DESIGN OF A DATABASE SYSTEM FOR GEOMETRIC DOCUMENTATION

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ABSTRACT

The modern perception for the methodology of geometric documentation of monuments is a combination of three methods: topometric, topographic (mainly tacheometry) and photogrammetric, which constitutes the most advanced way for a fully controlled survey of objects of high accuracy. The amount of information collected, but also produced after processing, in combination with the diversity of data, creates a lot of problems, which complicate the task, resulting to unreliable end products. The management of information is of utmost importance for the correctness of the result and it would be useful, if this data were to be categorized in a system, in such a way, that retrieval of usable information, along with permanent and easy record of data is possible. This paper describes the design of a Database System, which will help the organization of data and will constitute the base for the development of a complete and integrated system, which will be a useful tool in all phases of the survey, from the decision making to the delivery, but also in any future need. In the conceptual modelling 33 entities and 32 interrelationships were defined, which where categorized in 5 sub-databases. The logical modelling lead to the creation of 45 tables. The Database is able to administer all kind of data that is required (collected and produced) in all phases of a geometrical documentation of a monument, where the combination of the three methods, and eventually others e.g. laserscanning, is applied. Therefore it is able to contribute to the geometric recording of any kind of monuments, from the simplest to the more complex one.

1. INTRODUCTION

Experience of those who deal with geometrical documentation of cultural heritage, shows that there are numerous and diverse problems to overcome. The difficulty mainly originates from the nature of the monuments themselves, but also from the necessary inter-disciplinary approach, which imposes co-operation of different scientists and experts, who very often speak a different language.
The management of the enormous amount of data, collected and produced, which must be easily traceable and understandable from all those involved, constitutes one of the main problems, as, in many cases, it causes fatal errors and unwanted delays.
This paper describes the theoretical design approach of the database system which was developed during the compilation of a postgraduate thesis (Tapinaki, 2003).
A Data Base offers integral information organization, data safety, speed of information retrieval and segregation of data and program. Thus the easy access, addition, substraction or modification of information is ensured, as well as the efficiency, the independence and the flexibility of the system.
The Database System "Geometric Documentation Data" combines all the collected non-homogeneous data and changes them into usable information. In addition, a complete management system is being developed, for the particular data base. This system provides all the required operations for data management.

2. GEOMETRIC DOCUMENTATION

Geometric Documentation is the essential way of recording the present state of monuments, as it results through time and supply the necessary background to those who investigate the past, but also to those who care about the future of monuments. (Makris, 1999).
The aim is to record the position and the existing real form, shape and size of monuments, in the three-dimensional space, of a particular moment. The end products of this action form the base map of other special researchers, offering them more time, convenience and -of course- reliability (Georgopoulos & Ioannidis, 2005).

2.1. Methodology

The exact methodology of the survey of a monument depends on the combination of many parameters which, in each case, should be carefully considered and evaluated for the final choice. The modern perception for the methodology of Geometric Documentation is the combination of topometric, topographic and photogrammetric methods, which constitute the most advanced way for a fully controlled survey of the monument of high accuracy.
Surveying provides the geodetic, topographic and photogrammetric networks, photogrammetry records the details in space and the simple topometric methods complete the above, when it is impossible or inexpedient to apply. The procedures of measurements and calculations are the usual topographic and photogrammetric ones, adapted to the special needs for each monument. (Georgopoulos, 1998).
At first, inspection of the monument and the surrounding area is carried out and any available information, about the monument, is collected, such as previous surveys, old imagery, historical details about the construction etc. Then, the choice of the methodology and the programming of work are made, according to the demands of the survey, the monument attributes and the available equipment.

2.2. Data

The data collected, but also produced after processing, are diverse: images, notes, sketches, topographic measurements, points, coordinates, vector drawings, combined drawings orthomosaics and many more. The data format and storage also varies. Some data, such as digital images, measurements' and coordinates' files, vector drawings etc. are stored in hard drives or compact disks, unlike negatives, notes, sketches etc. Consequently, the more complex a monument is, the more complicated the necessary methodology, which results to even more diverse data.

3. NEED FOR A DATABASE SYSTEM

The diversity of data and its different kind of format and storage make the work difficult and the loss or omission a common fact. The survey of a monument may last from a few weeks to a couple of years, according to the size and complexity of the object and the demands of the specifications. In that period, the composition of the research or supervising team may change, for many reasons. Therefore, in order to avoid delays, there should be a way for immediately and completely informing the newcomers and enable immediate use of the acquired data.
Moreover, some data may be needed in a future survey of the same monument, from the same or even other persons. In that case nothing will ensure the retrievability of data, because if data is not organised, it is unusable.
Consequently, the management of information is very important for the correctness of the result and it would be useful, if this data were to be categorized in a suitably organised system and in such a way, that retrieval of usable information, along with permanent and easy record of data is possible.
In such a way, loss or omission of important data will be impossible and, most importantly, the communication between the persons involved in the whole process will be easier.
The solution can be given by a Database System which will organize the whole data and it will constitute a useful tool in all phases of the survey, from the decision making to the final delivery, but also in any future need.

4. THE DATABASE SYSTEM

4.1. Requirements

The complete database management system (DBMS) must:

- organize all necessary data of the geometric documentation of a monument,
- convert the diversity of data to usable information,
- give the possibility of information management,
- be easy to use, even to not familiarized users,
- have such a security system, so that it is reliable and ensures the controlled flow of data and
- provide suitable dat management and means of data retrieval pointing to their exact storage location.

4.2. Group of Users

The DBMS will cover the needs of several users:
The research team will be able to organize the collected data, during a project and achieve better co-ordination of works.
The project manager will be immediately informed about the progress of work and take the appropriate decisions.
The team supervisor will be equipped with a great tool for easier supervision, but also will be able to retrieve important and useful information at any desired time.
Moreover, in case of requirement of additional work there will be an easy way of retrieving the necessary data. While, in a future survey or other type of research, the use of required data will be possible, even to someone, who never worked in the project previously.

5. DESIGN OF DATABASE

The most important step in the development of a Database System is the design, which must always be carried out with a lot of attention.
The correct design of the database is the main criterion for the quality of the whole system. Insufficient and incomplete database means problematic storage of essential data, so that the extraction of information will be difficult, and failure in the representation of the real world in the database.

5.1. Conceptual Modeling

The goal of conceptual modeling is the representation of real world into the conceptual model, so that the content of database to be described in an explicit way, without regard to its materialization. A conceptual model is being used as the common communication platform between future users, designers, analysts and programmers of the database (Figure1).

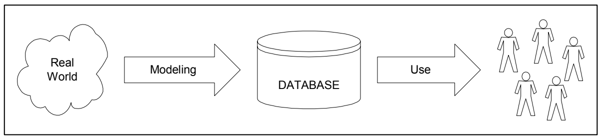

Figure 1. From real world to a database

In the phase of conceptual modeling the entities and the interrelationships are determined, their properties are defined, and the primary keys of each entity are selected. As entity is considered each object with natural existence or object conceptually real, with properties all the attributes and the characteristics that describe it. While, as interrelationships between the entities are considered all the processes that connect these objects. (Stefanakis, 2000).

Each phase of the methodology of Geometric documentation was faced as a separate subset, which is related to the others through certain procedures. This segregation facilitated the database design, simplified the database schema and lead to the development of subsystems, so that management of data follows the course of work.
These, totally five, subsystems are:
1. *Project*: includes all the concepts and procedures concerning the project, the research and supervisor teams, the surveyed object, the projection planes, the division of object in architectural parts and the single objects that it incorporates.
2. *Photography*: includes all the concepts, procedures and equipment concerning the acquisition of photogrammetric imagery, the images and scanning for the production of digital imagery.
3. *Topography*: includes all the concepts, procedures and equipment concerning the topographic method, in the field and in the lab, measuring and processing: establish, measure and solution of topographic networks.
4. *Photogrammetry*: includes all the concepts, procedures and equipment concerning the photogrammetric method and its products: processing images and production of orthomosaics, DTMs etc.
5. *Vector Drawings*: includes the production of drawings, primary and final.

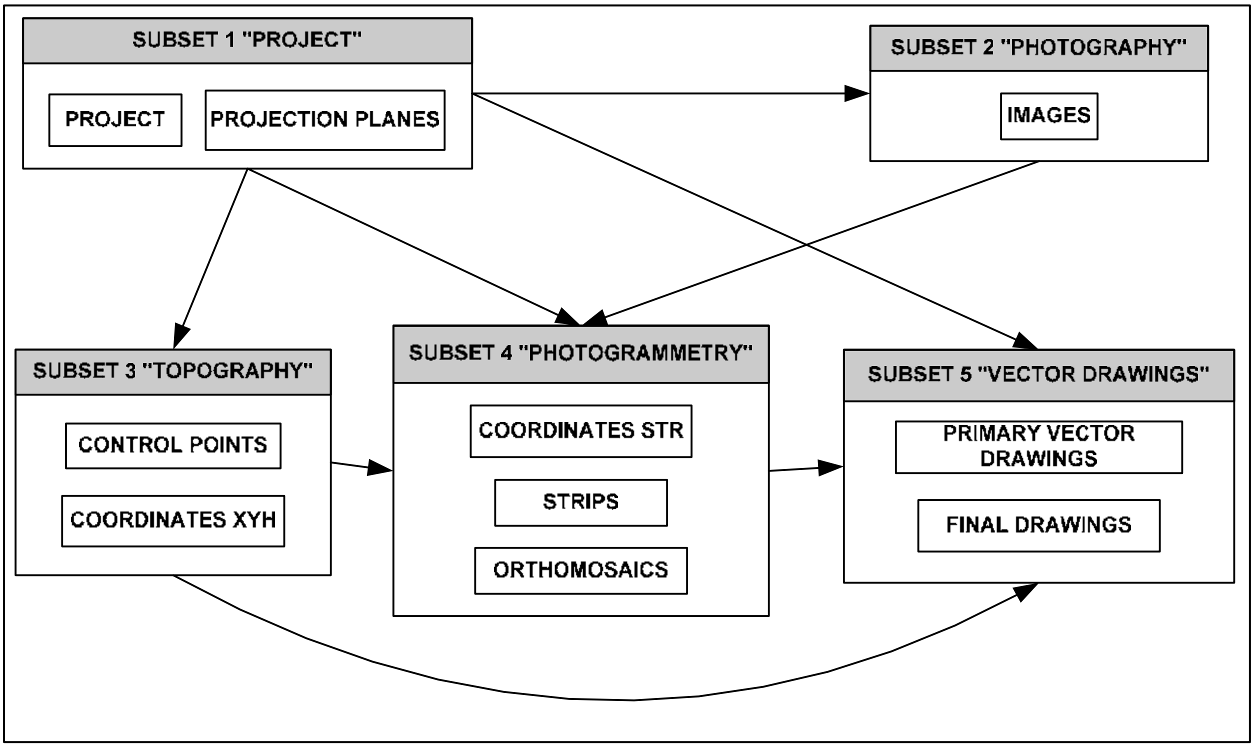

Figure 2. The subsets and the node-entities.

Each subset has Master and Secondary entities. *Master* entities are those which represent each phase of the methodology (project, objects, tacheometry, orthomosaics etc) while *secondary* are considered the ones which play only auxiliary roles (cameras, surveying and photogrammetric instruments etc).In both cases there are entities who owe their existence in the processes (digital images, strips, DTM etc), while others are independent (supervisors, researchers etc).

Moreover, there are the *Node-entities*, which are the master ones responsible for the connection between the subsets (Project, Projection Planes, Images, Control Points, Geodetic Coordinates, Photogrammetric Coordinates, Stereo, Orthomosaics and Primary Vector Drawings). On the contrary, although some entities are present in more than one subset, they are not involved in the connection and so they are considered as secondary (cameras, surveying and photogrammetric instruments).

At the end, 33 entities and 32 interrelationships were defined. The representation of the conceptual model was made with the Entity Relationship Model (E-R Model), which assembles all required attributes of an ideal model, as expressiveness, simplicity and formality while, at the same time, it models the absolutely essential concepts and gives the possibility of graphic representation of natural world in the formal world of "entities" and relations between them, that are called "interrelationships".

The subsets and the node-entities appear schematically in figure 2, and the conceptual model is shown in figure 3.

The logical modelling is the next step of database design. The goal is to hide certain concepts of data storage, but the result must be able to be directly materialised in a computing system. The relational model was used, in which the database is represented by a group of relations, where each relation is described with a table. That is to say, users see the entities and interrelationships as tables. Finally 45 tables were created.

6. USE OF THE DATABASE IN GEOMETRIC DOCUMENTATION PROJECTS

The Database is able to support the geometric documentation of a monument during all phases. Its flexibility makes the system capable to cover all kind of monuments, from the most complex to the simplest ones.

The goal is the management of data to follow the course of work. In this way, the data collected or produced will be immediately entered and can be restored at anytime.

When data is stored in the database, it is being coded with an alphanumeric code. In this way the immediate identification of its attributes is possible, since each digit of this code represents the value of a certain attribute. For example each image is being coded with a 10digit number and each projection plane with a 4digit one.

In addition, the continuous supervision of work, the timely intervention in eventual problems, the correction of errors and the cover of omissions will be possible.

Significant advantage of the system is the extraction of reports, which help the collection of data, facilitate the insertion in the database and, moreover, they can be used in the compilation of technical reports which accompany the delivery of end products.

The system is easy to learn and use and provides two subsystems: management and retrieval. In this way, the flexibility of the system and the safety of data are ensured, as different access rights can be defined for various groups of users. The management subsystem provides operations for addition, abstraction or modification of data, while the retrieval allows only search and retrieving operations.

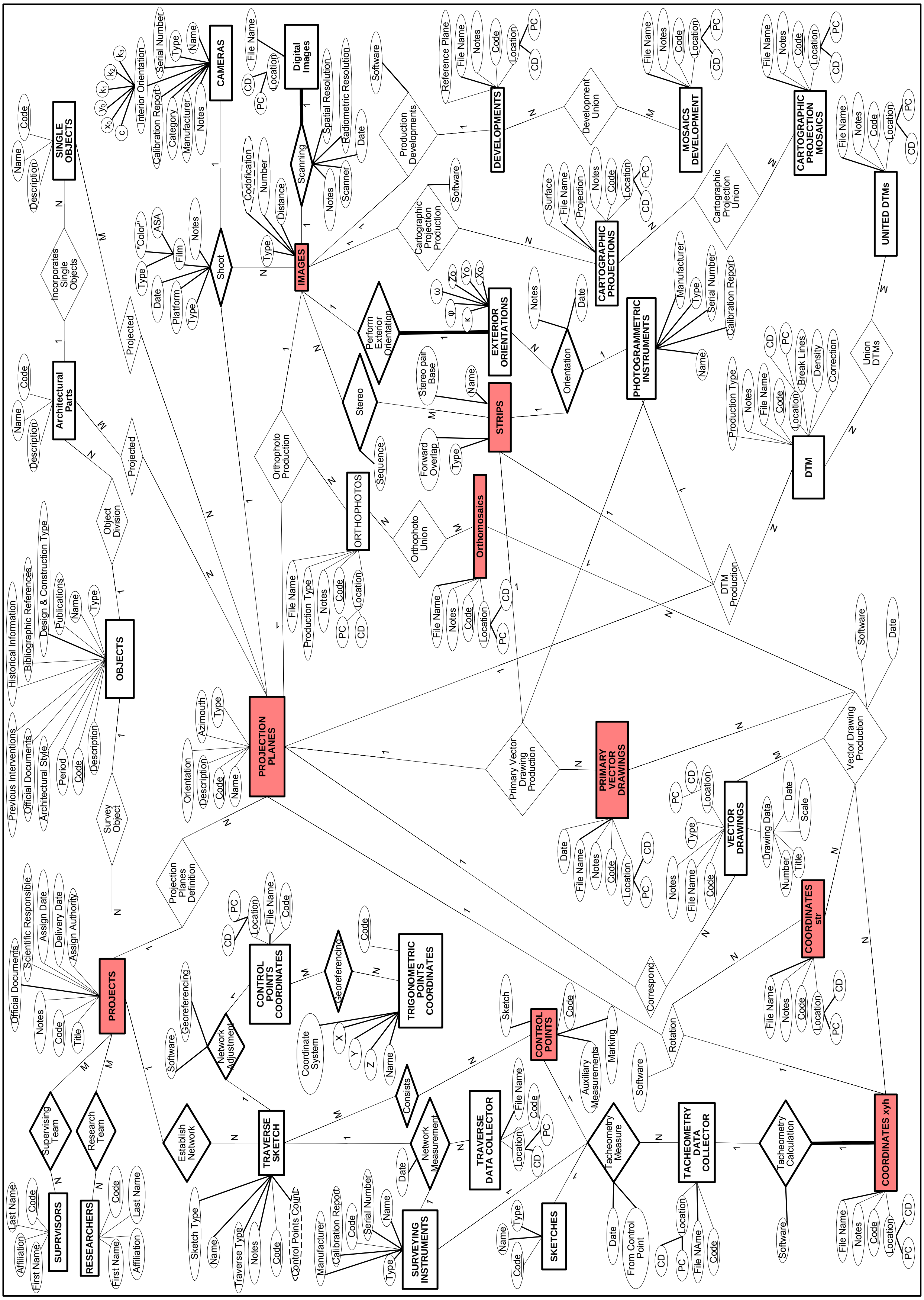

Figure 3. The Entity Relationship Model

7. CONCLUSIONS

Geometric Documentation of cultural heritage is a very complicated issue. The methodology depends on several factors and differs for each monument. Thus data is not always the same. Depending on the requirements of the survey it is possible for certain data not to exist or come from different sources.

The Database System "Geometric Documentation Data" is a first attempt for the collection and the analysis of the demands and data of Geometric Documentation of monuments. The main goal is the organization and essentially the record keeping of all data and information involved in surveying of monuments.

The flexibility of database makes the support of geometric recording of any kind of monuments possible, from the simplest to the more complex one, in all phases of the survey, from the decision making to the delivery, but also in any future need.

In future this database is going to be integrated into a GIS, for more efficient and complete work. In order to transform the database into a spatial one, the design of it must be reconsidered and the logical modeling must be done with the object-oriented model.

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