDIM Initiative will acknowledge and work for every individual country's needs and determine the particular information and technological gaps in these countries. However, the Turkish heritage professionals have to be more involved in these international platforms and share their experiences and conceptualizations and thus be a part of the solutions. I believe the Turkish heritage professionals have the expertise

¹⁹⁴ Although many Turkish professionals have been utilizing digital technologies in heritage documentation and discussing their problems and solutions in diversified symposiums; there is only one task group in the RecorDIM which includes a Turkish scholar examining a general problem in the heritage field to bridge the gap. Bilgin, Güliz (METU Faculty of Architecture); Rinaudo Fulvio, (Politecnico di Torino, Italy), Task Group 9: Generic Template for the Management of Heritage Places. Both of these scholars have been working together to develop a common GIS tool in cultural heritage management.

and diversified case studies to become leaders in the process of resolving the current challenges in documentation process.

Although, the RecorDIM Initiative has been concentrated on the heritage industry and has been examining different case studies to determine solutions and methodologies for the gaps at present, this methodology is lacking the advances that are evident in the scanning projects undertaken in the industry sector. Laser scanner started to be utilized in industrial projects to generate as-built products, assess the quality control and quality assurance of the products. This technology has still continued to be widely employed in this industry.¹⁹⁵ Further, in different industries such as volcanology, mining, rock fall studies, etc. the laser scanner has been substantially employed and the implementation process of this tool has been increasingly improved by the scholars. For example, the volcanologists and scholars who have been investigating the rock falls have been examining the performance of the laser scanner from long distances and under hazardous circumstances. In the mining industry, scholars have been trying to improve this technology to be used in the quarries where the field work is highly constrained by the physical features of these underground corridors and with the absence of any external georeference systems. Recently, researchers have generated a prototype system for documenting a bridge from a vehicle at highway speed. In other words, they have developed a laser scanner which can acquire 3D data for accurate bridge height clearance information from a moving vehicle.¹⁹⁶ These case studies are crucial for the heritage professional to examine different variables in the scanning projects and evaluate them for possible

¹⁹⁵ Correspondence with Bora Sayın, geodesy team, the Seddülbahir Project, 17 May 2007.

¹⁹⁶ University of California. "On-the-Fly Bridge Profile Sensor Provides Data for Oversize Permitting". AHMCT web page. April 2006. 07 June 2007.
< <http://www.ahmct.ucdavis.edu/index.htm?pg=BridgeProfiling>>.

application in heritage projects. Therefore, in terms of benefiting from the methodologies and tools that have been utilized in the industrial sector, the RecorDIM should acknowledge and investigate these industrial scanning projects more extensively and not see these application of laser technology as a separate endeavour.

8.2.1. A Proposal for a Methodology for the Utilization of the Laser Scanner in Architectural Documentation

Although the employment of the scanner in heritage dates back to late 1990s, the technology has developed rapidly during this short time and this promising device has become quite a permanent tool in the field. However, the great leap in technology has not been followed by a similar advancement of theory and practice of architectural documentation and hence this has resulted in gaps between the information providers who are using the newer technology and the users who do not have the sufficient training to process the data. For instance, the utilization of the digital surveying technologies, especially the laser scanner, in the architectural documentation has brought new dimensions and application schemes which have to be considered extensively. Mastering the laser scanner technology and integrating it with architectural documentation inevitably will take time. Perhaps, conveying the history of photogrammetry is a useful act to evaluate the incorporation of a surveying tool to the architectural documentation: The first photogrammetric devices were invented in 1851 and then the architects started to experiment with photogrammetry in architectural documentation. In 1885, the first photogrammetric institute was established. (Royal Prussian Photogrammetric Institute) In 1885, the ancient ruins of

Persepolis were the first archaeological site documented with photogrammetry. In 1910, The ISP (International Society for Photogrammetry), now ISPRS, was founded in Australia followed by the first congress in 1913, Vienna. In 1968, first international Symposium for photogrammetrical applications to historical monuments was held in Paris - Saint Mandé. In 1970, CIPA International Committee for Architectural Photogrammetry) was constituted. Photogrammetry has had a long history in architectural documentation. Since its invention, the architects have been exploring this technology and experimenting it with architectural documentation. Now photogrammetry is one of the major surveying tools in the field.¹⁹⁷

There is a great need for an adequate methodology for utilization of the laser scanner in architectural documentation. The RecorDIM Initiative is one of the few organizations working towards a methodology for the utilization of digital technologies in the documentation process.

Although, the problems in Turkey and the laser scanner projects in the industry have not been represented in the RecorDIM extensively, I believe this methodology is an important step to incorporate the digital technologies in the architectural documentation effectively. Hence, I recognize the RecorDIM's methodology and propose further methods for the utilization of the laser scanner in architectural documentation. The proposal is made of three main sections, pre-surveying, surveying and processing the scan data, highlighting various points what should be taken into consideration during the scanner applications.

¹⁹⁷ The Institute for Prehistory and Protohistory of the University of Vienna. "Introduction to Photogrammetry". The Aerial Archive. 1999. May 16 2007. <<http://www.univie.ac.at/Luftbildarchiv/wgv/intro.htm>>.

8.2.1.1. Pre-Surveying

Surveying is not a mere improvising operation in the field to record the physical configuration, condition and use of structures or sites. Rather it is a planned program based on a series of studies which not only consists of extensive historical research, but also preliminary field trips to a site to determine the impact of various issues ranging from scan schemes, georeference systems, to time management.

It must be realized that the laser scanner is not a replacement for the other more traditional surveying equipments. Before a decision is made to utilize a scanner, the reasons for using particular equipment should be considered carefully. The type of the structure to be scanned and the anticipated final products required should be decided upon and the appropriateness of laser technology should be debated. Other surveying techniques should also be investigated. For instance, if a structure at risk is required to be documented to produce the restoration project, the laser scanner is the appropriate tool as it can, capture a gigantic amount of data in high precision and represent every detail of the site. Even though the project goals change in the long term, this data archive will be fundamental in the project; particularly if there is a case that the structure may be eradicated by natural disaster or man-made developments such as dams.

8.2.1.1.1. Historical Research

As with traditional surveying methods, historical research is essential before any laser surveying begins since this research provides a more through extensive understanding of the value of the structure/site. Although the existing topographical and architectural data can be obtained by surveying, historical research adds a dimension to the understanding of the value of the site. For instance, consulting the archives and libraries for historical records of the structure/site/ can uncover how the structure functioned in the past, or reveal the existence of earlier structures on the site which may have been destroyed long ago. This kind of historical data can shift the emphases of the surveying to different points and be a reason for selecting or rejecting particular surveying equipment.

8.2.1.1. 2. The Target Audience

The target audience should be decided upon because surveying and documentation now include a wider and more diverse range of professions. Before beginning any field work, it is important to review the difficult processes and expectations that each discipline and its practice have. For example, an engineer will approach a scanning project with a particular set of expectations and an idea of the sequence of decisions that have to be made. This sequence, as well as difficult types of concerns can be very difficult for an architect or an architectural historian involved in the same field work to understand, so the needs of each description must be explained to the others involved in the project prior to embarking the field work. What each stakeholder anticipates as the sequence of actions, potential challenges and

anticipated end results must be clearly communicated at the beginning of the project and regularly throughout the project's evolution.

8.2.1.1. 3. The Scan Data Decisions

The determination of the scan data in the beginning of the project is a crucial decision and better ensures that successful results will be obtained. According to the scope of the project (what is to be captured, what is the smallest feature to be recorded, what the data is going to be used for), the accuracy, resolution, point density etc. of the scan data should be decided upon. For instance, if the features of the scan data and thus the end products will be used for preservation purposes, these can be different data than the type of data which will be obtained only for research and archival purposes. The first project requires data which is precise enough to produce 2D architectural drawings; the latter can be a wide range of data type depending on the nature of the research project. Further, although the project defines its scope and the final products in the beginning, and the scan data is determined accordingly, the scanning team will need to make several decisions during the project's duration. As recent scanning projects have demonstrated, the more data collected the more accurate and less ambiguous the documentation will be. Yet, it should not be forgotten that more data brings more data processing, archiving, problems and an increasing need for more sophisticated and costly processing hardware and software.

As the people who procure the data in the field and those who process the scan data in the office are not the same, decisions need to be made about the project design

for the metadata. Data has to be organized in such a way that it is clear to everybody who is allowed access to it so it can be processed more easily. The data should be compatible with the software and the hardware that is being utilized in the other facets of the project.

8.2.1.1. 4. Pre-liminary Field Trip

Prior to the actual surveying process, preliminary field trips are essential to establish the guidelines for the surveying. The preliminary field trips are principally undertaken to become familiar with the site, design the scan scheme, determine the coordinate system, and identify further challenges. Representatives from different teams must participate in these planning trips, and contribute to the decisions, including the scanner locations, the scan orientation, the target locations, maintenance considerations (power supply, transportation...).

8.2.1.1. 4.1. Scanner Selection

The programmers and engineers have been consistently working on the improvements of the laser scanner technologies and hence both the quantity and quality of the laser scanners have been increasing each day in the market, offering a wider range of scanners for documentation professionals to choose from. When selecting the type of equipment to be used the scale and scope of the project, the accuracy and resolution required (e.g. is the smallest feature to be recorded),

configurations of the structures in the site, volume of the structures, accessibility of the sites to be scanned, complexity of surface, time and budget constraints must be evaluated. What other measurement equipment will be utilized should also be considered when selecting the scanner tool.

8.2.1.1.4.2. Scan Data Collection Planning

One of the difficulties of using a laser scanner in the documentation projects, is the necessity of preparing a sophisticated preliminary plan to determine the scan scheme, locations of the targets, georeference system etc. The scan scheme is the outline of the positions where the scanner will be placed in the site and the sequence in which the scans will be done. The characteristics of the instrument (range, field of view, resolution, etc.)¹⁹⁸ and the configuration of the site should be considered to designate the optimum vantage point locations at the site to maintain high level coverage of the structure, to eliminate data voids and to provide the necessary overlapping scans which is 20%¹⁹⁹ of the scans. Further, according to the site and the required details of the structure, not only “over viewed scans” covering the entire site may be necessary, but also “detail scans” may be required to define the individual features of a structure.²⁰⁰ Especially, in large scale projects such as the Seddülbahir

¹⁹⁸ For instance, if the best range of the scanner to capture the site is 50m, the distance between the scanner and the structure should not surpass this value. Further, the configuration of the site should be determined, e.g., if the structure is too high for the scanner, additional equipment such as a lift should be utilized to raise the scanner to the appropriate height.

¹⁹⁹ Conversation with Karen Hughes, the Documentation Project of the Memorial Temple of Ramses II, Western Thebes, Luxor, Upper Egypt, architect, 10 January 2007.

²⁰⁰ *Overview scans*: Scans using a low point density intended to give an overview of the site/area being surveyed.

Detail scan: Scans using a high point density that give a detailed representation of a feature.

Project and the Digital Statue of Liberty, the scan scheme is crucial for an efficient application.

Along with the scan scheme, a coordinate system should be decided upon in the preliminary trip. The point cloud data must be referenced and it should be decided if the point cloud will be georeferenced with a national coordinate system and the known points near the site, or tied to a GPS network requiring the importing foreign points to the site.²⁰¹ Targets are essential to tie the point cloud data to the defined coordinate system and the locations of the targets should also be planned during the preliminary trip. According to Louden “The general method is to follow established practices of overall target placement for adequate overlap (20%), establish sightlines to the maximum amount of targets from the scanner positions.”²⁰²

Registration is the process of converting the point clouds onto a common coordinate system and the registration method should be decided in the preliminary trip if:

- will the data collection be performed from a station with known coordinates and a known coordination system
- will targets be used to transform the data onto common coordinate systems
- will surface matching algorithms be used to transform the data onto common coordinate systems
- will a combination of these methods be applied²⁰³

²⁰¹ Interview with Rahmi N. Çelik, İTÜ, project director, Seddülbahir Project in April 26 2007.

²⁰² Conversation with Elizabeth Louden, TTU, project director, DSOL, during the Documentation Project of the Memorial Temple of Ramses II, Western Thebes, Luxor, Upper Egypt, 10 January 2007.

²⁰³ Mills & Barber p.6.

The performance of the scanner is also dependant upon the reflectivity of the structure. For instance, a stone masonry²⁰⁴ structure such as the Seddülbahir fortress does not have any reflectivity problem. On the other hand, a structure made of reflective materials, such as the glaring metal torch of the Statue of Liberty, makes it very difficult to get any accurate scan data. Reflectivity is one of the major concerns during scanning and necessary reflectivity tests should be undertaken during the preliminary field trip.

8.2.1.1.4.3. Time Management

Generating the time management plan of the surveying project is one of the imperatives in a preliminary trip. However this aspect usually is not handled efficiently. If an applicable time management plan is prepared and all the dynamics in the site are carefully assessed, the surveying will be undertaken with few impediments and the team will be asked to allocate more efficient time to both the field work and processing. This management plan²⁰⁵ should evaluate the time needed at the site by different members of the survey team, not only concerning the scale and scope of the project but also the logistics of moving the equipment, determining secure places for

²⁰⁴ *Masonry* is bricks or pieces of stone which form part of a wall or building. Essential English Dictionary. London, Glasgow: William Collins Sons & Co. Ltd. 1990. p.480.

²⁰⁵ This kind of time management of the surveying in the field is an essential part of the project management which should assess transportation to the site, security regulations, weather conditions, and maintenance. In this context, a different project management plan should be created if the site is situated in an urban environment or on an island; if the team staying in a hotel near to the site or in the closest village, if there are different transportation systems to the site; if access to the site is prohibited by security regulations.

the equipment as it is very costly, and the facility with which equipment can be maintained.²⁰⁶

8.2.1.2. Surveying

If an extensive preliminary research is undertaken, data to be scanned is determined; the initial difficulties encountered when beginning a project will be reduced.

The latest advances in technology have been increasingly improving the quality of laser scanner technologies. At present, in the market there are scanners covering the 360° horizontal and 270 ° vertical domes in one attempt.²⁰⁷ Although the advanced technologies allow the operator to scan an entire scene at one time, it is a good safeguard measure to mitigate external problems such as inadequate power supply and human error, and to execute the entire scan by dividing into subsections to prevent any data and time lost.²⁰⁸

²⁰⁶ The Documentation Project of the Memorial Temple of Ramses II in Egypt is a useful example to indicate the importance of implementing a competent time management plan, and thus the significance of the evaluation of the logistics of moving the equipment and determining safe places in the field. The temple is located in an archaeological site in Upper Egypt. The site includes a group of structures including the pylon, temple, monastery etc. The entire site is in ruins and thus experiences for the team during the surveying where physical security is comprised. For instance, to generate the overview scans of the entire site, the team had to carry the scanner to the top of the pylon which was very dangerous. In addition to this, due to the weak power supply in the site, the team had to connect the scanner to an inadequate extension cord which generated frequent power cuts and threatened both the hardware and the software of the scanner. All these important aspects have to be assessed before surveying.

²⁰⁷ For example LEICA HDS3000.

²⁰⁸ Conversation with Elizabeth Loudon, TTU, project director, DSOL, during the Documentation Project of the Memorial Temple of Ramses II, Western Thebes, Luxor, Upper Egypt, 12 January 2007. Also Rahmi N. Çelik, İTÜ, project director, Seddülbahir Project, highlighted the same concerns as Loudon during his interview in 26 April 2007.

Throughout the field work, additional data about various aspects of the project research should be accessible to the decision makers during the surveying. Hand made sketches, supplementary field notes and explanatory photos should be generated to assist in the navigation of the entire process and to supply additional information thereby facilitating the data processing. The sketches are especially useful to describe the structure, the configuration of the structures in the site and the related details. Further, they are essential “to develop a three dimensional understanding of the structure being observed, and to connect that to the materials and forms of assembly used in its construction” (Warden & Woodcock 111). The supplementary field notes are also essential while processing the scan data, and greatly facilitate the process. Photos should document the site as well as individual details such as ornamentation, the sequence of different materials, and deformation analyses. Further, if photos of the site are taken according to the sequence in which scanning was done, they can be integrated to the laser scanner’s photo sequence and they will be more useful as accurate records. Some of these documenting needs have already been anticipated by the newer laser scanning equipment and some have an internal camera which takes pictures according to the scan orientation²⁰⁹. They add the color value taken from these pictures to the 3D vectoral image, therefore the more light an environment receives the higher the quality of the scan data will be. Therefore, before scanning in darker environments, an external illumination system should be designed to maintain a consistent and high quality of scan data.²¹⁰

²⁰⁹ For example LEICA HDS3000 has an internal camera taking pictures of the structure according to the scan orientation.

Scan orientation (Scan script): The sequence of the numerous scans one after another.

²¹⁰ Interview with Rahmi N. Çelik, İTÜ, project director, Seddülbahir Project, in 26 April 2007.

During the surveying, a total station should be used to georeference the data to the common coordinate system. Although, the scanners at present have an algorithm overlapping the pointclouds for the registration, this procedure lacks the ability to determine the precise location of the pointclouds in the common coordinate system and the pointclouds may become misaligned. Therefore, the simultaneous use of the total station and the scanner situates precisely the pointclouds in a common coordinate system and eliminates unwanted misalignments.

8.2.1.3. Processing the Scan Data

The information users may want to use the scan data in conservation projects, reports, multimedia presentations (including web), via software such as CAD, GIS, or as hard copy plans and drawings. Further, the raw scan data itself is a valuable resource and a decision needs to be made about how to organize the metadata for such a large amount of data. If there is a need to reprocessing the data at a later time, it can be easily accessed and manipulated for different uses and needs.

For architectural documentation projects that employ a laser scanner, the drawing team should be extensively familiar with the site, in order to generate a productive exchange exist between the drawing team and the field team. Furthermore, after processing the data, a system to check the architectural drawings with the scan data needs to be established. Because the use of the scan data in measured drawings requires a different approach from that which employs more traditional documentation tools, someone who understands the laser scanning process and the

data processing as well as architectural drawings should control the accuracy of the final products before the project is submitted to any kind of official institution or archive. At the present time, the Turkish Monuments and Preservation Council only accepts 2D measured drawings; however, in the future, when the utilization of digital surveying technologies has become more widespread in architectural documentation projects, there may be further changes in the requirements for official documentation projects approved by the Council of Monuments.

Chapter 9

Conclusion

Documentation has had a long history and a substantial role in the development of architectural thought. It has been a fundamental aspect of conservation. Today, the importance of documentation, documenting our past for the future, is of even greater urgency due to the persistent loss of heritage by human occupation such as war, uncontrolled development, and inappropriate conservation applications, as well as natural disasters. The conceptualization of documentation has also been evolving as new understandings and new types of technologies are utilized in documentation. Documentation is “now a multidisciplinary activity including research, recording, evaluating, interpreting, correlating, archiving, managing and disseminating data. It involves written reports, surveys, photographic records, and the establishment of digital databases that try to make all relevant information accessible in one place.”²¹¹ Thus, documentation has become vital in assessing the values and significance of heritage, guiding conservation project, being a medium for monitoring and managing of the heritage.²¹² Both the Seddülbahir Project and the Digital Statue of Liberty Project have indicated the importance of documentation in cultural heritage management projects and emphasized the challenges of documentation in decision making process based on survey, analysis and evaluation of the cultural heritage. Also as attested in the RecorDIM Initiative, documentation has to be better integrated into the cultural heritage management process, before the documentation process starts. The purpose of documentation and the stakeholders should be identified, the

²¹¹ Schmid, Werner. “People and Technology: A Discussion about Heritage Documentation”. GCI Newsletter 20.3. Fall 2005. <<http://www.getty.edu/pf/PF>>, April 25 2007.

²¹² Ibid.

short term and long term goals of the project should be determined, and an extensive research of the existing data should be conducted. Documentation is not mere recording the cultural heritage; it is a complicated act encompassing an extensive planning procedure before the actual recording in the field such as defining the data requirements, determining the adequate methods of recording tools, information dissemination and archiving, elucidating the roles and responsibilities in the team (Letellier & Gray p.39).

The architect involved in a restoration project today has a different role and a role much more complex as new technology is introduced into the process of documentation. In the past, the architect was in charge of surveying and then producing the architectural drawings in the documentation and restoration projects. The architect was trained to convert the survey data into the 2D architectural drawings and interpret and analyze this data. However, at present, the architect is faced with new digital surveying technology and in addition to his/her conventional efforts, new tasks are added to his/her responsibilities: the designation of the data in the beginning of the project, estimation of the adequate surveying techniques, and the supervision of the data processing. “Now, the architect is a manager and visionary of all the potential from scan data, in particular for quantities, material estimates, visualization, but without the technical background and time to learn the new software, the architect is left to only barely understand the full potential. Scanning is a full time career direction, not a part time expertise.”²¹³ Beside the technical tasks, the multidisciplinary approach of this type of documentation process is different than the traditional projects because team members are now from the fields of architecture, engineering, geomatics as well as art and architectural history. This new composite of disciplines requires a much more fluid

²¹³ Correspondence with Elizabeth I. Loudon, TTU, project director, DSOL, in 25 April 2007.

mechanism for communication and collaboration between the different disciplines working on the same data with different approaches to its interpretation. The architect is situated at the crossroads of these different disciplines and must facilitate the communication, guidance, production of the drawings in the project and among the diverse team members who are working with digital surveying technologies. The communication role of the architect in this new approach can be observed in the Seddülbahir Project and the Digital Statue of Liberty where the architects have been working “at different levels of the operational and managerial status (Özsavaşçı & Thys-Şenocak 4)”.

Digital surveying technologies have been increasingly utilized in heritage projects. Both the Seddülbahir Project and the Digital Statue of Liberty have employed digital surveying technologies in the field and experienced the limits as well as the advantages of the laser scanner. The first project used the scanner for the first time in Turkey and investigated its feasibility. On the other hand, the latter project utilized the scanner during their previous experiences with the scanning technology and to explore the more challenging scanning curvilinear forms of a colossal metal structure. Laser scanner technology has been increasingly employed in documentation projects because of its ability to capture a gigantic amount of data at near real time. Compared to the conventional techniques, such as the total station acquiring one point at a time, the laser scanner is advantageous because it can obtain millions of points at a second. The scan data has many advantages once the data is registered, because not only the point cloud itself is a 3D model, but also various architectural drawings can be extracted from the point cloud, and solid 3D models can be created. Additionally, the scan data can be used as the base data for a GIS project

and used to monitor the site, chart the structural deformations and deteriorations of the structure.²¹⁴

However the laser scanner is not a miracle creating the required data on the spot. It requires a through process of planning and a feasibility analysis for both the work done in the field and the data processing in the office (Özsavaşçı & Thys-Şenocak 1). The scanner itself is not the only instrument in the surveying armory either. There are occasions when the scanner is unable to capture the required data. For instance, the ultimate scan resolution may not be enough to detect the small details on a façade. In that case, another surveying technique should be utilized to capture the detail. One of the major shortcomings of the laser scanner is that although it is a useful instrument for capturing volume such as measuring rock falls, mining, the scanner does not capture edges. The scanner indisputably provides more accurate data compared to the traditional methods, however the scan data still does not reach the quality of accuracy that the professionals sometimes need in the documentation projects. Even though the scanner captures millions of highly accurate data in the field, the point clouds represent the volumes, but fail to indicate the precise edges of the objects. Therefore, when the architects deal with this huge amount of data to convert into architectural drawings, they are still confronted with many challenges such as determining the accurate edge of the objects in the point cloud or extracting the adequate information from the point cloud. These decisions are highly subjective and are dependant on the level of architectural training of the architect in charge of processing. However this is just a temporary phenomenon. When the programmers do

²¹⁴ GIS is a significant part of the cultural heritage management project which has to be discussed extensively and a strategy for GIS should be developed. For example, the integration of the scan data into GIS is a very important issue that has to be organized before surveying. The final products of the scan data have to be predetermined and especially the use of this data in GIS has to be designed before surveying in the field.

develop a way to improve the scanning technology and eliminate the human error, the scan data will reach the quality of the precision needed in documentation and the scanner will be an even more convenient instrument for documentation.

With the emergence of digital technologies a new challenge now exists: the long term preservation of digital data. It is not clear how to organize and maintain the vast amount of data that is accumulated in different digital forms during documentation activities such as scanning. The lifetime of digital data is very short compared to analog ones²¹⁵ and the nature of the data has been changing on a regular basis. Scholars have been working on solving this problem and there are several approaches such as converting the legacy data to the new format, but this is often very costly, particularly if the legacy data has not been used for over a decade. “Propagating the data over time by detachment and migration, to convert the original data on a regular basis to new ones and stored in the new format (Paquet & Viktor 4)”.

Although the importance of documentation of has been stressed in academia, with the increasing utilization of digital surveying technologies the importance of standards and guidelines throughout the process has emerged. The lack of standardization and guidelines produces ambiguous final products, additional cost to the project budget, and the loss of time. Some very basic standards such as a preference for the metric system vs. the English system or even the basic format of the digital data are unresolved. There are different documentation projects done on a different measurement scales. If some international standards are established, there would be a smoother communication between the professionals involved in producing

²¹⁵ For example, a papyrus can easily last thousand of years if it is kept under proper conditions.

documentation, thereby, eliminating some of the gaps that currently exist between the information providers and the end users.

Documentation projects such as the Seddülbahir Project or the Digital Statue of Liberty which have benefited from multidisciplinary teams have indicated the importance of communication. In the first project the multidisciplinary approach included the members of different professions such as architecture, archaeology, history, heritage management, and engineering. In the second project where different surveying teams were working on the Liberty Island the TTU team was responsible of hand measurements, topographical surveying, scanning etc. In comparison to the multi disciplinary team of Kaletakımı consisting of architects, archaeologists, historians, engineers, the TTU team was constituted of architects.²¹⁶ However both projects have indicated the importance of communication where a consistent level of communication was required to continue the work. These communication links are essential, particularly, between the field team working on site and the drawing team who produces the architectural drawings working in office. These different teams should collaborate more, be trained to speak the same language and some standards should be instituted to facilitate the communication.

As this multidisciplinary approach is more commonly used in digital surveying technologies, there is a greater need for qualified staff. Although there are

²¹⁶ Kaletakımı has undertaken the entire Seddülbahir project and is responsible from different components of the project such as cultural heritage management, architectural documentation, historical research, archaeological excavation. On the other hand, National Park Service is responsible from the Liberty Island and has been conducting different projects regarding the island in which the TTU team has been conducting the architectural documentation project of the island and undertook surveying the entire island and generating the architectural drawings. Therefore, although the TTU team has been working together with historians and archaeologists from NPS regarding the project, the team is made of architects who are specialized in surveying, architectural documentation and historic preservation.

heritage scholars who have been involved in utilizing digital technologies in documentation, there are few scholars who can capture data, convert it for the purposes of critical analyses and then interpret it. More money should be invested into training people to understand and implement these different steps of the documentation process. More training should be supplied to educate professionals who can bridge the gap between the conceptualization of documentation and digital technologies. Along with the academic institutions which are engaged in efforts to systemize this kind of training, the attitude of the individual scholar involved in these hi-tech documentation projects as part of an outreach to young students is important. For instance, in the two projects analyzed in this thesis, the project directors were insistent upon employing students to work in different phases of the project, but also they have been transmitting their knowledge and experience to the younger generation by lecturing about these technologies in their courses.²¹⁷

In this thesis, the conceptualization of documentation is examined, the use of digital surveying technologies in this new documentation approach is investigated; the increasing use of laser scanner technology in particular is analyzed through diverse examples in the literature and through the two case studies the Seddülbahir Project and the Digital Statue of Liberty. Comparisons of the RecorDIM Initiative have also been essential in terms of the progress made towards a development in methodology. The challenges of using the laser scanner in heritage documentation projects are scrutinized, and methods for the scanning activities in the field are proposed. The use of laser scanning technology is increasing in documentation projects due to its ability to capture data accurately and quickly in real time. However as this thesis points out

²¹⁷ Thys-Şenocak, Çelik, and Loudon have been incorporating their experiences of new documentation technologies into their courses and publications.

during the implementation of all new technologies, the laser scanning has its drawbacks as well. Not only does this technology require an extensive preliminary preparation phase, a considerably high budget and an intensive processing phase, when compared to the conventional measuring techniques must be considered. Also manipulating the instrument in the field can be difficult because the equipment is still expensive. Although it can capture an accurate 3D point cloud data of a structure, it is still difficult to detect small or distant details due to the technical limitations of the scanner such as the resolution quality and range. When considering the case studies investigated, it is also evident that the scanner itself can not be used as the only surveying instrument in the field. A hybrid system should be undertaken consisting of not only the scanner but also other measurement tools, i.e., total station, digital photography, hand measurements, photogrammetry. Different documentation methods and tools should be employed based on the goal of each project and according to the scale and scope of the project. Undoubtedly as the programmers continue to improve the drawbacks of the laser scanning technology, it will reach the level that the heritage professionals need in documentation projects and the laser scanner will be the major surveying tool in the field. The increasing viability of these technologies requires a useful methodology. The RecorDIM Initiative is a useful process indicating the importance of bridging the gap between the diversified heritage professionals and suggesting a methodology to incorporate digital documentation tools into the process of documentation. However, there are still further studies which must be done. I hope this thesis will constitute another step to bridge this gap.

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Appendix A

Glossary

Aerial photography: The taking of photographs from the air with a camera mounted, or hand held, on an aircraft, helicopter, balloon, rocket, kite, skydiver or similar vehicle.

Albedo: The ratio of reflected to incident electromagnetic radiation. It is a unitless measure indicative of a surface's or body's diffuse reflectivity. The word is derived from albus, a Latin word for "white".

Algorithm: A set of steps in a specific order, such as the instructions in a computer program. Different image compression schemes employ different algorithms; for instance, the JPEG algorithm processes images as 8 X 8 image blocks and applies cosine transformations to each block, while the JPEG2000 algorithm applies wavelet transformations to the image as a whole.

Archaeological geophysics: Most often refers to geophysical survey techniques used for archaeological imaging or mapping. More broadly defined, the term could refer to any geophysical techniques applied to archaeology.

Architectural documentation: A compilation of both graphic written records that explain and illustrate the significant characteristics of a historic building, site, structure, or object

AutoCAD: Software used in architecture, archaeology, design and other fields to create precision drawings, models and technical illustrations in two or three dimensions.

Bias: The bias of an estimator is the difference between an estimator's expectation and the true value of the parameter being estimated.

CD-ROM: A type of write-once, read many (WORM) disk used to store and distribute large amounts of digital data on low-cost, optically recorded media. CD-ROM's profess to have much longer storage life ratings than magnetic media such as tape or hard discs, though there have been a few notable instances of failure in less than five years.

Conservation: All actions or processes that are aimed at safeguarding the character-defining elements of a cultural resource so as to retain its heritage value and extend its physical life. This may include "preservation", "rehabilitation", "restoration", or a combination of these actions or processes.

Database: A structured collection of data. The most common data-structuring model is "relational", where data is organized in related or linked tables that can be accessed or reassembled in many different ways.

Data Voids: Sections within the point cloud, more than twice the point density of the scan in size, which contain no data despite surface information on the object itself.

Detail Scans: Scans using a high point density that give a detailed representation of a feature.

Digital: Electronic technology that generates, stores, and transmits data in terms of a limited number of discrete states, most commonly as binary data in which two possible states, positive or non positive, are represented by 1 or 0, respectively. Because there are only two possible values, the accuracy of binary data at any given point is relatively easy to test, and therefore digital technology facilitates the creation of accurate copies.

Documentation: As the information units acquired over time through heritage recording and other research means, and the creation of a knowledge base for particular sites and objects.

DVD-ROM (Digital Versatile Disk, Read Only Memory): A type of write-once, read many (WORM) disk used to store and distribute large amounts of digital data on low-cost, optically recorded media. The DVD-ROM is a newer, and more densely packed, form of storage than the CD-ROM, and therefore not as well established or, possibly, as reliable for archival purposes.

Format: A specification for organizing data. Digital image (and their associated metadata) may be presented in a number of formats depending on compression schemes, intended use, or interoperability requirements. Some image formats are broadly decipherable, while others may only be accessible to certain application programs.

Georeference: The geometric alignment of the separate data set into a common reference frame.

Ground based remote sensing: Remote sensing is the science of deriving information about the earth's land and water areas from images acquired at a distance through a ground based device. It usually relies upon measurement of electromagnetic energy reflected or emitted from the features of interest.

Gouache paint: A type of paint consisting of pigments in water.

Heritage Value: The aesthetic, historic, scientific, cultural, social, or spiritual importance or significance for past, present or future generations. The heritage value of a historic place is embodied in its character-defining materials, forms, location, spatial configurations, uses and cultural associations or meanings.

Image resolution: The number of pixels, in both height and width, making up an image. Generally, the higher number of pixels, the greater the image's clarity and definition.

Integrity: A digital entity has integrity when it is whole and sound or when it is complete and uncorrupted in all its essential respects.

Interface: Allows users to communicate with, or use, applications by entering or requesting data. Most are now graphical user interfaces (GUIs), in which functions are displayed graphically and can be activated using a cursor or similar pointing device rather than using older text, keyboard, or menu driven controls. Hardware interfaces allow pieces of equipment to communicate or work together.

Intervention: Any action, other than demolition or destruction, that results in a physical change to an element of a historic place.

LIDAR (Light Detection and Ranging; or Laser Imaging Detection and Ranging): An optical remote sensing technology which measures properties of scattered light to find range and/or other information of a distant target. The prevalent method to determine distance to an object or surface is to use laser pulses. Like the similar radar technology, which uses radio waves instead of light, the range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal. LIDAR technology has application in geology, engineering geology, seismology, remote sensing and atmospheric physics.

Masonry: Bricks or pieces of stone which form part of a wall or building.

Metadata: Commonly defined as “structured data about data”, or data captured in specific categories or elements. Metadata can include data associated with either an information system or a data object or set of objects for purposes of description, administration, preservation the documentation of legal requirements, technical functionality, use and usage, and so forth.

Method: A particular way of doing something.

Methodology: A set or system of methods, principles, and rules for regulating a given discipline, as in the arts or sciences.

Network: An arrangement of devices such as servers, computers, and printers joined by transmission paths which programs make requests of one another. Local area networks (LAN), metropolitan area networks (MAN), wide area networks (WAN), and the Internet is all examples of networks.

Noise: Unwanted data or imperfections in a file that are somehow developed in the course of scanning, processing or data transfer.

NURBS (Non uniform rational B-spline): NURBS model is produced by breaking the point cloud into manageable sections. A NURBS model reduces the file size considerably, since the computer will, in essence, be dealing with a single 3-D curved surface rather than millions of line segments.

Orbital imaging: Orbit is the path of an object that is moving around a second object or point and orbital imaging means surveying or getting images of the planet by the satellite that has been launched on the planet’s orbital path.

Overview Scans: Scans using a low point density intended to give an overview of the site/area being surveyed.

Pixel: From picture element. The smallest programmed unit of a bitmapped image, similar to grain in a photograph or a dot in a halftone prints. Pixel size, frequency, and color determine the accuracy with which photographic images can be represented. The greater a pixel's bit depth, the greater the number of different shades or colors it can represent. The larger or fewer the pixels within an image, the more likely "pixilation"-where individual pixels become apparent and break the illusion of continue tone-is to occur.

Point cloud: A collection of XYZ coordinates in a common coordinate system that portrays to the viewer an understanding of the spatial distribution of a subject or site. It may also include additional information such as an intensity or RGB value. Generally a point cloud contains a relatively large number of coordinates in comparison with the volume the cloud occupies, rather than a few widely distributed points.

Point density: The average distance between XYZ coordinates in a point cloud. This is commonly represented in two forms, spatial and angular.

Point spacing: The distance between points in the x, y, z coordinate system.

Polymesh: Three connected straight lines define a triangular surface or a simple polygon. This process continues until a polygonal mesh of triangles is created from the points (x, y, z coordinates in space in the point cloud.

Preservation: The action or process of protecting, maintaining, and/or stabilizing the existing materials, form, and integrity of a historic place or of an individual component, while protecting its heritage value.

Registration: The fusion of several point clouds in one coordinate system.

Rehabilitation: The action or process of making possible a continuing or compatible contemporary use of a historic place or an individual component, through repair, alterations, and/or additions, while protecting its heritage value.

Resolution: A relative, rather than an absolute, value, usually expressed as the density of elements, such as pixels, within a specific distance, most commonly an inch.

Restoration: The action or process of accurately revealing, recovering or representing the state of a historic place or of an individual component, as it appears at a particular period in its history, while protecting its heritage value.

RGB (Red, Green, Blue): An additive color model or system for representing the color spectrum using combinations of red, green, and blue. Used in video display devices, and is the standart color system for most digital imaging devices and applications.

Scan area: The area the user designates for scanning.

Scanner: A device that captures images from analog sources for computer editing and display.

Scan script (Scan orientation): The sequence of the numerous scans one after another.

Scanworld: A sort of a database which constitutes of more than one scan. Every time a new scan location or angle is determined, another scanworld is designated. In a scanworld the total amount of points can reach to 10 millions. However due to the browsing and modeling efficiency, the number of points in a cloud should be reduced to 50.000 or 200.000 points.

Scene distance: The distance between the scanner and the structure to be scanned.

Standards: Norms for the respectful conservation of historic places. Formal structures, procedures, and tools designed to promote uniformity and predictability.

Surface reconstruction: The conversion of the irregularly distributed point cloud data into 3D surface information to analyse the character and shape of the object. From the reconstructed 3D surfaces, it is possible to generate 2D profiles, elevation contour lines, etc.

Surveying: A measurement collection system to represent a 3D existing structure with 2D measured drawings such as the plans, elevations, and sections. These measured drawings are different from the original construction drawings. Measured drawings correspond to the existing conditions of the structure during the surveying phase. Therefore, particularly, the new alterations should be indicated in the measured drawings.

Vantage point: The location of the instrument which the architect/engineer designates in order to get more data of the structure.

Thermal imaging or thermography: A type of infrared imaging. Thermographic cameras detect radiation in the infrared range of the electromagnetic spectrum approximately 900–14,000 nanometers. Infrared Thermography is a picture of heat.

Triangulation: The scanner emits a thin sheet of red laser light to the object, illuminates the object and forms a stripe onto it. A video camera looks at the object from the side. By analyzing the image seen by the camera, and by knowing the position and orientation of the laser and the camera, one can use trigonometry to determine the location in space of each point on the stripe.

Vector graphic: An image composed of mathematically described elements such as lines, arcs, and points (vectors), plotted in two or three dimensional space. The use of mathematical formulas to describe an image, instead of pixels, means vector graphics are not constrained by resolution, allowing them to be output at any size without loss of detail or other artifacts of pixel-based processing.

Appendix B

Interview with Dr. Lucienne Thys-Şenocak²¹⁸

S.A.: I am interviewing Lucienne Şenocak, my advisor and I am going to ask questions about (um) the Seddülbahir project. Actually we have been talking and we have been interchanging ideas since you know since from the beginning. But I have questions as well. For instance I have been examining the RecorDIM (um) documents and the task groups, and there is the task group number one I think and they are working towards making (um) bridge the gap between the digital technologies the information users and the providers (um) by establishing guidelines and establishing guidelines for both the information management and both in the field, both not post processing but processing the scan data. In the Seddülbahir, you had some problems regarding the lack of guidelines and lack of not methodology but... That you could not anticipate the final products because you were the first team you know dealing with so...

L.T. Ş.: Well, I think with Seddülbahir, I mean one of the things that happened was that (um) from the very beginning we did not really think this is the kind of project we need to use a laser scanner for, in some way sit came together the opportunity presented itself through the ITU contacts and so... I think but you've seen sort of the whole history of the Seddülbahir project is that we always really jump on the opportunity of the use of new technologies. In that sense I think the decision was make to do a laser scanning project. Essentially we make decisions about the project always which is you know whenever we can use in terms of testing new technology and teaching students that's been a constant theme of the project since 1997. As far as setting up a real methodology (um) I think that the looking at the insight I mean it is... At that part I don't think we knew that much the fact that the Getty calling together these groups to work out

S.A.: But these are very recent examples.

L.T. Ş.: Exactly. So I mean. In that sense it looks like everybody is struggling with the same thing. So I think when you start a new project (um) very often you don't have you don't have a set of a methodology because it comes from looking a number of a different projects. So one of the things that I think the Seddülbahir Project will do is to help at to how a methodology for laser scanner can be done. Of course it is very different as you know from the (um) the project in New York. You are dealing with different kinds of legislative sorts of different conditions here different in Turkey than in the US. So again a methodology can I think be have some common common points, but there is gonna be real differences. There is gonna be for example in Turkey you can't bring certain kinds of equipment in from outside the country without special service of forms or permissions or so. You know those are the sort of things you're facing sometimes and that will change whatever nice methodological framework you set up for yourself, so...

²¹⁸ Project director, the Seddülbahir Project, 05 June 2007.

S.A.: Sure in the RecorDIM... The main thing is that (um) they are setting a methodology but (um) they allocated the problems according to the task groups and from different countries and from different regions are determining the gaps and determining the needs. So that the countries who have similar problems...

L.T.Ş.: can work on similar...

S.A.: can work can consult. But the problem is that I have only found one scholar who is Turkish... She is from METU. She is Güliz Bilgin I think. And she and her colleague from Polytechnic in Mileno is working towards... Establishing guidelines in GIS for instance. But she is the only Turkish scholar.

L.T.Ş.: I see...

S.A.: Maybe it is the problem that

L.T.Ş.: There is not many people working on

S.A.: Yeah.

L.T.Ş.: Well that is true. I mean that's one of the things about (she sighed) both about laser scanning projects and methodology and processing and also about GIS is that what I see a lot of times the kind of creative work that goes into say GIS or into making decisions about how you set up a laser scanning project is done by an outside team by a foreign team and then so all the data you get is processed outside, all the categories, all the kind of (uh) thinking work gets done in some office in England or somewhere else. So (uh) that has to change because I don't think I mean in the case of GIS I don't think an effective GIS is can be run unless the entire project knows what they are doing and how it's benefiting because it's not something where it is just a data bank that you send stuff to somebody.

S.A.: Sure.

L.T.Ş.: Anyway I don't want to get too much to the GIS things but I think the same thing with laser scanning is that you know you can bring in, like Global Heritage is bringing people... To do the scanning but that is the short part of the deal because I mean in Seddülbahir 19 days of scanning. It's what happens afterwards and how you process that data for a particular group like (uh) Çanakkale Koruma Kurulu, so there is all sorts of restrictions and adaptations that you need to move that data into, so in that sense (she sighed) I think these... Projects have to be... Centered here... If there gonna be... Down in Turkey there need to have the group knows how to creatively deal with that data not just get the data and put the people.

S.A.: Sure, even they are centered here they are not for instance I could not see any Turkish scholars in the RecorDIM Initiative, so if there are these projects here going on in Turkey and I 'm sure there are competent projects and I am sure accomplishing something but...

L.T.Ş.: Some of it maybe just the places like Getty aren't... Aware yet these things going on. I mean in fact there is a Getty (she sighed) (um) Getty workshop happened

in September. And it specifically I mean I presented my case for looking the Seddülbahir Project as a Turkish...

S.A.: Example?

L.T.Ş.: Example. I think it is just a matter of people you know...

S.A.: Connections?

L.T.Ş.: Connecting around and learning it. There are actually... You know when you look at CIPA there are people who are working on.

S.A.: Sure.

L.T.Ş.: I mean there is quite a lot of people working on GIS. METU is actually working on GIS not so much for historical purposes but for urban planning.

S.A.: But this scholar is from the architecture department.

L.T.Ş.: Yeah. Urban planning?

S.A.: Maybe.

L.T.Ş.: Because I know they were teaching... GIS for a couple of years ago. We looked at what they were doing. But I don't know in real terms what they were doing so...

S.A.: And also maybe I have to jump to another, you know, another question another area. I want to... Know your ideas about working with the government because you worked with the government and I want to know... What is your idea?

L.T.Ş.: About what part of the government? (she laughed) well, I guess, I personally... I personally feel that you can work with anybody and I think the part of the government we've been working with is the Orman Bakanlığı, the Forest Ministry... (uh) I don't think the Forest Ministry has done that much restoration projects. In that sense... I think that's where they needed a lot of guidance. That's basically what we figured out very early on in many ways. You know we were able to sort of navigate through things. On the other hand some of the frustrating things of the aspect that

S.A.: Ignorance?

L.T.Ş.: Well, since they don't know that certain things have to be done at certain times and that has to come through them because our project was set up where... essentially we are hired by... the Orman Bakanlığı, so all the things that we had to do are actually have to go through the Orman Bakanlığı, so that often created a really lack of time.

S.A.: Bureaucracy?

L.T.Ş.: But even I think, I think... (um) they are very hardworking peop... They are extremely hardworking. That's one thing I would say... I don't (uh). Maybe there could be more efficient but... On the other hand they are dealing with a huge number of national parks and Seddülbahir is one project of many (uh) and the Gelibolu Park Project. I think one of the things that the Gelibolu... Peninsula needs is a much better integrated... Team to really look at how... How that peninsula is gonna develop because I think it's happening little bits and pieces but there is not one kind of cohesive vision and I think that's that's really... Or maybe there is we don't know about it but... But I think that's really important. There was something done like that this ÜGDP planning generated by (eee) Ragıp Bademli... (she sighed) (uh) where there was you know this attempt to get together all the data all... Major documentation but I think that... since then and well it is ten years old now then there is something sort of a task force it has to be gathered to deal with you know how... How the bureaucracy is gonna be one thing one of the imar planning mechanisms there is so much not known in terms of the legal infrastructure still I mean that is part of what we are struggling with a lot, it is just a basic imar plan that haven't been completed.

S.A.: Sure.

L.T.Ş.: And I don't think it is, I still think it's not completed.

S.A.: (she laughed)

L.T.Ş.: Or there are changes I mean though the imar planning group that works... You know they are they are good people they work hard. You know you can't go down and do something that is that significance in couple days, it takes long time.

S.A.: And in my point of view, in the States, the National Park Service hired the Texas Tech University as Orman Bakanlığı hired you, but National Park Service you know just motivating the team to use the laser scanner motivating the team to use the digital technologies. Maybe that's the difference. The Orman Bakanlığı should update themselves the government bodies here should update themselves with the latest events.

L.T.Ş.: Yeah, I don't know say, I don't know if it's unreasonable. I think it may be too much to expect them to know about you know laser scanning and things like that. But I think they need to just put you know one or two people in charge constant communicative link because that's there is so much change in the people we've been dealing in Orman Bakanlığı. (the door is knocked)

...

L.T.Ş.: So, I think in terms of working with the government, now... The other part of the government is the Koruma Kurulu in Çanakkale. I think the problem there is that (um) this new way of setting up the kuruls local kuruls is, unfortunately there is very little training for the people so on the Çanakkale Koruma kurulu we have not one.

S.A.: Hmmm

L.T.Ş.: Nobody knew anything restoration, architecture

S.A.: The basic things not the laser scanning, but the basic things

L.T.Ş.: No no even the basic this things. I think there is a little bit of hostility initially towards the kind of technology that we are using (um) and just basically just basically... You know the kind of unwillingness to to look at what we gave them in the end sort of in a comprehensive way. You know I think... Kurul's are different all over the country. But I think hopefully the Çanakkale Kurul will improve with more qualified people because the kinds of things they ask us to do not actually is not legal in terms of (um) reconstructing things in areas which are first degree archaeological site. Anyway you know... But that part of the government I think (um) more problematic because they are unwilling to communicate whereas the Orman Bakanlığı is just busy and not efficiently communicating but they are not hostile.

S.A.: I have a friend in the Council of Monuments and I was chatting with him. I was telling him that the Council of Monuments required the restitution project of the barrack even though there is a you know you have the excavation going on, still you have only few pictures and you have only a façade actually. And he said that that is enough, we'll do it.

L.T.Ş.: Well, I mean restitution is fine, but reconstruction is...

S.A.: Sure, reconstruction, he said that you have a lot of data.

L.T.Ş.: Well not accordingly internationally... Actually that's because you know I sort of tested the waters some of these in the UNESCO conferences you know what do you think about this it is what we will have in the end. There was a resounding no. I mean these things come and go sometimes with fashion and different approaches to restoration and reconstruction. You know but I think right now, internationally... Will be received very poorly if we reconstructed on the site where it was located. There are different approached say in the Hadrian's Wall. They have reconstructing reconstructed things in a different place than the original. So it is very clear that it is reconstruction. So it is a problem reconstructing something on the site where... And the other thing was we just did not think it was the best usage of the space so... You know to put a big barrack that is actually not built for a museum so you have to adapt that space to your needs. (um) It is very heavy structure very expensive. The other alternative was... Seemed to us better which was to to remove these concrete barracks that were really actually creating kind of a distraction.

S.A.: The military barracks?

L.T.Ş.: The military, I mean there is cases if you are a real post modernist as if to keep those but... Right now they are actually we do not know how the plumbing system works they are creating a lot of damage to the site and also I think there is a lot of information we got from excavating there (um) so... After that's finished after the excavation is finished then we can decide is that an area that we can built a light structure or alternatively nothing and take out the building outside the fortress? So there are all sorts of those different scenarios. But I think the one where you put up the barrack and reconstructed it is not. That might be done here but it is not approved of internationally. You know we are trying to work international standards. So...

S.A.: Thank you so much.

L.T.Ş.: You're welcome. There is one thing more I want to mention about methodology that is came up in your paper and that (um) is in terms of I mean why you do laser scanning (uh)? Is it the most efficient way to do something?

S.A.: No it is not?

L.T.Ş.: Well I mean I know you have talked to Arzu and there is a command in your paper about how she mentions that you know it is not efficient to use and it could be done more quickly... (um) I wrote some commands about but I actually feel pretty strongly that... It depends on what kind of the project that you are doing. So if you are doing a small fountain that is... you know maybe takes less time because it is smaller and you can scan quickly. But the reality is you need that kind of detailed data (um) I think with the project like Seddülbahir where you don't really know how long it's gonna go it's a huge site (um) I think in fact doing the scanning for that reason you have all the data.

S.A.: Hmmm hmmm.

L.T.Ş.: (um). A snapshot of it... At one particular point in time then allows you and this is also because this is a research project as well. But even if it wasn't... You do not know over ten years you know you can make these management plans of things but things come up there can be an earthquake there and the whole thing can tumble down especially these earthquake fond areas. So actually it is actually one of the most efficient things to do. (um) and I think the computer software all that stuff the hardware is going to be worked out. It is just a matter of you know people dedicating time at larger... Hard discs things like this so my sense is... you know giving the choice having all the data... Or having some of the data. I would always go for all the data because you just don't know which part of it you're gonna need. Especially here in Turkey where it is hard if you wanna go and do this you have to apply for the Ministry of Culture. You have to wait a year approved. It is nine months very often before you go back down so from that point of view it is highly inefficient no do laser scanning so I would say if you have the resources to do that why not? You don't have to process all the data. You can decide you know you can make your pointclouds you can pick them and make them as big or as detailed as possible. But at least you have the option.

S.A.: Sure sure

L.T.Ş.: So I really disagree with the part of it. But the processing time initially yeah it's gonna take time but that will go quicker too. It is just because it is new technology.

S.A.: (um) for instance there is a house in my neighborhood, it's in ruins it is about to you know...

L.T.Ş.: Collapse?

S.A.: Collapse any time. You need to have a restoration plan immediately. So scanning and processing the data will consume a lot of time. You know during that time the structure will be gone. So maybe of course you have to scan it in some time but maybe getting the data with the traditional techniques I mean let's say traditional techniques and just starting to draw the plans the sections the elevations that you can initiate the restoration project.

L.T.Ş.: Well, it is easier now because everybody knows how to do it.

S.A.: Sure.

L.T.Ş.: The laser scanning the equipments still but it is definitely these are like the computers started out either taking up a whole room and now there laptops and it is just a matter of time and more people that are actually using this the more efficient it's gonna get. So I think it is just it is one of these learning curves and we are at the beginning of it but there is no doubt me that it is the most efficient way to do things. The... Stop is that training the architects because nobody knows how to do it so you can't blame the technology I think for the lagged time in terms of architectural training

S.A.: No no I'm not...

L.T.Ş.: No no, I am not saying you are. But I'm just saying... This is the same sort of argument that when the computers came out people like ooh you know take so much do the zero one zero one... (um) but now there you know now you can't think of doing stuff without them so but it's hard to be at the beginning because you know there is a lot of people who are best but not having stuff like this... Take over because they don't know it. It's the same way with people didn't want computers to come around or digital photographs then you have to learn something. So I think that argument about I mean for me having all the data whether use it or not that is a good feeling that you could and your questions are gonna change over ten years. You don't, I mean that is same with the GIS too, it's the same sort of philosophy you don't know what your questions are gonna be or what say my questions as an art historian might be different than an engineer's than an architects'. We may all need very different kinds of points and data things like that.

S.A.: Sure.

L.T.Ş.: So in that sense better to have everything than some thing that is preselected by the surveyor or by the architect.

S.A.: Sure

L.T.Ş.: I mean I don't like to have people to make choices for me (she laughed) In that sense I guess would say I just want all, I want it all, all the data (she laughed)

S.A.: You're just like a rock song, I want it all (she laughed)

L.T.Ş.: Oh I just, I like to know that if you need this little corner, or if that you know if that falls down tomorrow, we know where it is. It is you know, it's a good thing.

Actually, making a backup of the computer there, so it is another copy up here. So anyway...

S.A.: Thank you so much.

Appendix C

Interview with Dr. Rahmi N. Çelik²¹⁹

Serra Akboy: Önce Seddülbahir'i sormak istiyorum. Çünkü, daha önce Lucienne'le konuştum, Arzu Özsağcı'yla, Umut Almaç'la konuştum. Bir de sizden dinlemek istiyorum Seddülbahir Projesi nasıl bir proje? Az çok biliyorum nasıl başladığını... Ama bir mühendis olarak nasıl bir proje?

Rahmi N. Çelik: Hmmm, anladım, şimdi ne amaçla bu bilgiyi topluyorsun? Bir tarihçesini mi yazıyorsun, ona göre anlatayım yoksa teknik olarak mı anlatayım?

S.A.: Yok. Şöyle, tarihçesini yazmıyorum. Çünkü, benim ilgilendiğim (eee) aslında bu tip mimari belgeleme projeleri ve bu tip multi disiplinler projeler ve dijital röle tekniklerinin bu projelerdeki yeri (eee) aynı zamanda bu tip multi disiplinler projelerde mesela bir mühendisin yeri, bir mimarın yeri. Çünkü, artık bu disiplinlerin yerleri değişiyor ve anlamları değişiyor (eee) dijital teknikler farklı disiplinlerle nasıl kaynaştırılabilir? Bu yüzden, benim iki vakam var. Biri Seddülbahir projesi. Yaptığımız müthiş bir şey. Değerlendirilmesi lazım. Daha on tez çıkar bu projeden.

R.Ç.: Kesinlikle.

S.A.: Bir de benim yazın çalıştığım, Özgürlük Heykeli Projesi, Digital Statue of Liberty. İkisinde de dijital röle teknikleri uygulandı. Gerçi sizin projeniz daha farklı. Çünkü multi-disipliner bir dokümantasyon projesi. Halbuki benim yazın çalıştığım proje büyük bir dokümantasyon projesinin röle ayağı. O yüzden, takım, mimarlar ve bir jeodezi mühendisinden oluşuyordu ve o bakımdan değerlendiriyorum. Bir tarihçi olarak değil.

R.Ç.: Tamam anladım. Şimdi.

S.A.: Bir de kullanımı.

R.Ç.: Tamam. Ben o zaman şöyle anlatayım. 1997 yılındaydı yanlış hatırlamıyorsam. Ben çünkü 1996 yılında yurtdışından geldim doktoramı tamamlayıp. 1997 yılında Lucienne ile bu proje vesilesiyle tanıştık. O, oranın dokümantasyonunu yapabilmek açısından (eee) bir imkan yaratmaya çalışıyordu kendisine ve... Onu ararken bazı ilişkiler dolayısıyla biz birbirimizle tesadüfen tanıştık.

SA.: Ne de iyi olmuş.

R.Ç.: ve o görüşmemiz kapsamında da ben kendisine elimizden gelen bütün yardımı yapabileceğimizi söyledim. Ve ilk onun istediği şey oranın bir haritasının planının çıkartılmasıydı. Çünkü o güne kadar herhangi bir planı ve haritası düzenli olarak çıkarılmamıştı.

²¹⁹ Project director, the Seddülbahir Project, 26 April 2007.

S.A.: ki en önemli yerde, şehitliklerin olduğu yerde.

R.Ç.: Kesinlikle, sadece çevresi kadastral anlamda ele alınmış ve onun dışında hali hazır anlamda çok detaylı bir projesi, haritası hiç bir zaman yapılmamış. Onu söyleyince, biz o zaman tamam dedik ve 97'ydi ilk defa (öksürdü) o yaz Seddülbahir'e gittik bizim araştırma görevlisi arkadaşlarla hep beraber. Ben o zaman yardımcı doçenttim. (öksürdü) Arazide hep beraber çalıştık. Ve araziye gördük, öğrendik. Ve bizim için de çok farklı bir deneyimdi. O güne kadar o anlamda bir çalışma yapmadık. Çünkü klasik anlamda haritacılık yaklaşımından çok daha farklı bazı ölçmeler yapmak gerekiyor. Biz mesela öyle bir yeri bir iki günde ölçüp bitirebileceğimiz durumda biz onu işte (eee) 97 yılından işte su anda 2007'e geldik, hala ölçüyoruz bitmedi yani diye değerlendirilebilir ve o süreç içindeki en yüksek teknolojileri kullanarak aslında bunu ölçmeye başladık. Şimdi biz (eee) oraya ilk gittiğimiz zaman buraya bir tane jeodezik ağ kurmak lazım ve bu ağı kurduğumuz zaman ancak burada düzgün bir takım şeyler yapılabilir ve bunu da GPS teknolojisiyle yapalım dedik, işte global konum sistemleriyle uydu teknolojileriyle, elimizde de cihazlarımız vardı onları götürdük. Onun dışında da yersel konum belirleme sistemleri de var bizde işte total station gibi. O tür cihazlarımızı götürdük. Bu cihazlardan aslında bizim üniversitemizde olmakla beraber (eee) son teknolojileri üniversite laboratuvarları o kadar kolay takip edemiyor alım güçleri dolayısıyla. Bu kapsamda da benim bir arkadaşım var. İşte Sistem Bilgisayar ve Teknik Hizmetler Sanayi AŞ'nin sahibi. O da Leica'nin Türkiye distribütörlüğünü yapıyor. O diyaloglarımızdan yararlanarak kendisinden rica ettik, bize belirli sürelerde kullanmak için bazı aletler verebilir misin diyerekten ve o kapsamda o da bize bu destekleri verdi ve sağ olsun (eee) bugüne kadar o desteklerini hiç esirgemedi ve biz bu projede gerçekten çok yüksek güncel teknolojiyi kullanabildiysek onun katkıları yadsınamaz. O açıdan değerlendirmek gerekiyor. Biz de elimizden geldiği kadar bu projeden kazandığımız deneyimle, onların elemanlarını da zaman zaman projede şey yaparak ey yaparak veya bizim öğrencilerimizden mezun olduktan sonra oraya çalışmaya giden çok oldu. Yani bir daire kuruldu çok hoş bir daire kuruldu. Üniversiteler ilişkisi ve sanayi ilişkisi söz konusu oldu bu yüksek teknolojinin kullanılmasında ve biz bu teknoloji kapsamında GPS teknolojisini total station teknolojisini reflektörsüz total station teknolojisini ve endüstriyel ölçmelerden aldığımız bir takım deneyimlerle bazı görülmeyen çünkü özellikle tarihi eserlerde ölçülmesi gereken çok fazla detay var ve bu detayların bulunduğu yerlere de alet sokmak falan pek mümkün olmuyor. Onların farklı yöntemlerle ölçmesine yönelik yine endüstriyel ölçmelerden yararlanarak oralarda kullanılacak teknikleri kullanarak oraları ölçmeyi başardık. En son işte bu laser scanner teknolojisini devreye soktuk. Bu laser scanner teknolojisi de aslında bu anlamda Türkiye'de ilk defa bu amaçla kullanılan bir çalışma oldu sanıyorum bundan daha büyük şu anda Türkiye'de şu anda demeyeyim belki çünkü belediye meclisi bazı çalışmalar başlattı ama ne aşamalarda ne yapıyorlar bilemiyoruz. İstanbul surları ve çevresindeki bir takım şeyleri taramak açısından. Tarama yapıyorlar da değerlendirmeler konusunda ne noktaya geldiler bilmiyoruz ama bu kadar şu ana kadar bu büyüklükte böyle değerlendirilmiş tek proje denilebilir ve tabi biz şuna çok seviniyoruz aslında biliyoruz bir takım aksaklıklarla yürüyor bazı bürokratik nedenlerle projenin ayakları, ama o laser scanner teknolojisini de kullandıktan sonra özellikle biz biliyoruz ki bu kaleye bir şeyler olsa biz bu kaleyi sayısal olarak tekrar ayağa kaldırabiliriz çünkü elimizde o kadar çok veri var. Yanlış hatırlamıyorsak 3-3.5 milyon veri civarında nokta toplamıştık. Bunlar tabi yersel noktalar hariç ki yersel noktalar da 1997'den günümüze kadar toplandı. Tabi bu araya bir de Kumkale girdi. Kumkale de Lucienne Hanımın ilgi alanı içindeydi ve orası askeri bölge idi. İlk önce

girmek falan sorun oldu yani sorun oldu derken izin vermediler falan ama bizi, tabi kamu üniversiteler arasında bir çalışma da yaptığımız için hem özel üniversite vakıf üniversitesi hem kamu üniversitesi. O zaman askeriye buna biraz daha sıcak baktı ve bizi oraya aldılar sağ olsunlar aslında çok güzel çalışmalar yaptık. onların çok güzel katkıları destekleri oldu bize lojistik anlamda özellikle yani Seddülbahir’de lojistik anlamda o kadar rahat edemiyorduk. Oranın tek avantajı orada kalamadığımız için dışarıda kalıyorduk. Gidip gelmek biraz zaman alıyordu. Seddülbahir köyün içinde olduğu için gidip gelmek bir takım şeyleri yapmak çok daha kolay oluyordu. Kale elimizin altında oluyordu. Ama tabi bu laser scanner teknolojisiyle kale zaten bizim yirmi dört saat elimizin altında oluyor. Her an kullanabilecek durumdayız yani Seddülbahir Projesi genel anlamda böyle değerlendirilebilir. Ama bunun dışında şunu tabi çok disiplinlilik açısından değerlendirmek gerekiyor. Bu arada bu projede herkes birbirinden çok şey öğrendi. Birbirlerinden bir şey öğrenmeyen herhangi bir disiplin olduğunu hiç düşünmüyorum ben. Hepsi birbirinden çok önemli katkılar aldılar. Biz ki yani projenin tarihi bölümüyle olsun yani genel kültür düzeyinin dışında ilgilenmediğimiz halde mimarlık tarafıyla genel kültür düzeyinde ilgilenmediğimiz halde, bu konuda onlara katkı sağlayabilecek ölçme tekniklerini geliştirmek açısından bu proje gerçekten çok önemli bir deneyim oldu. Bu projede jeodezi, fotogrametri mühendisleri, sanat tarihçiler, mimarlar, arkeologlar, sözel tarihçiler, ondan sonra işte yine aynı şekilde bu koruma kurulları demeyelim de ne oluyor kültür bakanlığının temsilcileri falan da bu projeye çok katıldılar. Onlar içinde kolay bulunamayacakları bir proje oldu bu proje. Onlar da her sene gelen arkadaşlar bazen değişik arkadaşlar geliyordu onlar da hem gruba entegrasyon konusunda hem de ileri teknolojiler konusunda çok deneyim kazandılar. Bu özellikle kazanılan deneyimler açısından değerlendirirsek, teknik deneyimler açısından değerlendirirsek, biz özellikle mimarların bu tür projelerde ne tür verileri toplamaya eğilim gösterdiklerini gördük. Bizim bugüne kadar hiç ilgilenmediğimiz verileri toplama eğilimindeydiler. Ve bunları toplama tekniklerini de gördük ve onların toplama tekniklerini biz nasıl daha geliştirilebiliriz ve bunları sayısal hale dönüştürebiliriz onlar mesela iskele kurarak şey yapıyorlar, iskelelerin üzerine metre çekiyorlar falan işte dik alıyorlar. Öyle değişik ölçme yöntemleri kullanıyorlar. Halbuki bizler için bunlar çok daha farklı bakış açılarıyla çok daha kolay ölçmeler diye değerlendiriyorduk biz. Ve fotogrametrik yöntem bile kullandık aslında. Değerlendirmelerde çok fazla kullanmadık ama dokümantasyon açısından fotogrametrik çalışmalara altlık olacak fotoğraflar çektik. Çok az bir değerlendirme yaptık.

S.A.: Ne zaman kullandınız bunu?

R.C.: O da işte bu 98’de başladık.

S.A.: Bir sezon mu kullandınız?

R.Ç.: Yok, bir kaç sezon kullandık orada onları. Ve yalnız şöyle tabi olaylar oldu. Disiplinlerin birbirini anlaması açısından bazı sıkıntılar oldu. Mesela biz gördük ki mimar arkadaşlardan bazıları daha önce bazı fotogrametrik çalışmalar yapmışlar ve fotogrametriye olan güvenleri sarsılmıştı. Bir takım, çalıştıkları ekiplerin aslında onlara yeteri kadar onların beklentilerini karşılayacak bilgiyi vermemesinden kaynaklanıyor. Yoksa yöntemle alakası yok. Bunu biz onlara epey anlatmaya çalıştık sonra işte bu laser scanner teknolojisinde aynı şekilde. Mimar arkadaşlar çok şey kazandılar diye düşünüyorum ve bu projeye yetişen yaklaşık beş mimar arkadaş var.

laser scanner verilerini deęerlendirme konusunda. Onlar geen seneye kadar beř tanelerdi. O kadar yani. Belki şimdi hem kendileri ğretiyorlardır belki bařka arkadaşlara hem de dięerlerine o aritmetik ortalamayla oęalır artık diye deęerlendiriyoruz. ünkü laser scanner teknolojisi popler bir teknoloji haline gelmeye bařladı Trkiye’de. Ve ok sayıda laser scanner alan da var. Tabi alanların ok verimli kullandıklarını sylemek yanlış olur yani gerekten ünkü ok bilinsiz alımlar sz konusu olabiliyor bazen deęerlendirmeler. niversite laboratuvarları gibi alım yapıyorlar. İřte biz ünkü alım yaparken sadece aletlerin presizyonuna ve doęruluęuna bakmayız biz bu aletlerin ka tane farklı řeklini gsterirsek ęrencilerimiz o kadar ok bundan yararlanır diye dřnrz. Onun iin bir alete konsantre olmayız. Ama biz mesela genellikle bu proje alıřmalarında hep aynı tip aletler kullandığımız iin birbiri arasında bir uyum sz konusu oldu. řimdi mesela bakıyorum ben laser scanner alanlara farklı farklı firmaların laser scannerlerini alıp birlikte kullanma eęilimine giriyorlar. Onların řu anda laser scanner teknolojisinin en nemli sorunlarından bir tanesi verisi ok yoęun olduęu iin o veriyi deęerlendirme sorunları var ve dzgn geometrilerde ok bařarılı ama byle dzgn olmayan geometrilerde duvar gibi veya iřte doęal objeler gibi onları ıkartmada bayaęı sorunlar yařanıyor bunun sebebi hem ok yoęun veri var bir de tarama sistemi olduęu iin istediğiniz detay deęil aslında belirli sıklıkta bir detay lmř oluyorsunuz ve onları ancak modelleyerek onların iinden o dubleleri ıkartmanız mmkn. ünkü siz total stationla tek tek lme yaptığınız iin zaten lme yapacaęımız geometrinin řeklini bildiğinizden ona gre lmeleri yapıyorsunuz. Ama taramada yle olmuyor taramada siz hangi objeyi tarayacaksanız tarıyorsunuz. O taradığınız noktalar objenin kenar noktalarına dřmeyebilir detay noktalarının stne dřmeyebilir gerekten yle olduęu zaman da siz farklı bir modeli karřınıza alıyorsunuz o modelden gerek modele gemek esas sorunu o yaratıyor zaten. Ve iřte bu beř tane mimar dediğim arkadaşımız, bizlerle beraber alıřan arkadaşlar bu konuda ok deneyim kazandılar. İlk bařlarda ok yani bunlar nasıl olacak bir trl iřin iinden ıkamam gibi sorunlar olmaya bařladı. ünkü bulut grntsn anlamak kolay deęil. İnsanların en ok zorlandıkları řeylerden bir tanesi  boyutlu grnty algılamaktı ve mimarlar da bu konuda aslında en ok bařarılı olması gereken disiplinlerden biri olması gerekiyor. İřte jeodezi fotogrametriilerde olduęu gibi ama yine de ekranda iki boyut gryorsunuz nereden bakarsanız bakın iki boyut var ekranda. Ama nc boyutu algılayarak grmeniz gerekiyor perspektif var. Bunlarda bazı sorunlar oldu. İlk bařlarda yanlış noktalar yakalayarak bulutun iinde. Mesela gerideki noktayı yakalıyorsunuz bambařka bir řekil ıkıyor. Halbuki nde bařka onun nnde bir noktası daha var. Byle bir takım sıkıntılar oldu. Software’ler bu konuda yeni yeni bir takım alıřmalar geliřtiriliyor. Bizde mesela yle bir tane master alıřmamız var. Bu proje kapsamında yrtlyor eęer gerekleřirse bu tr mimari detayları daha kolay o alıřmalar ierisinden modellenmesini saęlayacak... İřte genel olarak Seddlbahir Projesi disiplinler arası iliřkiler bu dzeyde...

S.A.: Benim kiřisel tecrbem, O laser scanner ok gzel zel bir alet ve ok gzel belgeliyor her řeyi ama hacim yakalıyor.

R..: Hhmm.

S.A.: Kenarları yakalamıyor. Sorun oradan kaynaklanıyor.

R..: Evet evet.

S.A.: Halbuki mesela fotogrametri veya fotoğrafla birleştirilebilirse o... Software ve laser scanner

R.Ç.: Evet evet

S.A.: O zaman hani mimari belgeleme için biçilmiş kaftan olacak.

R. Ç.: Evet evet

S.A.: Ama şu anda sanırım takıldığımız nokta o.

R.Ç.: (eee) aslında şöyle fotoğrafla ilişkilendirme var. Bizim çok ilginç bir tane (eee) ... Scan ettiğimiz görüntü var, biliyorsun scannerler aynı zamanda görüntü de capture ediyorlar o görüntünün üzerinden aldıkları bilgiyle bütün o ölçülen (eee) vektör bilgilerine renk bilgisi ekliyorlar ve o vektörleri birbirine yaklaştırdığınız zaman ortaya şekil çıkıyor. Açıldığı zaman vektörler resolution çok bozulduğu için görüntüyü yakalayamıyorsunuz. (derin nefes aldı) öyle bir sıkıntı var. Bizim şöyle olmuştu. İlk işte biz HDS300 kullandık Leica'nin şeyde. Siz hangisini kullandınız?

S.A.: Aynısını.

R.Ç. Aynısını mı kullandınız? O mesela dünyadaki en iyilerden bir tanesi bu tür detayları yakalamak açısından çok yüksek doğruluklu. Biz şimdi bir tane kubbenin içinde kubbeyi tarayacaktık ve sabaha karşı bitirebildik o kubbenin taramasını ama çok eğlenceliydi ilk günümüzdü o gün (eee) ve bir de bu şeylerde şöyle bir sorun var hazır o da yeri gelmişken kubbe örneğini verirken bunun aydınlatma sistemleri yok.

S.A.: Hmmm.

R.Ç.: Laser scannerlerin aydınlatma sistemleri olmadığı için fotoğraf çekiyor, çektiği fotoğrafın kalitesine bağlı olarak renklendirme yapıyor. Dolayısıyla siz çok güzel bir fotoğraf çekebilerseniz o zaman çok daha iyi bir kalitede o vektörlerin ucuna eklenen renkleri sağlıyorsunuz. Biz bunu keşfettikten sonra ... spotlarla aydınlattık olduğu gibi şeyi. Spotlarla aydınlatınca ve özellikle bir spotu da sürekli fotoğraf çekilen yerde dolaştırdık aynı bir flaş gibi. O zaman çok güzel görüntüler elde edebildik. Yani kaliteli görüntüler elde edebildik. Ayrıntıları daha rahat görebildik. Çünkü aslında ... Yaptığımız ölçme sonucunda üç boyutlu olarak siz o noktanın şeyini biliyorsunuz (eee) nerede olduğunu ne şekilde olduğunu ama anlamını verebilmeniz için onu gerçekten ilişkilendirmeniz gerekiyor onlardan bir tanesi size verilen şey renk derinliğin ve konumun dışında ve o rengi doğru tutturmanızın en güzel koşulu da o fotoğrafı doğru çekebilmek o fotoğraf yanlış çek... Karanlık çekildiyse yine bir görüntü var orada ama karanlık bir görüntü oluyor. Aydınlik ayırtıramıyorsunuz o zaman görüntüyü ama bazı şimdi laser scannerlerde farklı tekniklerle o renkleri algılama (eee) şeyleri var. Tabi fotoğrafın bir bütünlüğü de var. Fakat fotoğraflar biliyorsunuz raster görüntü veriyor. Bunlar vektör görüntü veriyorlar (öksürdü) dolayısıyla raster görüntüyü vektörle ilişkilendirmek (eee) rasterlar daha büyük vektörler daha küçük oluyor. Dolayısıyla onun içinden ancak renkleri alarak şey yapıyorsunuz ben onu şeye benzetiyorum bilirsiniz belki böyle (eee) bir tane şey

vardı (öksürdü) Eskiden Çin'den geliyor derlerdi Japonya'dan Çin'den. Bir ışık gece lambası gibi böyle ince ince misinalardan oluşur.

S.A.: Aaaa biliyorum hala var.Uçlarında da renkler vardı fosforlu renkler.

R.Ç.: Evet renkler vardı evet değişik şekillerde yanar falan. Aslında bir nokta bulutu öyle bir şey yani, ucunda renkler olan bir şey.

S.A.: Doğru.

R.Ç.: Nokta bulut. Aslında o bir nokta bulutu olarak değerlendirilebilir. Tabi orada bütün şeylerin çapları bir arada olduğu için ortaya düzgün geometrik şekil çıkıyor ve laser scannerlerin düzgün geometrik şekilleri belirlemede hiç bir sorunu yok

S.A.: Evet

R.Ç.: Düzgün olmayan geometrileri belirlemede esas sorun var. Bir de ölçme açısı çok önemli. Kıvrımlarda özellikle detayların çok yoğun olduğu yerlerde... Şeyi anlatıyordum kubbenin içerisinde fotoğrafı çekerken bir kola kutusu vardı... Sonra biz taramayı yaparken ya kola kutusu burada kalmış dedik...Aldık kola kutusunu... Ve kola kutusunu alınca kola kutusu taranmadı...

S.A.: Hmmm.

R.Ç.: Ama fotoğraflar kola kutusuyla birlikte çekildi...

S.A.: Ve sonuç?

R.Ç.: Ve sonuç kola kutusu duvara böyle gölge yapışmış olarak çıktı uzayarak anlatabildim mi yani oradan da aslında teknik olarak o vektör tarama görüntüsüyle fotoğrafın nasıl ilişkilendiği çok net çıkıyor. Muhteşem bir örnek baktığınız zaman yani (eee) şey. Şöyle bir merdiven düşünün. O merdivenin adımlarından bir tanesindeydi (eee) basamaklarından bir tanesindeydi. Kola kutusunu kaldırıncı kola kutusu merdivene yayılarak çıktı yani merdiven görüntüsünü üstünde çünkü tarama orada yapıldı. Görüntünün rengini de oradan aldığı için resmen kola kutusu gözüküyor. O resmi gösterelim size çok hoş.

S.A.: Tamam.

R.Ç.: Onu bulalım mutlaka görün o hoş bir örnek (öksürdü) ve oradan da bunların nasıl çalıştığını teknik olarak algılamak çok kolay yani fotoğrafla olan ilişki nasıl oluyor. Şimdi üç boyutlu olduğu için fotoğraflar iki boyutlu biliyorsunuz. Üç boyutlu oldukları için fotoğraf görüntülerinin burada yüzde yüz çözüm vermesi mümkün değil. Yani kullanamazsınız fotoğrafı öyle canınızın istediği gibi. çünkü fotoğraf bir kesit oluşturuyor. Ama o kesitin için bir suru derinliği sıkıştırıyor. Şimdi bu ise o derinliği acıyor... Fotoğrafın derinleşmesini sağlıyor . aslında olay o.

S.A.: Hmmm.

R.Ç.: Ama fotoğrafın derinleşmesini sağlarken fotoğraf tabi o derinleşmeyi onan tam olarak veremediği için ikisini tam olarak ilişkilendirmek mümkün değil. O nedenle

(eee) burada daha farklı biri takım çözümler bulmak gerekiyor. Yani gerçekten oradan alınan görün 3 boyutlu görüntü çekebilerseniz o zaman aslında o olabilir. üç boyutlu fotoğrafta biliyorsunuz aslında biz kullanıyoruz. Ama kullandığımız kullandığımız şeyler iki boyutlu fotoğraflardan yararlanarak üç boyutu... Ya zihinde oluşturmak ya da sayısal olarak oluşturmak mümkün oluyor. Yani su anda fiziksel olarak 3 boyutlu görüntüyü... Hologramlar falan var iste onlar da zaten bu hudutlar sayesinde falan oluşuyor baktığınızda. Dolayısıyla orada yapılması gereken çok iş var teknolojik olarak daha. Ama çalışmalar iyi yönde gidiyor. Orada bence fotoğraflar onu ilişkilendirmenin dışında... Şunu yapmak gerektiğini düşünüyorum (öksürdü) bir kere mutlaka ayrıca oranın fotoğraflarının çekilmesi gerekiyor.

S.A.: Bağımsız bir kamerayla

R.Ç.: Mutlaka bağımsız bir kamerayla fotoğraflarının çekilmesi gerekiyor ya da içinde entegre olur ama sürekli o fotoğrafların çekilmesi lazım. Ve o çekilen fotoğraflarda değişik boyutlarda bir önden bir de yanaşarak yanaşarak yanaşarak...

S.A.: Hmmm.

R.Ç.: Çekeceksiniz ki olayı algılamazsınız çünkü ekranda belirli bir şeyi algılayabiliyorsunuz çünkü ekranları biraz daha büyütsek aslında algılama gücümüz daha çok artacak. Ve şeyleri şekilleri yakamamamız da. Şimdi biz en büyük on yedi on dokuz inch kullanıyoruz. Halbuki daha çok büyük plazmalar kullansak o şekiller daha araları açılacak ama seklin bütününe görme sansımız olacak. Simdi bu şeylerde açtığınız zaman s eklin belirl bir bolumun görüyorsunuz bazen gazetelerde öyle bulmacalar çıkar çekerler bir fotoğrafını sadece bir bölümünü verirler bu ne diye sorarlar siz tahmin edersiniz o bambaşka bir şey çıkar. Yani dolayısıyla buradaki olay da biraz öyle onun için (eee) yani bu teknolojiye fotoğraf çok önemli yani mutlaka fotoğrafı yanda bilgi olarak tutmak gerekiyor ve onun dışında arkasında koyabilmemiz lazım. Ama bunlar tabi deneyimle o fotoğrafların kullanılması hemen olma. yani size ancak deneyimle kazanabilecek bir şey. yani ben hem fotoğrafları hem bulutu versem siz de hiç kullanmıyor olsanız sistemi sizin algılamanız pek mümkün değil. Çünkü... Derinlik olduğu için noktanın fotoğrafta gördüğünüz noktanın o derinlikteki hangi nokta olduğunu kestirmeniz biraz sorun oluyor. Onun için daha çok kesitler yöntemiyle çalışarak. Aslında burada sunu yapmak gerektiğini düşünüyorum ben. Eğer üç boyutlu modellerin bu tur çalışmalarda kullanılmasına izin verseler bizde hukuk pek müsait değil biliyorsunuz

S.A.: Hmmm.

R.Ç.: Rölövelerde şurada burada hep 2 boyutlu kesit görünüş istiyorlar. Kesit görünüş değil de katı modeli isteseler mesela şeyde solid olarak siz onu oluştursanız.onu oluşturmak bulut da çok kolay

S.A.: Ama yine o nokta bulutuyla oluşan model katı model değil. Onu kullanamazsanız.

R.Ç.: Tabi aslında o da bir soft.ama oradan katı modele dönüştürebilirsiniz şeyle (eee) ne derler ona... (öksürdü) Bilgisayardan başka bir tezgaha ya da farklı bir programa getirebilip dönüştürebilirsiniz. Onu dönüştürdüğünüz zaman da bu sorun

kalkıyor ama onun üzerinden nokta okuyabilmeniz lazım. Biz mesela bunu kendimiz arazi şeylerinde yapıyoruz. Biz Mesela arazi modellerini sayısal arazi modellerini DTM'leri kullanıyoruz. (telefon çaldı) o DTM'leri kullanarak şeyi oluşturabiliyoruz.

S.A.: Buyurun bakın

R.Ç.: Pardon

S.A.: DTM'leri anlatıyordunuz

R.Ç.: (eee) DTM görüntüleri anlatıyordum değil mi

S.A.: Ama kalenin sonuçta katı modelini oluşturamadınız değil mi? Onun için yeterli software yok çünkü

R.Ç.: Şöyle biz kalenin katı modelini oluşturduk belli oranlarda fakat kullanamıyorsun. Katı modeli kabul eden kimse yok ki (telefon çaldı) bizi rahat bırakmayabilir. Efendim?

S.A.: Onu neyle oluşturduğunuz katı modelini peki? Hangi programla?

R.Ç.: Valla ben şöyle söyleyeyim. (eee) Nerede. Bizim Bora falan ilgileniyor.

S.A.: Hmmm anladım

R.Ç.: Hatta bizim böyle bir tane şey var üzerinde uyuştuğumuz bir şey var.(telefon çaldı) Ama Katı model değil o nokta bulutu daha çok . Ama bazı yerlerin katı modelini oluşturduk. Bu 3D Max falan gibi bazı yazılımlar var. E oraların içerisinde bu tür katı modeller oluşturmak mümkün. Katı model oluşturmaya yönelik bir sürü yazılım var aslında.

S.A.: Ama hep kendileri bir şeyler üretiyorlar. Ben okuyorum makaleleri. Katı model oluşturmuşlar ama ufak objeler için. En büyük yaptıkları Michelangelo'nun heykelleri. Davut'un katı modelini oluşturmuşlar.ama Rhinoyla oluşturduk diyorlar ben de Rhino kullanıyorum. Ama onu Rhinoyla yapmak imkansız. Mutlaka içine bir şey eklemişlerdir diye düşünüyorum.

RC. Belki script micrpt diye yazmışlardır.

S.A.: Herhalde.

RC yani ben (eee) bu katı model ama katı model bu veriler olduktan sonra o verilerden katı modeli oluşturmak zor değil. Demin de söylediğim gibi bu biz arazi modellerini oluştururken yapıyoruz o işi. Aslında oluşturduğumuz bir katı model değil bizim orada. Şey bu DTM'leri falan oluştururken. Orada ama deri üzerinden geçerek koordinat alabiliyoruz. Şimdi nokta bulutlarında bunu yapamıyoruz. Nokta bulutlarında iki noktanın arasına girdin mi boşluğa gidiyorsan boşluğa gittiğin için de hatta iki noktanın bulunduğu yer yüzeyi belirlese o zaman boşluğa gitmeyeceksin herhangi bir yere tıkladığın an nokta okuyabileceksin. Şimdi biz DTM de bunu

yapıyoruz. Ben aslında böyle bir şeyi yapabiliriz biz. Yapabiliriz çok rahatlıkla böyle bir çalışmayı yapabiliriz ve yapabildiğimiz zaman da hem mimarların üzerinden şeyi alması çok daha kolay olur hem de (öksürdü) insanların bunu algılaması daha kolay olur bulutları. Fakat ne yazık ki bizim şu anda işte koruma kurulları falan hep rölöve rölöve iki boyutlu çizim istiyorlar öyle olduğu için de...

S.A.: Doğru.

R.Ç.: Büyük sıkıntı oluyor bu veriler size kolaylık getireceğine bazı durumlarda zorluk ve angarya getiriyor.

S.A.: Doğru doğru.

R.Ç.: Ama bizim şöyle bir sloganımız var biz kalemizi aldık kahvemizi içerken değerlendiriyoruz her tarafına bakabiliyoruz. Gerçekten de öyle yani. çok büyük oranda taranmış hali var su anda.

S.A.: Peki Seddülbahir... İlgili gitmeden önce laser scanner 'i kullanmaya karar verdiniz ve Onun için nasıl hazırlık yaptınız? Mesela bir metodoloji belirlediniz mi? İşte su saatlerde kullanalım bunu yapalım veya şunlara dikkat edelim?

R.Ç.:Evet Tabi ki

S.A.: Öyle bir şey belirlediniz mi?

R.Ç.: Tabi söyle (eee)aslında belirledik tabi ama tabi ki her zamanki gibi evdeki hesap carsıya uymadı. Burada şöyle bir şey var alet kendimize ait olmadığı için. Demin de söylediğim gibi.

S.A.: Zaman kısıtlaması vardı?

R.Ç.: Rica üzerine aleti aldığımız için ve Bora da şirketin elemanı olarak bize geldi dolayısıyla onun da yapması gereken başka işleri vardı ama ben tabi planımızı yaparken arkadaşşıma dedim ki bana dedim bu on beş gün lazım dolayısıyla on beş gün kimseyle şey yapmıyorsunuz, şirketin bu elemanı ve bu aleti bize tahsis olacak. Tamam dedi. ama tabi ticaret öyle olmuyor. Bir kaç gün sonra bir telefon aldık biz. Alet su günlerde lazım olacak çünkü şöyle şöyle şöyle bir iş çıktı falan dediler (telefon çaldı) öyle olunca tabi biz süreci hızlandırmak zorunda kaldık. Ve günlük çalışma saatlerimiz on beş on altı saate çıktığı zamanlar oldu. Bora telef oldu yani (güldü) gerçekten çocukcağız. Ama söyle bir metodolojimiz vardı düşüncemiz. Simdi laser scanner teknolojisini... böyle ilk kullananlardan olmak... Bazı şeyleri de teknolojik olarak da... Kestirmek gerekiyor yani eski deneyimlere dayanarak. Simdi mesela laser scannerle iki tip şeyleri vardır (eee) datum yani koordinat sisteminin belirli bir sisteme oturtulması... Var o söyle oluyor. Bulutları birbirinin üstüne bindirerek örtüştürürsünüz. Belirli örtü oranlarıyla o bulutları birbiriyle match ediyorsunuz eşleştiriyorsunuz, ve eşleştirdiğiniz zamana bir önceki bulut bir sonraki bulut la aynı koordinat sisteminde oluyor ama bu doğruluktan kayıp sağlıyor. Su nedenle kayıp sağlıyor çünkü siz her zaman aynı bulut noktalarını tarayamayabiliyorsunuz aynı bulut noktalarını tarayamadığınız için de onlar belirli bir şekilde filtre olarak birbirileriyle çakışıyor o çakışmalardan elde edilen bir model

oluşuyor... Onun dışında laser scannerin kendisi bir takım reflektörleri var, o reflektörlere ölçme yapıyorsunuz. O reflektörlerin aynı iki, farklı bulut da ortaklaşmasını sağlıyorsunuz ve o ortaklaşma sonucunda bu daha yüksek doğrulukta bir çakışma sağlıyor. Ama bunların hepsi uzayda çakışma sağlıyor. Hiç bir zaman şeyde çakışma saylamıyor sizin koordinat sisteminde bir çakışma sağlanıyor. Çünkü Biz 97 den beri orada ölçme yapıyoruz. Bunu yapabilmek için de işte daha bizim daha ilk başta 97 de oluşturduğumuz o jeodezi kontrol ağıyla ilişkilendirerek yani laser scanneri (eee) kurduktan sonra o taktığımız reflektörlerin hepsini kendimiz koordinatlandırdık biz.

S.A.: hmmm.

R.Ç.: Onları koordinatlandırdığımız zaman onların oluşturduğu bütün bulutlar bizim koordinat sistemimizde olmuştu oldu böylece. Bu vesileyle biz bütün lakenin bütününü kendi istediğimiz her yere endi datum sistem, kendimize koordinat sistemimize k oturtma sansına sahip olduk. İşte bizim de formasyon olarak katkılarımız esas bunlar oluyor baktığınız zaman, yani laser scanneri koyuyorsun basıyorsun düğmeye kendi tarıyor aslında belirli i oranda. Ondandır Bu en önemli metodolojilerimizden birisiydi. Buraya katkı verebileceğimiz. Tabi bunu yaptığın zaman geçmişte yaptığın bütün ölçülerle bunu ilişkilendirebiliyorsun. Fotogrametrik olanlarla ilişkilendirebiliyorsun, total stationla ölçtüklerinle, GPSle ölçtüklerinle her şeyle ilişkilendiriyorsun bir sorun kalmıyor. Hepsi aynı koordinat sisteminde. Öteki türlü bulutlar havada yüzer. Onların yüzmemesi için de böyle bir yöntem kullandık. Bunun dışında (öksürdü) (eee) demin de söylediğim gibi mesela aydınlatmanın ...

S.A.: Etkisini gördünüz

R.Ç.: Çok önemli bir etkisi olacağını gördük. yaptığımız bir iki çalışmada baktık ki bazı sorunlar var. O sorunları çözebilmek için. Hatta bora demişti ki ya bunu aydınlatarak bunu çözemeyiz demişti ki, ben de ona demiştim ki bak aydınlatacağız daha güzel bir sonuç olacak ve o da çok şaşırmıştı. Sonra bu merkezleştirme olayını (eee) da işte hani koordinat sistemine oturtma olayında biz total stationla arkasından giderek koordinat vermemiz. Ona da çok deneyim kazandırdı. Boraya da çok deneyim kazandırdı o tur şeyler. Böylece o da mesela başka zamanlar başka yerlerde yaptığı işlerde bu teknikleri kullanmaya (eee) başladı. Camiler falan taradı bir suru. Cami taradı İstanbul'da, Türkiye'nin. Ani harabelerine gitti taramalar yaptı falan. Hep oralarda bunları kullandı. Çünkü özellikle Ani harabeleri gibi bir yeri düşünürseniz bizdeki kale gibi kopuk kopuk bir suru obje var. O objelerin hepsini bulut olarak tarayabilirsiniz ama o objelerin biri biriyle olan ilişkilerini kurmaya çalıştığınız zaman bir koordinat sisteminde hepsini tanımlamanız lazım ve o bulutların doğru yerlere yerleşmesi lazım coğrafik ortamda. Dolayısıyla bu anlamda siz bir jeodezik ağ üzerinde yaparsanız, bütün çalışmaları onunla ilişkilendirirseniz böyle bir sorununuz kalmıyor ortada. Dolayısıyla hepsi oraya oturuyor. Aslında çok hedeflerimiz var. Daha bir çok şey (eee) yapacağımız. Simdi Caner arkadaşımız yine coğrafi bilgi sistemlerinde çalışmalar yapmaya devam ediyor onlar. Lucienne hatta hemen hemen her Cuma günü geliyor. Çalışmaları burada yürütüyorlar ofiste birlikte. ben de iste çok fazla katkım olamıyor ne yazık ki buradaki görevlerimizden dolayı. Ama (eee) orada güzel şeyler olacak. Mesela bu kaleyi büyük bir olasılıkla biz Google'in üstüne de oturtacağız diye düşünüyorum. Benim öyle kafamda modeller var. Bu konuda birlikte çalıştığımız bir arkadaş var. (eee) O arkadaş bu konularda bayağı deneyimli.

Bina modellemeleri konusunda. Ona mesela bu binayı modelletmeyi falan da planlıyorum. O da doktorasını yurtdışında daha bitirdi yeni inşaat mühendisi bu arkadaş. İnşaat mühendislerinin arasından böyle bu tur ilgileri olan arkadaşların çıkması azdır. Ama o bilişimci kendini o işe adanmış. O da onu da devreye sokacağız. Eğer onunla şey yapabilirsek aslında çok hös (eee) çalışmalar olacak. Ama dediğim gibi (eee) su anda biz bu modelleme üzerine çalışıyoruz. Daha rahat modelleme üzerine. Çok fazla manual iş yapmanız gerekiyor su anda. O veriyi gerçekten isleyebilmeniz için. Halbuki bunun çok daha otomatik bir hale gelmesi geliyor. İşte bunun otomatik hale gelmesinin en önemli koşulu katı modele geçebilmek katı modele geçtiğiniz zaman o olay büyük oranda gidiyor ama bir de bu katı modeli (eee) buradaki bürokratik birimlerin de kabul etmesi gerekiyor hukuksal olarak da buna bir yol açmak gerekiyor. (derin nefes aldı) İşte yav herhalde mimar arkadaşlar buralardan kazandıkları deneyimleri oralara aktarıırken falan şey olacak (eee) bunları oralarda hukuka çevirecekler diye ümit ediyoruz tabi bakalım. O Olmazsa biz yine el atacağız o işlere. (güldü)

S.A.: Peki son bir soru sorayım. Biraz daha metodoloji hakkında sorayım. Sizce bir metodoloji nasıl olmalı nasıl hazırlanmalı. Mesela ben scannerı alıp bir alan çalışmasına ekleyeceğim. Nasıl bir metodoloji hazırlamalıyım?

R.Ç.: Simdi (eee) su bir kere

S.A.: Nelere dikkat etmeliyim

R.Ç.: Bir kere sunu yapmak gerekiyor. En önemli şey tasarımıdır. Sizin yapacağınız işi planlama ve tasarlamamız gerekir. Simdi on bilgi toplamamız gerekiyor. Biz Seddülbahir kalesinde on bilgi toplama ihtiyacımız söyle olmadı, bütün bilgileri daha önce den çok önce topladığımız için onlar vardı bizim elimizde. Ama ilk defa bir yere gidiyorsanız. Bizim istikşaf kanavasını dediğimiz bir kavram vardır. Yani bir on etud yaparsınız. Nerede hangi işi yapacaksınız, o işi yapacağınız, mesela burada bir laser scanner la bir obje taramaksa bir kere o bölgeye gidip gezmeniz gerekiyor. Onu gezdikten sonra (öksürdü) oranın koordinat sistemini yaratabilmek için o bölgenin bir hangi koordinat sisteminde yaratacağınıza karar vermeniz gerekiyor. Bunu ülke koordinat sisteminde yaratacaksanız bu sefer çevrede ülke koordinat sisteminin koordinatlarını size sağlayacak bir takım noktalar bulmanız gerekiyor bulmanız gerekiyor ya da bunu GPS'le varolan daha uzak referanslardan taşıyıp oraya getirmeniz gerekiyor. Bu noktaları oluşturduktan sonra etrafta daha sonra (öksürdü) binanın nerelerden taranabileceğini çünkü laser scannerı koyduğunuz yerler çok önemli eğer laser scannerı bir yere koydunuz ondan sonra ikinci yerin neresi olacağına düzgün karar veremezseniz bir kere orada binayı ortaya çıkartırken bir sürü boşluk oluşacak o boşlukları tekrar taramak için yeniden taramalı. En optimize taramayı yapabilmek için d...oğru yerlere yerleştirmeniz gerekiyor. Bu doğru yerlere yerleştirmek konusunda laser scannerın teknik özelliklerini çok iyi bilmeniz gerekiyor. İşte şimdi laser scannerlar (eee) iki yüz yetmiş derece düşeyde üç yüz altmış derece (eee) yatayda tarama yapabiliyorlar. Bu çok güzel bir özellik. Mesafeleri de elli metre civarında falan. Dolayısıyla siz elli metrenin uzağında bir takım obje ile karşı karşıyaysanız ona göre bir yöntem geliştirmek gerek. Laser scannerı o binaya çalışmayı yaptığınız objeye yaklaştırmamız gerekiyor veya çok yakında kaldığınız zaman daha geniş alanı almanız için uzaklaştırmamız gerekiyor dolayısıyla çevrede bulunan mekanın bulunduğu yerin çevresinde bulunan objelerinde

ona göre nerede oldukları çok önemli. Her zaman her yerde her şeyi taramayabilirisiniz. Bu planlamayı çok iyi yapmanız lazım ve ... bu planlamayı da yaparken de hangi noktaları ortak alacaksınız ki... Bir bulut diğer bulutla ilişkilenecek ve en sonunda bütün bir bulut elde ettiğinizde 360 derecelik bir bulut elde ettiğinizde o bulut tek bir koordinat sisteminde olacak tabi buradaki 360 derece (eee) laser scannerin bir keredeki taramadaki 360 derecesi değil sizin binanın etrafındaki dönüşünüzdeki 360 dereceyi oluşturmanız gerekiyor artı fotoğraflar çok önemli (eee) laser scanner in taradığı... Sistematiğe uygun fotoğraf çekip o fotoğrafları da doğru numaralandırmanız gerekiyor. Yani ve laser scanner file'larıyla hatta bunları ilişkilendirmeniz lazım. öteki türlü çünkü veriyi her zaman ölçen değerlendirmez. Veriyi ölçen değerlendirmezse siz veriyi veririsiniz. Onun için bir çöptür aslında o bir yandan şey yapamaz ona bir de diğer bilgileri vermeniz lazım ki. Biz mesela arazide bu işler için krokiler tutarız. Röper krokilerimiz vardır.noktalarımıza ilişkin bilgi kayıtlarımız vardır. Bunların hepsini tutarsınız. Ve biz de genellikle arazi ekibiyle çizim ekibi farklıdır. Dolayısıyla Arazi ekibi çizim ekibine

S.A.: Verir datayı.

R.Ç.: Verir datayı gider. Çizim ekibi yapayalnız kalır orada. Şimdi o hiç araziyi görmemiştir bile. ama ortaya çıkartması gereken set oradaki ölçülerdir. Bunu yapabilmesi için de sizin çok iyi bir şekilde o doneyi vermeniz gerekiyor. dolayısıyla böyle bir standart olması gerekiyor ve bu ekiplerin aynı sekiler yetiştirilmiş olması lazım aynı dilden konuşan birbirini anlayan kişilerden oluşmuş olması lazım. Ya da ... bunları zaman zaman bir araya getirip konuşturmanız gerekiyor. Yani Sadece veriyi göndermekle bu iş olmaz. Çünkü gerçekten Laser scanner verisi çok yoğun bir veri... Korkunç yoğun bir veri yani siz bunu yarım santim aralıklarla taradığınız zaman bir objeyi. Muhteşem bir veri kümesi çıkıyor ortaya. Bu veri kümesini ne bilgisayarda döndürmek o kadar kolay. Yani işte biliyorsunuz AUTOCAD ondan sonra benzeri (eee) Netcad Türkiye'de bir yazılımımız daha var. bunlar da mesela verdiğiniz zaman 3 boyutlu noktaları işleyebileceğiniz şeylerdir. Ama siz Autocad'in içine ham bir laser scanner verisini koyduğunuz zaman o da kilitlenip kalıyor. Çünkü o veriyi normal AUTOCAD verisi gibi algıladığından yoğunluğunu da o şekilde zannediyor. Ama siz milyonlarca veriyi zıp diye oraya koyduğunuz zaman veriyi çeviremiyor bir türlü . O yüzden Autocad'e ayrı bir ... script yazılmış. O script o veriyi optimize ederek Autocad'in kullanmasını sağlıyor. Böylece AutoCAD'de rahat hareket edebiliyor.

S.A.: Evet.

R.Ç.: Yani çünkü AutoCAD varolan veriyi tabandan büyük olduğu gibi çekiyor. Halbuki öteki diyor ki sen diyor bunu daha optimize olarak çek ihtiyacın olduğu kadar bol. Çünkü ekranda zaten her şeyi göremiyorsun. Gördüğün zaman da o kadar detayı bir arada göremeyeceksin. Yani bir genelleştirme var aslında veride. bunu yapmak gerekiyor. Bunu yapmadığınız zamanda doğru bir çalışma platformu yaratamıyorsun kendine. Onun dışında tabi çizimden sonra bunun bir de kontrol edilmesi var. Gerçekten orası doğru mu çizilmiş. O kontrollerin yapılması gerekiyor. O kontrolleri de yapanların işte daha çok mühendis düzeyinde bu işten teknik olarak anlayan araziye de bilen çizim tekniklerini de bilen birilerinin olup bak şurada şunu yanlış bağlamışsın bunu git şöyle bağla demesi gerekiyor. Biz de mesela... (derin

nefes aldı) tabi şeylerde çok zor. Objelerde model yaratırken bu tür şeylerde objeyi çok iyi bilemeniz gerekiyor ve objeyi algılamamız gerekiyor. Arazide bizde mesela tesviye eğrileri vardır bizim yükseklik eğrileri. Yükseklik eğrileri biri birini kesemez. Bu bir kuraldır. Yani kesiyorsa...

S.A.: Bir hata vardır.

R.Ç.: Bir hata var demektir. Hemen çıkartabilirsiniz. Yükseklik eğrileri yolu kesemez. Yola gelir kalır. Obur taraftan çıkar devam eder, hiç bir zaman yolun üstünden geçmez. O tip kurallarımız vardır. İşte laser scanner modellerinin getirilmesinde de bu tip kurallar yavaş yavaş gelişecek. Kullanılan yere bağlı olarak. Şimdi dediğin gibi Örneğin bir fabrikada bu taramayı yapınca zaten borular var yuvarlak objeler var elips var işte daire var. bunları çok kolay modellemek. çünkü objeler belli ne çıkacağı belli. şimdi şeyde öyle değil eee mimari çizimlerde. Karşınıza çıkan objelerin çoğu şimdi bu düzgün binalar olsa çok kolay bunları modellemek dört tane nokta seçersiniz bu binadır dersiniz oraya bir kutu koyarsınız şıp diye bu bina olduğu belli yani. Ama şeyde özellikle duvardan oluşan (öksürdü) binalarda her duvar kendi içinde tek zaten. Öyle olduğu için de o modellemelerde standartların da yavaş yavaş artık bu sayısal modeller göre oluşturulup her iki ekibi de anlatılıp eeee şey yapılması lazım. Bir de tabi şeyi unuttuk galiba... Noktalar örtü oranı olacak ama noktalar örterken de bulutların da birbirini örtmesi gerekiyor. Yani bulutları belki çakıştırma için kullanmayacaksınız ama siz o çizimi yaparken o üretimi yaparken modeli yaparken iki bulutun birbiriyle eşleştiği yerlerde çok daha düzgün bir model oluşturabilirsiniz geçiş açısından. Eğer siz şimdi şurayı ölçtünüz şurada şu kadar ölçtünüz şu aradaki geçişi kestiremezsiniz. Ancak onu siz dersiniz ki böyle düz geçti dersiniz veya işte söyle eğri geçsin dersiniz halbuki söyle bindirmeli yaparsanız bu model bunu üzerinde çok daha rahat şekilde geçer. Bu bindirmelerin de mutlaka bulut olarak da yapılması gerekiyor. Laser scanner noktaları da tek tek ölçüyor. Bu bindirme oranının da nereden baksanız yaklaşık olarak yüzde on yüzde yirmi oranında olmasında yarar var aksi halde oralarda yamalı bohça gibi bir bulut kümesiyle karşılaşmak mümkün olabilir... Yani metodoloji olarak böyle bir sistem uygun olur şeyde... Yani hangi objeyi ölçerseniz ölçün bunun öyle olmasında yarar var. Ama mesela söyle düşünün bakın ilginç bir örnek olabilir. bir kubbe ölçüyorsunuz. İçinde tam orta yere laser scanneri kurdunuz. Tam ortaya. Taradınız. Her yeri tarayabilirsiniz bir anda. 360 derece 270 derece ya. Yani dolayısıyla bir noktadan hepsini tarayabilirsiniz sadece o sistemi o koordinat sistemine oturtmanız mümkün. Bir (eee) onun dışında bir şey yok. (eee) Örtü oranı yaratmak falan yok zaten tamamının ölçüyorsunuz ama bu da sunu getiriyor. Onu gördük biz. Böyle büyük objeleri öyle bir kerede taradığınız zaman elde ettiğiniz verinin yoğunluğu o veriyi ele almanızı çok güçleştiriyor.

S.A.: Halbuki parça parça olsa daha rahat işlenir.

R.Ç.: Evet. Evet ve ölçmeniz sırasında her hangi bir şekilde arıza marıza akü bitmesi gibi şeyler olduğu zaman veya aydınlatmada bir sorun olduğu zaman veriyi toptan gitmese bile o verinin şey yapılması parçalanması falan tekrar ilişkilendirilmesi daha büyük sorun oluyor çünkü o ortak noktaları falan oluşturamamış olabiliyorsunuz böyle bir durumda her karede. Ama ötekileri de oluşturuyorsunuz. Dolayısıyla bunları değerlendirirken biraz parça parça yapmakta yarar var.

S.A.: Evet

R.Ç.: Oluyor. Öteki türlü veri yoğunluğu çok fazla. Ama ileride mesela bilgisayarlar çok daha güçlendiği zaman mesela bu yazılımlar paralel processing olarak değerlendirilebilecek bir şekilde değerlendirirse o zaman bunlar çok daha rahat olacak bu tür olaylar yani bir makinede değil de değerlendirmeyi yaparken belki arkanızda yüzlerce makinede bu çalışacak siz sadece görüntüyü orada göreceksiniz ama orada bir suru işçi makine sizin için çalışıyor olacak. bizim mesela üniversitemizde öyle bir sistem var ama daha çok bu tür verileri değerlendirmek için değil daha farklı hesapları yapmak. Çünkü bazı hesaplar var bugün ki teknolojide bile basıyorsun düğmeye üç gün sonra geliyor ancak sonuç geliyor. Yani öyle hesaplamalar söz konusu o tür hesaplamalar için. Ama bu veri işlemlerde falan da çok arkada bir suru makineyle çalışabilirsen çok daha kolay bazı şeyler öz aman o bölme işleminin parçalama işlemini orada yapabilirsin. (güldü)

S.A.:Evet. Daha çok zaman var bunları yapabilmek için .

R.Ç.:Evet yani işte zamanla gelişecek bu sistemler bu şekilde .

S.A.: Teşekkür ederim

R.Ç.: Ben teşekkür ederim. sen bütün sorularını sorabildin mi,

S.A.: Sordum sordum.

R.Ç.: Yani soramadıysan ben çok konuşurum görüyorsun yani güldü.

S.A.: Yok yok hayır zaten soracağım sorulara da arada geçişlerde cevap verdiniz.

R.Ç.: Tabi oldu o zaman Yani yararlı olabildiysem ne mutlu bana.

S.A.: Çok yararlı oldunuz. Çok mutlu oldum. Özellikle dediklerinizi ekleyeceğim ve tekrara düşüneceğim.

R.Ç.: Daha sonra kafana takılan bir şey olursa sorabilirsin.

Appendix D

Interview with Umut Almaç²²⁰

Serra Akboy: Benim soracağım (eee)

Umut Almaç: Bana soracağın sorular teknik sorular mı yoksa...

S.A.: (eee) Şöyle ben...

Umut Almaç: Başka tipteki sorular mı? Çünkü hani ben mailimde de belirttim ya, Arzu şey...

SA. Biliyorum hmm.

UA: projeye daha hakim yani o çünkü başımızda o vardı. Arzu vardı.

S.A.:Hmmm. Benim soracağım, şimdi zaten, (eee) Seddülbahir Projesi'nin nasıl bir proje olduğunu Lucienne'den de Rahmi hocadan da Arzu'dan da öğrendim.(eee) Herkes bana bir sürü doküman sağladı. Birebir de konuştum insanlarla ve...

U.A.: Bora'yla filan tanışmışsındır herhalde.

S.A.: Bora'yla tanışmadım. (eee) Geçen sene tanışabilirdik ama ben gidiyordum denk gelmedi. İki dakika tanıştık, el sıkıştık. Ama Caner'le tanıştım. (eee) Bora'yla da inşallah tanışacağım bekliyorum. (eee) Onların hep anlattıkları var. Zaten bir altlık oluşturdum o bölüm için. Hani, nasıl bir proje? Nasıl yapıldı? Kimlerden ne destek alındı? Ne kadar data toplandı? Ne yapıldı, ne edildi? Ama şu aşamada (eee) takımda olanların kişisel deneyimlerine ihtiyacım var.

U.A.: Tamam.

S.A.: Ve bunu da üç aşamada topladım ben kafamda... Mesela... Senin açıdan Seddülbahir nasıl bir projeydi? İkinci aşama, laser scannerle ilgili, laser scanner'la ilgili mesela, onu efektif kullanabildin mi? Alan çalışmasında nasıl kullandınız? Nelerle...

U.A.: Şey, alan çalışmalarında ben yoktum. Ben bayağı geç katıldım şeye. çalışmalarını kere Alan çalışmalarına gitmedim.

S.A.: Hmmm.

U.A.: Ben hep... Verilerle uğraştım bilgisayarda.

S.A.: O da çok önemli

²²⁰ Architectural team, the Seddülbahir Project, 13 April 2007.

U.A.: Büro çalışmasında ben vardım.

S.A.: İkinci soracağım zaten etap da büro çalışması, nelerle karşılaştınız?
Şimdi alan çalışmasını o yüzden geçiyorum. Alanda olmadığım için.
Ama yine de... Herhalde mesela...

U.A.: O 3D laser scannerla hiç uğraşmadım alanda, alanda olmadığım için.
Tamam önemli değil. Ama sonuçta yine de kafanda bir şey oturmuştur. Hani laser scanner kullanırken... Acaba kullanılmalı mı, kullanılmamalı mı gibi?

S.A.: Tabi canım, kullanılmalı yani. Kullanılmamalı diye bir cümle bile yanlış bence.
Hayır ama herkesin fikri değişik.

U.A.: (güldü) Konservatifler biraz öyle yaklaşıyor. Ama yani kullanılmalı.

S.A.: Bir de... Peki registration...

U.A.: Ben inşaat mühendisiyim, mimar değilim biliyor musun.

S.A.: Ne güzel, daha güzel. Ben bayılıyorum değişik mesleklerden gelenlere. Neyse...
O zaman nasıl başlamak istersen...

U.A.: Şimdi Seddülbahir projesinde be ne kadar çalıştım, bilmiyorum. Aşağı yukarı altı ay filan çalıştım. Ben işe girdiğim zaman şeye taşındık tam. Yani 10 gün kadar Arzu'nun bir arkadaşının ya da kuzeninin bürosunda çalıştık. Sonra hemen şeye geçtik.

S.A.: Maslak'a.

U.A.: Maslak'a geçtik. Yani Maslak'da beraber başladık diyebilirim. İlk başta ben total station verileriyle çalıştım.

S.A. Onu nasıl kullandın? O da önemli. O da sorularımdan biri.

U.A.: Total station verilerini AutoCad... Auto CAD'e 3 boyutlu nokta bulutları var, ondan...

S.A.: Ama anladığım kadar total stationda hani, o scan data diyeceğim artık, taradığınız. Ona altlık olarak kullandınız değil mi?

U.A.: Tabi, total station verileri altlıktır, tabi.

S.A.: Mesela, benim sormak istediğim şu, sonuçta cyclone'in içinde bir algoritma var ve o algoritma sayesinde akında total station kullanmadan ya da target hedef kullanmadan scanleri...

U.A.: Doğru, ama, şey, laser scannerin girmediği yerler olmuş benim anladığım kadarıyla mesela.

S.A.: Nereleri mesele?

U.A.: Eee...

S.A.: Arkada kalan yerler mi, gölgede kalan yerler mi?

U.A.: Bilmiyorum ama böyle iç mekanlar iç hacimler vardı. Oralarda tam girmedeği görmediği noktalar olmuş. Mesela... Oralarda tam total station verilerinden yararlanıldı... Bir de tabi ben daha işe başlarken... Ben AutoCad kullanıyordum ama mesela iki boyutlu kullanıyordum, üçüncü boyuta hiç geçmemiştim, hiç bilmiyordum üçüncü boyutu. o yüzden total station verileriyle başlamak benim için iyi oldu. Total station laser scanner a göre nokta sayısı

S.A.: Daha az.

U.A.: Daha az tamam, binlerce ama... Şeydeki gibi laser scanner deki gibi milyonlarca noktayla uğraşmıyorsun. O yüzden biraz daha rahat çalışması. Üçüncü boyuta başlamak için ideal bence total station verileriyle başlamak.

S.A.: Benim takıldığım nokta şu. Mesela, geçen ay ben ocakta Mısır'a gittim. Mısır'da Ramses'in tapınağını laser scannerla taradık. Orada biz ne target kullandık, ne total station kullandık, hiçbirini kullanmadık ve Cyclone içindeki algoritmayı kullanarak...

U.A.: Referans noktalarını görebiliyorsanız, birleştirebilirsiniz ayrı ayrı okumalarda da. Öyle mi yaptınız?

S.A.: Evet, öyle yaptık. Öyle yaptık. Total station daha kesin veriler mi veriyor onu sormak istiyorum.

U.A.: Hayır canım değil. (güldü)

S.A.: Onu sormak istiyorum.

U.A.: Şey, ikisi de temel olarak aynı.

S.A.: Aynı. Hangisi daha kesin sonuçlar veriyor. Algoritmayı kullanmak?

U.A.: İkisi de kesin sonuçlar veriyor. (güldü) Hiç bir farkı yok. Şey yani 3D scanner yalnızca günümüzün yani daha yeni bir teknoloji, daha fazla nokta alıyor. Milyonlarca nokta alıyor. Total stationda daha az nokta alıyorsun. Ya da o kadar nokta almak için gereken zaman daha fazla.

S.A.: Kesin olan bir şey yok... Peki o zaman, total station'ı sadece (eee) scannerin tanımlayamadığı bölgelerde mi kullandınız?

U.A.: Noktalarda kullanılabilir. Bir de işte koordinat meseleleri var ya...

S.A.: Hmmm.

U.A.: Mesela bazı noktaların koordinatını tam olarak istiyorsan istorsan total station daha pratik.Yani... daha kısa sürede yapabileceğin işler var total station da. Noktasal işler mesela. Yüzey taramana gerek yoksa, total station la gidersin. Daha rahat. Daha kısa sürede çıkabilirsin mekandan. Birbirinden farklı. İşe göre hangi aleti kullanacağını seçmen gerekiyor. Seddülbahir' i şöyle yapmışlar. O, bildiğim kadarıyla. 3D scanneri bilinen koordinatların üzerine yerleştirmişler.

S.A.: Evet, Arzu'nun dediği o.

U.A.: Yani, şey, total station la okumalar yapılmış daha önce. Bir takım röper noktaları var. O röper noktalarının üzerine ya da koordinatları bilinen noktaların üzerine koymuşlar aleti.

S.A.: Evet.

U.A.: Hani biraz önce bahsediyordun ya, koymadan da yapabilirsin. Ama o zaman çok kesin noktalara ihtiyacın var. Bir köşe olabilir. Sivri bir köşe olabilir... Ne bileyim. Farklı taramalarda aynı noktaları seçebilmen gerekiyor. İki farklı mesela farklı tarama yaptın. Onların ortak noktası olması gerekiyor. Bilmiyorum kaç tane.

S.A.: Çakışan nokta olması gerekiyor. .

U.A.: Çakışan nokta. Çakışan ve iyi görebildiğin noktalar olması gerekiyor .

S.A.: 1/5'i kadar.

U.A.: Teorik olarak.

S.A.: Teorik olarak 1/5 i kadar.

U.A.: Çünkü ben de kullanmadan alanda şeyi.

S.A.: Çünkü Arzu, kesin olarak total station kullanılmalı...

U.A.: Total station eğer kullanılırsa bence çok tecrübem yok ama daha verimli olur gibi geliyor bana da.

S.A.: Anladım. Çünkü makaleleri okuyorum. Makalelerde total station kullanmadan sadece Cyclone' i kullanarak...

U.A.: Yapılabilir.

S.A.: Arasındaki farkı anlamaya çalışıyorum. Hangisi daha kesin sonuçlar verir.

U.A.: Ama şöyle bir şey var, eğer bir obje varsa, o obje rölatif olarak mesela laser scanner'la mesela bir kutu diyelim, 3 boyutlu bir kutu. Bunu... O kutuyu çok güzel çizebilirsin laser scanner' la. Yani bu hani dokulu bir kutu da olabilir, yani bir yüzey olabilir, bir bina olabilir. Bunu laser scanner çok güzel çizersin ama bu kutuyu dünyanın hangi noktasında bulunur. Bu kutu, onu cevaplandırmaz. Yani o yüzden

total station'ın koordinatları gerekir. O kutuyu Türkiye'nin içinde bu kutu nerededir? O kutuyu genel çerçevenin içine yerleştirmek için total station gerekiyor.

S.A.: Doğru.

U.A.: Bir takım koordinatlar gerekiyor ki bütünün içine koyabil şeyi... cismi.

S.A.: Georeference dedikleri değil mi o?

U.A.: Hmmm. Yani koordinatları gerekiyor onu da total stationla yapabilirsin

S.A.: Ama... O zaman GPS'e tanımladığında dünya üzerinde mi tanımlıyorsun?

U.A.: Yani, GPS... Orada x,y,z koordinatların var. Bunun herhangi bir kutunun herhangi bir noktasını... bir kaç noktasını tanımlayıp, bulup onu genel çerçevenin içine yerleştirme meselesi.

S.A.: O zaman GPS ne zaman devreye giriyor?

U.A.: GPS ne zaman devreye gidiyor? Mesela bir köye gittin hiç o hani haritacıların şeyleri olur ya böyle betondan. Öyle bir şey yok... Herhangi bir okuma yapamıyorsun total stationla, geri okuma yapamıyorsun. Yani... Bildiğin koordinat noktalarını göremiyorsan o zaman aletle gidersin GPS'le... Orada kullanabilirsin GPS'i. Orada GPS sana verir koordinatlarını. Yani yaklaşık olarak verir. Çünkü sen koordinatları kesin olan noktaları göremiyorsun. O köyde ya da neredeyse.

S.A.: Ama sonuçta total station da senin konumunu belirliyor.

U.A.: Tabi, tabi yani koordinat olarak tam olarak belirliyor.

S.A.: Kusura bakma ben...

U.A.: Yooo. (güldü) Ben de daha yeni öğreniyorum.

S.A.: Ben de Hiç bitmiyor ki öğrenmek... Durmadan öğreniyorum. O zaman mesela... Şeye geçelim, çizimleri nasıl yaptınız? Ne zorluklarla

U.A.: Ben şimdi kendi tecrübemden bahsederken, total station la başladım dedim. AutoCAD'de 3 boyutlu çizime hakim olmam total stationla çalışmamla başladı. Yani, başlangıç total stationla olmalı bence hemen laser scanner' a geçilmemeli.

S.A.: Evet.

U.A.: O hani kafada tam oturmalı, çökmeli olur ya, veya ya da neyse işte. O bilginin süzülmesi gerekiyor. Onu anlaması gerekiyor çizim yapacak... İnsanın total stationla çalışan insanın. Ondan sonra laser scannerla çalışırsa daha rahat eder.

S.A.: Şey de eee Seddülbahir'in farkı var zaten. Seddülbahir2de ben hiç içinde olmadım ama sonuçta herkes her konuya... dan biraz kapmış hani ama mesela yazın

U.A.: Tabi yani o multidiscipliner yaklaşım

S.A.: Her yerde. Amerika’da Özgürlük Heykeli projesinde çalışırken herkesin işi belliydi. O yüzde ben de mesela ben total station nasıl kullanılır bilmiyorum. İkisi de üniversite bazlı organizasyon hani proje diyelim ama ikisinin yaklaşımı farklı.

U.A.: Şöyle anlatayım mesela şöyle bir duvar olsun

S.A.: Hmmm hmmm

U.A.: Burada kesme taşlar olsun

S.A.: Hmmm

U.A.: Şey mesela burada verdiğin projelerde filan kurula verdiğin projelerde filan duvarın mesela kurul sende bu dokuyu istedi tamam mı? Kesme taşları nasıl çizebilirsin?

S.A.: Scan datanın üstüne koyarım.

U.A.: Yani bu şey yapabilirsin. Bu fotoğrafı, fotogrametri kullanabilirsin Bir fotoğrafı çekilir ondan sonra perspektifsiz bir hale getirilir. Ondan sonra fotoğrafı AutoCAD’e atarsın. Taşların üzerinden geçersin. Yollardan biri budur. İkinci bir yol aklıma gelen. Şey kurarsın total station’ı kurarsın duvarın önüne. Ondan sonra bu köşe noktalarından hep okumalar yaparsın. Ne kadar uzun süreceğini düşünebiliyor musun? Burada binlerce nokta var. Her taşın köşesinden almak günlerini alır. Tamam mı? Üçüncü bir yol geleneksel yöntemlerle olabilir. Buradan bir şakül sallandırırısın. Tamam mı? Ondan sonra buradaki şeyleri taşların köşelerini hep bu şakülle okursun. 10 cm 30 cm filan. Bir tane nivo aleti koyarsın. Kodlarını da okursun burada. Ondan sonra geleneksel yöntemlerle çizilmiş olur duvarı.

S.A.: Yine de en yeni yöntem de scan datayı kullanırsın

U.A.: Şimdi dördüncü yöntem de diyelim ki laser scanner. Aleti kurarım. Burada Yarım saat içerisinde bu duvarı tararım.

S.A.: Evet

U.A.: Ama burada aşağı yukarı 1 cm de bir benim tanımlamama göre bilmem kaç santimde bir o alet okuma yapabilir. Taşın üzerinden şuradaki taşın üzerinden bile binlerce okuma yapacak. Ve bu köşe noktaları ondan sonra birleşim derzler lazer scanner da çok rahat görebiliyorsun. Ondan sonra ne yapacaksın? Bunu Cloudworks AutoCAD şeyleri taşları çizeceksin.

S.A.: Ben kendi deneyimimi anlatayım. Stage 1... Kaide de taş. O kaidedeki taşları çizerken (eee) bu scan (eee) taradığımız datada sorunlar çıktı çünkü çok yoğun bir data.

U.A.: Ya işte çözünürlük çok önemli.

S.A.: Evet onu hep ayarladık.

U.A.: Yani o mesafesinden bile önemli. Bu duvara ne kadar mesafede olduğu.

S.A.: Evet hatta onun bir kısmını kapatıyorduk, sonra ikinci bölümünü açıyorduk.

U.A.: Tabi yani bir de çok şey o ağır o. Şeyler, lazer scanner verileri çok ağır olur. Hiç onu ben yapmam bile. Şu duvarın sağına doğru gitmeye çalışmam bile belki bir dakika filan aldığı oluyordu. Bilgisayar kilitleniyordu.

S.A.: Evet evet

U.A.: O yüzden lazer scanner'la çalışırken çok iyi bilgisayarlara ihtiyaç var.

S.A.: Evet

U.A.: O bilgisayar teknolojisi yetişemedi bence şeye veri işlemeye

S.A.: Amerika'da benim çalıştığım takımda bir mimar vardı ve onun işi bu altyapıyı sağlamaktı.

U.A.: Bilgisayar altyapısını?

S.A.: Evet. Ve çok iyiydi bu işte. Ve bütün bu altyapıyı o sağlıyordu. Her çöktüğünde biz ağlayarak ona gidiyorduk.

U.A.: Bizim de Seddülbahir'de işte çok iyi bilgisayarlar vardı. 1giga'lık...

S.A.: Bilgisayarın yanında bir de teknisyen lazım.

U.A.: Tabi, bir tane de 2 giga vardı ama o bile kaldırmıyordu. Geçen sene için bir giga çok iyiydi.

S.A.: Anladım.

U.A.: 2, 4 filan olabilir ama.

S.A.: Peki mesela, Arzu'nun dediği bir şey var. Bana şöyle yazdı (eee) lokal doku olarak taradık. Herhalde demek istediğiniz parça parça taradınız taşları.

U.A.: Tabi tabi.

S.A.: Peki bütün görünüşlerde bütün taşları gösterdiniz mi?

U.A.: Hımmm. Yani?

S.A.: Hani bütün taşları taradınız mı, yoksa tarayamıyoruz diye bir kısmını gösterip

U.A.: Ha, Seddülbahir'de alanda mı diyorsun. Nereler tarandı. Onu tam ben de bilmiyorum. Ya da taranmışsa bile bazı yerler işte senin o karşılaştığın sorun gibi... Çizmeye çok elverişli değildi.

S.A.: Evet evet.

U.A.: Yani o mesela derzler filan çok belli olmuyor. Tabi çizeceğin duvar da çok önemli. Yani eğer düzgün kesme taşsa çok rahat ama mesela şeyse tuğla mesela, ve tuğlalar deforme olmuşsa, bozulmuşsa, korozyona uğramışsa. Ondan sonra derz aralarında çok mesafe kalmamışsa böyle düzgün bir yüzey filan olmuşsa veya çok amorf bir şeyse...

S.A.: Hmmm.

U.A.: Böyle moloz taşlı filan amorf bir duvarsa bunu çizmek çok zordur. Ya böyle kesme taşlar da ya da çok düzgün tuğla bir örgüde gayet işe arıyor. Ya da mono blok bir heykelcik ya da bir duvar. Böyle şeylerde rahat. Ama iş biraz amorf bir yapıya geldiğinde çuvallıyor bence. (güldü)

S.A.: Ayrıca bence o sübjektif de oluyor.

U.A.: E tabi. AutoCAD'de çizen artık karar veriyor. Acaba bu taş mı, köşesi mi biraz karışıyor.

S.A.: Peki siz...şey... bütün cephelerdeki... kalenin cephelerindeki bütün taşları taradınız mı?

U.A.: Bilemiyorum.

S.A.: Onu bilmiyorsun. Önemli değil, onu Arzu'ya sorarım.

U.A.: Ben çalışırken şeyleri, o burçlar var ya? Burçların içlerini filan çiziyorduk. Biraz Duvar filan da çizmiştik. Duvarlardan da çizmiştik. Mesela o duvarlar kesme taştan daha rahat... Uçların içi biraz daha amorf. Dediğim gibi böyle moloz taş gibi.

S.A.: Evet.

U.A.: Deforme olmuş. İşte harç gelmiş kapatmış filan. O çok zorluyor yani.

S.A.: Evet.

U.A.: Uçlar zordu. Bir de şey de vardı. Hani, dairesel ya. Kesmek gerekiyor falan bunlar perspektife giriyor. Bayağı zorluyor.

S.A.: Evet.

U.A.: Karşıdan bakarmış gibi güzel gözüküyor. Buradan baktığın zaman minicik bir şey gözüküyor. Şöyle bir şey gözüküyor. Ama o taş normalde böyle büyük bir şey aslında. Bunu nasıl çizeceksin?

S.A.: O aynen o şekilde de vardı. Arkadan perspektiften gelenler...

U.A.: Yani bu açı daraldıkça, mesela burçları çizerken, hani şu göbek bölgesi diyeyim karşı taraftan gördüğün taşlar çok güzel. Lay lay lom çiziyorsun... Buradaki açı

daraldığı zaman taşlar da perspektife giriyor. O zaman karar vermek de çok zor oluyor. Yani bu taş nerede başlıyor nerede bitiyor. O yüzden buraları çizilemiyor belki de. Şu bölge.

S.A.: Hmmm...

U.A.: Biz hem böyle yaptık. Çizmeye çalıştık. Bir de üç boyutlu olarak da çizmeye çalıştık...

S.A.: Hmmm...

U.A.: AutoCad'de üç boyutlu olarak çizmeye de çalıştık buradaki taşları...Çok zor ama. Bayağı zor ama daha doğru...

S.A.: Hmmm. Anladım. O tip şeylerle biz de karşılaştık. Mesela taşlar... Bazısının çözünürlüğü çok iyiydi. Bazısının çözünürlüğü çok kötüydü. Bazısı hiç okunmuyordu. Orada zaten artık...

U.A.: Burada çizerken mesela burayı çizdin. Görüntüyü biraz döndürdün. Üç boyutlu da çizilebilir ama çok zor. Zaman çok istiyor.

S.A.: Evet doğru.

U.A.: Zahmetli iş yani...

S.A.: Doğru... Peki başka nelerle karşılaştın çizerken? Ne aklına geliyor mesela ofiste çizerken hani bilgisayarın çökmesi dışında?

U.A.: Bilgisayar sık sık çöküyordu. (Güldü)

S.A.: (Güldü) Biliyorum. Onu hep Arzu da söylüyor.

U.A.: Ondan sonra bilgisayarların kapasitesinden bahsettik. Hani hızlı bilgisayar olması çok şey avantaj.

S.A.: Neydi bilgisayarınız? Hatırlıyor musun modelini?

U.A.: Valla, bir giga byte dı. Bizim üç tane dört tane bilgisayar vardı. Üçü bir giga byte dı. Biri 2 gigabyte dı. Anladığım... Hatırladığım kadarıyla. Eğer o bir giga byte da çok ağır kalıyordu. Şeylere verilere...

S.A.: Peki bunlar çökünce kim toparlıyordu?

U.A.: Valla bir çocuk vardı, ismini hatırlamıyorum ama öğrencilerdendi...

S.A.: Biri geliyor toparlıyordu.

U.A.: Biri geliyordu, o anlıyordu.

S.A.: Hmmm.

U.A.: Aletleri o toparlamıştı. Zaten bilgisayarları da o, konfigürasyonunu da o ayarlamıştı.

S.A.: Peki neler çizdiniz mesela? Burçları çizmişsiniz ama, onun dışında kaç ölçekte çizdin? Neler, sadece burçları mı çizdin? Hatırlayabiliyor musun neler çizdiğini?

U.A.: İşte burçları çizdik, bir de şey kapalı hacimler şimdi hatırlamıyorum neredeydi ama

S.A.: Hmmm anladım

U.A.: Kapalı hacimler böyle tonozlu beşik tonozlu hacimler çizmiştik.

S.A.: Peki onları çizerken (eee)... Bence o önemli kimsenin de düşündüğünü sanmıyorum ama. Hem tararken çözünürlüğü hem tararken o çözünürlüğü ayarlamak önemli. Mesela 1/10 çizeceksen farklı bir çözünürlük, ama 1/20 çizeceksen farklı bir çözünürlük. Hani onu belirlemiş miydiniz?

U.A.: Zannetmiyorum. O belirlenmemiş.

S.A.: O zaman...

U.A.: Bu şey, bu proje ilk defa yani Türkiye’de bildiğim kadarıyla ilk.

S.A.: Evet, bu ölçekte ilk defa. Evet, çok büyük bir proje.

U.A.: O yüzden çok normal yani...

S.A.: Hmmm... Peki... Sence yararlı mı?

U.A.: Bora, mesela, o çizim şeyi yoktu herhalde bu projeyle bayağı kazandı.

S.A.: Evet, evet...

U.A.: Çizime çok hakim değildi. Belki şimdi daha iyidir. O da... İşin o tarafı konusunda çok bilgili olmadığından belki tararken... Belki daha yüksek çözünürlükte tarayabilirdi bazı yerleri. Bazı yerleri de daha az çözünürlükte mesela tabi. O da tam belki o zaman yeni öğreniyordu o kısmını...

S.A.: Evet...Peki...

U.A.: O dediğin mesele yani. Daha sık belki bazı yerler taranabilirdi... Taranabilir miydi onu da bilmiyorum... Belki de en sık çözünürlükle taradı bilemiyorum ki.

S.A.: Hmmm. Doğru. Evet. Onu Arzu’ya da sormam lazım... Peki gerçek...

U.A.: Mesela ışık şeyde...Karşılaşılan problemlerden biri. O Lazer scanner mesela... Şeyleri... O noktalar filan... Renklerle filan geliyor ya? Yani, yalnızca koordinatlar yok o şeyin içinde... Noktaların içinde. Renkler de var içinde. Işık çok etkiliyor...

Mesela bu hani duvar dedik ya? Tuğla mesela bir duvarı scan ediyorsun. O ışık çok önemli... Işık eğer uygunsa o derzleri, taşları filan tuğlaları görmen çok rahat. Çok daha rahat. Ama karanlık bir ortamda ise eğer...

S.A.: Ama laser scanner?

U.A.: O burçlarda mesela burçlarda bayağı zordu. Karanlıktı çünkü içerisi. Veya gece mesela scan yapılmış ya da hava kararırken scan edilmiş.

S.A.: Ama kullanıcı için onu bulmak zor. Sonuçta laser scanner aynı şekilde tarıyor.

U.A.: Tarıyor ama sana karanlık bir görüntü veriyor mesela. O zaman hiç bir şey yapamıyorsun ki...

S.A.: Hmmm.

U.A.: Veya da işte yapay ışıklandırma yapılmış burçta. Mesela ışık verilmiş Bir bölüm parlıyor. Ayna gibi parlıyor. Hiçbir şey göremiyorsun. Diğer bölümde mesela siyah. Işık olmadığı için... O da problemlerden biri... Yapay mesela ışık verilecekse çok böyle homojen ışık verilmesi gerekiyor anladığım kadarıyla mesela. Burçta yapılıyorsa zor... Bütün her yeri homojen ışıklandırmak gerekiyor veya işte gündüz. Ama burç zaten burç kapalı. Fazla ışıklığı yok. Karanlık her zaman için.

S.A.: Çünkü laser scanner sonuçta o laser ışınının gidip geldiği zamanı

U.A.: Evet yani gece de okuyabilir.

S.A.: Evet gece de okuyabilir. Ama o zaman

U.A.: Sonuçta reflekte olacağı bir yüzey

S.A.: Anladım. Senin dediğin nokta, bilgisayara gelen data o anda gelen data karanlık olduğu için kullanıcı ne olduğunu seçemiyor.

U.A.: Sonuçta sen AutoCAD'de bu taşları çizerken renklerinden de hani...

S.A.: Evet.

U.A.: Burada mesela daha arkada bir yüzey varsa, onun rengi daha farklı oluyor. Önde mesela... Bir yüzey varsa, onun rengi daha farklı oluyor. Sen burada derz mesela çizerken ondan o renkten... de anlayabiliyorsun nereden geçmen gerektiğini.

S.A.: O zaman çizerken bu bayağı fark ettirdi.

U.A.: E tabi renk olayı çok önemli. Işık.

S.A.: Gece... Gece taranan obje...mekan...

U.A.: Gündüz taranan çok farklı mesela. Gündüz taranan açık mekan mesela daha rahat o açıdan bakıldığında.

S.A.: Renk... Işık yüzünden

U.A.: Işık

S.A.: O zaman aslında...

U.A.: Işık önemli yani.

S.A.: Anladım. O zaman hani tamam... Teoride karanlıkta

U.A.: Yapılabilir ama

S.A.: Yapılabilir ama

U.A.: İyi bir ışıklandırma lazım

S.A.: Teoriyle pratik uyuşmuyor o zaman... Peki laser scanner gerçekten gerekli mi?

U.A.: Tabi gerekli. (güldü)

S.A.: Gerçekten hani yapılmalı mı? Mesela bu taşı... Hani bu duvar üzerinde konuşurken bunun için dört tane... yöntem sen saydın... Geleneksel... o da olabilir...

U.A.: Geleneksel yöntemler, total stationla işte o uzun şey, fotogrametri olabilir, ya da laser scanner.

S.A.: Ama mesela bu baz alındığında fotogrametri de kullanılabilirdi?

U.A.: Fotogrametri de ama fotogrametri kullanmak için o yüzeyin çok ideal olması gerekiyor. İşte fotoğrafı çekeceksin ya? Belli bir mesafe olması gerekiyor. Mesela dar bir sokakta mesela tarihi bir binadan bahsedersen. Daracık bir sokak burada da tarihi bir bina var. Tamam mı? Sen buradan fotoğrafı çektiğin zaman... Yani fotoğrafın belli bir mesafeden çekilmesi gerekiyor. Tam perspektifsiz bir fotoğraf elde edebilmek için. Yani sokağın geniş olması gerekiyor. Böyle bir durumda fotogrametri işe yaramaz.

S.A.: Fotogrametri için mesafe önemli mi?

U.A.: Ya fotoğraf çekerken tabi mesafe, çok dar bir yerden fotoğrafı çekersen parçalı bir şey olur. Hepsini birleştirmen gerekecek.

S.A.: Benim fotogrametri hakkında pek bir bilgim yok ama... Fotogrametri hani... Şeyi... perspektife girmiş fotoğrafı düzleştirmiyor mu?

U.A.: Evet doğru ama şey elinde... Sağlam bir fotoğraf olması gerekiyor.

S.A.: Anladım. O zaman fotoğrafın da olabildiğince bakış açısının düzgün olması gerekiyor.

U.A.: Fotoğrafi düzgün çekmen gerekiyor. Buradan bir sürü fotoğraf çekeceksin ya farklı açılardan. Eğer bu sokak darsa, sen binanın hepsini kadrajın içine alamıyorsun ki.

S.A.: Doğru... Doğru laser scanner de öyle bir şey.

U.A.: Mesela bu binayı üç fotoğrafta belki aynı açıdan çekiyorsun ama, yan yana üç tane çekip onları birleştirmen çok uzun iş.

S.A.: Peki fotogrametri benim bildiğim kullanılmış daha önce.

U.A.: Kullanılıyor tabi ki.

S.A.: Şeyde, Seddülbahir’de kullanılmış daha önce.

U.A.: Onu, o verileri hiç görmedim ben.

S.A.: Ama işe yaramamış herhalde.

U.A.: Mesela o burçlarda filan çok zor. Bir de fotogrametri biraz daha... Benim hani kendi kişisel... İzlenimlerinden biraz daha düzgün yüzeylerde daha iyi işe yarıyor.

S.A.: Daha rijid yüzeylerde. Taşkışla mesela?

U.A.: Mesela bir bina cephesi, çok hani üçüncü boyuta kaçmıyorsa, düzgün bir yüzeyse panel gibi çok güzel işe yarayabilir. Fotoğrafi da böyle biraz daha mesafeli bir yerden çekebiliyorsan uzaktan çok güzel işe yarayabilir. Ama üçüncü boyut girerse, işte binanın bir tarafı önde bir tarafı arkada filan... Üçüncü boyut girdiğinde biraz çuvallıyor gibi geldi bana.

S.A.: Ki özellikle Seddülbahir gibi bir kalede deformasyon var taşlarda.

U.A.: O burçlar tamamen dairesel, çok zor orada dairesel...

S.A.: Ki taşlarda da deformasyon var.

U.A.: Tabi.

S.A.: O yüzden işe yaramıyor belki de. Taşların kendi zaten üç boyutlu. Artı taşların kendisi ideal değil.

U.A.: Çok ideal, mesela bir... kabartma filan ufak bşir filan. Belki hani işe yarayabilir... veya işte güzel bir cephe filan...

S.A.: Hmmm. Peki....

U.A.: Sur duvarı da o düz kısımlarının yapabilirsin duvarın. Ama o burçta herhalde biraz zor. Düz duvarlarda yapılabilir. Mesafe de varsa fotoğraf da iyi çekemiyorsan yapabilirsin.

S.A. Peki... Biliyorum (eee) sonuçta o... Yani rölöve çıkarılırken o alan çalışmasında bulunmamışsın ama... Laser scanner mesela bütün topografyayı taramamış. Tekrar ben total station'a dönüyorum da. Total station bütün zaten alanı taramış, ayrıca (eee) bütün burçları, bütün kaleyi taramış. Laser scanner da bütün kapalı alanları taramış, burçları taramış, topografyanın bir kısmını taramış. Niye topografyanın hepsini taramadılar laser scanner'la. Zamanları mı bitti?

U.A.: Belki zamanları yoktu...

S.A.: Arzu'yla konuşmadım...

U.A.: Belki zamanları yoktu. Galiba zamanları yoktu.

S.A.: bana da öyle geldi.

U.A.: Yani Türkiye'de galiba iki tane üç tane alet var.

S.A.: Almış belediye. Yedi tane almış.

U.A.: Öyle mi? Abartmışlar. (güldü)

S.A.: (güldü) Kullanmayı bilen yok, alıp alıp istiflemişler. Herkese iş düşecek.

U.A.: ...Belki Bora'yı filan çağırdılar. Seddülbahir'de çalışırken. Belki başka bir iş çıktı. O zaman çünkü alet yoktu. Leica'nın bir tane ya da iki tane aleti vardı. Belki Bora'yı çağırdılar bir iş için. Bora da belki ayrılmak zorunda kaldı... Kesitlerde mesela çok rahat scanner'la çalışmak. Kesitler çok rahat çıktı.

S.A.: Evet o kesitler?

U.A.: (güldü)

S.A.: (güldü) Kesitleri nasıl aldın?

U.A.: Kesitleri işte şey mesela... (çizerek anlatıyor) Şöyle bir mekan diyelim tamam mı?... Şey yani bunun bütün verileri vardı. Burçlarda mesela. Laser scanner'la alınmış. Ben yalnızca diyordum ki şuradan bana bir dilim ver. O bütün dilimi veriyordu. Şöyle bir şey çıkıyordu. Aynen bunun gibi çıkıyordu. Ondan sonra bunun üzerinden AutoCAD'de üstünde geçiyordum. Tabi bu kadar ideal değildi, taşlar filan. Çok güzel işe yarıyor mesela kesitlerde gerçekten.

S.A.: Ama biz kesitlerde mesela (eee) çizerken çünkü biz ofis çalışmasına başladığımızda biz elimizdeki normal aldığımız geleneksel yöntemlerle aldığımız noktalarla rölöve projesine başladık. Bir yandan. O yüzden zaten... O... İşte scan data diyeceğim... Onu zaten o eleman vardı birleştiren, o onları birleştirirken biz zaten bildiğimiz yöntemlerle plan ve kesitleri çıkarmıştık. O yüzden ben hiç scan datadan kesit çıkaramadım çünkü zaten biz kesiti çıkarmıştık.

U.A.: Mesela şöyle bir şey söyleyeyim. Mesela bu total station'la bu kesit çıkarılır. Çıkarılır çıkarılmasına ama mesela şu yüzeyden bahsedersen mesela şurada bir tane

taş var. Derz var diyelim. Başka bir taş var. Ondan sonra bu taş bozuluyor. Burada bir derz var.

S.A.: Ama total stationla bu çok zor.

U.A.: Eğer ben total stationla alsaydım, burada total station kursaydım, buradaki bütün şeyleri almam detayları gerekiyordu. Laser scanner la bir anda hemen tıp diye çizebiliyorsun. Çok pratik yani... Bu noktaları almak mümkün değildi total stationla yani bu kadar nokta almak... Bu hassasiyeti veriyor aslında, bu güzel bir şey...

S.A.: Evet... Mesela benim bahsetmiştim ocakta Mısır'a gitmiştim. Orada (eee) tapınağı taradık beraber ve hani biz orada taradığımız datayı verdik gruba. Onlar registration birleştireceklerdi. Ne total station istediler ne işte target istediler. Sadece datayı verin dediler ve yapacakları şey müthiş. Ama ne kadar zaman alır hiç bilmiyorum. Bence onlar da zaten önünü göremediler. O... Biz bütün bir arkeolojik alanı taradık. Tapınak ayrıca bütün taşlar yerlere dökülmüş. Afrodisyas gibi ya da Sard gibi ve onlar bizim taradığımız, ama taşlar savrulmuş, her yerde üst üste yığılmış... O taradığımız taşları üst üste koyacaklar... Hani...

U.A.: Ha anladım... Şey restitüsyon çalışması mı yapacaklar? Orada mesela... Bir tane diyelim şey... Kolon diyelim. Bu yıkılmış. Parçaları duruyor mesela bu şekilde.

S.A.: Sadece kolon değil. Bütün bir arkeolojik alandan bahsediyoruz.

U.A.: Ben hem. Bu sadece bir örnek. Bu taşları üst üste koyacaklar restitüsyon yapacaklar.

S.A.: O taradığımız... Çünkü artık taşların taranmış verileri var ellerinde ve onların üst üste koyacaklar.

U.A.: Vay anasını. Bayağı zor iş.

S.A.: Çok zor iş. Ne kadar zamanda yapacaklar bilmiyorum ki. Hani ne total station istediler. Siz dediler tarayın o iki iskele arasında

U.A. Bayağı zor, ben pek bilmiyorum.

S.A.: Ben de bilmiyorum.

U.A.: Yere düşen parçaların hepsi üç boyutlu çizilmeleri gerekiyor ki, bunu alacak sonra üç boyutlu üst üste koyacaklar.

S.A.: Bilmiyorum. Hatta registration'da da biz scan' leri üst üste koyarız dediler. Hiç bilmiyorum paraları çok.

U.A.: (güldü)

S.A.: Hem kendileri birleştirecekler o taradığımız alanları üst üste koyarak, ki anladığım kadarıyla şimdi seninle konuşmam üzerine hem total station'la bu yapılsaydı bu çok daha kolay olurdu. Hem de bu taşları teker teker tanımlayıp, ki ben

alandan Seddülbahir Kalesi'nin darmadağın olduğunu düşün onarlı teker teker üst üste koyacaklar.

U.A.: Bence teorik yani hiç pratik değil. Mümkün değil.

S.A.: evet bir kere tabi taş yığınının da nasıl nirengi alınır bilmiyorum. O da ayrı bir konu zaten. O yüzden sordum ben... yani benim soracağım ana başlıklar bunlardı... Söylemek istediğin... sen nasıl bir proje, memnun kaldın mı?

U.A.: Memnun kaldım canım. Ben hiç bir fikrim yoktu. Mesela AutoCAD' de üç boyutlu çizmeyi öğrendim bir şekilde... Ondan sonra laser scanner la tanıştım bir şekilde...

S.A.: O müthiş, o çok önemli mesela... Mesela ben inşaat mühendisiyim dedin. Hani mesela sence o inşaat mühendisinin projedeki yeri neydi ya da bir mimarın yeri neydi?

U.A.: Ama ben orada mühendis olarak çalışmadım sonuçta. Ben orada taşıyıcı sistemi filan incelemedim hiç.

S.A.: Ama olsun yine de bir fikrin vardır.

U.A.: ben orada çalışırken işin mimari kısmıyla uğraştığım için.

S.A.: O zaman bir mimarın yeri ne böyle bir projede.

U.A.: Hmmm. (güldü) Bilmem.

S.A.: Arzu'dan biraz. Arzu'nun anlattıklarından biraz ipucu vereyim mi?

U.A.: Yani orada işte mimar günümüzün tekniklerini yani bir şekilde kendini güncellemesi gerekiyor.

S.A.: Yani her şeyi bilmesi gerekiyor artık. Sanki bana bir arabulucu gibi geliyor o projede... hem güncel teknikleri biliyor. Hem mimarlık eğitimi var... Biraz daha arabulucu gibi orada...

U.A.:Ama hani sonuçta proje teslim edildi ya kurula. O mimarlık işi. Mimar olmadan o proje verilemez...

S.A.: Evet...

U.A.: Kurula verilen proje bakıldığında orada mimar çok önemli

S.A.: Zaten Gülsün Tanyeli danışmandı.

U.A.: Danışmandı. Ama işin tarihsel literatür taraması tarihsel tarafı. O da Lucienne' nin mesela yapabileceği iş bence... veya alanda işte bu laser scanner in kullanımı, o haritacıların yapabileceği iş.

S.A.: Ama artık mimarlar da giriyor bu işin içine

U.A.: Giriyorlar

S.A.: İnşaat mühendisleri de giriyor işin içine... sanki bana öyle geliyor ki o mimarın zaten inşaat mühendisi olmana rağmen biliyordur mimar inşaat mühendisi arasındaki ilişkiyi. Verilmiş bazı nosyonlar vardır. Sanki bildiğimiz mimarlık başka bir yola gidiyor gibi geliyor bana. Mesela şu anda laser scanner' dan bahsediyoruz. Üç boyutlu nasıl çizilir ne yapmak istiyoruz. Hani mimarı o projedeki yerinden bahsediyoruz. Ama aynı zamanda mimar anıtlar kuruluna proje de teslim etmiş.

U.A.: Ya işte işe göre çok değişiyor mimarın yeri.

S.A.: Yeri biraz değişiyor galiba.

U.A.: Çok değişiyor. Ama yani mimar mimardır. O tasarımı yaratıcılığın olması gerekiyor. Onun üzerinde spesifik bir şeydir. Mesela laser scanner... mimar oluyorsun ilk başta hani o kapasitedesin. Ondan sonra iki üç sene bu konuda uzmanlaşıyorsun.

S.A.: Evet, zaten mimarların bu konuya el atması lazım bence kesinlikle.

U.A.: Ya sonuçta o üç boyutlu bakış filan diyoruz ya biz. Canlandırma...

S.A.: Mimarlık terbiyesiyle gelen bir şey

U.A.: O eğer çok iyiye zaten bunları çok kolay kaparsın... Başka mühendislikten gelen biraz daha zor anlar yani. O çizim rölöve filan, laser scanner. Ama inşaat mühendisliğinde de teknik resimler var.

S.A.: Bir altyapı veriliyor

U.A.: Yapı bazında uğraşıyorsun. Biraz uğraşıyorsun. Canlanıyor kafanda... Yakın yani. İnşaat mühendisi.

S.A.: Evet inşaat mühendisi de olabilir o konuda. Ben ofise geldiğimde (eee) jeodezi mühendisi vardı. Jeofizik mühendisi kızlar vardı.

U.A.: İşte jeodezi mühendis, de çizim tarafı şey kalıyor

S.A.: Daha eksik mi kalıyor?

U.A.: Biraz eksik tabi. Ama normal yani. Onların görevi olmadığı için hani... işte o çezecek ancak... anlayabilir... yani nasıl çezeceğini biliyorsan ona göre ölçü alırsın yani...

S.A.: Evet evet

U.A.: Yani jeodezici haritacı ölçü alırken onu

S.A.: Ölçü almak için alıyor. Onu alması gerektiği için

U.A.: Haha. Mesela Haritacılar, onların da çok uzmanlık alanları vardır. Bazıları kara yollarında çalışıyor bazısı garaj. Çok ayrı spesifik şeyleri var onarılın da. Mesela yapıyla uğraşmak onlar için ayrı özel bir alan. Hepsi bilmiyor yapıyla çalışmayı. Ya da nokta hangi koordinatı alması gerektiğini bilmiyor. Çalışa çalışa öğreniyor. Ekstra bir de nasıl çizeceğini biliyorsa daha da güzel alır.

S.A.: Benim soracaklarım bu kadar çok teşekkürler.

Appendix E

Correspondence with Bora Sayın²²¹

Date: Thu, 17 May 2007
From: "Bora Sayın" <bora.sayin@gmail.com>
To: "Serra Akboy" <serraakboy@yahoo.com>
Subject: Re: seddülbahir

...

1) Türkiye'deki "laser scanner projeleri" hakkında bilgi verebilir misin?

Türkiye'de farklı markalarda yaklaşık 20 adet lazer scanner bulunmakta. Bunlardan ucu devlet üniversitelerinde (Yıldız, Selçuk ve İnönü) diğerleri ise özel sektör şirketlerindedir. Üniversiteler bu cihazları öğretim amaçlı kullanmaktadırlar, ancak henüz bu cihazlarla yapılmış ciddi bir akademik çalışma bulunmamaktadır. Öte yandan özel sektördeki en büyük kullanıcı İstanbul Büyük Şehir Belediye'sine bağlı Bimtaş şirkettir. Bimtaş 2005 yılından bu yana Eminönü bölgesi mimari rölöve ve restorasyon projeleri için bu teknolojiyi kullanmaktadır, şirket bünyesinde konu üzerinde birçok mühendis ve mimar deneyim kazanmıştır. Bimtaş'ta toplam 9 adet scanner bulunmaktadır.

Ayrıca satıcı firmaların kendilerine ait demo amaçlı lazer scanner'leri vardır. Bunlardan sadece Sistem AŞ-Leica firması uygulama hizmeti de vermektedir. Bu zamana kadar Sistem AŞ bünyesinde yapılan çalışmaların bazıları şöyledir: Seddülbahir Projesi, Kültür Bakanlığı Kars Ani Antik Şehri Rölöve Projesi, Global Heritage Fund Kars Ani Lazer Tarama Projesi, Marmaray Yenikapı 1000 Yıllık Gemi Batığı Tarama Projesi, Eminönü Vefa Kütüphanesi Rölöve Projesi.

2) "Laser scanner metodolojisi" hakkında neler düşünüyorsunuz? "Laser scanner" in ilk endüstri projelerinde kullanılmaya başlandığı düşünülürse (mühendislerin, fabrikaları tarayarak hatalı parçaları "scan data"dan bakarak düzeltmeleri veya o parçaları üretmeleri gibi) acaba mühendisler laser scanner'i kullanırken nasıl bir metodoloji izliyorlardı?

Lazer scanner teknolojisi mühendislikte QA/QC²²² ve "as-built" işlemleri için kullanılmakta. Bu sayede inşa ya da imal edilen objelerin üretim sonrası ya da üretim esnasındaki durumu ve üretim sonrasında üretim kalitesi tespit edilmektedir. Lazer scanner teknolojisi aslında ilk olarak bu tip uygulamalarda kullanmak üzere geliştirilmiştir. Halen birçok sektörde bu teknolojinin nimetlerinden

²²¹ Geodesy team, the Seddülbahir Project

²²² Quality Assurance / Quality Control

faaydalanılmaktadır. Yksek hassasiyet isteyen uygulamalarda insan kaynaklı hataları elemek iin de bu teknoloji kullanılmaktadır.

3)Lucienne, Rahmi hoca ve Arzu, Seddlbahir hakkında beni olduka bilgilendirdi. Ama yine de sormak istiyorum, Seddlbahir’de sahada alışırken nelerle karşılaştın? Ne tr zorluklar ektin?

Seddlbahir’de aslında en fazla zorlandığımız konu zamandı, bu yzden yoğun ve uzun saatler alıştık. Lazer tarama alışmaları iin o zamanlarda fazla deneyimli olmadığımız iin ne kadar surede bitirebileceğimizi tam kestirememiştik ama sonuta iki farklı zamanda bitirme sansımız oldu. Zorluk olarak ayrıca scanner bataryalarının şarj edilmesinden bahsedebilirim. Bataryalar maalesef ok uzun mrl değıldi, bu yzden bir kişinin gidip bataryaları şarj etmesi gerekiyordu, aynı zamanda lap top bataryası da abuk bittiğinden bazen alışmayı btn şarjlar tamamlanana kadar durdurmak zorunda kalıyorduk.

Appendix F

Correspondence with Arzu Özsavaşçı²²³

Date: Tue, 27 Mar 2007
From: "A. Ozsavasci" <aozsavasci@yahoo.com>
Re: seddulbahir
To: "Serra Akboy" <serraakboy@yahoo.com>

... bildiğin gibi çok disiplinli bir ortamda her disiplin kendi bakış açısı ile çalışıyor, ve her ne kadar sayısal kökenli olsak da mühendislerden farklı bir yaklaşımımız var. bir mimari urun ortaya çıkarmak için, belgelemenin basından itibaren proje yönetiminin ortaklaşa olması gerektiği kanısındayım. sadece belgeleme yapmak ya da sadece post process yapmak değil olay, dokümantasyonun basındaki kurguyu, sürerken arşiv ve kataloglama düzenini, datanın ne için kullanılacağını bilmek, kontrol etmek ve süreç bitince bir sonraki kullanıma kadar ise yarar bir şekilde saklamak gerekiyor. bu süreç basından sonuna bir tasarımdır ve bunu ilerde kullanacak olan kişi ancak tasarlayabilir, ya da en azından yönergelerini yazıp bir sonraki mimara iletebilir. eskiden kağıtlar tozlu raflarda kayboluyordu, şimdi ise dijital veri hard disk içinde, veri ne kadar detaylıysa, veri kaybı da o kadar çok ve hayati önemde olur. bütün bu öngörülerini yapmak ve basından bu süreci böyle kurgulamak gerekli. mesela ben en basından beri çok sistemli tuttuğum için arşivleme olayını hiçbir bilgi kaybolmadı, 2000 yılından beri yapılan her çalışma arşivlendi, yine çalışmanın sonuna doğru uç bilgisayar da çoktu, ama sistemli yedekleme yaptığımız için hiç bir şey kaybolmadı. bu anlattıklarım sanırım senin sorduğun üçüncü soruyu cevaplıyor. bence her ölçekte herhangi bir “mimari” koruma projesinde eğer disiplinler arası çalışma söz konusuysa, proje yönetimi grubunda kesin bir mimar olmalıdır, hatta projenin mimariyle ilgili tüm adımlarını yöneten kişi kesinlikle mimar olmalıdır. Seddulbahir projesinde projenin mimari kısmının yöneticisi bendim, arkeolojide Carolyn, tarihte Lucienne, jeodezide de rahmi hoca vardı, ama ben bütün sürecin basından beri arkeolojik çalışmalar sürecinde mimari destek verdim, tarih ekibiyle restitüsyon bilgilerinde koordinasyon yaptım, jeodezi ekibini arazi çalışmasından post process dahil yönetip denetledim. sonuçta bütün adımlardan haberim oldu, ve yapılan herşey anında denetlendi, yanlış yapılan düzeltildi, bu kadar koordinasyonlu çalışabilmek çok büyük bir lükstü tabi akademik bile olsa her projede böyle imkanlar zor bulunur. mesela çok önemli bir olcum hatası ilk aylarda hemen farkına varılıp düzeltildi, aynı mekanda hem jeodezi hem de mimari ekibin çalışması çok önemliydi. benim ekibimde basından sonuna kadar Deniz, Nurdan, Umut, Selin ve İrem yer aldı, ben çok fazla detay çizim yapmadım, proje yönetimi ve diğer ekiplerle koordinasyonu yaptım detayları diğer arkadaşlar kotardı. burada önemli olan iki şey var, birincisi herseli gören, anında iletişim kuran ve yöneten bir proje lideri çok önemli, inter disiplinler çalışmalarda her disiplin kendi dilini konuşur, bu farklı disiplinleri aynı dilden konuşturmak bence mimarinin ismi, bunun sebebi de hem sözel hem de sayısal yönden projeye hakim olmak. ikincisi ise gelen verileri doğru değerlendirebilecek ve

²²³ Supervisor of the architectural team, the Seddulbahir Project.

gerekli alıřmaları yapabilecek donanımda bir ekip, bence bu ekibin iinde farklı disiplinler olabilir, srekli alıřma ortamında, ki biz de oėunlukla byle alıřtık ofiste, bu anında iletiřim kurmak iin ok gerekli.

Olayın dijital dokmantasyon acısından syle de bir tarafı var. aslında Seddulbahir’de lazer scanner’i kullanmak sebebi akademik olan bir karardı, yapmak istediėimiz Trkiye’de hi yapılmamıř bir dokmantasyon yntemini bir akademik projede test etmekte. sunu aıka syleyeyim ki eėer proje niversite kaynaklı olmasaydı bu kesinlikle yapılamazdı. ben en basta projenin alan alıřması iin iki ay, toplam proje surecini 18 ay olarak hesaplamıřtım. normalde niversite projesi dıřında hibir projede bu kadar uzun bir sureye sahip olma lks yoktur. lazer scannerin alanda alıřması kısa surdu ama elimizde milyarlarca nokta ile yksek konfigrasyonlu bile olsa tam kapasite alıřamayan bilgisayarlarla alıřmak ok zorlayıcıydı... nitekim, bilgisayarlar kilitlendi, ok yavaş izim yapıldı ve sonunda bilgisayarların hepsi oktu. bunu en basta ngremedik, ama ihaleyle almıř olsaydık projeyi batmıřtık. daha sonra piyasada lazer scannerle alıřmak isteyip vazgeenleri duydum, hem pahalı olması hem de post process’in ok zorlaması sebebiyle. biz mesela btn alanı hem lazer scannerle hem de total station ile taradık, bu her ikisinin de hatalarını grmemize sebep oldu, mesela lazer scannerde olan hataları ve bořlukları oėunlukla total stationla giderdik. lazer scanner’i tam randımanlı program buglarından ve konfigrasyon yetmezliėinden tr kullanamadık, belki yeni teknolojik geliřmelerle kullanabileceėiz, bunları boraya da, Leica’nin İtalya distribtrne de anlattıėımda aynı řeyi sylediler. ama bana sorarsan oėu yerde lazer scannerden cephe izmek ya da almak yerine fotogrametri ile de tamamlayabilirdik. ya da sunumlarda farklı bir takım gsterimler yapabilirdik, mesela lazer scannerden ok detaylı 1/20 cephele almak istedik, bu sefer de plotter kaldırmadı, biz de yapabildiėimizi sunduk. ayrıca cyclone datasını, cloudworks dıřında rhino ya da benzeri bir programda nurbs olarak modellemek ok ise yarayacak, ben bunları arařtırıyorum bir yandan. bu arada lazer scanner verisinden izim yapan ok da fazla deėil, yeni oėalıyor, ben Floransa’da paperi sunduėımda bana bu izimleri nasıl yaptınız diye sordular, nk onların elinde bir suru taradıkları bina modeli vardı, ama izime dkmemiřlerdi.

lazer scanner ile alan alıřmasında, diėer aletlerde olduėu gibi biz de ok sistematik alıřtık, bora kendi ekibi ile alıřırken total station ile ayrı bir ekip de alıřıyordu, btn blmlerin plan, kesit ve grnř eskizleri yapıldı ve detay islendi, bunlar daha sonra elimizde lazer scanner yzeyleri ve fotoėraflar olsa bile ok isimize yaradı. alanda her yer en kk bir duvar parasına kadar fotoėraflandı, albmlendi, bu fotoėraflar da ok isimize yaradı, zellikle aynı cephenin farklı ışıklarda ve gnn farklı zamanlarında ekilmiř fotoėrafları. alan alıřmasında ok fazla sorunla karřılařmadık, genel sorun aleti tařımak, zemin oynamaları ve aėalardı, onun dıřında azami kontrol ve zenle kaza olmadan iki ayı tamamladık, sadece bir kiřiye yılan saldırdı :) bu alıřmaların sonucunda elimizde drt klasr eskiz, 100lerce megabayt fotoėraf, data ve bilgi vardı. total station lmlerinde ok az hata ıktı, aslında btn olcum temel olarak total station zerine oturtuldu. lazer scanner lmnde eksik alanlar vardı, mesela topografyayı tarayamadık, tarayabilseydik ok iyi olacaktı, arazinin bazı blmleri eksik kaldı. btn duvarlar ve kulelerin ii tarandı, btn lmler kendi iinde doėruydı, birleřimlerinde kayıklıklar vardı ama biz onları total station datasını kullanarak dzelttik. ofis alıřmasına gelindiėinde total station datası

ile mekanların genel outlineini kurup daha sonra lazer scanner verisi düzenlendiğinde detaylı çizimlere geçebildik. önce bütün planları oturttuk, daha sonra kesitler ve en son da görünüşleri tamamladık, görünüşlere lazer scanner verisinden cephe taslarını işlemek çok ama çok uzun surdu, bunu kısaltmak için islenecek alanları azalttık, lokal doku olarak isledik çoğu yerde, bazı yerlerde fotoğraftan yararlandık daha hızlı oldu. proje bir sene daha sürseydi hepsi biterdi :) kısacası çok fazla veri olması bizim isimiz kolaylaştırmadı daha da karmaşık hale getirdi, bu teknolojinin ilerlemesi ancak işletim sistemlerinin ve ekran kartlarının gelişmesi ile mümkün olabilecek, ayrıca bana efektif gelen bir yöntem ve veri başka birine efektif gelmeyebiliyor, bütçe ve zaman açısından.

sadece rölövenin hazırlanması 12 ay surdu, restitüsyon ve restorasyona çok az vaktimiz kaldı, aslında önemli olan da burada rölövenin kotarılmasıydı, keşke sadece rölöve olabilseymiş projenin konusu. restitüsyon ve restorasyon kendi içlerinde çok detaylı ve uzun süreçler...

Appendix G

Correspondence with Elizabeth I. Louden²²⁴

Subject: DSOL

Date: Wed, 25 April 2007

From: "Louden, Elizabeth" <ELIZABETH.LOUDEN@ttu.edu>

To: "Serra Akboy" <serraakboy@yahoo.com>

...

...I would say that the general method was to follow established practices of overall target placement for adequate overlap (20%), establish sightlines to the maximum amount of targets from the scanner positions, and work methodically around the island and buildings to ensure good coverage.

...Plan what the owner wants, Plan what you can actually provide, Plan on site and workers capabilities, Scan to get as much as you can, but always aware of 'too much data', replan and reorganize, register to look for gaps as you go, communicate constantly with the scan team. Plan the output very carefully and the process of creating the drawings. Train and retrain, constantly evaluate your data.

How should be the general scheme and the management scheme? Thus how do you place an architect in these digital surveying technologies?

An architect is an excellent manager and visionary of all the potential from scan data, in particular for quantities, material estimates, visualization, but without the technical background and time to learn the new software, the architect is left to only barely understand the full potential. I think scanning is a full time career direction, not a part time expertise...

²²⁴ Project director, DSOL.

Appendix H

The RecorDIM Initiative. “Bridging the Gap Between the Information Users and Information Providers”. California. Getty Publications: 2002.

Bridging the Gap Between **Information Users and Information Providers**

**Recording, Documentation and Information
Management (RecorDIM) Initiative**

GCI – ICOMOS – CIPA

Report of Roundtable 1

Los Angeles, California

March 4-5, 2002

Robin Letellier - RecorDIM Initiative - International Coordinator

Christopher Gray - RecorDIM Initiative - GCI Liaison Officer



Summary

Between 1995 and 1999, a series of outreach workshops held by the International Committee for Architectural Photogrammetry (CIPA) has identified critical gaps in the fields of heritage Recording, Documentation and Information Management between those who provide information for conservation and those who use it. In response, the International Council on Monuments and Sites (ICOMOS), the Getty Conservation Institute (GCI) and CIPA together created the RecorDIM (for Heritage Recording, Documentation and Information Management) Initiative partnership. The purpose of the initiative is to bring information users and providers together to identify the nature of the gaps between them, to develop strategies to close the gaps and to recommend a framework for action to be coordinated by the RecorDIM Initiative over the coming five years.

On March 4-5, 2002, the RecorDIM Initiative convened an international group of information users – conservation specialists of all trades, cultural resource managers, heritage program planners, etc. – to discuss their experiences with heritage recording, documentation and information management. A total of 23 experts from 12 countries, representing most regions of the world, participated in a two-day roundtable discussion to define user needs and suggest strategies to close the gaps between users and providers. In addition, the group developed a list of recommended next steps for RecorDIM over the next five years.

The group identified six general areas where actions were needed:

1. To improve perception and communication in recording, documentation and information management
2. To integrate recording, documentation and information management activities into the conservation process
3. To increase resources for documentation
4. To define, develop and promote documentation tools
5. To disseminate information
6. To make available specific RecorDIM Training / Learning Programs

For each of these areas, the group developed a list of strategies to close the gaps between information user and provider and improve conservation recording practice.

The group called on RecorDIM Initiative Partners to use the gaps and needs as a framework for future activities. Further, it called on each of the partners to adopt the strategies and coordinate efforts to implement them.

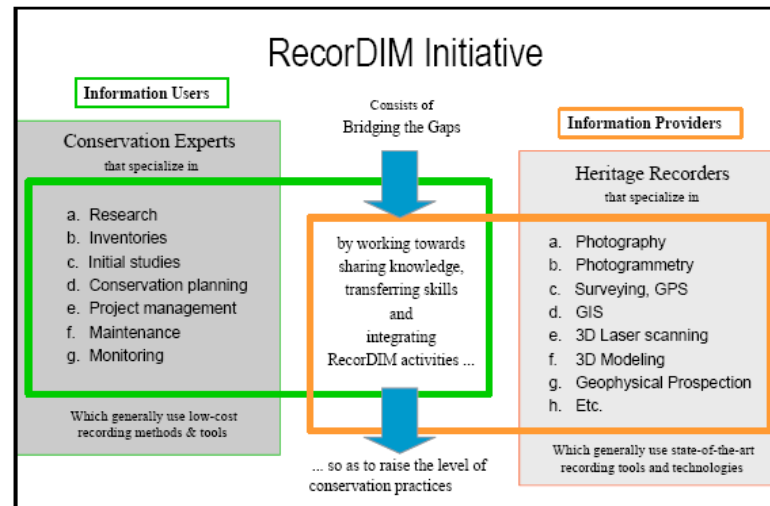


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Introduction

In 1995, CIPA's Working Group 1 – Recording, Documentation and Information Management Principles and Practices (WG1) - was created to provide a forum for photogrammetrists and conservationists to meet and discuss the integration of heritage recording activities to conservation practices. To achieve this objective, WG1 held three Outreach Workshops (Austria 1996, Sweden 1997 and Brazil 1999). At these workshops, participants expressed the pressing need for heritage recording guidelines, technical manuals, training and information dissemination.

In 1998, the Getty Conservation Institute (GCI) approached CIPA to discuss partnership possibilities. The dialogue between the GCI and WG1 led to Bridging the Gap initiative to improve the communication between information users (conservation specialists, site managers, etc.) and information providers (heritage recorders, building surveyors, photographers, photogrammetrists, etc.).

At the Plenary Session of the September 2001 CIPA Symposium in Potsdam, papers by Robin Letellier, chair of CIPA's WG1, Francois LeBlanc, GCI's head of field, and Giora Solar, ICOMOS' delegate to CIPA, proposed a five-year Recording, Documentation and Information Management (RecorDIM) Initiative. (Gaetano Palumbo presented the paper by Giora Solar.)

The RecorDIM Initiative focuses primarily on creating a partnership between CIPA, ICOMOS and the GCI that will:

- organize roundtable discussions to define the gaps between information users and providers;
- publish guidelines for heritage recording, documentation and information management;
- develop "how-to" handbooks for recording;
- create a Web presence on these subjects;
- develop training opportunities and materials and
- develop further partnerships with appropriate and committed organizations.

This RecorDIM Initiative proposal was accepted unanimously at CIPA's executive meeting following the Potsdam Symposium. CIPA voted to support the project and become a partner in the five-year initiative.

Similarly, when Giora Solar presented the RecorDIM Initiative to the ICOMOS Executive Committee in Dubrovnik in October 2001, the Executive Committee expressed its support in principle for the RecorDIM Initiative subject to a plan of action.

To support the RecorDIM initiative, CIPA, ICOMOS and the GCI formed a partnership with the goal of providing support, guidance, training and the dissemination of information that will raise the level of heritage conservation practice worldwide. It is important to note that the RecorDIM Initiative partners welcome organizations and individuals interested in joining the effort to bridge the gaps and address needs identified in this report. (Additional information on the RecorDIM Initiative and its partners can be found in appendices B-D.)

The Venue and Participants

The Venue

On March 4-5, 2002, 23 expert participants met at the Getty Conservation Institute in Los Angeles, California, as the first stage of the RecorDIM Initiative.

The Participants

The majority of participants were drawn from the information user community. They represent a broad diversity of disciplines and cultures, reflecting the variety of conservation activities and diversity of heritage recording experience in different regions of the world.



Participants from left to right:

Back Row: Albini Soucy, Mitchell Bishop, Kalandar Kamalkhan, Carolina Castellanos, Paul Box, Paul Bryan, Giora Solar, Francoise Descamps, Shin Maekawa, Mary Hardy, Chris Gray

Front Row: Rand Eppich, Robin Letellier, Jack Vandenberg, Marieke Kipers, Werner Schmid, Peter Waldhausl, Blaine Cliver, Francois LeBlanc, Jovo Grobovsek, Lori Wong

(Not in the photo: Jeanne Marie Teutonico and Gaetano Palumbo)

Photo courtesy of Robin Letellier.

The Objectives

The objectives of the meeting were threefold:

1. to define the gaps that exist between the information users (conservation specialists and managers) and the information providers (photogrammetrists and heritage recorders)
2. to identify a range of specific solutions to close these gaps
3. to create task groups, composed of representatives from the three RecorDIM partners, that will initiate the process and be responsible for its development.

The meeting began with opening remarks from Tim Whalen, Director of GCI, and a vision statement from Robin Letellier. Following these remarks, the agenda was divided into four distinct steps. For each step, the group was divided into small working groups to address specific questions or concerns. Following the working session in each step, the small groups reported back to the general session, to build common understanding and consensus and for clarification when needed.

The group approached its task in four steps:

1. Analyzing the situation – the general situation of heritage recording and documentation, particularly relationships between information users and providers;
2. Identifying the gaps – the gaps in working relations between information users and providers;
3. Translating gaps to needs – a range of solutions that would bridge gaps between users and providers
4. Formulating strategies – specific strategies that could bridge the gaps. (A full agenda is included in Appendix E.)

Interim RecorDIM Definitions

To facilitate understanding / dialog during RecorDIM meetings, the following definitions were provided. They are taken from the Heritage Recording, Documentation and Information Management Guidelines for World Heritage Sites manuscript that was developed in the mid-nineties with the participation from ICCROM, ICOMOS and UNESCO.

Heritage recording - the capture of information relevant to understanding the physical configuration, evolution and condition of heritage sites and objects, at known points in time, and the basis of decisions made to alter or care for such sites and objects.

Documentation - information units acquired over time through heritage recording and other research means, which constitute the knowledge base for particular sites and objects.

Information management - the process of acquiring, storing and sharing site documentation to ensure its accessibility, security and reliability.

Conservation - concerned with the transmission of cultural heritage, with its significant messages intact and accessible to the greatest degree possible.

Conservation process - the analytical decision-making process of ensuring that conservation intervention at all levels will respect heritage values of sites while maintaining functional effectiveness within applicable budget and other constraints.

Conservationists / conservation specialists - those who, whatever their profession, trade or discipline of origin (i.e., art historians, architects, archaeologists, planners, etc.), engage in the practice of conservation and are committed to the application of the highest principles and standards of the field in their work. They are also referred to as information users.

Heritage recorders / photogrammetrists - all levels of experts in the design and execution of effective heritage recording activity within the conservation process. They are also referred to as information providers.

RecorDIM - acronym referring to the activities of recording, documentation and information management

Summary of gaps and needs

The following list summarizes the main gaps and needs identified during the roundtable. (The complete, unedited list of gaps and needs can be found in Appendices F and G.)

1. To improve perception and communication in heritage recording, documentation, and information management

- **By information dissemination**

Very little information specific to the purpose and benefits of heritage recording, documentation and information management is currently being distributed to and shared between information users and providers. Partners need to understand each others' role and responsibilities better. (Users believe providers are rooted in the future and providers believe that users are rooted in the past.) More needs to be done to educate users of available tools and providers of the goals of conservation management.

- **By creating bibliographies, thesauruses, definitions**

There is an urgent need for the compilation of a complete bibliography of recent publications on heritage recording, documentation and information management tools, technologies and applications. (Information is often published as conference or symposium proceedings, but not easily accessible.)

- **By creating focused newsletters**

Currently, there is no international periodical in the field that allows experts in recording, documentation and information management to share their knowledge and experience. This communication tool would be an effective way to bridge the gap between information users and providers

- **By establishing integrated professional networks**

Although specialized professional networks already exist and provide forums for exchange on specialized topics, they need to be strengthened. Multidisciplinary exchanges are growing in many disciplines, bringing together varied expertise for complex projects. Heritage conservation is a complex activity that requires exchange of ideas and information and the integration of diverse skills and knowledge.

- **By encouraging joint symposia, seminars and tradeshows**

A growing number of specialized groups already meet to exchange on specific technical subjects. CIPA is an example of a very specialized international scientific committee that is working towards inviting experts outside the discipline to their meetings. There is a need for other ICOMOS scientific committees (and other organizations) to join the RecoDIM Initiative and be part of symposia and seminars to build bridges between heritage recorders and conservation specialists.

- **By involving the private sector and outside organizations**

It is critical to involve the private sector in RecoDIM activities. The private sector needs to be exposed to governmental conservation practices since government often is responsible for managing projects. Education and dissemination of knowledge should reach beyond the traditional conservation community. It is particularly important to communicate the benefits of documentation to owners, interpreters and marketers, among others, by showcasing model projects and best practices.

2. To integrate recording, documentation and information management activities into the conservation process

- **By developing and implementing recording and documentation processes**
One of the important gaps named during the roundtable was the fact that few organizations have developed a recording and documentation process that is integrated into their conservation activities. Furthermore, few information users work within a well-defined conservation process. The group expressed an urgent need for promoting the integration of these activities to increase effectiveness in conservation practices.
- **By including recording, documentation and information management practices in conservation management guidelines**
Conservation management guidelines exist, but few refer to the importance of recording and documentation as activities that should be central to conservation practices. There is a need for guidelines that provide heritage conservation managers and practitioners with proper guidance and direction. Such guidelines must be developed jointly by users and providers of information.

3. To increase resources for documentation

- **By promoting its benefits**
Decision makers are often unaware of the purpose and benefits of recording, documentation and information management activities. It was suggested that the benefits of these activities can be demonstrated by case studies and best practices. Another major benefit is that RecorDIM activities also provide 'posterity records' for future generations. As investments in recording and documentation improve quality and cost effectiveness, bigger budgets should be allocated to recording activities.
- **By writing related policies**
To ensure sustainable resources for documentation activities, policies must clearly state that these heritage recording, documentation and information management are integral parts of the conservation process. Such policies are essential to sustaining the discipline in the long term.

Archiving with concurrent cost implications is another area where policy guidance is required to make better informed decisions.

4. To define, develop and promote documentation tools

- **By writing:**
 1. *Standards*
 2. *Guidelines*
 3. *Handbooks*
 4. *Best practices*

There must be well-defined standards and guidelines to ensure a good level of understanding and knowledge of documentation and recording principles and practices. Handbooks generally complement the standards and guidelines and case studies help link theory to reality. Few publications on these subjects exist.
- **By encouraging the development of software**
Some general commercial software is used for documentation activities but in many

cases without the level of effectiveness and accuracy that can be achieved with specialized software. Better software will facilitate and expedite conservation work by assisting in producing better records, research, analysis, design, maintenance and monitoring. Information users can encourage the production of better, more specialized software by promoting its benefits, sharing customer feedback with producers, and investing more in technology (e.g., low-cost rectified-photography and 3D modeling software).

- **By encouraging the development of hardware**
Hardware can be cost-effective if well designed for specific applications. Through outreach to the private sector, universities and research centers, heritage recorders can encourage good dialogue and knowledge transfer. The RecorDIM Initiative partners represent users and providers who are interested in adapting existing hardware and software to the needs of conservation practices (e.g., low-cost and user-friendly photogrammetric systems, portable 3D laser scanners).
- **Other tools required**
 - Tools to enable cost-benefit analysis
 - Case studies
 - Economic models
 - Tools for estimating, procuring and tendering

5- To make available training and learning programs in recording and documentation

- **By offering courses, seminars, workshops, etc. through:**
 - o CIPA
 - o ICOMOS
 - o ICCROM
 - o National conservation organizations
 - o Universities
 - o Other groups and organizations

Although a growing number information users are requesting training in heritage recording, documentation and information management, there are few courses that offer such training. This keeps many users from benefiting from the many available tools.

- **By establishing certification and accreditation**
Proper heritage recording and documentation certification or accreditation does not currently exist. Some type of accreditation would certainly create greater interest in this type of training and would give more credibility to the activities of heritage recording, documentation and information management. This could occur at both graduate and mid-career level.
- **By educating providers**
Consideration should be given to extending the education of heritage information providers beyond the technical requirements to provide a better understanding of the non-quantitative value of cultural heritage – the sense of place, people, landscapes, quality.

Conclusions

The roundtable succeeded in producing a list of significant gaps and needs that provides a clear framework for the work of the RecorDIM Initiative over the next five years. In addition, the group identified many strategies to promote heritage recording activities and to address the gaps and needs.

Importantly, the spirit and participation of attendees was high during the entire meeting, and their feedback was positive in all respects. This two-day exchange was a meeting of minds between three international groups, the partners that are now engaged in supporting the RecorDIM Initiative.

Participants were asked to commit themselves to work at resolving some of the gaps and needs. François LeBlanc for the GCI indicated an interest in guidelines, handbooks and training. Representatives of the U.S. National Park Service, English Heritage and Parks Canada, three major heritage conservation organizations, had the opportunity to consider common issues. The three began discussing the possibilities of pooling resources to address shared needs in their organizations and conducting outreach to the international community. On an individual level, many expressed a high level of commitment to the success of the initiative.

Next steps

At the conclusion of the roundtable, participants made a number of recommendations for carrying forward their findings:

The group recommends that the above list of gaps and needs be used by the RecorDIM Initiative Partners (ICOMOS, CIPA, GCI) as a framework to promote, define and coordinate future activities and to encourage other organizations to participate to this project. (This list should be considered preliminary; it will be presented, discussed and expanded during the CIPA RecorDIM Task Group meeting in Corfu in August 2002 and at the ICOMOS RecorDIM meeting in Madrid in December 2002.)

The participants also recommend that the RecorDIM Partners be responsible for coordinating at least one task each. This would give the Initiative a good start by ensuring institutional support and a certain level of sustainability to the project. For example, the need to develop more training programs could be shared by CIPA's Working/Task Groups, ICOMOS' Scientific Committees and National Committees as well as ICCROM's Seminars. National conservation organizations, such as English Heritage, Parks Canada and the U.S. National Park Service, could also participate as could universities such as Columbia University (New York), University of Pennsylvania (Philadelphia) and the University of Leuven (The Netherlands).

At this date, it is likely that ICCROM and UNESCO will join the current RecorDIM Partners to help deliver this five-year Initiative. In this situation, it is hoped that each of the five main areas of needs or gaps could become the responsibility of one partner organization, for instance, The GCI could oversee efforts in the area of Perception / Communication. ICOMOS could be responsible for activities in Conservation Process. UNESCO could oversee the Resources area; CIPA, Tools and ICCROM, Training and Education. This shared responsibility could become the basis for the RecorDIM Initiative five-year plan with a RecorDIM Steering Group (composed of one representative from each partner organization) that would coordinate the overall RecorDIM Initiative activities.

The Working Sessions

Step 1: Analyzing the Situation

In the first step, participants built a common understanding of the working relations between the information users and providers. In small working groups, they addressed three basic questions:

1. *What is the current relationship between users and providers?*
2. *Is this relationship helpful?*
3. *What would be the ideal situation?*

Some in the group noted the difficulty in separating the two roles of information user and provider. Recording or surveying requires provider and user to work jointly. The way a base map is recorded, for instance, depends on the project and its aims, which involve both provider and user.

The relationship between users and providers is complex, dynamic, and even contradictory, as some participants described it. The list of issues raised during this first exercise indicates that participants share similar experiences in the user-provider relationship, but few work in environments where the relationship is clearly defined and where conservation activities integrate recording and documentation practices effectively. The group expressed a strong concern that, in general, users' needs and objectives are not well defined at the beginning of a project, therefore hampering the providers' understanding of the job at hand and their ability to decide what tools are best suited to the task.

The consensus was that a well-defined relationship between information users and providers is both necessary and essential to ensure proper conservation practice. In addition, the relationship needs however to be understood and organized so that the providers respond to the specific needs of the conservation team and project and that users and providers understand which tools are best suited for the project. Ideally, a set of generally accepted standards and guidelines would indicate how best to integrate providers' knowledge and skills to the team and project. Such guidelines would have to apply to a range of conservation disciplines and applications, as each specific project has unique requirements.

After small working groups reported their findings, the group created a common list of features of the current situation between information users and providers.

What came out of Step 1 was more a preliminary list of generic gaps (in no particular order) rather than a close look at the relationship between users and providers or what the Q3 "ideal situation" between these two would be:

- Communication: Users must clearly articulate their needs and purpose of the documentation while providers must communicate clearly the possibilities of existing tools to *improve* the documentation. Neither group should make assumptions about the others' knowledge or lack of it.
- Terminology is not well defined
- There are different main *types* of providers (therefore their goals will not be the same):
 - Those involved with tool development
 - Specialist 'heritage recorders'
 - Other (including general surveyors, GIS experts, etc.)
- What is the range of users? Specify "user community" — the number of people who will use the documentation and what their needs are as different needs might require varying levels of recording

- Improve training — greater emphasis on conservation training for providers and likewise with surveying and recording technology for users
- Integrate documentation into the budgeting process. Project managers and funding bodies incorrectly perceive that documentation is not necessary or “a waste of money”
- Greater degree of planning necessary
- More preliminary dialogue necessary. Users should be able to sustain, maintain and manage the documentation. Providers should help users assess the potential feasibility of recording.
- Disagreement on the appropriate levels of recording
- Accessibility and dissemination of information
- Post-treatment recording
- Conservation issues surrounding digital documentation (i.e., long-term archiving)
- Sustainable documentation (costs, maintenance, etc.)
- User must make an active commitment to understanding the information (method) the provider is providing. Users are not victims: It is their responsibility to educate themselves to find the appropriate sources of information or training when necessary and to know the relevant questions to ask
- Users do not always know what they want or how it can be done

Step 2: Identifying the Gaps

In the second step, the group identified the gaps between information users and providers that hinder work in recording, documentation and information management as well as in conservation management. Again, the session divided into small groups for discussion of three issues:

1. *Develop general categories of gaps based on issues raised in Step 1*
2. *Ensure that all issues identified in Step 1 are integrated into the list of gaps*
3. *Synthesize gaps*

Each small group reported back to the general session, where a common list of gaps was composed.

Communication was a key gap mentioned by participants in each group. Even at the level of terminology, communication was raised as a problem. Some participants attending this roundtable have been working in the field for many years and yet don't agree on frequently used terms. At a different level, the roles and responsibilities of users and providers within the conservation process are still not well understood, leading to communication problems.

Levels of recording, with their varying costs and level of detail, came up as a principal gap in effective practice. This is a critical dimension of heritage recording, and often users are poorly informed about the levels of recording and their cost implications. It was noted that few publications exist on this subject.

There was also a perception of a gap between users who live more in the "traditional past," and providers living more in the "technological future." Participants suggested that this gap might be widened because there are limited opportunities for mid-career practitioners to get information and training on new tools and technologies. Well-designed training opportunities are needed to bridge many of the gaps.

Information management is another area that should be recognized as an essential activity within a conservation team or organization, facilitating and expediting decision-making. However, few organizations seem to have recognized the benefits and cost savings that result from well-integrated information management practices.

On a few occasions, participants referred to the difference between governmental providers and commercial providers in approach, understanding and background.

During this lively session, it became even clearer that participants had a wide variety of ideas regarding the roles of information users and providers, their relationship, and their level of involvement came out of the discussions:

- The importance of developing guidelines was stressed.
- The GCI documentation program, which was dissolved, is no longer a service provider but an integrated part of field projects.
- International protocol(s) using existing systems should be used as models.
- There are significant differences between heritage (or government) providers and commercial providers.
- Despite the differences, users and providers are closer than we thought. Both groups want to place heritage at the center and to identify problems that exist. We have the same intentions, vision, and causes.

The general group combined small group findings into a comprehensive list of gaps, which fell into six basic themes:

Communication

- Lack of definition of roles and responsibilities
- Lack of established terminology
- Lack of technology and information transfer between provider and user
- Lack of user knowledge – not aware of available tools, possibilities, costs
- Providers' lack understanding of users' needs

Training/Education

- Need for manuals, handbooks
- Need for courses, seminars that take a multidisciplinary approach
- Need to include mid-career specialists and management in training

Process

- Need protocols to define and structure documentation "road maps"
- Need to define standards for basic requirements of documentation
- Need to define scope and levels of recording
- Need to integrate heritage recording into conservation projects
- Need to identify all parties who will use project data – the immediate team, partners and others in the conservation field, anticipated future users
- Need to properly manage and maintain digital documentation
- Need to know how to locate appropriate providers

Tools

- Need cost-estimate tools
- Need cost-benefit tools
- Need comprehensive list of tools with their characteristics, benefits, impacts, capacities, limitations and costs
- Need information sharing/management tools
- Need appropriate storage for archiving
- Need guidelines and standards

Resources

- Need to increase awareness about the value and benefits of heritage recording, documentation and information management
- Need strategies to increase recording, documentation and information management budgets
- Need to differentiate between first world and third world requirements, immediate vs. long-term needs, national vs. private expectations

Professional Accreditation

- Lack of understanding and recognition of skill base pertaining to heritage recording and documentation
- Need to provide certification with training

Note: In later sessions, it was decided to incorporate accreditation issues into the broader topic of training and education.

Step 3: Translating Gaps into Needs

In the third step, the group examined the broad gaps in order to define a range of solutions that would bridge them:

1. *Communication / Perceptions*
2. *Tools*
3. *Training/education*
4. *Process*
5. *Resources*

Each of the five gaps identified was assigned to one small group for discussion. At the conclusion of the small group sessions, findings were brought to the whole group for discussion. These findings represent the consensus of the entire group.

1- Communication / Perceptions

Many information users and cultural resource managers do not clearly understand recording, documentation and information management activities. This major gap must be addressed as a top priority. Informed users and managers are crucial to obtaining resources and support necessary for the evolution and spread of recording practices and consequently a higher level of conservation itself. To close this information gap, the group emphasized the need for knowledge transfer through newsletters, Web presence, workshops, seminars, networks, trade shows and other media.

Currently, most exchanges exist at a technical level and exclude to a certain degree the private sector and a larger audience of potential supporters. Involving outside organizations, private practitioners, experts from other fields, decision-makers and the politically connected would help promote the activities of heritage recording within public and private environments.

Among the key issues raised by this group:

- Most countries have no certification or accreditation for professional conservators, let alone professional providers.
- Encourage commercial groups to be interested in heritage. There are no direct financial rewards but some companies are keen to use heritage for their benefit to market their products.
- Some were surprised that there is no emphasis on involving people other than users and providers. Discussion focused on technical aspects (i.e. terminology, etc.) rather than the "essence of communication."
- Look at other fields for more ideas and models of how they have dealt with similar issues.
- Certification (for individuals and organizations) is sometimes only a "paper exercise." A company's past ability to work on heritage projects demonstrates that the company can do the work.

2- Tools / Policy

The group shifted the emphasis from tools to policy, highlighting the importance of improving perception, communications and better interaction between users and management, and decision-makers.

Participants recommended that study and research concentrate on synthesizing information into generic standards (emphasizing existing information, not "reinventing the wheel"). These

standards could then be used to generate more specific guidelines and to create tools to be used in the conservation process, as well as in training and allocating resources.

On a policy level, the participants called on member countries of ICOMOS to promote Article 16 of the Venice Charter and heritage recording statements from other charters. (See Appendix C.) They also proposed the development of recording policies in their respective countries and organizations. These policies, if well tailored to the countries' requirements, would facilitate the implementation of heritage recording and documentation. The framework that will result from the RecorDIM Initiative should refer to existing policies, standards, guidelines, training, etc. as models. Publishing case studies of successful projects was identified as another way to use existing information to improve policy and practice.

3- Training and Education

The Internet has become the tool of the century for information access and dissemination and should be at the foundation of information sharing within the RecorDIM Initiative. The Web can make databases, distance learning, live video of meetings, etc. available worldwide. The Web can also provide low-cost information-sharing opportunities for all levels of users and providers within heritage conservation and in the broader community.

More training opportunities with professional accreditation were identified as priorities. Training should help to bridge gaps between users and providers, as well as between public and private institutions. In training, developing an understanding of the complementary knowledge and skills of members of the conservation community should be emphasized, which should foster better communication and professional respect.

4- Process

Participants agreed that heritage recording must be integrated into the conservation process. In fact, conservation process and planning may be the most practical way to bridge many of the gaps and needs identified during Roundtable 1.

There was general discussion on the importance of recording intangible values. Participants noted the importance of understanding the values of a site— before starting to think about tools, etc.

There is a strong need for standards and guidelines. Three of the important elements to be considered when defining the scope of recording and documentation are the site values, the project objectives and the budget constraints. Long-term conservation planning takes into account these three considerations, understanding that each project is different and these elements will have to be adjusted.

5- Resources

The key need identified here is demonstrating to conservation management that heritage-recording activities are central to decision making. Recording facilitates and expedites the conservation process and increases the quality of conservation research, analysis, design, maintenance and monitoring. Once management appreciates the cost-benefits of recording and documentation, it may be willing to realign budgets to support more recording in conservation activities.

It is important to offset the current perception of the high cost of recording tools with an understanding of how they contribute in the long term to cost efficiency and effectiveness. Benefit analysis models are necessary to demonstrate the importance of heritage recording in management's terms. At the same time, low-cost recording and documentation tools should be promoted. Good communication and training is needed regarding the levels of recording and how low- and high-cost tools can be integrated in long-term conservation planning.

Some believe that redirecting budgets to documentation activities may reduce the conservation activity budget. On the contrary, recording and documentation can foster better understanding and consequently an acknowledgement of the need for more resources for conservation. In situations where there is very little funding to undertake a conservation activity, recording may become the only justifiable activity, used to salvage information before the assets deteriorate further.

Key issues raised by this group:

- Valuation of cultural heritage — look at outcome and benefits (cost/benefit analysis).
- Heritage data potentially has a variety of uses, for example, for tourism. Natural resource management has been used successfully to support tourism. Why can't we do this for cultural heritage?
- Cultural heritage needs to be wary when big money gets involved. World Bank loans, for example, give huge budgets and project managers need special skills to manage and allocate resources at this level.
- Roundtable participants are not typical users.
- More money on documentation may mean less money towards conservation. In scarce resource situations, funds must be allocated wisely.
- Need further distinction not just between users and providers but also within wide range of potential users (conservators and project managers, for example).
- Need resource flexibility (budget, methods, tools, staffing) as aim and objectives of recording will change over time.

Note: Participants remarked that Roundtable 1 may not be representative of typical information users and providers. It is critical that the RecorDIM Initiative meetings represent all groups involved in heritage conservation.

Step 4: Formulating Strategies

Participants were asked to discuss strategies to respond to the five generic gaps and related needs identified during Step 3.

Appendix H provides the complete list of strategies collected during the group's wide-ranging discussion on how to bridge gaps. This list was used to produce the "Summary of Gaps and Needs" provided later in this report. It should be referred to for the work of the RecorDIM Initiative Partners over the next five years. The following pages summarize the main outcomes of STEP 4:

Perception / Communication

In order to improve the appreciation of recording activities within the process of cultural resources conservation, several strategies focused on dissemination of information to inform users, middle managers, decision-makers and policy-writers about the short- and long-term benefits of good documentation practice. Strong, well-coordinated, professional networks including both users and providers, were suggested as a strategy. (It was noted that some of the past problems in professional networking stemmed from the fact that these networks were driven by volunteers without sufficient time or resources to maintain the network.) Sustained task groups with leadership drawn from RecorDIM Partners would avoid some of these pitfalls. Good coordination at the international level would be critical to the success of the effort.

Tools

This subject was approached in the broadest way possible and generated lively discussion. It is clear that this area is one of the most important to information users. The outputs from this discussion were presented in a well structured outline that could be used as a 'table of specific tasks' to be addressed in the near future by the RecorDIM Initiative partners (For a complete list of the strategies, see Appendix H – Group 2 - Tools.)

Training and Education

The gaps and needs were restructured into levels of actions for different target groups (providers, users, middle management, decision makers and politicians). One of the key elements in these strategies is working by geographic levels of actions -- international, regional, national and local. RecorDIM Partners could work with recognized authorities and institutions that already have networks in place, opening the door to conservation organizations at any level that wish to participate to the RecorDIM Initiative.

Resources

The focus here was largely on advocacy, particularly on making documentation and heritage recording available in emergency conservation situations. Models of organizations that function successfully under emergency conditions (the Red Cross, the U.S. Federal Emergency Management Administration (FEMA), etc) were discussed. The question was 'who are we trying to reach' to get support and sponsorships? Emphasis was on current perceptions / understandings of RecorDIM processes so as to promote its benefits using convincing models. To further advocacy, future roundtables should reach out to a wider community. Outreach would educate users to appreciate the benefits of documentation and foster the transfer of effective conservation information management practices to documentation of emergencies, such as floods and earthquake disasters.

Process

RecorDIM activities are generally undertaken in an unstructured way and are seldom integrated to a well-defined process. Consequently, the strategies that emerged here focused largely on developing awareness of the importance and benefits of documentation. Participants suggested defining process concepts and developing conservation road maps that would allow users and providers as well as managers to perceive how activities can be integrated effectively.

Priority of Needs

Following the small group reports, the full roundtable voted on the top priorities for the RecorDIM Initiative in the near future.

1. *Tools*
2. *Training and education*
3. *Perception*
4. *Process*
5. *Resources*

The voting reflects the priorities of a group that was composed 80 percent of information users. Tools took first place by a solid margin. Training and education polled second followed closely by Perception.

Appendix A The Participants

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Appendix B

Minutes of RecorDIM Initiative Steering Group Meeting 1

March 21, 2002

To: RecorDIM Initiative Steering Group:

Peter Waldhäusl	CIPA
Giora Solar	ICOMOS
Chris Gray, François Leblanc	GCI

From: Robin Letellier – RecorDIM International Coordinator

CC: Orhan Altan	CIPA 2003 Symposium Director
Jack Vandenberg	PW&GSC / Parks Canada
Paul Bryan	English Heritage

Subject: RecorDIM Initiative – Minutes of Steering Group Meeting-1
(Los Angeles – March 6, 2002)

Dear Peter, Giora, Chris and François,

First, I would like to thank you for the excellent cooperation that took place before and during Roundtable 1, and for the good discussions we had during the RecorDIM steering group meeting on March 6. I must admit that, during the past months and especially during our exchanges in Los Angeles, I feel that this Five-Year RecorDIM Initiative looks promising.

The following draft notes summarize the key agenda items we discussed during our March 6 meeting. Please review and revise where needed so that we can make use of them for near future planning.

Corfu's RecorDIM Task Group 1 meeting (August 2002)

Peter Waldhäusl will officially organize a RecorDIM Task Group meeting to take place on the first day of CIPA's next business meeting on August 31, 2002. The results of this meeting will be discussed during CIPA's executive meeting on September 1. Follow-up RecorDIM discussions will take place during September 2 and 3. The main purpose of this Task Group meeting will be for CIPA to review the RecorDIM Roundtable 1 report and to discuss how CIPA work on tasks related to the needs expressed during Roundtable 1.

Paris / Malta's RecordIM Roundtable 2 meeting (October 2002)

Giora Solar will work towards getting ICOMOS to have a Scientific Committees (SC) meeting of 2-3 days during the up-coming proposed Paris / Malta ICOMOS meetings. Should this materialize, he will organize a RecordIM Initiative presentation at the beginning of these SC meetings so that all participants are informed of the Initiative and have discussions on how they could participate. At the end of the 2-3 days of SC meetings, Giora will organize a RecordIM Initiative Round Table 2 where ICOMOS SCs would be asked to express NEEDS pertaining to heritage recording, documentation and information management principles and practices.

Ottawa's RecordIM Task Group 2 meeting

Although it may be premature to circulate this information at this time, we now know that Jack Vandenberg of Public Works & Government Services Canada (together with Parks Canada) is planning to host RecordIM Task Group 2 meeting in the spring of 2003 (to be confirmed hopefully during the second half of 2002). It is assumed that this meeting would bring together the RecordIM Partners to address new requirements from the ICOMOS SC 2002 meetings from Paris / Malta, and prepare for the 2003 CIPA Symposium in Antalya.

Antalya's RecordIM Round Table 3 meeting (CIPA 2003 International Symposium in October 2003)

One of the main objectives of the RecordIM Initiative Partners is to create a balanced audience of information users and providers during the next CIPA Symposium in Antalya. As discussed on March 6, for CIPA to attract ICOMOS users to come and present their work and engage in dialogue with providers in Antalya, it is suggested that the symposium organizers consider structuring the upcoming program to broadest possible membership by adding these subjects and promoting them in the symposium announcement:

RecordIM Tools for Archaeology

RecordIM Tools for Architectural Conservation

RecordIM Tools for Engineering Conservation

RecordIM Tools for Landscape Conservation

RecordIM Tools for Risk Preparedness

Robin Letellier suggested to Peter Waldhäusl that the CIPA 2003 Symposium second announcement appeal to information users so that they recognize themselves in the symposium program and themes and are attracted to and attend this symposium. Users at large must understand and appreciate that this symposium provides an opportunity for them to meet and exchange with other information users as well as with the range of information providers, from low-cost to state-of-the-art.

In my capacity as RecordIM Coordinator, I will propose to Orhan Altan and Peter Waldhäusl, by the early April, a text that should make the Antalya CIPA 2003 Symposium a very attractive activity for ICOMOS' membership (and naturally to users from other organizations involved in heritage conservation activities). Peter Waldhäusl is supportive of this approach and after review by Orhan Altan and the CIPA Executive Board, the text should be inserted to the April 2002 CIPA's 2003 Symposium second announcement.

Robin Letellier

International Coordinator

RecordIM Initiative

Appendix C

Background information

The Venice Charter

Since 1966, most conservation professionals have regarded the Venice Charter as the key guiding reference in the field. While often criticized as overly European in its outlook and written for a limited view of heritage, the Venice Charter has yet to be supplanted by other documents capable of earning or gaining the same respect.

Article 16 of the Venice Charter states that:

"In all works of preservation, restoration or excavation, there should always be precise documentation in the form of analytical and critical reports, illustrated with drawings and photographs."

Every stage of the work of clearing, consolidation, rearrangement and integration, as well as technical and formal features identified during the course of the work, should be included. This record should be placed in the archives of a public institution and made available to research workers. It is recommended that the report be published."

This implies that the activities of heritage recording, documentation and information management, as defined hereafter, should generally be integrated into a conservation management process. This also implies that heritage recording should take place before, during and after any intervention to a resource if one wants to measure change over time.

ICOMOS

ICOMOS is an international, non-governmental organization dedicated to the conservation of the world's historic monuments and sites. The organization was founded in 1965 as a result of the international adoption of the Charter for the Conservation and Restoration of Monuments and Sites in Venice the year before. Today the organization has national committees in over 107 countries

ICOMOS is UNESCO's principal advisor in matters concerning the conservation and protection of monuments and sites. With IUCN-The World Conservation Union, ICOMOS has an international role under the World Heritage Convention to advise the World Heritage Committee and UNESCO on the nomination of new sites to the World Heritage List.

Through its 21 scientific committees of experts from around the world, and its triennial General Assembly, ICOMOS seeks to establish international standards for the preservation, restoration, and management of the cultural environment. Many of these standards have been promulgated as Charters by the organization as a result of adoption by the ICOMOS General Assembly. (www.icomos.org)

CIPA

The International Committee for Architectural Photogrammetry (CIPA) is one of the first ICOMOS scientific committee to be established. It was created in the late sixties, in cooperation with the International Society for Photogrammetry and Remote Sensing (ISPRS), to assist conservation experts with the activities of heritage recording and documentation. CIPA's task is to develop recording tools to address the documentation principles expressed in Article 16 of the Venice Charter

Article 16 has been driving the activities of CIPA's Working Group for the past five years as stated:

"to provide a forum for photogrammetrists (from CIPA and other organizations) and conservationists at large (from ICOMOS, ICCROM, UNESCO and other organizations) to meet and discuss how to best integrate heritage recording, documentation, information management principles and practices to heritage conservation management activities."

CIPA has since organized 18 symposia, 6 workshops and 7 meetings / colloquium to exchange on photogrammetric applications related to heritage conservation practices.
(cipa.icomos.org/index.html)

The Getty Conservation Institute (GCI)

The Getty Conservation Institute, a program of the J. Paul Getty Trust, engages in activities dedicated to furthering conservation practice and education in order to enhance and encourage the preservation, understanding and interpretation of the visual arts broadly interpreted to include objects, collections, architecture, and sites.

The Institute serves the international conservation community through scientific research, in education and training, model projects in the field, and the dissemination of information through both traditional publications and electronic means.

In all its endeavors, the Institute is driven by a commitment to address unanswered questions and to promote the highest possible standards of conservation.
(www.getty.edu/)

Appendix D Principles

To provide a common context for discussion in the roundtable, the 1996 ICOMOS publication entitled, "Principles for the recording of monuments, groups of buildings and sites," was provided to participants as advance reading (available through ICOMOS Secretariat). These principles were originally drafted by ICOMOS-UK and ICOMOS-France, and refined in 1996 by fifteen (15) senior conservationists representing all regions of the world. The principles were ratified by ICOMOS during its 1996 General Assembly in Sofia.

This publication can be obtained through the ICOMOS Secretariat in Paris.

Appendix E Agenda

In preparation for Roundtable 1, the following two-day meeting agenda was developed. The approach taken allowed participants to express and discuss their RecorDIM problems and needs, so as to identify and define gaps that require to be addressed by the partner organizations.

Monday March 4th

8:30 a.m. Welcome Address – Tim Whalen – Director, GCI

8:40 a.m. Participant Introductions and Meeting Objectives

The project vision (Robin Letellier – RecorDIM Initiative International Coordinator)

The session objective (Albini Soucy – Facilitator)

9:30 a.m. Situation Analysis

This first step of the process is meant to confirm with participants their understanding of the situation and becoming aware of the potential value of bridging the gaps

10:30 a.m. Break/Pause

10:45 a.m. Gap Identification

This second step is for participants to agree on the existing gaps that hinder their work in recording, documenting and information management principles and practices, and in conservation management practices.

12:00 p.m. Lunch

1:00 p.m. Needs Assessment

This third step is for participants to clarify and agree on their expectations about what they need, and what they believe to be the generic needs of conservation experts.

5:00 p.m. Day 1 closure

Tuesday March 5th

8:30 a.m. Summary of Day 1

9:00 a.m. Strategies Identification

This fourth step aims at identifying some of the strategies to deal with the gaps and respond to the needs.

12:00 Lunch

13:00 p.m. Bridging the Gaps

At this point, participants are asked to identify some of the barriers to implementing the strategies and the possible actions required to eliminate the barriers/ implement the strategies.

15:00 Follow-up and commitment

This last step of the meeting is to ensure follow-up for the meeting and participants' involvement in the future.

4:30 p.m. Adjourn

Appendix F Complete List of Gaps

This list of gaps is the unedited notes from discussion groups.

Group 1

Communication

- *No current opportunities for dialogue among users and providers (RecoRDIM is a start)*
- *Users must clearly articulate their needs*
- *Providers must clearly understand these needs*

Terminology (as subset of communication)

- *Difficult to communicate without understanding each others' "language"*

Costs

- *Lack of funding allocated to documentation*
- *Little understanding, misperception of the possible costs of documentation*

Information

- *Little or no written information on available tools, descriptions, costs, etc.*
- *Little or no information on how to obtain advice suited to heritage recording*
- *Potential information/technology gap between users and providers*
- *Information sometimes not accessible to potential users due to technology gaps, accessibility issues, etc.*

Agreement on aims and process

- *Lack of understanding of variety of aims*
- *Determination of method of recording (process) – selection of method(s), knowing which method is most appropriate.*
- *Determination of the level of recording necessary*

Knowledge of technology

- *Insufficient skills*
- *Expectations of providers, sometimes unrealistic on side of users*

Perception

- *Users stuck in the past*
- *Providers in love with the future*

Education and training

- *Education of providers on conservation issues needed*
- *Education of users in recording/documentation needed*
- *Mid-career opportunities – not presently available*

Digital archiving

- *Fear, concern about maintaining and archiving digital documentation*
- *Lack of research in this area*

Interdisciplinary collaboration

- *Lack of dialogue between user and provider throughout the extent of the project*
- *True partnership between user and provider is necessary*

Planning

- *"Bad project planning" (Paul Bryan) makes documentation suffer*
- *Determination of our desired impact/outcome of recording*

Group 2**Communication**

- *Lack of definition of roles and responsibilities*
- *Lack of established terminology*
- *Lack of technology transfer, information sharing between provider and user*
- *Lack of user knowledge, not aware of available tools, possibilities*

Training and education

- *Need for informative manuals, handbooks*
- *Need for courses, seminars that take a multidisciplinary approach*

Process

- *Protocols to define, structure documentation "road maps"*
- *Integrate heritage recorder into project*
- *Define basic standards for documentation*
- *Amount and level of recording*
- *Identify users*
- *How to locate appropriate provider*
- *Maintenance of digital documentation*

Tools

- *Cost estimate tools*
- *Cost benefit tools*
- *Comprehensive list of tools – costs and general description*
- *Appropriate storage for archiving information*
- *Guidelines*

Resources**Professional accreditation****Group 3**

Roles and responsibilities

- *Inadequate communication*
- *User community poorly defined*
- *Unclear definition of roles of user and provider*
- *Integration of heritage recording in multidisciplinary teams*

Terminology/standards

- *Lack of standards*
- *Lack of common terminology*

Training

- *No longer encompassing basic methods, concepts (loss of knowledge of manual recording methods)*
- *Aims, objectives and levels*
- *Poorly defined*
- *Unclear definition of levels of recording*

Data use

- *Underutilized as tool for management*
- *Sustainability of documentation of methods, process*
- *Documentation as ongoing tool – “not an end product”*
- *Not accepted as an essential tool for conservation management*

Data management

- *Access to data*

Resources

- *Lack of required funding*
- *Lack of cost-benefit analysis*
- *Lack of resources for information management (archiving, storage, data management)*

Dissemination

- *Spread good documentation practices*
- *Lack of sharing of information*

Group 4

Gaps

- *Education*
- *Communication*
- *Determining, establishing needs*
- *First world vs. third world, immediate vs. long-term needs, national vs. private expectations*
- *Involving decision makers*
- *Recording intangible values*

Obstacles

- *Lack of cooperation*
- *Bureaucracy*
- *Lack of flexibility in technology*
- *Limited resources (time, funding, etc.)*

Needs

- *Anticipate future needs of site*
- *Anticipate future needs of data*
- *Sustainability*

Appendix G

Complete list of needs

This list of gaps is the unedited notes from discussion groups.

GROUP 1 - "Perception"

Terminology

- *Dictionary, thesaurus*

Lack of knowledge/knowledge transfer

- *Bibliography, literature review*
- *Training*
- *Trade shows*
- *Product reviews*

Communication

- *Dissemination*
- *Workshops*
- *Development of training, teaching curricula*
- *Involving decision makers*
- *Newsletters*
- *Articulating needs (users)*
- *Understanding needs (providers)*

Professional network

- *Certification process*
- *List of professional providers*
- *Professional coordinators*

Problems

- *Human resources*
- *Language*
- *Cost*
- *Time*
- *Bureaucracy*

Group 2 - Tools

Communication

- *Lack of definition of roles and responsibilities*
- *Lack of established terminology*
- *Lack of technology transfer, information interchange between provider and user*
- *Lack of user knowledge – not aware of tools available, possibilities*

Training/Education

- *Need for informative manuals, handbooks*
- *Need for courses, seminars that take a multidisciplinary approach*

Process

- *Protocols to define, structure documentation "road maps"*
- *Integrate heritage recorder into project*
- *Define basic standards for documentation*
- *Amount and level of recording*
- *Identify users*
- *How to locate appropriate provider*
- *Maintenance of digital documentation*

Tools

- *Cost-estimate tools*
- *Cost-benefit tools*
- *Comprehensive list of tools – costs and general explanation*
- *Appropriate storage for archiving information*
- *Guidelines*

Resources

Professional Accreditation

GROUP 3 - Training and education

Lack of manuals and handbooks

- *Publication, Web sites, instructional material*
- *Develop Web information*
- *Refer to CIPA, ICOMOS, other organization*
- *Work closely with graduate programs*

Courses, Seminars, Interdisciplinary Meeting

- *Mid-career opportunities*
 - *Transfer of information among providers and heritage recorders*
 - *Courses to transform specialized providers into heritage recorders*
 - *Courses to inform users about heritage recording tools*

- o *Organization of interdisciplinary providers-users meetings at:*
 1. *Local level*
 2. *Regional level*
 3. *International level*
 - o *Course, workshop certification for users*
- *Accreditation*
- *Professional accreditation*
- *Heritage accreditation – status for providers*

Advanced courses

- *Knowledge of technology*
- *Providers in conservation*

GROUP 4 - "Resources"

Needs

- *Disaster response recording and salvage recording*
 - o *Guidelines*
 - o *Tools*
 - o *Network*
 - o *Source of funds*
 - o *Identifying related disciplines*
 - o *Identifying mechanisms for interchange*

Advocacy for heritage recording

- *Tools for cost-benefit analysis*
- *Mobilize academic community*
- *Sell this to decision makers; end results being more resources to heritage recording*

Roles and responsibilities

- *Methods, tools understand other related fields*
- *Exchange*
- *Need to clarify roles and responsibilities*

Data management and data use

- *Objectives, guidelines*
- *Cost effective tools*
- *Case studies as example of best practice to improve standards of practice*
- *Training in information management*

Group 5 - "Process"

Documentation should be integrated into management process

What needs to be documented?

- *Clarify purpose of documentation*
- *Identify users, immediate and long-term analysis what of users need*
- *Review, research existing data*

Documentation strategies

- *First world vs. developed world*
- *Immediate vs. long term*
- *Implementation*
- *Protocols*
- *Specifications*
- *Basic requirements and standards*
- *Data collection*
- *Integrated use*
- *Dissemination*
- *Archiving strategy (including digital storage)*
- *Information management (access, retrieval)*
- *Evaluation*
- *Monitoring*
- *Closure*

Strategies

- *Appropriate level of recording*
- *Defining data requirements*
- *Methods of recording*
- *Roles and responsibilities*
- *Transfer of knowledge*
- *Resource planning*
- *How to identify providers*
- *Tools selection*
- *Anticipate future use of site*
- *Anticipate future use of data*

Appendix H

Complete list of strategies

This list of gaps is the unedited notes from discussion groups.

Group 1 – Communication

Terminology

- *Dictionary, thesaurus*
 - *Form task groups with leaders and institutional partners*
 - *Identify partners, editors*
 - *Co-publish dictionaries, thesaurus*

Terminology Transfer

Lack of user knowledge of provider end product

- *Bibliography, literature review, abstracts*

Communication

- *Inadequate communication between users and providers*
- *Lack of information dissemination to raise awareness and understanding*
- *Lack of involvement of decision makers*
 - *Dissemination*
 - *Professional*
 - *Public*
 - *Education in standards*
 - *Policy and method*
 - *Newsletter, e-mail, Web site*
 - *Lobby - tool developers*
 - *Publish - product review*
 - *Conservation trade shows*
 - *Contact vendors for participation*
 - *Reusable displays*
- *Workshops*
- *Development of training, teaching curricula*
- *Involving decision makers*
- *Newsletters*
- *Articulating needs (users)*
- *Understanding needs (providers)*
- *Involve decision makers*

Professional network

- *Certification process*
 - *Form task groups to set certification criteria*
- *List of quality assured professional providers*
 - *Gathered by CIPA, English Heritage, PWGSC for Parks Canada*
- *Professional coordinators*
 - *Paid full-time professionals, coordinator support*

Problems

- *Human resources*
- *Time*
- *Bureaucracy*
- *Language, jargon*
- *Cost*

Group 2 - Tools

Training and education

- *Curricula*
- *Handbooks*
- *Case studies*
- *Bibliographies*
- *Index of opportunities*
- *Trainers*

Procedural tools

- *Standards*
- *Guidelines*
 - *Planning*
 - *Implementation*
 - *Information management*
 - *Archiving*
- *Protocols*
- *Directory of appropriate providers and advisors*

Policy

- *Legislation*

Technology

- *Hardware*
- *Software*
- *Techniques*
- *Development for conservation use*

Cost-benefit tools

- *Case studies*
- *Economic models*
- *Estimating databases*
- *Tendering protocols*
- *Procurement*

Group 3 - Training and education**Forums and methods**

- *Courses to inform users about heritage-recording tools*
- *Courses to transform specialized providers into heritage recorders*
- *Organization of interdisciplinary provider-user meetings*
- *Workshops*
 - *Stand-alone*
 - *Combined with other meetings*
 - *Training*
- *No meetings without*
 - *Lectures*
 - *Printed material*
 - *Web access*

Level of action (geographic)

- *International*
- *National*
- *Regional*
- *Local*

Target Groups

- *Decision makers*
- *Administrative structures*
- *Specialists in*
 - *Conservation, restoration*
 - *Archaeology*
 - *Architecture*
 - *Site management*
 - *Landscape architecture*
 - *Museums, artifacts*
 - *Other*

Accreditation

- *Heritage accreditation, status for providers*
- *Quality control*
- *Course, workshop certificates for users*

Training (users and providers)

- *ICOMOS, CIPA, ISPRS, Others*

Group 4 - Resources

Problems

- *People (managers, owners, providers, decision-makers, etc.) are going about documentation in an unstructured way or are not implementing a process*
 - *Skipping steps (e.g. objective definition)*
 - *Not enough understanding of steps required in process*
 - *Insufficient time, resources*
- *Documentation is perceived as an end-product, as opposed to an ongoing integral component of conservation management of heritage*
- *Cultural heritage is not only physical, it is not only quantifiable:*
 - *Features*
 - *Sense of place*
 - *People appropriation*
 - *Qualities*

Strategies

- *Awareness of the importance and benefits of documentation*
- *Precise definition of what documentation entails in specific projects*
 - *Integration of different disciplines*
 - *Definition of methods*
 - *Definition of tools*
- *Road map for documentation:*
 - *Design*
 - *Implementation*
 - *Evaluation*
- *Education, training, knowledge transfer*
 - *Conservation and management of cultural heritage*
 - *Understanding values of heritage*
 - *Documentation methods and tools*
- *Articulation between policy and management*
- *Adequate resources*

- o *Financial*
 - o *Technical skills*
 - o *Commitment*
- *Road map for non-quantifiable aspects*
 - o *Case studies*
 - o *Integration with other disciplines*
 - o *Methodologies*
- *Body of knowledge*
 - o *Phases*
 - o *Parameters*
 - o *Adaptation*

Disaster response – recording team and salvage recording

- *Evaluate models*
- *Propose strategy*
 - o *Red Cross*
 - o *FEMA*
- *Existing guidelines (CIPA, etc.)*
- *GCI, ICOM*
 - o *Business resumption planning*
 - o *Guidelines*
 - o *Tools*
 - o *Networks*
 - o *Sources of funds*
 - o *Identify related disciplines*
 - o *Identify mechanisms for interchange*
- *Define communities*
- *Research existing networks*
 - o *Brainstorming sessions with wider community*
 - *User*
 - *Producer*
 - *Consumer*
 - *Related communities*

Advocacy

- *Who are we trying to reach?*
 - o *Showcasing*
 - o *Identify targets*

- *Best cases*
 - *Pubs*
 - *Hustle the client*
- *Assessing perception or understanding*
 - *Pretty picture*
 - *Value (\$) of resources*
- *Cost benefit*
 - *Look at other models*
 - *Use of media*
- *Look at other models*
 - *Encourage heritage recording specialists to present on other platforms*
 - *Integrate as opposed to separate / isolate*

Group 5 – Process

Problems

- *People (managers, owners, providers, decision-makers, etc.) are going about documentation in an unstructured way or are not implementing a process*
 - *Skipping steps (e.g., objective definition)*
 - *Not enough understanding of steps or articulation*
 - *Insufficient time, resources*
- *Documentation is perceived as an end product, as opposed to an ongoing integral component of conservation management of heritage*
- *Cultural heritage is not only physical, it is not only quantifiable:*
 - *Features*
 - *Sense of place*
 - *People appropriation*
 - *Qualities*

Strategies

- *Awareness of the importance of documentation and benefits*
- *Precise definition of what documentation entails in specific projects*
 - *integration of different disciplines*
 - *definition of methods*
 - *definition of tools*
- *Road map for documentation:*
 - *design*

- o *implementation*
 - o *evaluation*
- *Education / training / knowledge transfer*
 - o *education in conservation and management of cultural heritage*
 - o *education in understanding values of heritage*
 - o *education in documentation methods and tools*
- *Articulation between policy and management*
- *Adequate resources*
 - o *financial*
 - o *technical skills*
 - o *commitment*
- *Road map for non-quantifiable aspects*
 - o *Case studies*
 - o *Integration with other disciplines*
 - o *Methodologies*
- *Body of knowledge*
 - o *Phases*
 - o *Parameters*
 - o *Adaptation*

Appendix I

The Advantages and Disadvantages of the Laser Scanner in the Field

Advantages
applicable to all 2D and 3D surfaces
can produce very detailed, accurate, submillimetric data
captures data very fast in (near) real time
produces portable/customizable 3D data
captures a tremendous of data with a high accuracy rate and eliminates further surveying trips to the field
has an ability to visualize non-visible features that are located in inaccessible places
is ideal for modeling and visualization
has an important educational/interpretational value
Disadvantages
both the hardware and the software needs to process the data is still very expensive
produces very large datasets which are often very difficult to move and manipulate
requires specialist processing and extensive training of architectural staff
its final product still needs manual digitization
used with other surveying and documenting tools such as total station, GPS, photogrammetry for cross checks and inaccurate points

Appendix J

The Planning Scheme of the Utilization of the Laser Scanner in Architectural Documentation

Name of the Phase	What to do?	Why?
A) Pre-Surveying	Historical Research	provides a more through understanding of the value of the object/structure/site
	The Target Audience	anticipates the sequence of actions, potential challenges, end results according to the stakeholder's point of view
	The Scan Data Decisions	determines what is to be captured, what is the smallest feature to be recorded, what the data is going to be used for and thus deciding the accuracy, resolution, point density etc. of the scan data
	Pre-liminary Field Trip	establishes the guidelines for surveying by determining scanner, scan scheme, locations of the targets, georeference system, maintenance considerations such as power supply, transportation.
	Scanner Selection	determines the appropriate scanner according to the scale and scope of the project and the dynamics of the site
	Scan Data Collection	provides a sophisticated preliminary plan to determine the scan scheme, locations of the targets, registration, georeference system, reflectivity considerations
	Time Management	assesses the transportation to the site, security regulations, weather conditions, maintenance (power supply etc.), logistics of moving the equipment in the site, determining secure places for the equipment...
B) Surveying	executing the entire scan by dividing into subsections	prevents any data or time lost
	generating additional data such as hand made sketches, supplementary field notes, explanatory photos	facilitates processing the scan data
	utilizing a total station	georeferences the scan data to the common coordinate system

C) Processing the Scan Data	generating a productive exchange between the drawing team and the field team	facilitates processing the scan data
	generating a mechanism to crosscheck the measured drawings and the scan data	provides highly accurate final products

Appendix K

Final Presentation, 22 June 2007

Anatolian Civilizations and Cultural Heritage Management,
Koç University, June 2007

**The Application of New Survey and Documentation Technologies
for Cultural Heritage Sites:
Case Study Analyses of
the Digital Statue of Liberty, New York City and
the Ottoman Fortress of Seddülbahir, Gallipoli Peninsula**



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Advisor: LUCIENNE THYS-ŞENOCAK

Anatolian Civilizations and Cultural Heritage Management,
Koç University, June 2007

**The Application of New Survey and Documentation Technologies
for Cultural Heritage Sites: Case Study Analyses of
the Digital Statue of Liberty, New York City and the Ottoman Fortress of Seddülbahir, Gallipoli Peninsula**

Why this thesis?

The Application of New Survey and Documentation Technologies
for Cultural Heritage Sites: Case Study Analyses of
the Digital Statue of Liberty, New York City and the Ottoman Fortress of Seddülbahir, Gallipoli Peninsula

The structure of the presentation

- Introduction: What is documentation?
- A brief history of the Architectural Documentation Practices from Traditional Methods to Contemporary Ones
- Laser Scanner
- Literature Review
- The Seddülbahir Project
- The Digital Statue of Liberty Project
- An overview of the utilization of laser scanner in heritage documentation
- A Proposal for the Methodology of the Utilization of the Laser Scanner in Heritage Documentation and the RecorDIM Initiative
- Conclusion

The Application of New Survey and Documentation Technologies
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Introduction

Documentation can be defined as a systematic examination and analysis of individual historic resources to produce a compilation of data about a site, structure or object of a subject. **Architectural documentation** is a compilation of both graphic and written records that explain and illustrate the significant characteristics of a historic building, site, structure, or object.

The evolution of documentation:

- The conceptualization of documentation: the multi-disciplinary approach
- The advances in technology

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Introduction

RecorDIM Initiative, 2002 (Heritage Recording, Documentation, and Information Management)

ICOMOS (the International Council of monuments and Sites)
GCI (The Getty Conservation Institute)
CIPA (International Committee for Architectural Photogrammetry)

“The purpose of the initiative is to bring information users and providers together to identify the nature of the gaps between them, to develop strategies to close the gaps and to recommend a framework for action to be coordinated by the RecorDIM Initiative”

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A brief history of the Architectural Documentation Practices from Traditional Methods to Contemporary Ones

Traditional Surveying Technologies

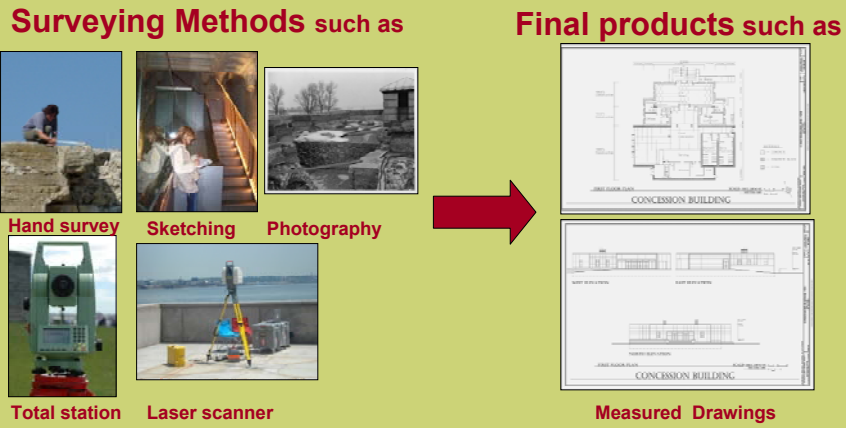
- Hand survey
- Sketching
- Photography (Orthophotography, rectified photography)
- Theodolite
- Total station
- Photogrammetry

Advanced Surveying Technologies

GPS (Global Positioning System)
Laser scanner
GIS (Geographic Information System)

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A brief history of the Architectural Documentation Practices from
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Laser Scanner

The **laser scanner** is considered to be any device that collects three dimensional (3D) coordinates of a given region of an object surface automatically and in a systematic pattern at a high rate (hundreds or thousands of per second) achieving in the real time and thus **captures the digital shape of physical objects**

- developed from tachaeometri (measuring distances and angles from one station; systems such as: tacheometer, binocular, laser tracker, laser radar, laser scanner)



The scan data
Digital Statue of Liberty

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Laser Scanner

How the laser scanner works?

•Triangulation method

In the optical triangulation technique a focused beam of light is emitted to the surface of the object illuminating the spot, a camera records the spot. The center pixel and the intersection beam is computed to get the digital image.



However they are useful for only small objects and work at distances ranging from one half meter to few meters.

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Laser Scanner

How the laser scanner works?

•Time of flight method

The scanner emits a pulse of laser light to the object and waits for its return. The time it takes to the object and come back is calculated by the sensor in the scanner and it provides the distance to the object from the scanner.



This method allows for larger distances to be covered, up to few kilometers. However, the loss of precision goes down to several millimeters which is a drawback if the structure is highly detailed and has small features to be captured.

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Laser Scanner

How the laser scanner works?

•Laser Radar Method

This technique is based on calculating the phase difference of the emitted and reflected power signals.



This method allows capturing data from a longer distance (up to 30m) but with a higher detail and accuracy like short range scanners.

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Literature Review

Applications of Scanning in Industrial Projects

Volcanology and geothermal research, mining, **rock fall studies**, etc.

- Vall de Nuria, Eastern Pyrennes, 2004
- The long range scanner, Ilris3D: long range 1km, 4mm accuracy up to 100m collects 2000 points per second
- Measure large above-surface volumes from a long distance with high velocity and accuracy

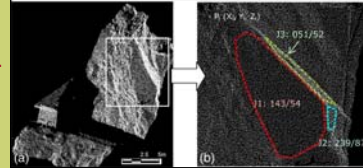


Ilris3D, long range scanner

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Literature Review

- A total of eight scans were undertaken under two hours from three stations.
- A LEICA TRC 705, total station, was utilized to overlap the scans.
- Shaded areas and voids were avoided by scanning at different positions and heights and combining different surveying techniques together.
- Four million 3D points were captured.
- Digital Elevation Models were created.
- Geometry of the joints, bedrock outcrops, unstable rocks, indicators of recent rockfalls were determined.



- The direct contact with the operator and the dangerous field was avoided with the utilization of the long range scanner.

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Literature Review

Applications of Scanning in Heritage Projects

Artifacts, archaeological sites, architectural documentation, etc.

- The tomb of German Emperor Maximilian, 2002
- Restoration purposes
- Short range scanner, MENSİ S25 for the overall structure and GOM ATOS II for details in 60 hours
- MENSİ S25, captured the complete scan of the entire cenotaph, point density 2mm from 20 vantage points, 10 million points were collected
- GOM ATOS II, captured 12 scans for each relief, the data for single relief is 450-700 Megabytes



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Literature Review

However,

- It was impossible to deal with the immense data during processing the scan data.
- The software was incompetent and the hardware was inadequate
- A combination of all the scans and the meshed data was not brought together and there is little hope that it will be accomplished in the near future.



Coarse resolution model

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The Seddülbahir Project

- The Seddülbahir Project was initially started as a research project by Lucienne Thys-Şenocak.
- In 1997, an official protocol was signed between the History Department of Koç University and the Geodesy Division of Geodesy and Photogrammetry Department of Istanbul Technical University
- In 2005, the project evolved from an extensive documentation project into a conservation and restoration project.
- In 2006, the Kaletakımı submitted the multi disciplinary documentation project to the Council of Monuments in Çanakkale.
- In April 2007, all the parts of the restoration project were approved by the Highest Council in Ankara.



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The Seddülbahir Project

- Since 1997, extensive historical and archaeological research; geodetic, and architectural surveys have been undertaken.

- The project has been an example in terms of benefits of a team of diversified professions using a **multi-disciplinary approach**. The team have been represented by a rich range of disciplines such as architecture, archaeology, history, geology, photogrammetry, art and architectural history, cultural history, oral history, geography, geodesy, heritage management.



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The Seddülbahir Project

The Architectural Survey in 2005

The team utilized a laser scanner,
HDS 3000 5mm accuracy

- 360° horizontal, 270° vertical field of view
- 1800 points in a second
- 350 million points
- Registration software: Cyclone,
- processing the scan: Cloudworks software



- LEICA TCR407, total station, crosscheck the point cloud accuracy, survey the topography, determine targets
- 20.000 points

- Hand surveys, sketches, photographs

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The Seddülbahir Project

Processing the scan data

- The outline of the drawings were prepared with the total station data in AUTO CAD
- The scan data was layered into this foundation data
- The team undertook the drawings
- The team submitted 1/50, 1/20 scaled drawings to the Council of Monuments of Çanakkale in August 2006.



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The Seddülbahir Project

- Now the Kaletakımı has the digital Seddülbahir fortress precise enough to serve as a basis for the conservation projects, undertake the further repairs, constructions **without any further surveying in the field.**

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The Seddülbahir Project

The problems encountered

in the field

- long hours of working in the field
- the maintenance of the power supply
- the insufficient light conditions in the dome

during processing the scan data

- the manipulation of the gigantic amount of point cloud data
- the drawing of the dome and the stones in the walls
- the frequent collapse of the computer hardware and software

There are no standards or guidelines

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The Digital Statue of Liberty Project

•The Digital Statue of Liberty Project was initially started in 2001 by National Park Service and Texas Tech University to demonstrate the feasibility of using a laser scanner to provide highly accurate documentation of the skin of the Statue, to monitor the patina and supply a plan for the maintenance and operation of the Statue.

•In 2006, NPS again contracted with TTU to provide an architectural documentation project of all the island and provide more extensive drawings of the Statue.



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The Digital Statue of Liberty Project

The Architectural Survey in 2006

- The team utilized a laser scanner, HDS 3000 5mm accuracy
- 360° horizontal, 270° vertical field of view
- 1800 points in a second
- Registration software: Cyclone, processing the scan: Cloudworks software
- LEICA TCR702, total station, crosscheck the point cloud accuracy, survey the island, determine targets
- Hand surveys, sketches, photographs



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The Digital Statue of Liberty Project

Processing the scan data

The team used the hand survey data and the scan data to produce drawings in AutoCAD.

The team undertook all the drawings.

The team submitted 1/8, 1/16 scaled drawings to the NPS in August 2006.

The team has been still working on further drawings.



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The Digital Statue of Liberty Project

The problems encountered

in the field

- long hours of working in the field
- the security guards on the island
- the peak visitor flows

during processing the scan data

- the manipulation of the gigantic amount of point cloud data
- the drawing the stones in the Fort walls and the curves of the Statue
- the frequent collapse of the computer hardware and software
- drawing the reflective parts such as the glaring torch

There are no standards or guidelines

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An Overview of the Utilization of the Laser Scanner in Heritage Management

The advantages of the laser scanner

- it is applicable to all 2D and 3D surfaces
- it can produce very detailed, accurate, submillimetric data
- it captures data very fast in (near) real time
- it produces portable/customizable 3D data
- it captures a tremendous amount of data with a high accuracy rate and eliminates further surveying trips to the field to procure any missing data
- it has an ability to visualize non-visible features that are located in inaccessible places with its capacity for generating 3D models
- it is ideal for modeling and visualization
- it has an important educational/interpretational value

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An Overview of the Utilization of the Laser Scanner in Heritage Management

The disadvantages of the laser scanner

- both the hardware and sophisticated software needed to process the data is still very expensive
- it produces very large datasets which are often very difficult to view and manipulate
- it requires specialist processing and extensive training of architectural staff
- its final product still requires manual digitization
- it is used with other surveying and documenting such as total station, GPS, photogrammetry for cross-checks and inaccurate points.

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A Proposal for the Methodology of the Utilization of the Laser Scanner in Heritage Documentation and the RecordIM Initiative

What is a methodology?

- it is a set or system of methods, principles, and rules for regulating a given discipline, as in the arts and sciences
- it can be assessed as an interchangeably broad approach including the analysis and development of these methods and principles of the discipline
- even agreeing upon the rules, tools and terminology within a discipline can be evaluated as adopting a methodology.

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A Proposal for the Methodology of the Utilization of the Laser Scanner in Heritage Documentation and the RecordIM Initiative

Methodology is often confused with **method**.

What is a **method**?

- it is a particular way of doing something
- methods along with other tools such as identification of terminology, standards, policies, rules, practices constitute a part of a broader methodology

For example, both in the Seddülbahir Project and the Digital Statue of Liberty, the **methodology** was to document a historic site and produce architectural drawings, conduct deformation analyses with experimenting new technologies, involving students in the project, disseminating the findings and final products by submitting papers, articles and further studies. Both projects utilized a laser scanner as a **method** to accomplish **methodology**.

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A Proposal for the Methodology of the Utilization of the Laser Scanner in Heritage Documentation and the RecordIM Initiative

The RecordIM Initiative offers a **methodology** to develop strategies to close the gap between information user and provider and improve conservation recording practice by

- organize roundtable discussions to define the gaps between information users and providers
- publish guidelines for heritage recording, documentation and information management
- develop how-to handbooks for recording
- create a Web presence on these subjects
- develop training opportunities and materials
- develop further partnerships with appropriate and committed organizations

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A **methodology** should be **simple, clear** to everybody and reflect a **general approach**

RecordIM offers a general methodology for the heritage professionals in the international context by expressing common problems and solutions in a comprehensible manner

A **methodology** is not a mere compilation of methods, but it highlights the underlying **principles of the discipline, emphasizes the philosophical assumptions** and then **analyzes the principles and finally offers solutions**. This requires professionals from diverse disciplines, sharing their experiences and knowledge and examining the present circumstances and then offering adequate methods such as the roundtable sessions, symposiums, workshops that the RecordIM have been organizing between diversified disciplines.

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However,

- the RecordIM methodology is too **general** and has to be reinforced with more information from the local and national level.
- the RecordIM methodology is lacking the advances that are evident in the **industry sector**.

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Overall, the RecordIM Initiative is an important step to incorporate the digital technologies in the architectural documentation effectively.

I recognize this methodology and propose further methods for the utilization of the laser scanner in architectural documentation.

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Methods for the utilization of the laser scanner in architectural documentation

- 1. Pre-Surveying**
 - 1.1. Historical research
 - 1.2. Target audience
 - 1.3. Scan data decisions
 - 1.4. Preliminary field trip
 - 1.4.1. Scanner selection
 - 1.4.2. Scan Data Collection Planning
 - 1.4.3. Time Management
- 2. Surveying**
- 3. Processing the Scan Data**

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Conclusion

- RecorDIM is an important step to bridge the gap between the digital surveying technologies and diversified heritage professionals offering an efficient methodology
- The documentation project should be integrated in the cultural heritage management plan
- The multi-disciplinary approach in documentation should be encouraged and the team members should be trained in different fields
- There is a great need for qualified staff who have been involved in utilizing digital surveying technologies in heritage projects
- There should more standards and guidelines
- When the programmers do develop a way to eliminate the human error and improve the drawbacks of the laser scanner technology, it will be the major surveying tool in the field.

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Thank you

Bridging



the gap