Digital recording of cultural heritage: case study AL-Remeilah castle, Al-Ain, UAE

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Heritage management whether conservation, restoration, etc. is a planning process that involves a sequence of decision making through the various levels of interest: policy making, planning decisions, management, administration and implementation. The efficiency of this process is largely dependent on the availability, accuracy and flexibility of the information systems supporting this procedure. The general objective of this research is to equip conservationists with an appropriate tool enabling the storage and consultation of archives and the communication and presentation of information. The work presented here is the first stage of a more complex research project to be carried out in a comprehensive scale in the city of AlAin, UAE. This paper is a contribution to the domain of computer tools for archeological and architectural restitution of ancient buildings. It describes on-going research project into sustaining the urban heritage of AlAin by means of a three dimensional heritage record. A brief theoretical review of 3D modeling techniques then a case study (AlRemailah Castle) will be presented to illustrate the initial process of a 3D model creation, opportunities and constraints.

لا بد للتغير السريع ان يواكبه نظام معلوماتي يتسم بالمرونة الكافية التى تؤهله لامداد صانع القرار بالبيانات اللازمة للاحتياجات دائمة التغير. و تعد عملية إدارة التراث سواء كانت بالحفاظ او بالترميم عملية تخطيط يتبعها قرارات إدارية و تنفيذية و تعتمد كفاءة هذه العملية بشكل أساسي على وفرة و مرونة المعلومات التى تدعمها. يمتد الموروث العمراني عبر أجيال عدة تتفاوت فى متطلباتها ، إمكاناتها و تطلعاتها ، مما أوجب التسجيل الكامل و المستمر لتلك البيئات الثقافية و التراثية بصفة دائمة و ذلك قبل و اثناء و بعد اى تدخل. سيكون لدقة و كفاءة نظام مثل هذا أكبر الاثر فى تطوير سياسات الحفاظ للتلائم و المعطيات الاقتصادية و المادية المتوفرة و كذلك تحديد الأولويات و الاحتياجات. وهو يهدف البحث الى توفير الأداة التي تمكن المختصين و المهتمين من متابعة توثيق و توظيف و عرض البيانات الخاصة بهذا التراث. تضيف هذه الورقة البحثية الى مجال استخدام الحاسب الآلي في مجال تسجيل و توثيق المباني التراثية. يتناول مشروع البحث الحفاظ على التراث العمراني و الثقافي للعين و ذلك من خلال التوثيق الثلاثي الأبعاد لهذا التراث سيقوم البحث بتناول حالة دراسية هى قلعة الرميلة بالعين و ذلك لتوضيح اسلوب و امكانات و محددات المجسمات الرقمية ثلاثية الابعاد فى اعمال التسجيل و التوثيق.

Keywords: Heritage, Recording, Digital modelling, Al-Ain

1. Introduction

For any given site, there is a vast amount of information all of which must be stored and kept accessible. The complete archive is of interest to only a small audience of conservationists while a television program or museum exhibit is prepared for a much larger audience but presents only a small sub-set of the available data. It stands to reason that the procedures appropriate for collecting and storing the primary record will be quite different from those needed to demonstrate and popularize a site. It is even possible that the tools we need will be unique to concerned authorities in that no other body is trying to document such resources or archive such material. A flexible mechanism for data handling need therefore to be devised to assure friendly accessabiltity to this data whereby it would serve professional, academic, educational as well as cultural interests [1]. This can only be achieved via constant renewal and maintenance of this data; this implies the necessity of an ongoing program of updating and maintenance.

2. 3D modeling

As working with 3D computer models is becoming a standard in architectural practice, architectural photogrammetry and CAAD c n

become partners very naturally [2]. As a discipline, architectural photogrammetry is currently undergoing profound changes. New technologies and techniques are developing in very high pace: for data acquisition (CCD cameras, photoscanners, 3d laser scanners), data processing (computer vision), structuring and representation (CAD; simulation, animation, visualization) and archiving, retrieval and analysis.

The graphic three-dimensional " digital architectural model" is, at the same time, a multi functional and a basis for stock presentations serving further archeological and cultural-historical research. This process involves three phases: acquisition (on site capture of data), modelling (data plotting) and presentation (visual reality, animation, ...etc.). The advantages of 3D modeling can therfore be formulated as follows:

- Plans for any possible field of research can be computed at invariant scales;
- Axonometric and perspective presentations, which make it easier to understand complex spatial relations, are directly accessible;
- Data material can easily be supplemented and reconstructed because of its digital storage;
- Animation and simulation programs produce highly realistic presentations of objects

4. Case study: Al Remailah fort

4.1. Background

Al Remailah fort is a small size castle, located in the northern gate of AlAin city, fig.1. The fort was chosen to illustrate the process of 3D documetation. Although the original date is not clearly evident, it is suggested that it dates back to the the middle of last century. It is mainly constructed and plastered in mud with timber roofs. The castle consists of a main building, surrounded by a fence. The building consists of two stories of multiple rooms, with a main function of hosting the guards and storing food supplies, weapons and ammunition. This is a typical style of forts built in this area, in the middle of the 19th century.

4.2. Methodology and work steps

The objective of the survey was to model the site in a computer based system, in a CAD environment. That is, to produce a complete 3D representation of all details of the site, with correct orientation, and dimensions between any two points of the site. Different methodologies and techniques were investigated to carry out the survey works. Various techniques were investigated, first 3D scanning, second photogrammetry employing CCD cameras of digital output, and the third was using a conventional surveying approach utilizing a total station. The later technique was chosen, primarily for the following concerns:

1-Accuracy

The obtainable positioning accuracy using a conventional technique, employing accurate total stations and adopting careful planning, could lie within a few millimeters. On the other hand 3D scanning and photogrammetric approaches require high accuracy cameras with involved software and the accuracy obtainable will be within a few millimeters to the cm level depending on camera resolution and complexity.

Availability

Off-the-shelf total stations can be utilized using the conventional approach, while dedicated cameras with special software were needed to carry out the photogrammetric method [3, 4]. Similarly special 3D .

Scanners would be needed to do the survey if the spatial scanning is considered.

Cost: the over all cost of the conventional method is lower than that applying the photogrammetric or scanning techniques. It is also worthwhile mentioning that the project on hand is a pilot project for an ultimate objective

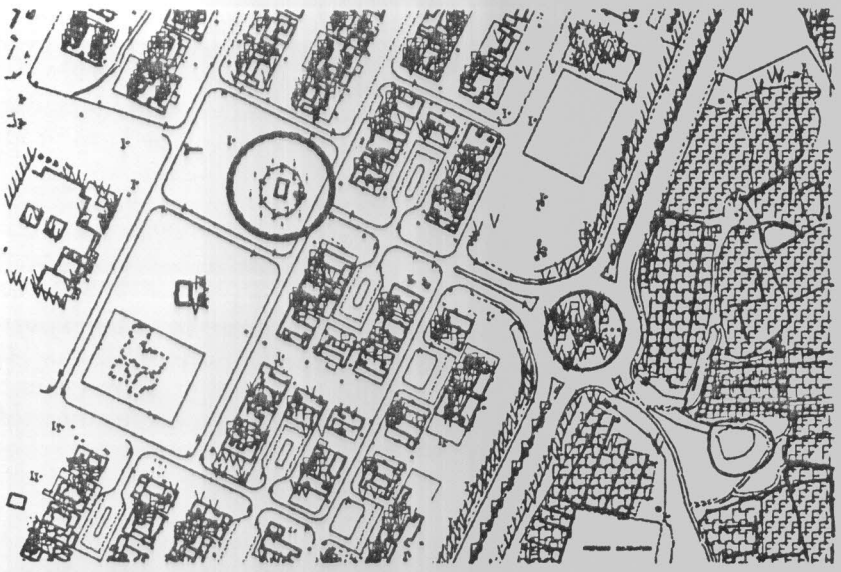

Fig. 1. The location of AlRemailah castle.

of documentation of all historic sites at the UAE, and investment in purchasing of dedicated CCD cameras or even employing some 3D scanning techniques can be considered in a future stage.

The survey works was made up of three phase:

First step: reconnaissance, included visiting the site, performing a complete photographic recording of the forte (Fig 2), key points were identified and labeled for each façade as depicted in Fig.3. Based on this data, the final reconnaissance step included choosing location of the ground control stations and linking them to nearby local control points, planning, and setting optimal methodology for the field work.

The second step: collecting field data (fieldwork), started by establishing an exterior traverse of five fixed points surrounding the castle. Fig.5 illustrates a sketch plan showing the location of these stations, marked (A) through (F). The traverse points were linked to existing control points in the area to relate the derived orientation and coordinates to the local frame of AlAin city. An interior traverse of four stations was needed in addition to the exterior traverse in order to determine coordinates of all details of the castle. The interior traverse (marked by the points I1, I2, I3, I4) is also shown in Fig.4. The mapped details included a fence, walls, shooting holes in the walls, doors, stairs, etc.. Since the objective was to produce a 3D model of the structure, a special procedure had to be adopted. For instance, when surveying a vertical line (such as the edge of a wall), at least three points were determined on different heights along that line. This is different somewhat from the conventional procedure of mapping in the 2D, in which only one point (usually the closer to the ground) is being

determined to represent projection of the vertical line. Determining points on different heights with the total station was challenging in certain spots, due to feasibility concerns while preserving high accuracy. In addition, point labeling was made for each point for easy interpretation when processing. Since the castle was originally built in the middle of the last century, the building methods and tools used were simple. This resulted in some irregularity in shapes that were supposed to follow certain modules. An example to that is shooting holes, which varied in dimensions between some locations. Therefore, a thorough survey work of every detail was necessary, without relaying on any apparent symmetry of the structure.

The total station used was the Sokkia, Power Set 3000, with angular display of 1" and a standard deviation of 3". The range accuracy is ± (2 + 2 ppm x D) mm, where (D) is the total station to the reflector range. With such instrument, and employing high standards in data collection and verification, accuracy in point positioning of a few millimeters was generally obtainable. Field checking (quality assurance) was carried out to ensure correctness of all gathered data, including measuring side lengths and diagonals by a tape and comparing results to those of the total station. In addition, over-determining coordinate determination of some key points by occupying different traverse station by the total station.

The third step: data processing, all data was gathered in the office, where final checking of the data was made. Processing methodology was carried out with a script file to plot this points in the 3D, providing workable method of identifying points according to their attribute (Fig.5). Final shapes were obtained by connecting points of the same attribute, and checking at points where additional data were collected in the field, as stated above for quality control purposes, Fig.6 shows the output 3D representation of one side of the forte, as an example of the final outcome of the surveying process.

Further processing of the acquired data has been carried out whereby points were arranged and contours were created vertically and horizontally, thus forming a mesh which was further developed to produce the model. (Fig.7)

4.3. Results and further work

As the model reaches a satisfying level of detail, the data is to be exported and used in other applications [5], as CAD- systems, programs for digital image enhancement and 3D-rendering and animation software.

4.4. Documentation

A simple database using Ms_ Access was designed to document visual material (Fig.8). It is organized to provide means for archiving and retrieving, a further elaboration could be made by establishing a GIS interface for a comprehensive interactive system.

5. Conclusions

Using conventional survey techniques has shown accurate and friendly means for documentation and data handling. It also has the advantage of being available and affordable.

We consider this a work in progress, the complete work is susceptible to further definition and development, in addition to improvements in its formal qualities. Further more for the several conjectures that it suggests to us, even sometimes in a problematic way; a further elaboration could be the building of a spatial data base incorporating architectural, urban and cultural aspects.

Ultimately, we consider the notion of creating a "laboratory for urban history" that would be an institutional structure that produce material simulating various aspects of the cultural heritage of AlAin.

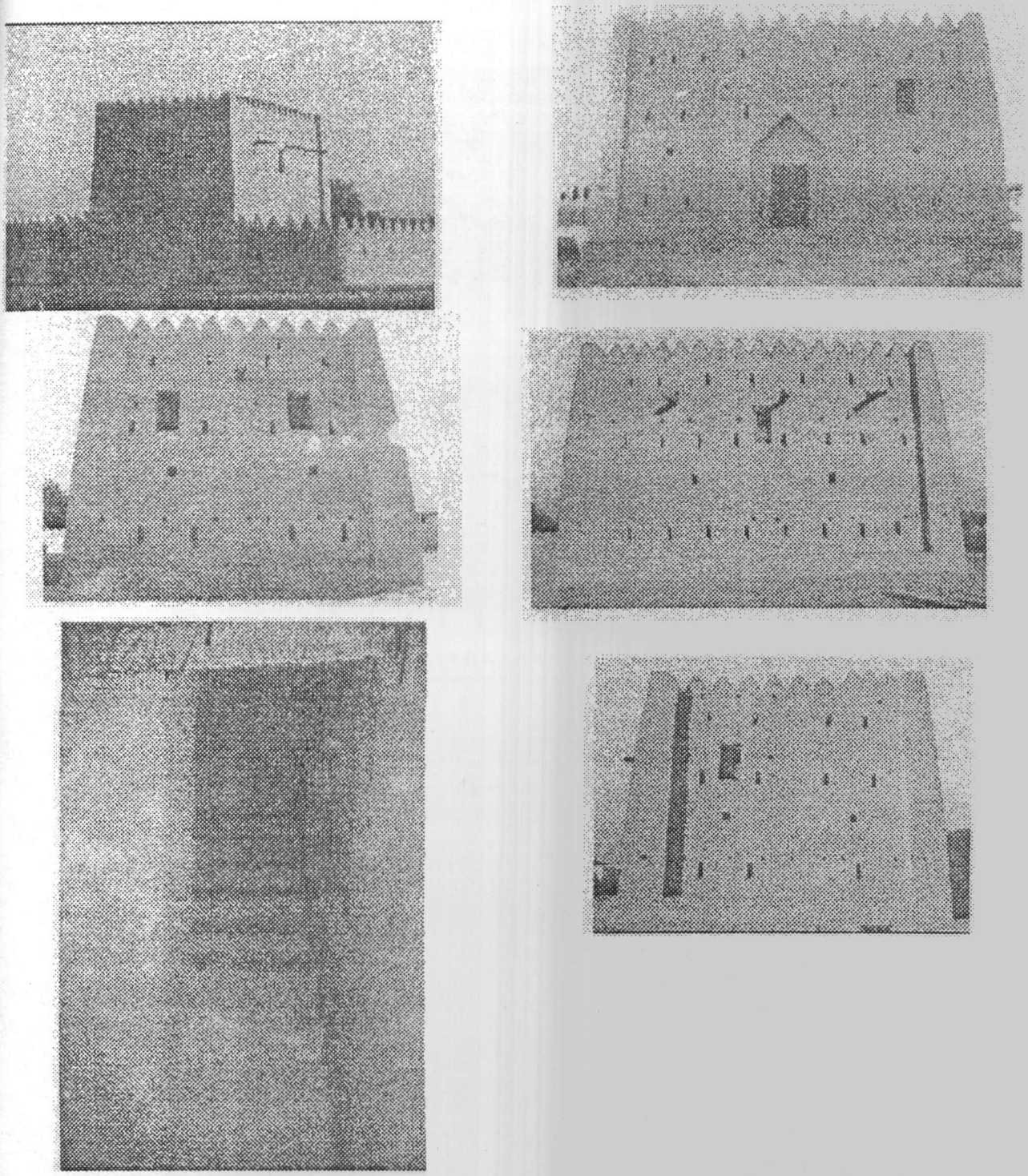

Fig. 2. A complete photographic survey was done.

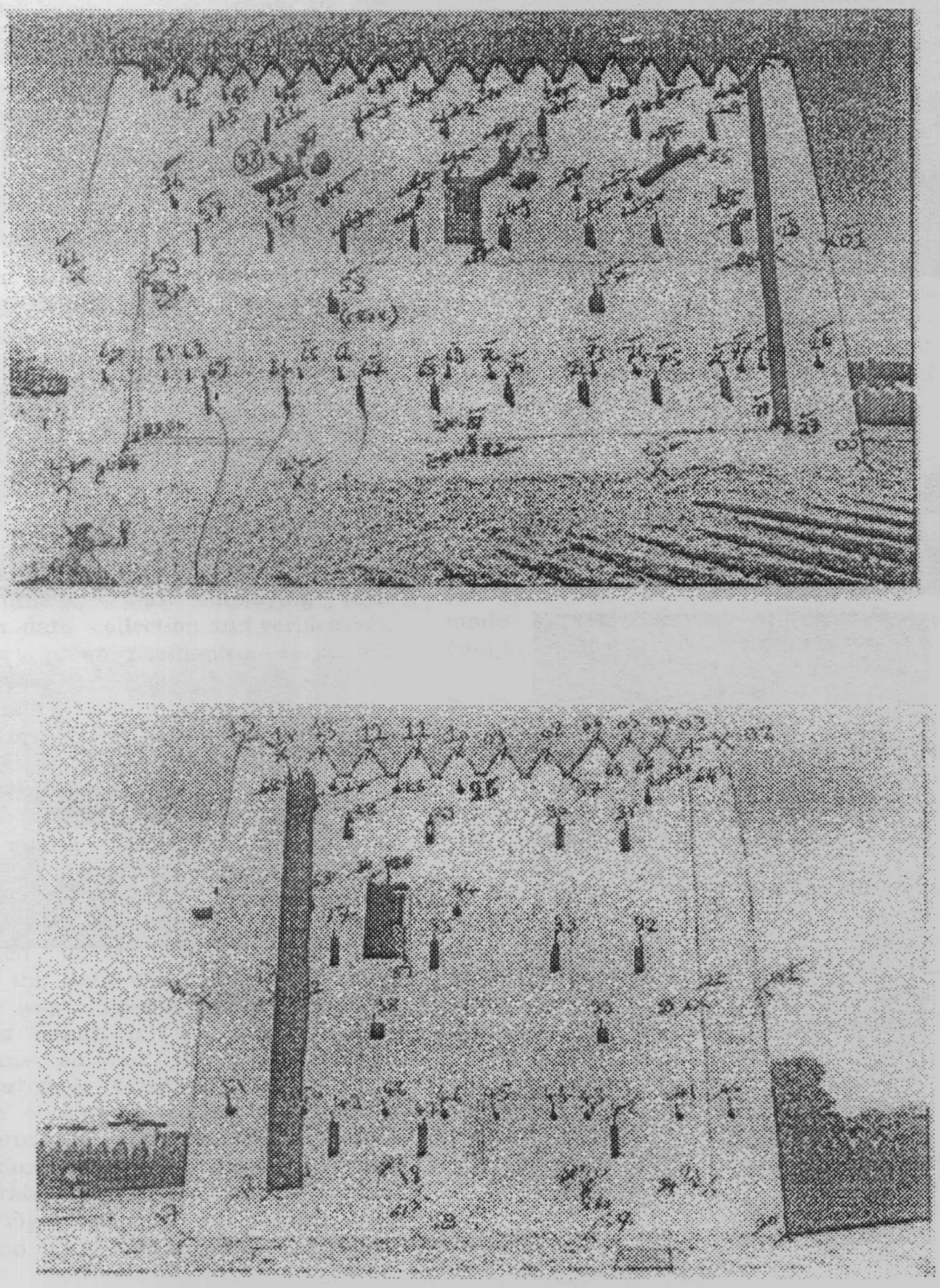

Fig. 3. Reference points were identified and marked for each façade.

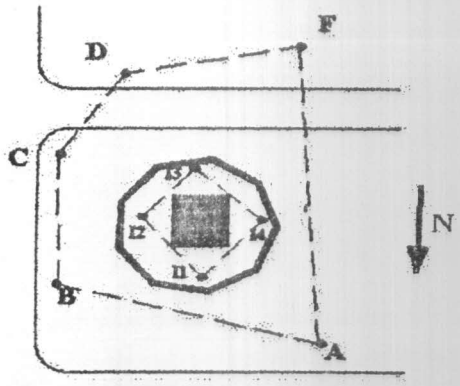

Fig. 4. The surveying traverses.

Fig. 5. Points were plotted into a CAD environment.

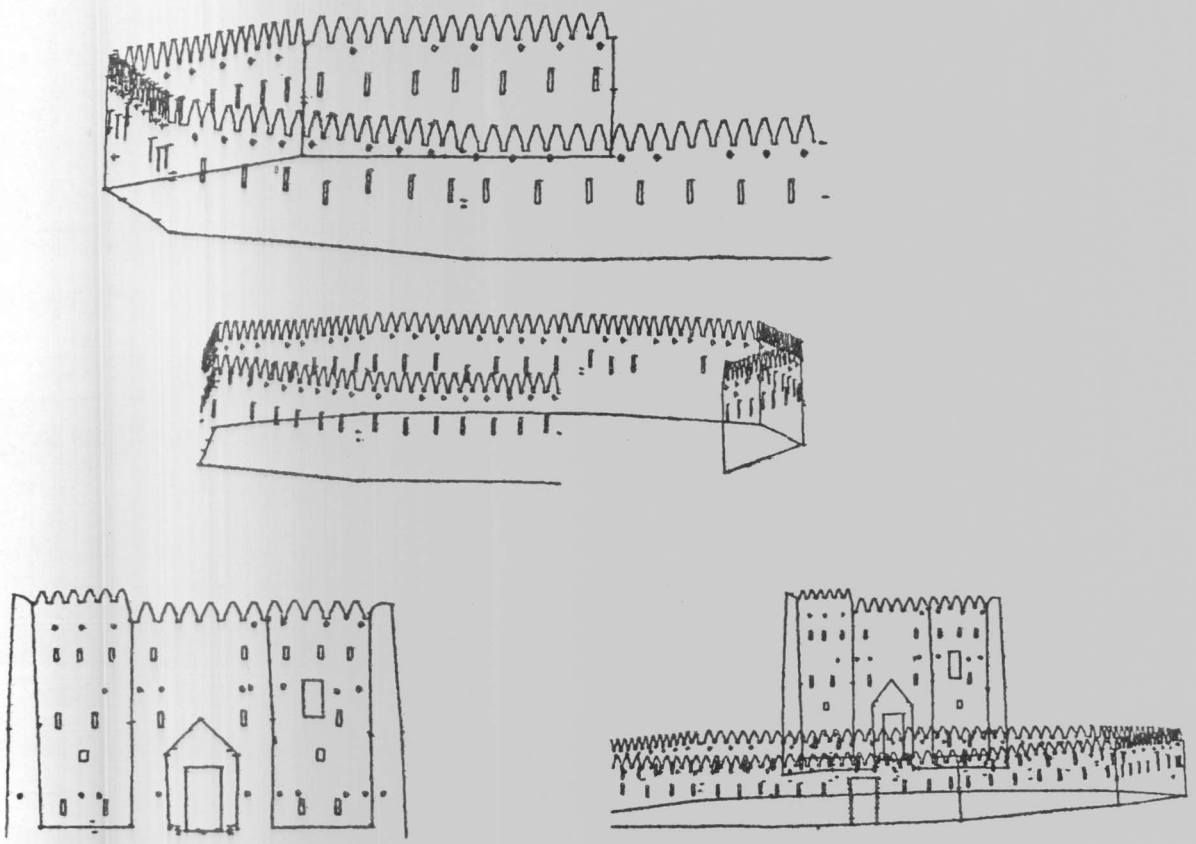

Fig. 6. A generated 3d model at its early stage.

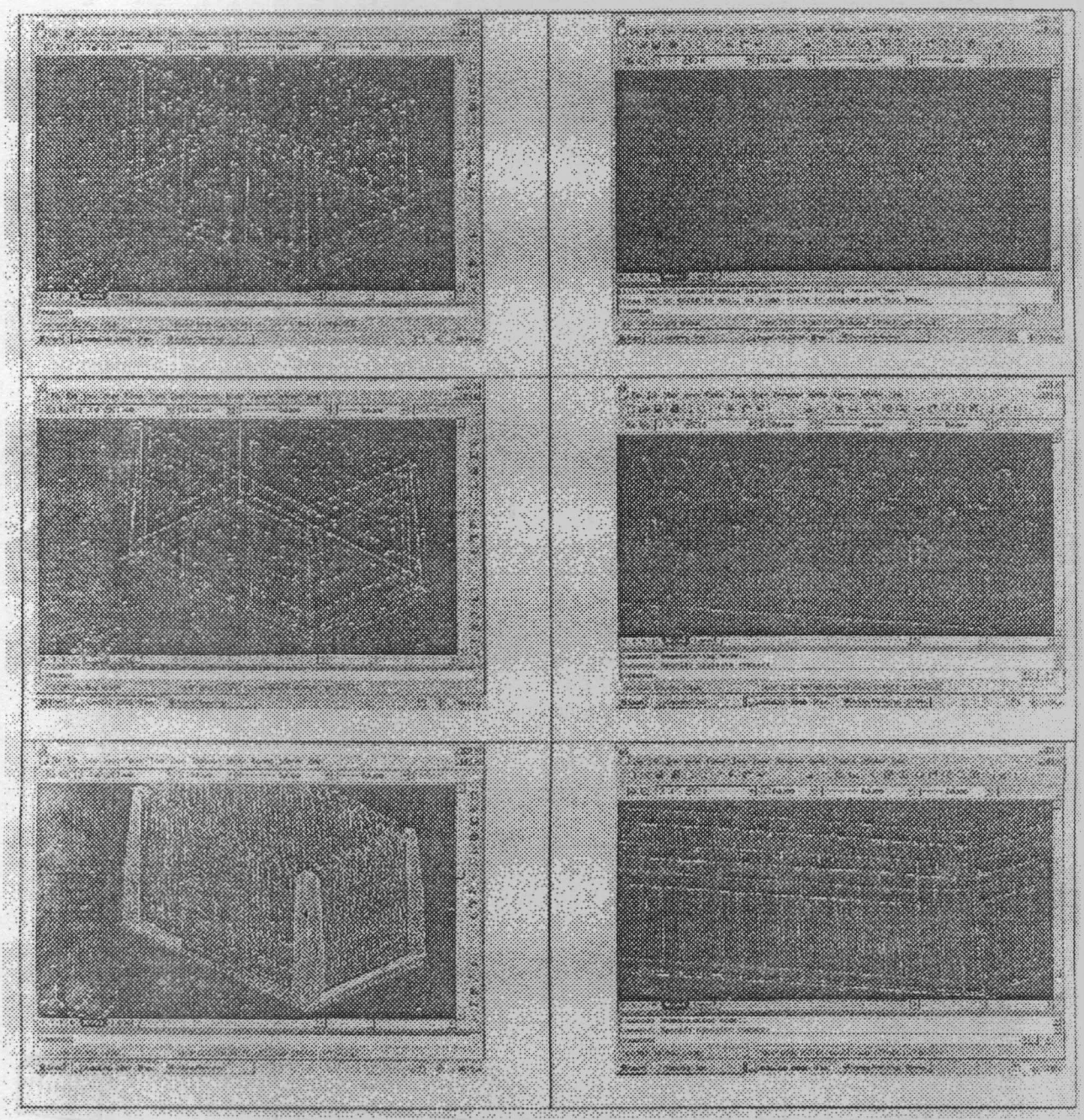

Fig. 7. Producing the model from points, continuos, and meshes.

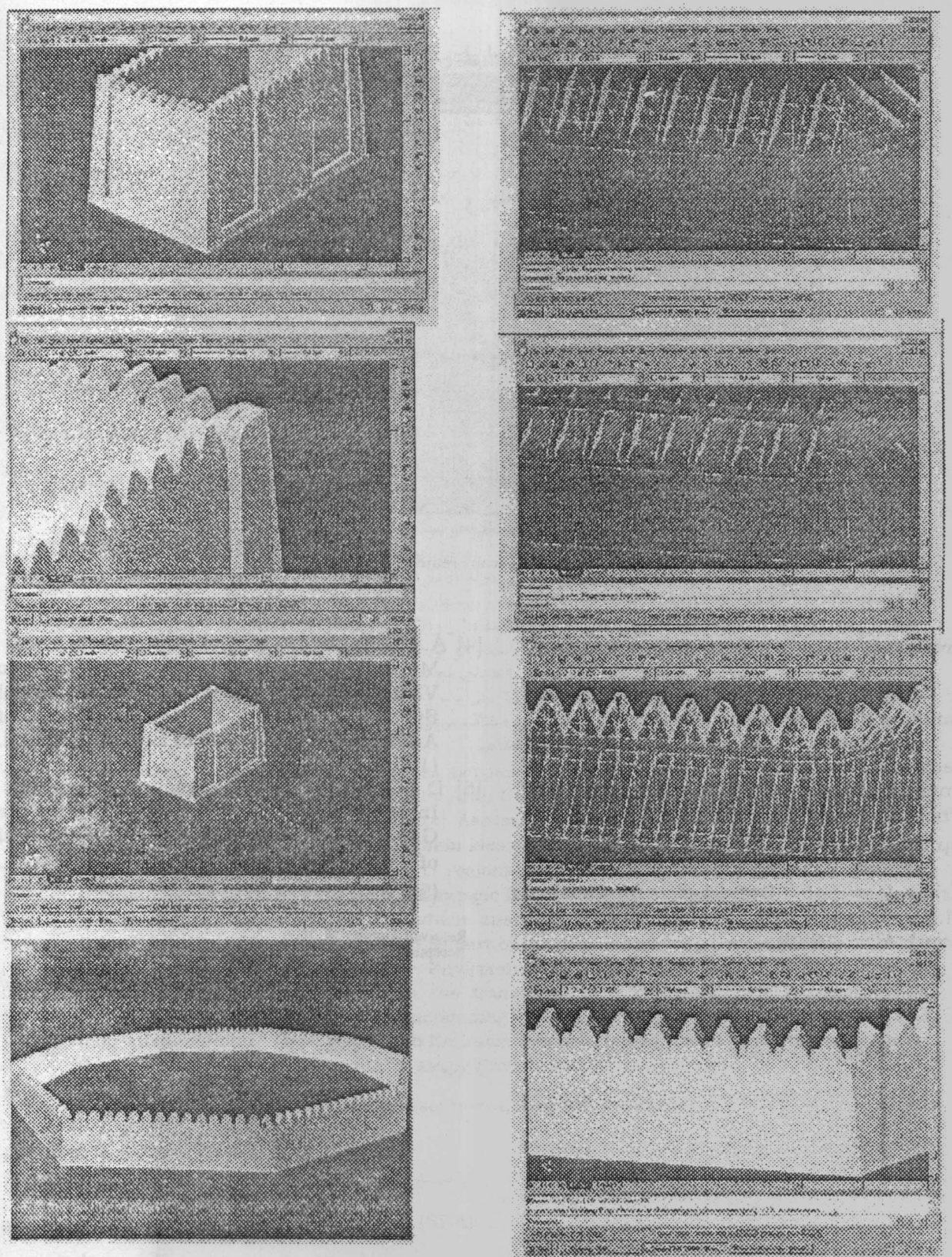

Fig. 7. (Cont.) Producing the model from points, continuos, and meshes.

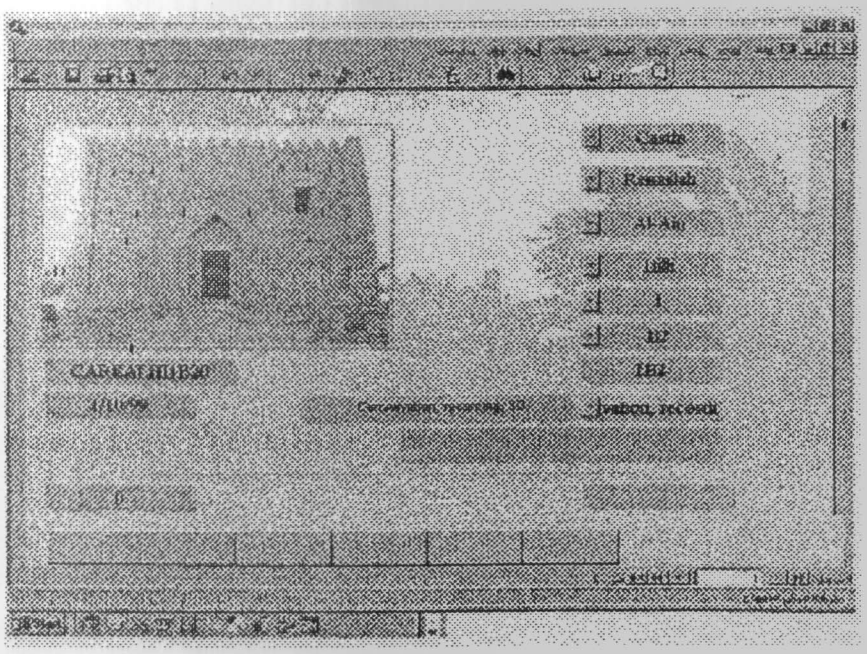

Fig. 8. An Ms-Access data base was created for visual archiving.

References

[1] B. Feilden, Conservation of historic buildings, Butterworths (1982).

[2] V. Sequeira, et , al., "Automated reconstruction of 3D models from real environments", ISPRS Journal of Photogrammetry and Remote Sensing, (54) pp.1-22 (1999).

[3] C. Shull, Photogrammetry and the Archeology of Buildings, unpublished M.Sc. thesis, University of Cape Town, South Afric (1999).

[4] A.S. Chalmers, M. Stoddart, Belcher, and Marc Day, An interactive Photo-Realistic Visualisation System For Archeological Sites, Technical report, Dept. of Archeology, University of Bristol, England. (1996).

[5] D. Chapman and A. Deacon, "Panoramic Imaging and Virtual Reality – Filling the Gaps Between the Lines", ISPRS Journal of Photogrammetry and Remote Sensing, (53) pp.311-319. (1998).

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