SPATIAL INFORMATION SYSTEM FOR CONSERVATION OF HISTORIC BUILDINGS CASE STUDY: DOĞANLAR CHURCH İZMİR

S. Günay [a]

[a] METU, Department of Architecture, Documentation and Conservation of Historic Buildings Master Program Ankara, Turkey – srkngny@gmail.com

Poster Session 2 – Archaeology & Conservation – GIS

KEY WORDS: Conservation, Decision Support, Information Systems, 3D Modeling, Database

ABSTRACT:

Conservation of historic buildings requires comprehensive and correct information of buildings to be analyzed in conservation decision making process in a systematic and rational approach. Geographical Information Systems (GIS) are advantageous in such cases which can be defined as computer based systems for handling geographical and spatial data. GIS have the potential to support the conservation decision making process with their storing, analyzing and monitoring capabilities. Therefore, information systems like GIS can be seen as a potential significant instrument for dealing with the conservation projects.
This project aims to analyze the transformation process of the data collected in conservation process into practical information in order to adapt this process to a spatial information system. In this context, use of Geographical Information Systems is tested in the process of historic building conservation on spatial information system designed for Doğanlar Church İzmir chosen as the case study. Hence the advantages and disadvantages of local information systems in conservation decision making process of historic buildings can be criticized.

1. INTRODUCTION

1.1 Spatial Information Systems (SIS) for Conservation of Historic Buildings

Conservation decision making process of historic buildings is a process that necessitates the utilization of spatial and attribute data considering different aspects of historic building and coming from different sources. At this point Geographical Information Systems (GIS), as systems developed to deal with complex and multifaceted geographical / spatial data, can be considered as an important supporting tool throughout this process.

In order to understand and assess the support of GIS in conservation of historic buildings, their definition, basic properties, components, functions and examples of their utilization in conservation of cultural heritage should be defined.

1.2 Aim & Scope of the Study

The major aim of this study is to asses, with pros and cons, the support of the spatial information systems especially in the analysis and evaluation phases of the conservation decision making process of a historic building from a conservation architect's perspective. Accordingly, the main goals of the study can be described as follows;

- To resolve the conservation decision making process of historic buildings and to state the structure of GIS database.
- To build a spatial information system by using GIS for a historic building and to exemplify the features of the database for analyzing and evaluating the data collected through a case study.

While doing these, the focus was on data storing, structuring, analyzing, monitoring and visualizing, as fundamental components of conservation decision making process of historic buildings.

1.3 The Method

As mentioned above, the aim of this study is to assess the support of GIS in managing spatial information about 'a historic building' within its conservation process. Hence, as there are very limited number of examples in which GIS is used as a tool for information management in single building scale, there is not an already established methodology and pre-defined processes which can be adopted and followed. Therefore, this study, itself, had been an empirical process of learning from the very beginning till the end.

In this study as the aim was to assess GIS through the architectural conservation perspective, it had been necessary to review the conservation decision-making process of a historic building so as to define the spatial and attribute data types required within this process. So, another important component of this study had been resolving the data types and procedures within the architectural conservation process. Parallel to this, the definitions, components, data types and data management procedures are also studied so that GIS data model for a historic building can be designed.

These had formed the fundamentals of the following phase, which focused on a specific historic building – Orthodox Church in Doğanlar, İzmir – chosen as the case study for this thesis. The criteria in choosing the case had been the variety in terms of materials used, structural and material problems, construction technique and change. The SIS established for this specific case is named as HBIS (Historic Building Information System).

From the beginning of the case study, some objectives were defined, it was not known if it would be possible to achieve all or not. Among these objectives was trying to provide a 3D SIS which would allow the data entry, structuring, and management and monitoring. Therefore, from the survey phase onwards data is always collected within a 3D coordinate system. Almost all the building except some details was measured with Total Station. Besides, all the inner and outer facades are photographed with high resolution digital cameras, which are then rectified by using photomodeler V.5.0 as a part of the documentation process. During the documentation phase data concerning the main topics defined in an architectural conservation process are also collected.

The collected data are later on transformed to CAD by using AutoCAD 2007 and the documentation drawings of the building were produced as CAD files. At this point two parallel studies have been done as producing 2D plan, sections and elevations as well as 3D model of the building.(Figure 1)

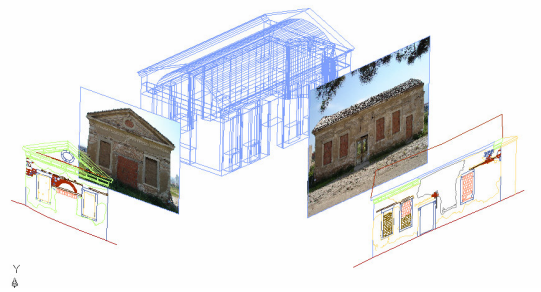

Figure 1. Production of CAD drawings and 3D CAD model

Although the multipatch geometry in GIS seemed to allow formation of a 3D model, after various trials, the studies showed us that data editing could not yet be possible with a 3D model in GIS without using additional scripts. After that result, this time various other trials are made to design the most efficient system which can support conservation process of a single historic building by using the 2D environment of GIS. Therefore, the data entry was done through the 2D documentation drawings. Following the establishment of the GIS data model with spatial and attribute data, visualization of the structured data and the results of the queries between different topics are made over the sections, elevations and plans. The integration of different 2D drawings and the management of the system are made by the help of a key plan.

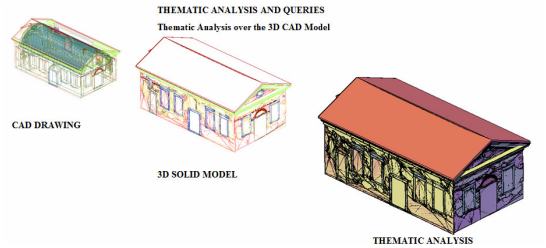

Figure 2. Thematic analysis

Thus, from the beginning of the case study till the production of the final output, there had been a lot of trials, failures, feedbacks and redoings within this process

2. HISTORIC BUILDING INFORMATION SYSTEM (HBIS)

The Historic Building Information System (HBIS) prepared for Doğanlar Church can be classified into four main phases. The first one is the survey phase, which covers the metric survey of the building and data collection about various aspects. The second phase is the "data structuring". In this phase, the collected data is transferred to the GIS by designing a database and defining a data model. Later, thematic maps on different topics are provided over the structured data. Then comes analysis and evaluations where queries are made between different data topics. Following these phases, all the raw and processes data are visualized in the GIS environment by using a key plan.

As the utilization of Geographical Information Systems (GIS) in conservation process of historic buildings is comparatively new issue, therefore the process of using GIS in the construction of HBIS for Doğanlar Church has created its own problems and solutions. Usually these problems were solved by reconsidering the application from the beginning.

2.1 Designing and Defining the GIS Data Model

Design of the database is one of the most important phases of a GIS base conservation methodology. At this phase, the necessary spatial data is decided and the database system is designed before entry of the data.

The content of the data that is used in database system can be very different and comprehensive. The above mentioned phases of the conservation process require information about the contents and components of historic building in order to structure an utilizable conservation process. The meaningful data groups are required in order to use the data for the following phases. Therefore feature classes should be defined with necessary attributes in appropriate formats.

In guidance to the resolving of the conservation process, the historic building can be evaluated with respect to three basic data groups; the building itself with its surrounded site scale, the spaces of the buildings and the components of the building.

It is clear that an historic building can not be evaluated apart from its surrounded site context. Therefore the main

attributes were decided for building feature class. First of all the geometry of this feature class was decided as polygon that is appropriate for visualizing the historic building as well as the surrounded buildings. The attribute data defines the data about the building in general. At this phase the data about the building is defined such as; the address, the owner, the registration status, current function, original function, structural system, change degree, construction period, etc. other than the data about the building itself the data about the survey and the method.

The building space was introduced as the next feature class at the database system. At this point the data about the space is defined as well as the data about the survey of the spaces. This feature class represents the attributes in order to have information about the current and original function of the spaces of the building as well as the space quality in guidance to decisions.

The other feature class is defined as the building components in which the data about the components of the building was studied such as the architectural, structural and finishing elements of the building. The data about the components of the historic building was classified according to its type and name and main data was introduced as the construction technique, structural and material condition, the change degree and the reasons and types of detachments.

In order to handle the collected data during the survey phase, the data groups should be classified into logical feature classes and attributes with appropriate geometry. All these feature classes and attributes are decided in order to utilize necessary analyses and queries in GIS environment.

Starting from the survey phase the collected data should be appropriate for GIS environment. The measurements of the 3D coordinate points, the creation of rectified images etc. are needed in order to structure the database system.

As it was mentioned before, historic buildings can not be evaluated apart from its own surroundings, therefore the database structure of the building need to involve the surrounded buildings, roads, natural objects, etc. In order to get brief information about the edifices around the building and about the building itself the database started with the definition of the surrounded site. At this point data model defines the name, the address, registration status, the owner, the donor, the original and existing function of the building as well as the height, structural system, material, etc.

Following creation of database design and the data model, the raw data collected during the survey phase is transferred to GIS environment. The data coming from different sources have been entered into the system in the forming relational database.

The spatial objects created through *Auto*CAD were transferred to the GIS environment with relation to the database system that was created with ArcCATALOG. At this point two parallel studies were carried on; the transfer of 2D documentation drawings of Doğanlar Church and the transfer of 3D model of the building.

After creating the geodatabase, which consists of the feature classes with specific geometry and atrributes defined during the database design, by using the ArcCatalog interface of the software, data entry is made in the ArcMap interface

During the data entry first the graphic data created in AutoCAD is transferred to ArcMap as different feature class and attribute data for each feature is entered.

However, the data entry process had not been so unproblematic. Especially during the transfer of both 2D and 3D graphic data created in AutoCAD, the study had to be reconsidered several times. The important point here is the format of the spatial objects at the drawings throughout the transfer of the drawings to GIS environment. At first the drawings were prepared in AutoCAD as polylines that represents the façade or plan objects. During the transfer of these drawings, it was realized that the spatial objects at the drawings (i.e. the plaster covering at the exterior façades, the stone lintels, the brick walls, etc.) should have been prepared as polygons in order to introduce the objects in GIS environment as visible and usable data. Hence the drawings revised and were changed to the polygons and transferred to GIS environment. But again the drawings could not be visualized as usable data objects in GIS. At this phase it is understood that the spatial objects should have been closed polygons in order to be visualized in GIS. Considering this problem the drawing process was repeated and the spatial objects that were created in AutoCAD were changed into closed polygone objects. By this exercise it was understood that, in order to use the spatial objects that were drawn in AutoCAD, it was necessary to draw closed polygone objects.

The other study was maintained with the transfer of the 3D model of the building that was prepared in 3D AutoCAD. The model was prepared as vertical and horizontal elements of the main building and completed with the architectural and finishing elements similar to the database system. At this study the important point was to evaluate the whole building as a complete model in order to visualize the building on different data topics with all components. The visualization of this model at GIS environment could not be possible. Only the model was transferred to the ArcVIEW in which no kind of data query is possible.

The queries in GIS could be prepared with closed spatial objects as previously mentioned, but it could not be possible to transfer and query the multipatch data to GIS. The model was evaluated as documentation drawing with the layer system that was prepared according to the material diversity of the building.

2.2 Data Entry, Structuring and Query

Following the entry of graphic and attribute data about each feature class, thematic maps are provided over different data topics.

Starting from the larger scale, first of all a map showing the the building within its surrounding site is prepared. In this map, the roads, the buildings and natural environment around the building were documented. The basic information about the building is given within its surrounding context, for instance; the address of the building, the ownership and the owner of the building, the registration status, the original and the current function of the building, date of construction, sources of information, height of the building, etc. these parameters documented with the building's surrounded site.

Following the site plan, various thematic maps are also prepared for the building itself over the measured drawings of plan, sections and elevations. In these maps, material, construction technique, degree and types of changes, structural condition and material condition are given. The detail drawings and pictures for the areas that were investigated in detail are linked by hyperlinks.

Last but not least are the thematic maps about finishing elements of the building. At this point the elements were

studied according to their name, construction type, material diversity, change degree, structural and material condition and reasons and types of decays. The detail drawings, photographs and the documents related to the surveyed area was added with hyperlinks to the places that are studied in detail.

2.3 Data Visualization

The components of HBIS of Doğanlar Church were stored through a file system. Each file related to the building stored according to its data type. First the main file was created with the name "Doğanlar Church". This file consists of six files that store all the documents due to the file type. First one is the "arcmap files" where the ArcMAP documents were stored. Another file is about the images of the building. This folder contains the image files with reference to their locations. The sketch files that have been prepared throughout the site survey also stored through this filing system and these files were located as sketches under the main file "Doğanlar Church". Another file folder was created for the text files related to the building, such as the descriptions.

This filing system also provides the organization of hyperlink files. (Figure 3-4-5) The 2D visualization files were connected through a key map. This key map combines all the information and document about the building such as the sketches that have been made through the site survey as well as the ArcMAP jpeg files. With the help of this filing system all the information and documents about the building can be managed.

The utilization of this filing system could be possible through GIS. With the help of this storing system the updated information about the building can also be added, this way monitoring of the building is provided.

The utilization of HBIS at this project enabled the author to deal with the comprehensive data through a pre designed data structure. So, the collecting, analyzing and evaluating the data about the historic building was utilized in GIS environment. The transformation of collected data to utilizable information was handled with HBIS by making different queries and different data analysis. (Figure 6-7)

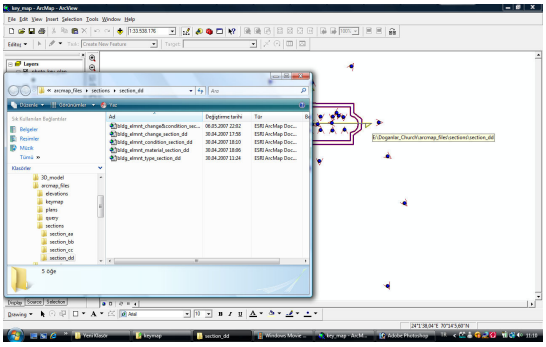

Figure 4. Utilization of hyperlink system

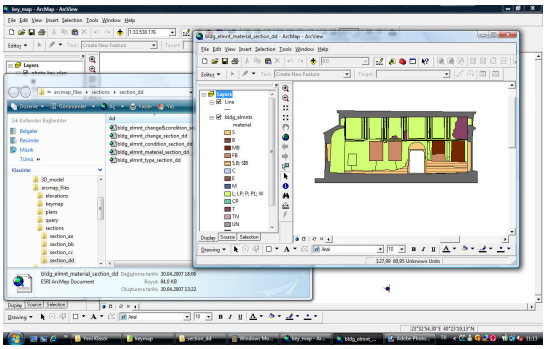

Figure 5. Utilization of hyperlink system

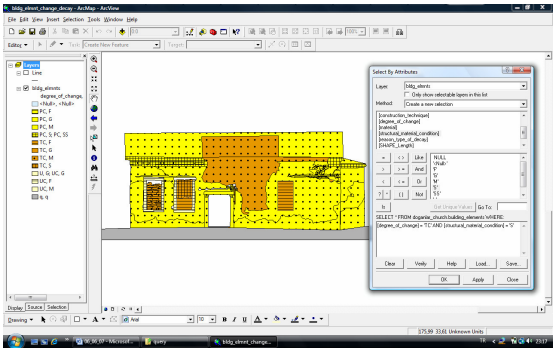

Figure 6. Queries about the building

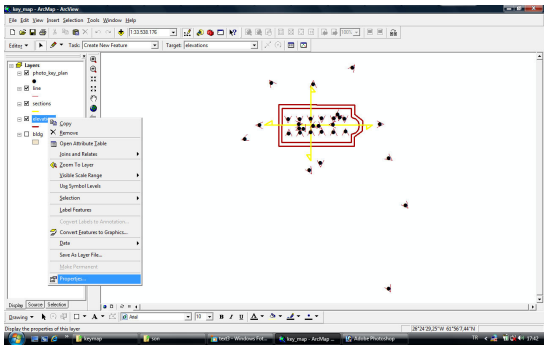

Figure 3. Hyperlink system

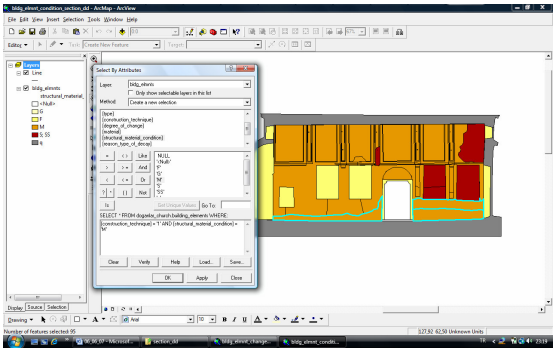

Figure 7. Queries about the building

3. CONCLUSION

Throughout the conservation decision making process of historic buildings, rich and complex data is evaluated. These data groups, coming from different sources, necessitate the management of data in order to provide utilizable information. Conservation process includes the collection, evaluation, analysis, visualization and continuous monitoring of data collected from the historic building. With the purpose of getting an organized data structure this process should be systematic and efficient.

One of the major conclusions of this study is that the conservation process of historic building requires the management of collected and evaluated data in order to improve the quality of information gathered. The data is the major component of conservation decision making process and information systems are efficient tools for storing, organizing, analyzing, evaluating and monitoring this data.

Historic Building Information System (HBIS) prepared for Doğanlar Church enables making an assessment of the advantages, disadvantages and problems of the utilization of GIS as a supporting element in conservation decision making process.

First of all GIS is a useful data management tool that enables the classification of data in different formats. Starting from the data entry to the system data is classified and categorized due to the data features. These obtained information can also be visualized in different formats in the system such as; thematic maps, table graphics or charts. This provides the variety in presentation techniques compared to the conventional techniques. The production of these kinds of display opportunities creates more efficient analysis and evaluations. With the help of various queries of different data topics enables more efficient analysis and evaluation phases. For instance, the material distribution, decay problem-intervention relation, decay types-material relation etc. can be queried with the help of the system and can be evaluated as valuable information for the conservation decision making process.

Secondly the opportunity of renewal and updating the data is a great advantage of GIS. These changes and additions can provide the continuous conservation of the building and creates a sustainable conservation decision making process. The monitoring can be provided by updating the data in the system and automatically all the changes and updates can be visualized thorough the system, however in the conventional technique this kind of corrections or updates can be provided only by utilization of the updated information for each map individually.

Additionally GIS is a useful storage tool for spatial data. Any data with any extension can be stored in the system and can be related with each other. These various data can be related with each other with the help of hyperlink feature of GIS and all these hyperlinks can be related with the help of a key map. GIS creates an integrated environment in which the spatially referenced data is connected with attribute data. The system provides the use of database system that enables making queries between different data topics. The visualization of these queries can be seen in thematic maps that can be the utilization of multiple data queries. This related environment is a consequence of different data types produced by different software programs. For instance, the transfer and adaptation of the CAD drawings or digital images is possible within GIS environment.

GIS creates information that can be shared easily through internet or shareware connections. This connected environment provides the use of the data in different systems and projects. For instance the information gathered from Doğanlar Church can be adapted to a large scale urban project. The scale of the data that is entered to the system is 1/1 scale, hence evaluations can be visualized and be a part of a project in any scale.

The utilization of GIS in Doğanlar Church also created some problems, such as; editing insufficiency (lack of 3D editing), complex and long preparation phase and limited possibility of renewal of data transferred from other software.

The documentation drawings of Doğanlar Church were prepared in CAD environment and the drawings transferred to the system. The lack of preparation of drawings in architectural detail in the GIS environment provided the correction and renewals held in CAD environment and transferred to the system. And the lack of 3D editing in GIS environment resulted as the inappropriateness of the system for 3D models. The capabilities of the system should be improved according to the use of 3D editing.

The process of the utilization of GIS in historic building conservation is a new issue. Therefore the process itself is challenge to understand the capabilities of the system properly. This creates a long time during the preparation and decision making process.

REFERENCES:

ALTINOZ A. G. B. (2002), Assessment of Historical Stratification in Multi-layered Towns as a Support for Conservation Decision-Making Process; a Geographic Information Systems (GIS) Based Approach Case Study: Bergama, Unpublished PHD Thesis, Department of Architecture – Restoration Program, METU

BAUMANN S. M. (1999), *'Integrating GIS and Cultural Resources Databases for Archaeological Site Monitoring',* Cultural Resource Management, 9, 33-35

BILGIN, A. G. (1996), Urban Archaeology: as the Bases for the Studies on the Future of the Town Case Study: Bergama, Unpublished Msc Thesis, Department of Architecture – Restoration Program, METU

DALLAS, R. (2003), '*Measured Surveys of Historic Buildings: User Requirements and Technical Progress'* Journal of Architectural Conservation, 2, 58-81

HEYWOOD D. I. (2006), An Introduction to Geographical Information Systems', Harlow, England; New York: Person Prentice Hall

NAYCI, N., BİLGİN ALTINÖZ, A. G., GÜÇHAN, N. Ş. (2003). 'An Appraisal of the Utilization of GIS in an Urban Conservation Project in Antakya', in M. O. Altan (ed.) Proceedings of the XIXth International Symposium, CIPA 2003: New Perspectives to Save the Cultural Heritage, Antalya (Turkey), 30 September-04 October 2003

WHITING D. (2005), Computer Aided Recording Tools Automate the Creation of a Site Information System, Government Services Canada Real Property Services for Parks Canada Calgary, Ontario