FACULTY OF ARCHITECTURE

DRAWING, GEOMETRY AND COMPUTATION

FA.ULisboa – 2015/2016

Luís Mateus (Immateus@ulisboa.pt)

Metodologias de Levantamento Arquitectónico

LISBOA

NIVERSIDADE DE LISBDA

CONTENTS:

<u>1. INTRODUCTION</u> <u>Framing of recording</u> <u>Documentation and Conservation</u>

2. SURVEYING METHODS Terrestrial Laser Scanning and Digital Photogrammetry Surveying with TLS and DP (three case studies)

<u>3. APPLICATIONS</u> <u>Models of building analysis</u> <u>Throughout Architectural Design</u>

4. PRACTICAL APPLICATION Exercise: 3D reconstruction based in images

1. INTRODUCTION

ArcHC 3D





"ArcHC_3D"

(FCT:PTDC/AUR/66476/2006) - from October 2007 to May 2011

Contributions to Architectural Heritage Conservation: Documentary Methodology based in terrestrial digital photogrammetry and 3D laserscanning

Summary

This research project arises from the need to understand the impact of the new documentary technology of 3D later scanning and the new vectors of photogrammetric research, namely automatic and semi-automatic methods of 3D reconstruction, in the study and analysis of the architectural heritage within Consensation. It was formed a multi-disciplinary team composed of researchers from several institutions (Faculty of Architectural heritage, University of Colmbra – CUC), institute Management of the Architectural and Archaeological Heritage – IGESPAR) and Laboratory of Architectural Photogrammetry. University of Valiadolio – LFAUVA). The project methodological Heritage – IGESPAR) and Laboratory of Architectural Photogrammetry. University of Valiadolio – LFAUVA). The project methodology was strongly based on the production of documentation, using the above mentioned technologies, in the context of practical application. It is noteworthy the production of documentation underlying the Rehabilitation Project of the tradese of the Terretro do Parco blocks in Lisbon, in which it was a survey a survey of 50000m2 of facade structure expective photogrammetric processes, the production of bocumentation in the Consensation Project of the Arco of Rua Augusta also in Lisbon, in which we accomplished a complete survey of that architectural and sculptural structure by the use 3D laser scanning, and also the various surveys held in Tomar, in the city historic center and in the Convent of Christ. These were carried out, among other methodologies, through the implementation of automatic photogrammetric techniquee.

Objectives

This research project had three main goals:

1. Create the basis for a minimum Architectural Heritage survey system based on low-cost terrestrial photogrammetry to:

- Support of three-dimensional restitution of buildings for repair or restoration interventions;

- produce plans, sections and elevations with great economy of effort.

2. Explore the possibilities of coordination between terrestrial laser scanning and photogrammetry in order to:

- Investigate the methodological implications in the analysis and diagnosis in the Architectural Conservation planning;

- Allow the acquisition and the production of basic data that enables the interventions of repair and restoration.

3. Define and propose an information system that allows the management of qualitative and geometric (2D and 3D) in order to:

- To support conservation and restoration analysis and intervention;

- Support for dissemination and study of the architectural heritage;

- To complement, with quantitative dada, other national information systems.

Main conclusions

The main conclusions of this research can be stated as follows:

Although more and more the paradigm of 3D documentation is becoming a reality, there are more traditional methods that still are valid.
 The use of three-dimensional graphic documentation systems in the context of conservation and rehabilitation, should be made being aware of the use of complementary methods (eg GPR) and maintaining a culture and a habit of direct observation of objects.

Atthough the use of three-dimensional systems results in a high amount of three-dimensional data, it is still a reality that in most cases these
are used to produce 2D documentation (CAD drawings).

 However, in this production, the 3D data can facilitate the process as it is more flexible because it allows greater freedom of choice both in the features to be depicted and in amount of information to be registered.

- The three-dimensional data extend the possibilities of reuse and revisiting the same objects.

(archc3d.fa.utl.pt/archc3d.html)

> FAUTE > CIAUD > UM > UC > IGESPAR > UVA > FCT

RESEARCH

> Home > Output_indicators > Gallery

LINKS > Architectural Heritage, Photogrammetry, 3D Laser Scanning,...



- Fig. 3 Workflow: Initial point cloud
- Fig. 4 Workflow: Evaluation function

ReabOP

Fig. 5 - Workflow: Automatic planar surfaces recognition

Museu da Presidência da Repúbliza

Data das imagens: 23/6/2007 🕗 2001

strated and

-

B.I.F













(2011) TLS and photogrammetric survey of the "Palácio de Belém"











Master thesis of João Covas - FAULisboa





Master thesis of João Covas - FAULisboa



VisualSFM developed by Changchang Wu (V0.5.20) A visual structure from motion system

Copyright (C) 2006-2012 Changchang Wu and University of Washington

http://homes.cs.washington.edu/~ccwu/vsfm/

Java Graticule 3D (OpenAdjustment) An OpenSource Least-Squares-Adjustment Tool

http://javagraticule3d.sourceforge.net/



http://www.123dapp.com/

http://www.netfabb.com/basic.php

» netfabb Basic

netfabb Basic is available to anybody, it is free just like in free beer, and runs on Windows, Linux or Mac.

		-	-	-	
net	fahh	Pro	fes	sion	12

CloudCompare^{V2}



http://www.danielgm.net/cc/



http://meshlab.sourceforge.net/

Screened Poisson Surface Reconstruction (Version 7.0)

http://www.cs.jhu.edu/~misha/Code/PoissonRecon/Version7.0/



JRC 3D Reconstructor FULL & FULL Edu

PIX4D simply powerful



http://www.gexcel.it/en/lidar-software-solutions/reconstructor-full



http://www.3dreshaper.com/

https://pix4d.com/



Home > Products > PhotoModeler Scanner
PhotoModeler Scanner

POLYWORKS® 2015 ENHANCES MEASUREMENT QUALITY, REPEATABILITY, AND PRODUCTIVITY

http://www.innovmetric.com/

http://photomodeler.com/products/scanner/default.html



http://www.agisoft.com/

FRAMING OF RECORDING

- Principles

General level of framing; general principles (ex. <u>ICOMOS charters</u>, <u>Guide to</u> <u>Recording Historic Buildings (ICOMOS</u>)

- Guidance

Orientation on how to do; best practice examples; publications with instructions (ex. <u>Recording, Documentation, and Information Management for the Conservation of Heritage Places (RecorDIM), Laser Scanning for Heritage (English Heritage), Measured and Drawn (English Heritage)</u>

- Specifications

Mandatory level; criteria that recording and documentation must comply (ex. <u>MSSCH – Metric Survey Specifications for Cultural Heritage (English Heritage)</u>

Important sources: CIPA/ICOMOS, ISPRS, ENGLISH HERITAGE



PRINCIPLES FOR THE RECORDING OF MONUMENTS,¹ **GROUPS OF BUILDINGS AND SITES (1996)**

Ratified by the 11th ICOMOS General Assembly in Sofia, October 1996.

DEFINITIONS OF WORDS USED IN THIS DOCUMENT:

Cultural Heritage refers to monuments, groups of buildings and sites of heritage value, constituting the historic or built environment.

Recording is the capture of information which describes the physical configuration, condition and use of monuments, groups of buildings and sites, at points in time, and it is an essential part of the conservation process.

Records of monuments, groups of buildings and sites may include tangible as well as intangible evidence, and constitute a part of the documentation that can contribute to an understanding of the heritage and its related values.

THE REASONS FOR RECORDING WHY?

RESPONSIBILITY FOR RECORDING WHO?

PLANNING FOR RECORDING

HOW?

CONTENT OF RECORDS

WHAT?

MANAGEMENT, DISSEMINATION. WHAT FOR?

AND SHARING OF RECORDS





FOREWORD by HRH The Duke of Gloucester

ACKNOWLEDGEMENTS

INTRODUCTION Purposes of recording

Chapter 1	WHY? Objectives of recording	3
Chapter 2	WHEN? Occasions for recording	10
Chapter 3	WHAT? Features that require recording	25
Chapter 4	HOW? Approaches and techniques	32
Chapter 5	WHO? Carrying out the initial survey	67
Chapter 6	WHERE? Preserving the record	69
Appendix I	Interpretative elements	73
Appendix II	Some useful addresses	77

CHAPTER I

WHY?

OBJECTIVES OF RECORDING

The first object of a survey should be to record what is necessary in order to understand and to illustrate the history of the building, its plan, structure, development, use and decoration (Figure 2). **TO** UNDERSTAND made of such features to inform the architect's own decisions, which in turn he sets out in drawings and specifications that will inform a contractor of those elements that are to be preserved, restored or accurately reproduced. Similarly, architects and contractors in the future will want to know what has been done here and now, and, if the work has involved strucrural repair, the reasons why it had to be done. On occasions, too, when specialist conservation **TO** KNOW WHAT WASCDONE HERE AND NOW of the future. if any further treatment is needed, the original form and condition of the object are known, together with the circumstances that made such treatment necessary.
Records of buildings are needed by their owners. In the last resort it is the owner of a building

who is responsible for what is done to it, and he needs to understand it as much as his architect does.

AS MANAGEMENT TOOL technical knowledge to read an architect's drawing or to understand a specification. Much that an owner may do. in any case. may be done without professional advice or assistance. Besides. most people have some curiosity about the history of the house they live in. and they will probably look after it better if they know something about it. Future owners of a building will find a full record, adequately illumated with drawings and photographs, an
 TO REGORD INTERVENTIONS IN THAT on but in case of fire or other accident. The aim should be to build up a comprehensive logbook of the treatment of the building over the years. including recording where additional information not contained ill the logbook itselfcan be found.

A record of the significant historical facts about a building is important to the administrator and the planner, so that they can base planning and other decisions on accurate information about it and so that they can produce evidence in support of these decisions (Figure 3). An obvious example is

TO SUPPORT DECISION ho uses the list description of a building in considering an application for listed building consent: the description is a record. to be used as an administrative tool, but more detailed information - a fuller record - both of what the building is and of what is proposed is often needed before the implications for the building can be properly assessed. Grant applications

TO INFORM ABROADER DATABASE ords are needed as supporting evidence. Planning authorities need in addition, to know the historic and environmental resources of their district, so that they can take these into account in framing local and strategic plans and in considering how to develop amenities.

Building records are needed as a management tool by those who have the care of a building, TO SUPPORT DATA GATHERING d out to the Structure (Figure 4). Surveyors need records

in assessing the condition and potential of the buildings they are called upon to appraise. Knowledge of the building's structural history makes it easier to come to an accurate assessment of its present state and to recognize any structural faults (Figure 5). Records are needed in planning a maintenance programme, in monitoring the long-term effects of repair and remedial works. in identifying defects that may appear over time. in deciding whether any historical aspects ot the building call for specially careful treatment (e.g. areas of historic decoration or where historic construction may not safely meet modem loading requirements), or in assessing whether any historic features of it deserve exploitation (e.g. by showing the building to the public).

TO SUPPORTOHISTORIC ANALYSIS are historians. Historians need records of buildings to show how people lived and worked in the past, as well as how they designed and built. Buildings can throw light on many broad historical questions - questions about economic. religious and social conditions. about the spread of ideas, and about how such conditions change over time (Figure 6). To answer such questions, historians need to understand buildings as they

were, rather than as restorations have made them; they need accurate and authentic information about how a building was built, used and altered. Historians want to know about the past as it **TO INFORMABOUT** available of the most eloquent artefacts that have come down to us from the past. Records of buildings facilitute the historian's work, and by the use of records the historian can feed information about what is important in a building back to the architect and the administrator who may have neither the time nor the expertise to acquire such information for themselves. CHAPTER 2

WHEN?

OCCASIONS FOR RECORDING

Records should be made whenever the people mentioned in Chapter I have a use for them. These people's needs will generally arise in connection with certain categories of buildings:

IF THERE WILL BE SOME SUBJECT For a particularly wen-hiformed undemanding of them if they are to be treated sympathetically (Figure 7). Such buildings may not necessarily be large ones: on the other hand. (he fact that a building is large and well known is no guarantee that it is either properly recorded or well understood. The reverse is often the case.

IF THE BUILDING IS REPRESENTATIVE OF A STYLE

• Buildings that are good examples of a particular type. form or style. These may be large and well known (Figure 8). or small and apparently insignificant but still of historical importance as illustrating living conditions at the level of the common man (Figure 9).

IF THE BUILDING POSES OR ANSWERS QUESTIONS

• Buildings that pose or answer historical problems, irrespective of their architectural merits (Figures 10 and 11). Some apparently ordinary structures (e.g. farm buildings and industrial structures) throw much light on the economy that produced them and on the daily life of the past.

IF THE BUILDING REPRESENTS SOME FORM OF INOVATION

• Buildings containing innovations of structure or design (Figures 12- 14).

IF SOME RELEVANT HISTORICAL FACT HAPPENED IN THE BUILDING

• Buildings that call for authenticity for non-architectural reasons (e.g. the places associated with great events or people. and which need to be preserved as they were at a particular time).

IF WORKS ARE TO BE DONE

All buildings where work is to be carried out and the owner. his architect or his surveyor want to know about the history and structural condition of the building before work begins.

IF WORKS ARE TO BE DOCUMENTED

• All buildings where work is being carried out and there is a reasonable expectation that people in the future may want to know what is being done now, and how (Figures 15-17).

Recording is almost always IlnpoTtJ.IH, but it is more important in some circumstances than in others. The particular circumstances of each building will in some degree affect the matter to be recorded. but occasions that will almost allways give rise to the need for a record age are:

IF A PART IS GOING TO BE DEMOLISHED

• work involving the total or partial demolition of structures of historical, architeclUral or engineering interesr;

IF A PART IS GOING TO BE HIDDEN

• work involving the destruction or concealment of any evidence for the building's origin and development;

IF A PART IS GOING TO BE DESTROYED

• work involving the destruction of historical decoration;

IF A PART IS GOING TO BE HIDDENV

• work involving the destruction of fittings, plant, etc., essential to the building's structure,

purpose or design;

IF A PART IS GOING TO BE REPARED

- major repairs of all kinds;
- work involving the temporary exposure, in the course of repair. of historical evidence normally concealed;

IF A PART IS GOING TO BE TEMPORARILY EXPOSED

- work involving remedi3l treatment that may call for monitoring over time;
- work involving the insertion of services, etc. whose location must be recorded;

PROPHYLAXY AGAINST DESTRUCTION

- fires or other accidental damage;
- abandonment of the building, accepting its subsequent deterioration;
- work ofstone-cleaning, as well as instances ofsevere masonry deterioration where the danger of loss of detail may result;
- dispersal of contents

and in all cases when, as outlined already, a proper comprehension of the building is important to its proper treatment.

DURING INTERVENTION WORKS

It is important to realize that even though work may affect only one part of a building, it may be necessary to record other areas in order to reach an understanding of it. It will be obvious that one can only tell if a part of a building is original or secondary by looking at the rest of it. Additions may be inexplicable without comp3rison with what they were added to. Elsewhere, evidence in one part will throw light on work in another. For instance, if one roof truss needs repair, evidence **DURING INTERVIENTION WORKES** of the end of the roof, for if the buildings are badly eroded, **RECORDED DATA** ginal form may have to be sought in another Part of the building. In addition to initial recording, it will often be necessary to return to the site periodically during demolition or radical alteration, to record information brought to light by the works.

Evidence for a building's history may lie below ground as well as above it, and when this is suspected of being the case (as with most buildings of which only a Part now stands, or buildings that stand on sites where earlier occupation is suspected), then the below-ground evidence should be investigated at the same time as that above ground (Figures 18 and 19). Other occasions when this should be done are when excavation for services may disturb remains associated with the building - remains such as foundations, burials, traces of garden layouts, etc.

Recording may be required as a condition of listed building consent or as a condition of repair grant from a local planning authority or from English Heritage. Archaeological recording below ground is offen a condition of scheduled monument consent, and is sometimes called for in other cases. Full use should be made of the information and expertise that may be available through the involvement of organisations such as English Heritage and the Royal Commission on Historical Monuments, and through regional Archaeological Units (see Chapter 5). CHAPTER 3

WHAT?

FEATURES THAT REQUIRE RECORDING

As a preliminary to recording, it is imponant to discover what records exist already. These may FIRST CHECK IF, THERE ARE RECORDS THAT ARE SUITED FOR THE throws light on the building's history and explain features otherwise inexplicable. Such records are of many NEEDS and available from many different sources: this is disclissed further in Chapter 4. The features that require recording are a mixture of evidence and conclusions: facts about a building's structure, form and decoration and the conclusions about the building's history that have THEN REASON ABOUT WHAT MAKES SENSE TO RECORD ice. and comes to conclusions about how Ihe building was built and used. The administrator needs the recorder's appraisal of the building, and may in addition want a record of the evidence for his conclusions. The architect needs these conclusions also, and should understand the evidence for them so that it can be physically preserved in the building. He needs too, to know the nature of the evidence and 10 understand its strength, in case further information comes to light in the course of work that may lead to a modification of the original interpretation. In addition, the surveyor and engineer need facts of their own - facts about the building's structural system and condition. about services and about previous work. Some of these will be items of which everyone involved will want a record; others may be oflirnited general concern but none the less give rise to conclusions about the building that are of value to everybody.

Items that will generally call for record include :

• overall form and dimensions - evidence for the original form of the building and for its evolution over time (Figures 20 and 21);

RECORD THE OVERALL FORM AND DIMENSIONS

• materials and construction - type of foundations, wall structure, roof (Figure 22);

SEGMENT THE BUILDING INTO SIGNIFICAN PIECES TO BE RECORDED

- decoration and ornament (Figures 23 and 24);
- plant and fittings;
- evidence for the use of the building and for changes in its use over time:
- dating evidence this may be absolute or relative.

Recording should also include information about ancillary buildings. garden and estate layouts and enclosures. and the relationship with adjoining buildings especially where this is of a formal naturl. In addition, notes should be made of items on the site which are clearly not in their current location.

Some of these enquiries may be answered by looking at documents. even though the implications of documents should always be checked against the evidence of the building itself before they are accepted as a true and accurate account of what may have happened. In many other cases, it may be possible to reach conclusions on some of these points on ly after careful and minute examination of the fabric of the building. In Appendix I is a list of the evidence that may be looked for, and recorded where appropriate, in support of these conclusions: Chapter 4 discusses how this evidence can be used.

RECORD THE INITIAL CONDITION AND THE PROGRESS OF THE WORK

in mind during the progress of the work: frequently in stripping-out or in the course of further work evidence will come to light that bears on all these issues. Any such discoveries should be **THATOMAY** the **CHANGEETHERINITIAL** in the second of the building, may demand a reappraisal of a scheme for the building's treatment, and will in any case beimportant to the historian since they may modify his original view of it.

Particular attention should be paid to recording any work in these categories that is to be covered up or destroyed. While some evidence that remains clearly visible and untouched may call for no more than a note, anything that is to be lost must be recorded fully and unambiguously so that there can be as little doubt as possible about its interpretation. There will, howlever, always be clements in a building that cannot be understood, and these also should be recorded in case subsequelll discoveries may serve to explain them,

There are occasions when material samples may be subjected to scientific analysis to determine their composition (such as a mortar make-up. a stone type, or the materials used in an earlier conservation programme), their structural properties or physical condition, or their date. Expert guidance should always be sought in these fields, and reports of experts' findings carefully preserved.

IF SOMETHING MEANINGFUL IS SUSPECTED TO BECOME LOST, RECORD IT COMPREHENSIVELY

FURTHER ANALISES MAY BE REQUIRED. THOSE CAN BE TAGED IN THE GRAPHICAL RECORDS

CHAPTER 4

HOW?

APPROACHES AND TECHNIQUES

As a first step, it is important to look for any documentary material that may throw light on the building's history or condition. There are many kinds of such material, and it may be sought in many different places. It will nearly always be found that the following are useful:

• Survey and architectural drawings The accuracy of existing drawings must never be assumed; none the less they are obviously of the greatest value, particularly when they show work to be carried out or an earlier stage in a building's development.

Written descriptions (published or unpublished). Where these are the result of a first-hand examination of the fabric or of documents relating to it (e.g., accounts. specifications, diaries) they can be of great value: on the other hand there is a tendency, particularly in the published descriptions of well-known buildings, for historical statements to be repeated uncritically from LOOK, FOR, EXISTING MATERIAL (SURVEYIS; DRAWINGS; WRITTEN SOURCES, ARCHIVE IMAGERY,...)

Other Documents. These can be of many sorts - diaries, letters, or building accounts and vouchers. They may relate to the building's origin or to its later history. The interpretation of these sources, particularly when they are old, may require specialist help: terms may be obscure handwriting may be difficult to decipher, the arrangement of information in accounts may seem illogical and the circumstances of their making must be understood in order to comprehend both the potential of such documents and the limits to what to expect from them.

 Old illustrations. Sketches. paintings and prints can be dangerously subjective (Figures 25-28). Moreover, if a drawing or an engraving has been made not from the building itself but by copying an existing illustration of it, misrepresentation may appear as truth simply because of the number of different images in which the misrepresentation occurs. But used with caution, such illustrations can be of great value (Figures 29-32), Photographs on the other hand are generally objective, and should always be looked for: they may very often be the only source of information available on relatively humble and little known buildings.

The range of potential sources for documentary information is huge, but in practice a point of diminishing returns will be recognized: after the more likely sources have been explored. it will Seem increasingly improbable that the more obscure sources can help and the time spent in searching them will seldom be worth while.

SOURCES OF INFORMATION - NATIONAL

CHOOSE THE APPROPRIATE SOURCES OF INFORMATION (NATIONAL OR COCAL COCACULAR COCULAR COCULAR COCULAR COCULAR COCULAR COCULAR C

1. The lists of historic buildings produced by the Secretary of State for the Environent. The DoE Lists", and (for Scotland) the Secretary of State for Scotland. Some description is available in the lists for vinually all of the 500,0000 or so listed buildings in England. Wales and Scotland. The information in these lists is of variable qaulity, depending on the date of survey and the qualifications of the surveyor, and in many cases was made from an external inspection only, ignoring historic features only visible from within Listing in England is now carried out on the recommendation of the staff of English Heritage and in Wales by the staff of CA DW (see Appendix II); in recent lists the account can be very full and of great value. These lists can be seen in some local libraries and planning offices. and all arc available at the N Hiollal Buildings Records (see below).

- 2. The National Buildings Records (NBRs). The English. Scottish and Welsh NBRs are the national public archives for photographs and for other unpublished records. These are run by the respective Royal Commissions on Historical Monuments (see below). Although most of the photographs held in the NBRs are of comparatively recent date manny go back to the last century, whereas the NBRs have since their esublishment in the 1940s collected measured drawings and unpublished reports of all kinds.
- 3. Of published, national surveys of historic buildings. the volumes of the Buildings of England CHOOSE THE APPROPRIATE SOURCES OF INFORMATION (NATIONAL a brief or a fuller description of the majority of the more significant buildings of England; the Series is in progress for Scotland and Wales. A building described in this series may well be recorded more fully elsewhere.

The articles in *Country Life* (from 1899 onwards and increasingly full and accurate from the 1920s) are useful. although for the most part dealing only with country houses. Also valuable are the volumes of the *Royal Commissions on Historical Monuments* (for England. Scotland and Wales; the three Royal Commissions have slightly different titles). Nonee of the three countries bas been fully covered. but where coverage exists it is generally more detailed than that in the DoE lists. The original field notes, etc from which the published accounts have been made are

held in the respective NBRs (see above). Also useful for London are the volumes of the Survey dLondon (from 1896). which has covered about one-third of the Greater London area to date.

The Victoria County Histories contain useful information about the more notable buildings of the places so far covered. being concerned in parricular with the ownership and descent of such buildings; the series is complete for some counties. in progress for others. while in yet other counties work is in abeyance.

AU these sources (except *Country Life*) cover churches as well as houses and other secular buildings. For buildings erected since about 1840. it may be worth consulting the increasingly large range of professional journals. such as *The Builder* and *The Building News* most of these can be found in Ihe public libraries of the major cities and in specialized libraries such as those of universities and of the RIBA in London.

SOURCES OF INFORMATION - LOCAL

The range of possible local sources is almost unlimited - previous ownen. local historians and collections in local libraries, local architects who may have been concerned with the building. the .archives aflocal newspapers, and so forth. Many of these will in practice prove difficult to locate without some prior knowledge (although there are many excellent guides to documentary sources published for the assistance of taeal historians), and possible sources of information may well prove unproductive. The most likely sources are:

- 1. *Published Accounts* often more readily available through the local history collections of the principal local public library. A great deal of local history (not all of it accurate, but much of it the result of research of a high standard) does not reach national publiations. Useful information, particularly on older buildings. can be found in the transactions of national and local archaeological and historical societies, although the earlier volumes of some of these societies tend to contain information that reflects tradition ramer than accurate first-hand analysis.
- 2. Unpublished documents, generally available through local (County) record offices. These exist for almost all counties and for some smaller and city authorities, and contain a mass of private and public documentary collections for the area they cover. There are generally very comprehensive indexes to the material and the collections held. Many County Record Offices also serve as Diocesan record offices for the area and thus contain church records as well as the records of the secular :administration. The Church of England has its own statutory machinery for the deposition of parish records (the Parochial Records Measure), while most Cathedral churches have an official archive and archivist.
- 3. Local government offices. The chief source here is likely to be Building Control plans and documents, and although the majority of these will be found to be site plans only, showing the location of services, omers will show the detailed form of the building as erected (if built subsequent to the adoption of local by-laws). On the other hand, many local authorities destroyed early deposited plans on the reorganizations of local government in 1974 and 1986.
- 4. *Estate office archives.* Especially for buildings dating from the eighteenth century onwatds, owners and estate offices often have comprehensive archives, including survey and architectural drawings, even where there has not been continuity of ownership.

The more important the building appears to be, the more likely it is that it will have generated records in the past. It must be recognized, however, that very many of the old buildings which will be encountered in day-to-day work possess no surviving documentation. Documentary research may often be best contracted out to a specialist, whose knowledge of likely sources and of how to use them can save a great deal of time. In approaching a specialist documentary researcher, it is EVENNED AS BUILDINGNS RECORDS CONTRACT THERE of ARE PREVIOUSS RECORDS SOMETIMES THEY WERE LOST OR NEVER EXISTED.

ANALYSIS OF THE HISTORIC STRUCTURE

It has been said already that the essence of the record lies in coming to an understanding of the building and of its development and structure, and that all recording should have as its objective

the elucidation and illustration of this understanding. This process has been called 'analytical recording' - it involves a close examination of the building, during which the building recorder seeks to disentangle its history using the many strands of evidence and the many analytical **THECHIGAS ANALUSTRATION** recorder the Wilding recorder the Wilding recorder to the wishes to building available to him.

answer about how the building was built. how it developed and how it was used - and he knows. too, the sort of evideence that is most likely to contribute to this understanding. The following are some of the most useful of the approaches that the analytical recorder employs: Some of these points are expanded in Appendix I:

MAYBE AN EXPERT IS REQUIRED. HE SHOULD BE BRIEFED ABOUT WHAT ARE THE IMPORTANT ASPECTS TO BE ADRESSED.

- Archaeological method: primarily, the identification of structural sequences by recognizing the
 ARCHAEOLOGY
 by understanding that one part of a building must necessarily pre- or post-date another. This is the fundamental technique whereby one identifies the relative (as opposed to the absolute) dating of different parts of a structure.
- Assessment of the most likely explanation for structural features: for straight joints, blocked
 STRUCTURE are several more of similar kind) are susceptible of more than one explanation. and it is important to remain open-minded to all possible inerpretations. No one explanation will be right in all cases (Figure 33).
- Recognition of the economy of a structure: the distinction between necessary and redundant structure and mass. Redundant work (e.g. inexplicably thick waUs or a rooftruss apparently out CONSTRUCTIVE PRINCIPLES AND MATERIALS of sequence may be secondary of may be a partial survival from an earlier phase of building.
- Recognition of the characteristics of the materials employed, and of what they are and are not likely to have been used for.
- Recognition that a feature of a building that may now be inexplicable could be explained by presupposing another structure, now demolished. of which no traces have otherwise been noted (and for which confirmatory evidence should now be sought).
- Recognition of evidence for related structures now destroyed (irrespective of the above).

• Recognizing when materials have been re-used, and when possible identifying tht'ir source **SOMETIMES** MATERIAS AND ELEMENTS WERE REUSED redecessor).

- Distinguishing between primary and secondary decoration.
- Recognition of the functional logic of a building: that it was built to work in a certain way for the convenience of those who used it. and that in its successive stages of development it will have IIMPEORTANCE TOFT FUNCTIONAL DUNDERSTANDING
 - Recognition of a hierarchy of spaces in a building. which may be identified directly by degrees of decoration or by external ornament. and indirectly by the position of rooms on the plan and their position in the circulatory system.
- Identification of the functional spaces normally to be met with in a building of well-recognized type (e.g. Hall, Great Chamber. etc.).
- Recognition of evidence for absolute dating.
- Identification of elements which may be explained through the employment of specialized techniques; for example, by remote sensing in order to gain access to concealed areas, by dendrochronology in order to reach an absolute date for the building, by reference of stone and mortar samples to experts for the identification of their sources, or by the employment of REGORDING ASISYNTHESISGOF ALCHENOWSEDGE ACQUIRED

And finally, the synthesis of all the material evidence suggested by the consideration of these points into a coherent account of the building's history. It sometimes happens that even the most expert building historian is beaten at the end of the day: some buildings are of such complexity, or the evidence for their history is so baffling, so inaccessible or else just so partial, that a coherent story is not possible. When that happens, one can do no more than record the evidence as it is, hoping that **RÉCORD AS¹OBJECTIVELY AND KEEP OPÉN MINDED TO FUTURE EXPLANATIONS**

Dimensioned sketches and site notes



Figure 34 Gurney Street Manor, Cannington, Somerset; perspective sketch of the junction of roof and wall structure at the north end of the solar. This type of drawing, by an experienced recorder, conveys information on structure, condition and dimensions in a clear and

Hand measurement



Figure 35 Yardley Hastings Manor, Northansptonshire; site measurements worked up into an accurate, fully dimensioned and at the same time visually pleasing structural drawing (1908)



Figure 36 Ightham Mote, Kont; ground floor plan prepared by EDM (Electronic Distance Measurement) combined with hand survey. The use of electronic equipment overcomes the problems which might jeopardize the accuracy of a survey of so irregular a plan by hand measurement alone

Photographyy



Figure 39 Barn at Walton, Peterborough, Cambridgeshire; photograph of surviving members of the structural frame. To record such a deformed structure by drawing would be practically impossible; the camera records the etsential features of the structure and its jointing and averably



Figure 40 59 High Street, Buntingford, Hertfordshire; photograph of the corner of a room. The photograph readily conveys the nature, materials and form of a rediscovered early doorway formed in the timber frame and subsequently blocked

Rectified photography



Figure 41 Mortimer's Cross Water Mill, Herefordshire; an elevation recorded by rectified photograp This technique is especially suited to simple rectilinear buildings with few changes of elevational pl Figure 42 shows that, where a reasonable camera location cannot be found, part of the elevation has to



BOWTH CAST FAIL



3087# LAS1 -482E

Photogrammetry



Figure 43 Little Moreton Hall, Cheshire; stereo-photographs for photogrammetric survey. The stereoscopic effect of taking paired photographs from slightly different viewpoints forms the basis of the survey.

Photogrammetry



2 method of sur are demonstrating that this that approp ā Castle, Kent; photogramm

Other techniques

Other methods of recording may be used on occasion. A very full understanding of a building may be conveyed by a carefully planned tour with a video camera, accompanied by a written or spoken narrative account. On occasions, it may be easier on site to speak into a hand-held tape recorder than to make notes in a book. In such cases as these, the recordings made may usefully form a part of the record of the building to be preserved for reference later. CHAPTER 5

WHO?

SEVERAL AGENTS MAY BE INVOLVED IN RECORDING

The person making the preliminary record of the building will often not be the one who is responsible for making (or correlating) the record of the work done. The ideal person to make the initial record is the person who will have to take the decisions about what is to be done to it - what alterations may be compatible with its historic character, how necessary repairs can be carried out while at the same time respecting the integrity of its structure, and what new decoration may be **THE ACCH AND WHE CONDOUTED INTEGAL INSECTION FORMATION SET ON THE ACCH AND WHE CONDOUTED INTEGAL INSECTION SET ON THE INTEGAL ACCOUNT OF THE INT**

The principal national body charged with the recording of historic buildings is the Royal Commission on Historical Monuments. Each of the three national Commissions (see Appendix II for their addresses) has the duty under successive Town and Country Planning Acts to record listed historic buildings before they are to be demolished, in whole or in part, but on occasions they may wish, or may be invited, to make a record of a building before decisions have been reached on what may become of it. The reports made by the Royal Commissions' expert architectural staffcan be of the greatest value if the building is to be altered or restored. On the other hand, the Royal Commissions have limited staffresources, and many other tasks to perform, and there will be many occasions when it is necessary to employ other recorders.

There is a number of local Archaeological Excavation Units operating throughout the British Isles. Some of these units (though not all of them) have been recording buildings for many years and may be asked for advice or for active help. A unit would normally expect to charge for its serVIces.

Throughout the country, there are architectural historians active in the analytical recording of historic buildings. Their competence varies, and though much may be learnt through personal recommendation, the safest way of assessing their skills is by taking a copy of an existing record and testing it against a standing building. There is a growing number of people who are recording buildings or carrying out historical research upon them, professionally, although there is as yet no central body through whom these professional recorders can be approached. Some of them advertise in relevant periodicals. The English Royal Commission on Historical Monuments has published its *Survey oj Architectural Surveys*, which is a list of those historic building recorders that are known to it. Many active recorders belong to the Vernacular Architecture Group (for address see Appendix II), although most of its members record buildings for their own interest, and may be unwilling to accept specific commissions, while their expertise generally lies with the humbler buildings - the vernacular buildings of a particular area. None the less they represent a great body of knowledge which should be drawn upon whenever appropriate.

A number of County and District Councils employ conservation officers to exercise controls over the historic building stock and to advise planning committees on the exercise of their powers. It is seldom that such officers are themselves able to make full records of a building, but their inspection of it may often have led them to recognize important historic elements that should be regarded in any scheme, while their local knowledge may enable them to recommend some person or organization with the resources to undertake a proper record. It is in any case always advisable to have a preliminary, informal discussion with the appropriate conservation officer before undertaking any work for which the Council's Listed Building Consent will be required. Most dioceses and most cathedrals have archaeological consultants, who should be the first people to turn to for advice, and sometimes for practical help, in arranging archaeological recording of the churches of the Church of England. Information and advice is also to be had from Diocesan Advisory Committees - the standing committees in each diocese whose duty is to advise the church authorities on the historical and artistic implications of the grant of faculties (which are necessary for all structural work to the fabric of a church in use).

Some building recorders deposit their records in local Record Offices, which may also be a source of information about such people. Increasingly, too, the need for records and the curiosity of house owners is creating a demand for professional building historians, some of whom advertise in periodicals dealing with old buildings. Once again, however, the expertise of such people must not be taken on trust; some may be tempted to make an old building appear more interesting and important than it really is and to find in it historic features it may not actually possess.

THE ARCHITECT AS THE PERSON RECORDING THE WORK UNDERTAKEN THAT SHOULD RECORD THE WORK DONE

Recording the work done in execution of a contract ought to be the duty of whoever is supervising the contract, and in most cases of the kind that this book is considering this will be the architect. In addition to ensuring that whatever work he has been Alact KINDSSOF twoReKorSHOULD BE whatever drawings, specifications and descriptive accour ECORDED to any likely demands in the future, he should make sure that whatever sub-contract he may have authorized, whatever work was placed with specialists - with structural engineers, conservationists, preservative treatment firms, and so forth - is fully recorded. The level RECORDINGStWHATEREMENT he question, 'Who in the future is likely to want to know what?', and the same question must

RECORDS SHOULD BE DONE UNDER THE ASSUMPTION THAT THEY PS WILL BE PRESERVED hat it is futile to make a record that cannot be preserved.

CHAPTER 6

WHERE?

PRESERVING THE RECORD

To make the fullest and finest record possible is obviously pointless, except for the recorder, if nobody else thereafter is going to be able to use it. The question of who is to use and who is to maintain and preserve the record is one that should be faced at the very outset, rather than left until TWO KINDS OF, RECORDS

The records to be preserved are, of course, of two kinds - those made as part of the initial appraisal and survey, and those generated as a result of the work carried out. The first record will often be manageable: it will comprise a written account of the building, backed up by drawings and photographs that will not usually amount to a very bulky dossier. In the latter case, however - the documents that record what was actually done - some selection will almost certainly be needed: it is unreasonable to expect anyone to keep all the papers generated in the course of a job, and the object should be to reduce the archive (which is what the accumulation of papers will form) to a level that combines the preservation of essential information with what it is practical to preserve. **PRESERVE THE ESSENTIAL INFORMATION**

In the case of those records of a building that are the result of the initial survey, wherever possible consideration should be given to depositing them for safe keeping in a public archive. This will ensure not only their efficient management, but also that they are available to anyone in the future who may have a legitimate concern with the building and who requires further information about it. Nationally, the body to be considered is the National Buildings Record (see Chapter 4); locally, the appropriate County Record Office. In addition, most local authorities maintain a Sites and Monuments Record (SMR), comprising information about the historic and environmental

resources of the area for use as a planning tool. The level of information required by different SMRs differs from one to another, but planning or conservation officers should always be approached and asked whether they will accept records for deposit in the local SMR.

A copy of the initial record should always be lodged with the owner or occupier of the building, so that it is on hand for reference at any time. This is particularly so in the case of those buildings - e.g. institutional buildings of any kind - where repairs and minor works are liable to be carried out by non-expert staff, and where the building manager should be able to refer to an expert appraisal of the structure to see whether what is proposed will have a damaging effect on it.

For the records of work done in the course of a contract, the national repository of contemporary architectural drawings and related documents of all kinds is the British Architectural Library of the RIBA. The policy of the library is to collect material of national or international importance; it may not therefore be able to find space for all records that are offered to it.

Some local record offices have a more active policy than others in collecting the drawings and working papers of local architectural firms or those relating to buildings in their area. The RIBA and the English Royal Commission on Historical Monuments have jointly produced a booklet, *Architectural Records in National and Local Collections - Guidance Notes for Archivists and Record Offices* (free from the librarian of either organization) which offers advice to those responsible for local collections and which lists those documents that are most likely to be of permanent value.

In the case of the public archives already described, help or guidance will be offered on what it is desirable to preserve (within the archives' own terms of reference). In some cases the work will have been undertaken for institutions such as the church or the National Trust, whose permanence and size make it possible for them to preserve the archive and whose management system should ensure that it is not lost sight of. In other cases, where the record is to be preserved privately, it will need to be ordered and a selection made of essential material so that it can readily be used in the future. Indeed, if the architect does not do this himself, the archive is unlikely to be used, since the

difficulty of finding in it the information that may be needed will probably deter anyone from trying. An architect will recognize that the endurance of the work he was responsible for depends on its being looked after, and that to prepare an archive of this kind ought therefore to be a part of his job. It has to be realized that this responsibility may impose a good deal of additional work on the architect (or whoever prepared the specifications and supervised the work). For some complex jobs, even a reduced archive will still amount to a great deal of paper.

The alternatives to public repositories for the deposit and preservation of records are (a) the body or individual commissioning the work, (b) the architect, and (c) the recorder, where an outside recorder has been involved.

THE NEED TO ORGANIZE THE RECORDS SO THAT THAT BECOME USEFUL IN THE FUTURE; THE NEED TO KEEP THE RECORDS; THE ROLE OF THE OWNER AS KEEPER OF THE RECORDS

The building's owner

This ought to be the best solution, since the records should thus be available at the building when they are required, and the building's owner should have an interest in keeping them safely. An owner who is interested in the history of his house is quite likely to want to keep an initial survey, if it includes (as it should) an account of the probable origins and subsequent development of the building. The problem becomes greater in relation to the mass of documents that are often created in the course of a contract for alterations, extensions or for major repairs.

Even if owners are conscientious in keeping them (which cannot be guaranteed), it is impossible to be sure that records will be passed on to successive owners and preserved. Many private owners these days have in their own possession no legal document relating to their house, and it is unrealistic for a sheaf of drawings and specifications to be lodged with deeds held by a building society. The answers may be (a) for an owner to be encouraged to keep a building logbook, in which all significant work is noted down, which can be passed on to his successor and which by its existence can remind him of other papers to be passed on as well; and (b) where it is practicable, for a summary of what has been done (a summary account was suggested in Chapter 4) to be attached to the deeds, together with a record of the architect or contractor involved. Similar documents, such as the guarantees issued by preservative treatment firms, are often attached in such a way. But it has to be recognized that none of this is ideal, and that a great many owners will fail to see the value of preserving papers that relate to building work long after the likelihood of further repair or remedial works has passed.

The architect

An architect will generally keep records of a contract for as long as may be necessary for insurance purposes, and frequently long after that. If the procedures recommended here are followed, the architect will have in his possession records made before the commencement of the work, and records made in the course of it. If someone other than the architect (a specialist building recorder or someone acting for the contractor) has been monitoring discoveries made during the contract, then just as it will have been for the architect to ensure that the record is made in the first place, so it should also be his responsibility to see that the record is preserved together with any other relevant contract papers. The same holds true for records made by conservators in the course of any specialist treatment.

Before finally disposing of records, the architect should try to contact the building's present owners and a national or local record office (see above) and suggest that they take over the documents that he no longer needs. If this is done, however, it should be made clear that the recipient understands the copyright position in the documents.

The building recorder

If the initial survey has been made by someone other than the architect, then this person will probably keep a copy (or the original) of his record. When he wishes finally to dispose of it, he should do so along the lines suggested in the preceding paragraph.

	A Reconnaissance Record Low Accuracy	B Preliminary Record Midrange Accuracy	C Detailed Record High Accuracy
Purpose of Recording	Reconnaissance Initial inventory Initial planning Reference data	Planning Initial condition Investigation Stabilization Pre-design Reference data	As-found condition Design Construction As-built record Maintenance/monitoring Posterity
Accuracy of Drawings	Not to scale	Plans and elevations ± 5.0 in. (± 10 cm) Details ± 1.0 in. (± 2 cm)	Plans and elevations ± 0.5 in. (± 1 cm) Details ± 0.1 in. (± 2 mm)
Results	Photographic report Photo-key plan Initial condition Descriptive sketches	Measured drawings Asset description/condition Observations Photographic report	Measured drawings Asset description/condition Observations Photographic report
Cost (will vary in absolute terms with scale and complexity of site)	Low (a few days on site by recording team)	Moderate (several weeks or more on site by heritage recording team and input by conservation professionals)	Moderate to high (extensive and possibly ongoing activity on site by recording team and increased input by conservation professionals)

Levels of Heritage Recording

Table retrieved from Recordim.

DOCUMENTATION AND CONSERVATION

- Iconic analysis

Image, perception, plastic qualities, shape, geometry, volumetric relations.

- Distributive analysis

How spaces relate to each other, how spaces relate to the building functions, what is the hierarchical structure of spaces, how are spaces.

- Constructive analysis

What materials, what construction techniques, how do materials relate construction techniques.

- State of conservation analysis

Anomalies description, assessment of the causes of the anomalies.

- Structural analysis

Understanding the building structural principles, how the materials relate to the statics of the structure, to model the structural behavior, to calibrate the model with site observations of the deformations.

- Stratigraphic analysis

Historic layering of the building.

2. SURVEYING METHODS



Source: Mitchell & McCullough (1994)

SURVEYING METHODS

- Direct Methods

Each point of the object under recording is carefully chosen and recorded in the field.

In practice we select and record a small amount of points that we find as necessary to correctly depict the object.

Examples: Manual surveying, Classic topographic surveying, GPS positioning

- Indirect Methods

In the field we don't select specific points for recording. Points are recorded indistinguishably.

In practice we record a large amount of points and point selection, if done, is accomplished later at office.

Examples: Terrestrial Laser Scanning (TLS), Digital Photogrammetry.



Table retrieved from Recordim.



TERRESTRIAL LASER SCANNING (TLS) SYSTEMS

(range based and active)

Terrestrial Laser Scanning is an active technology that uses laser light to determine the spatial coordinates of a large amount of points in an almost continuous way and almost in real time.

PHOTOGRAMMETRIC SYSTEMS

(image based and passive)

Photogrammetry is defined as the science that studies the mathematical models, and its applications, that enable object measuring based on measurements made on images of that object, by correctly determining the spatial relation between both images and object.

Laser Scanning classification criteria

Satellite (*profilers*) Aerial (LIDAR) Terrestrial

Time of flight - TOF (emission of discrete pulses of laser light) Phase shift - PS (continuous emission of modulated laser beam) Triangulation (usually emit a plan laser beam)

Static Dynamic

Very short range<5m</th>Short range<100m</td>Medium range<300m</td>Long range>300m

(TOF) – typical range > 100m



http://www.riegl.com

(TOF) – medium and large scale objects





Tower of the castle of "Mota del Marqués" in Valladolid, Spain (left). "Nave Manuelina" of "Convento de Cristo" in Tomar (right).

(PS) – typical range < 100m





http://www.faro.com/

"Pátio da Universidade de Coimbra" in the University of Coimbra, uptown of Coimbra.

(PS) – medium scale objects



"Praça da Républica" in Tomar.

(Triangulation) – typical range < 5m



http://www.konicaminolta.com/



(Triangulation) – small scale objects



Point Clouds – the result of scanning



Photogrammetry classification criteria

Aerial Terrestrial

Analogical Analytic Digital

Architectural Industrial Engineering

Images Video sequences

"Manual" processing Semi-automatic processing Automatic processing






Photogrammetry

Images – the result of photographing



OBJECTO

2D Methods – image rectification



2D Methods – image rectification / photo mosaics







Terreiro do Paço - Alçado da ala poente (TPp_01 e TORp_02) -

3D "Manual" Processing – manual point selection on all images



3D Semi-automatic Processing – some automatic features implemented



3D Automatic Processing – completely automatic 3D reconstruction



FOV: Ortho	
FPS: 3.2	
Clipping: N:	8.9 F: 10.7

Current Mesh: option-0002.ply Vertices: 1153480 (7948016) Faces: 0 (0)

The ability of using digital cameras on UAVs makes digital photogrammetry more versatile than laser scanning...



ADP D. Data acquisition (images) with balloon and vane (roof), and mast (details)





... and enables us to acquire useful and beautiful imagery!



Aerial view of "Convento de Cristo" in Tomar.



Aerial view of "Convento de Cristo" in Tomar.



Aerial view of "Convento de Cristo" in Tomar.

LEVANTAMENTO DO ARCO DA RUA AUGUSTA POR VARRIMENTO LASER 3D

1. Planning (surveying plan – topography)



Impactos em peões ou veículos eventualmente motivados por descolagem dos mesmos.
Nota 5; Prevê-se apenas a necessidade de duas estações topográficas.

Nota 5: Os alvos serão removidos após conclusão das operações de Varrimento Laser.

Ateller 15	Planeamento do levantamento do Arco da Rua	esc	
	Augusta por Varrimento Laser 3D Terrairo de Paço, Ueboe	2010-09-17	
espotsive, reconversion Arg. Luis Mateus	Localização dos Alvos	HEF.	
LINAR AMERIC HIS DUTADO POR			

1. Planning (surveying plan – scanning stations selection)



2. Execution (target fixation)

AZIS go home

2. Execution (topographic survey – control survey)

referencial_topografico.txt - Notepad							
File	Edit	Format	View Help				
1		2.659	5.961	2.744			
2		14.408	2.92	2.697			
3		25.028	2.954	2.763			
4		36.764	6.056	2.856			
5		1.857	5.962	17.077			
6		37.568	6.065	17.227			
7		11.056	3.037	30.613			
8		15.714	3.191	31.453			
9		24.124	3.201	31.88			
10		28.33	3.086	30.611			
11		14.863	13.757	2.692			
12		24.551	13.793	2.766			
13		24.551	5.856	2.737			
14		14.836	5.827	2.679			
15		28.391	16.657	2.738			
16		24.836	16.693	2.784			
17		14.791	16.657	2.786			
18		11.096	16.605	2.747			
19		28.599	16.72	17.397			
20		10.757	16.648	17.334			
21		28.968	16.683	30.56			
22		19.922	16.609	30.502			
23		10.317	16.631	30.574			



2. Execution (manual recording – hand drawings)



2. Execution (Four TLS sessions – 175 point clouds

3. The main data (point clouds)



4. Processing (spurious data elimination)



4. Processing (point cloud orientation)



4. Processing (visual inspection of the results)



4. Processing (external orientation of the 3D model)c



4. Processing (3D model sectioning)



4. Processing (image extraction)



5. Processing (ortho-image composition)



5. Processing (Final ortho-image – Principal Elevation)







6. Processing (2D drawing – Principal elevation)





7. Deliverables (Plans)




PHOTOGRAMMETRIC SURVEYING OF OF "JANELA MANUELINA" IN "CONVENTO DE CRISTO", TOMAR

1. DATA ACQUISITION –digital images





2. DATA PROCESSING – automatic relative orientation of images





2. DATA PROCESSING – sparse reconstruction of point cloud model



This reconstruction was done with the software VSFM (Visual SFM) developed by Changchang Wu. (http://www.cs.washington.edu/homes/ccwu/vsfm/)

3. DATA PROCESSING – automatic reconstruction of dense point cloud model



This reconstruction was done with the software CMVS+PMVS developed by Yasutaka Furukawa. (http://grail.cs.washington.edu/software/cmvs/)





SURVEYING OF THE EXTERIOR OF "NAVE MANUELINA" IN "CONVENTO DE CRISTO", TOMAR





1. DATA ACQUISITION – point clouds and digital images



1. DATA ACQUISITION – point clouds and digital images

		and a state of the
		No.

AND S

10.00

🖹 🖸 S 🗸

ask Viewer		83
image size:	4416x3312	
focal length:	3631,971	
#sift count:	9704	
IMG_2942		
image_size:	4416x3312	
focal_length:	3631.971	
#sift count:	7761	
IMG_2958		
image_size:	4416x3312	
focal_length:	3631.971	
#sift count:	7683	
IMG_2955		
image_size:	4416x3312	
focal_length:	3631.971	
#sift count:	10727	
IMG_2953		
image_size:	4416x3312	
focal_length:	3631.971	
#sift count:	9820	
IMG_2954		
image_size:	4416x3312	
focal_length:	3631.971	
#sift count:	8745	
Loading 22444 3D	points	
ERROR: something	g wrong with image #6 in NVM	
Skip 192 3D points		
IMG_2952		-
image_size:	4416x3312	=
focal_length:	3631.971	
#sift count:	9055	
# images loaded	60	+

- 6 -

VisualSFM - [Thumbnails] - [0]
File SfM View ViP Rep Tools Help

🗐 📑 📑 📑 📲 🛍 🍠 🕫 🦉 🕰 🔍 🗸 🛔 🛔 🚻 🌮 🔀 🚸 🚀 BA 🔲 🤎 🥀 🛔

0



2. DATA PROCESSING – point clouds relative orientation



Before

After

3. POINT CLOUD 3D MODEL



Oriented point clouds

Reflectance mapped

4. DATA PROCESSING – texture mapping



Projecting image

Adding color point cloud

5. POINT CLOUD TEXTURED MODEL







6. EXAMPLES OF DELIVERABLES

2D drawings

Ortho images

3. APPLICATIONS

ICONIC ANALYSIS (examples)





Image Sequence of a texturized 3D model of the Chapel of "São Frutuoso de Montélios" in Braga.

ICONIC ANALYSIS (examples)

	4	<u>a → 1/ ét áb áb áb</u> ti
÷		<u> </u>
State State and State	and the street	

Metric analysis of the façade of the "Palácio de Valflores" in Loures, near Lisbon.



Geometric analysis of the dome of the "Arco da Rua Augusta" in Lisbon.



Geometric analysis of the dome of the "Arco da Rua Augusta" in Lisbon.













DISTRIBUTIVE ANALYSIS (examples)





 Venezia, Oratorio dei Crociferi. Modello iconico e logico-distributivo, finalizzato alla comprensione dell'aggregazione volumetrica e funzionale, dello stato attuale della fabbrica.

Distributive analysis of "Oratorio dei Crociferi" (left) and "Palazzo Pisani", both in Venice. In FEIFFER, Cesare: Il progetto di conservazione. Milan: Franco Angeli Libri s.r.l., 1989. 595p. ISBN 88-204-3055-X



Relative positioning of building elements. "Palácio de Valflores" – Loures.



General view of "Convento de Cristo" – Tomar.







Mapa OpenStreetMap do Centro Histórico de Tomar, incluindo o Convento de Cristo - Setembro 2011 Dados de apoio: ortoimagens extraidas das nuvens de pontos EMV xecutados na tese.

CONSTRUCTIVE ANALYSIS (examples)



Materials description (by Nova Conservação) of the "Chafariz dos Canos" in Torres Vedras.

CONSTRUCTIVE ANALYSIS (examples)



Geometric analysis of the dome of the "Arco da Rua Augusta" in Lisbon.

STATE OF CONSERVATION ANALYSIS (examples)



Conservation assessment (by Atelier 15 and FAUTL) of the façades of "Terreiro do Paço" in Lisbon.
STATE OF CONSERVATION ANALYSIS (examples)



Conservation assessment (by INSITU) of the "Nave Manuelina" of "Convento de Cristo" in Tomar.

STATE OF CONSERVATION ANALYSIS (examples)



Conservation assessment with photography and Laser Scanning reflectance image interpretation. Red image - 683nm (left) and Near Infra Red image – 1500nm (right). In "Convento de Cristo" located in Tomar.

STATE OF CONSERVATION ANALYSIS (examples)



Conservation assessment with Laser Scanning reflectance image processing. Normalized Difference Vegetation Index (NDVI) calculation (left) Principal Component Analysis (PCA) (right). In "Convento de Cristo" located in Tomar.

STRUCTURAL ANALYSIS (examples)



Deformation visualization. The dome of the Church of "Convento do Sacramento" in Lisbon.

STRUCTURAL ANALYSIS (examples)



Deformation visualization and quantification with depth maps. The façade of "Palácio de Valflores" in Loures.











Deformation visualization and quantification by slicing the model. Comparing TLS and ADP. Small house in Coimbra.



Deformation assessment through dynamic sectioning of three dimensional point cloud model

STRATIGRAPHIC ANALYSIS (examples)



Basic documentation for archaeology; stone by stone drawing of part of "Cerca Moura" in Lisbon (left). Stratigraphic analysis recording of "Calçada dos Carrascos" in "Convento de Cristo" in Tomar.



STRATIGRAPHIC ANALYSIS (examples)

A



















Modelo após orientação das nuvens de pontos - MeshLAB



Exemplo de documentação obtida - Corte perspectivado





Master thesis of Pedro Mateus - FAUTL

4. PRACTICAL APPLICATION

Download the files in the link bellow:

(http://home.fa.ulisboa.pt/~Immateus/TRANSF/CEAPA2015.zip)