The International Archives of the Photogrammetry,
Remote Sensing and Spatial Information Sciences
Volume XLII-2/W14 • ISSN 1682-1750

2019

CIPA
Heritage
Documentation

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https://doi.org/10.5194/isprs-archives-XLII-2-W14-1-2019

CIPA Heritage Documentation

# Preface

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The ICOMOS-ISPRS Scientific Committee, CIPA-Heritage Documentation is proud to present this publication in the occasion of its 50th birthday.

Our intention with this publication is to look backwards at the achievements of CIPA while at the same time to look ahead the future of cultural heritage documentation.

The publication begins with the introductory messages from the Presidents of CIPA, ISPRS and ICOMOS respectively. The first contribution concerns the future of cultural heritage documentation, with respect to the editor's perspective. Andreas Georgopoulos, current CIPA President (2015-2019) discusses the CIPA slides on architectural photogrammetry and the application of contemporary technologies from its early years. Peter Waldhäusl, past and honorary President of CIPA, writes on the foundation and fundamentals of CIPA in memory of Maurice Carbonnell (1923-2015) and Hans Foramitti (1923-1982), the so-called "fathers of CIPA". Ross Dallas, an honorary committee member of CIPA, is looking backwards to the late 80s to share some personal thoughts. Bill Blake also is looking towards the history of CIPA and the English Heritage Metric Survey Publication Programme 2000-2009. The publication concludes with the contribution of Fulvio Rinaudo, concerning two CIPA initiatives, the "O. Wagner Pavillon Test" and the "RecorDIM Initiative".

I would like to thank all contributors for their support in this commemorative publication, to celebrate CIPA's 50th birthday. As CIPA's Secretary General, I undertook this honorable task of organizing the contributors and editing the book. My thanks are also for Abhijit Dhanda for his valuable support in reading and editing the book.

It is an honor for me to serve CIPA as Secretary General at its 50th birthday and to be the editor of this valuable record of the history of CIPA.

Thanks to our colleagues across the world who served CIPA voluntarily.

The future of CIPA is ahead!

# Contents

# CIPA's first 50 years

Andreas Georgopoulos
CIPA President (2014-2019)
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With this commemorative volume you are now reading, CIPA celebrates its 50th birthday. It was back in 1969 that some open-minded colleagues with great love for cultural heritage, led by Maurice Carbonnel, decided to establish this hybrid International Scientific Committee (ISC). Hybrid because it was endorsed both by ICOMOS and ISPRS. Its mission was clear: To bring technological advances to the service of heritage conservation. At the time the name of the Committee was decided as "*Comite International de Photogrammetrie Architecturale*", CIPA.

Although the mission seemed clear, the implementation proved difficult! A balance should always be kept between the two sides, which was not easy. It was after the verge of the 21st century, that CIPA's Vice President Robin Letellier's RecorDIM initiative boosted this effort and as a result CIPA has now a large membership base spanning over multitude of disciplines, all contributing to the conservation of heritage. Almost two decades ago CIPA's name was adapted to CIPA-Heritage Documentation, in order to better reflect its mission and include any kind of documentation, not only the geometric one.

This commemorative volume has been very carefully prepared by the current Executive Board of CIPA. The contributions cover a large part of CIPA's activities so far, always with an eye to the future, as we really hope that this admittedly very successful ISC will continue to contribute towards fulfilling its mission. This will be realised by understanding the contemporary technological advances on one hand and on the other by exploiting and disseminating their potential for the benefit of cultural heritage to cover the needs of the conservation community.

I consider myself grateful to be honoured with the Presidency of this ISC back in 2014 and to be its President at its 50th birthday and be at the fortunate position to present this book to the scientific community.

Very special thanks should go to our Secretary General, Prof. Stratos Stylianidis, who undertook the huge task of coordinating the contributors, editing the volume and having the book ready for publication in time. Special thanks go to our contributors, who gave their best efforts to present an interesting view each one in order to present CIPA's past activities.

Lastly, I would like to take this opportunity and thank all colleagues who served in the Executive Board since 1969, whose voluntary contributions made this Committee what it is today. I am really looking forward to the next decades of successful contribution of CIPA-Heritage Documentation for the benefit of mankind's cultural heritage.

Long live CIPA!

# CIPA – to 50 years of successfully integrating culture and technology

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In the name of ISPRS – the International Society for Photogrammetry and Remote Sensing, I would like to wholeheartedly congratulate CIPA-Heritage Documentation on its 50th anniversary.

CIPA is both a permanent committee of ISPRS and an International Scientific Committee of ICOMOS – the International Council on Monuments and Sites. This unique structure reveals the two major pillars of CIPA: the technological pillar which uses and improves methods for capturing, documenting and visualising cultural heritage sites, and the cultural pillar, which studies and disseminates captured information in the historical and cultural context. Only by bringing these two aspects together, sound data on heritage sites can be properly understood, both by experts and the society at large.

The old name of CIPA – Comité International de Photogrammétrie Architecturale – reveals its roots. In earlier times, data capture was predominantly carried out by photogrammetric means. It is worth to note that in the early years of photogrammetry, i.e. the second half of the 19th century, the main application of photogrammetry was in fact the documentation of historical architectural sites. One of the first applications of photogrammetry was the 3D reconstruction of the Château de Vincennes near Paris by the French Colonel Aimé Laussedat, who by most experts is considered to be the inventor of photogrammetry. Soon afterwards, Albrecht Meydenbauer established the *Königlich Preußische Meßbildanstalt* in Berlin, with the main goal being to document the relevant architectural buildings in 3D using close range photogrammetry.

Over the years, new and exciting measurement and documentation techniques for heritage conservation have of course been developed – examples include laser scanning, computer aided design, as well as virtual and augmented reality – and computer science has made major inroads into the field in terms of indexing and querying data stored in spatial databases. CIPA has also widened its activities, and now promotes the development of principles and good practices for recording, documentation and information management of cultural heritage, offers related training programmes and organises a biennial conference to foster exchange of ideas between research, best practice and end users.

Photogrammetry and computer vision have continued to play a major role in CIPA activities to this day. To mention only one example, one of the first benchmarks in close-range photogrammetry was organised by CIPA in the late 90's of the last century, to showcase the potential of 3D object reconstruction from digital imagery.

We, at ISPRS, are proud of the CIPA achievements, we are happy to have CIPA as one of our very active permanent committees, and we are certain that things will continue to develop in this way in the future.

Happy birthday, CIPA and ad multos annos!

# CIPA – 50 years of the ICOMOS International Scientific Committee

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Documentation is crucial for the conservation of cultural heritage. Only properly recorded data enables heritage experts to take appropriate measures for restoration. Since proper documentation ensures the authenticity of cultural heritage sites, it is no coincidence that the Comité International de la Photogrammétrie Architecturale, the precursor of CIPA, was established in 1968, only 4 years after the adoption of the Venice Charter. This year, CIPA celebrates its 50th anniversary. I would like to congratulate everyone involved on the fact that CIPA has been successfully fulfilling the vital task of documentation for half a century. I would also like to stress that the documentation of cultural heritage has become more significant, since many heritage sites are under greater threat as a consequence of natural disasters, intentional destruction, climate change, etc. The reconstruction and recovery of cultural heritage are only possible with proper prior documentation.

Another mission of CIPA, the integration of advanced science and technology into the conservation of cultural heritage, stands out in heritage communities as a particularly pressing issue. It is especially promising in today's world where constant innovation is occurring. The situation today is comparable to the situation in the early 20th century. Between 1901 and 1914, an automated system of car manufacturing was established for the first time in history. As a result, within less than 15 years, the carriage was replaced by mass produced automobiles, such as the Ford Model T, which was first put on the market in 1908.

Significant changes in the economy, culture and society are rapidly occurring today because of destructive innovation. Drones are already becoming a part of our everyday lives. "Flying-cars" will soon start to operate. The IoT (Internet of Things) has been transforming how we live. Technology impacts and changes people's life and society. What would happen next in a heritage context? How might innovation benefit heritage communities? It would not only be technology on the level of tools but may also be on the level of a "platform" or other systems for data sharing and use. Blockchain as a decentralized, credible and transparent database might offer an interesting starting point for heritage communities as well. It seems likely that the next five years will be equivalent to the last fifty years in terms of the scope and reach technological developments.

I congratulate everyone involved on the achievements of CIPA over the last fifty years and very much look forward to seeing what can be achieved by CIPA in the future.

# The future of cultural heritage documentation

Efstratios Stylianidis
CIPA Secretary General (2014-2019)
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## 1. The importance of cultural heritage

Cultural heritage is an integral component of a complex and multidimensional environment that is both natural and human-made. It is created by people and societies, constituting a priceless treasure for the current and future generations. Cultural heritage provides a global value system for mutual understanding, respect, and freedom of expression, which is realized through its tangible or intangible character. Cultural heritage as a whole enriches people's lives.

However, it is often devastated by natural causes or human acts. The reasons are many, ranging from floods, fires, earthquakes to civil wars and terrorism, the latter being some of the worst expressions of criminal acts against humanity. We are often unable to safeguard the cultural heritage bequeathed to us by previous generations, whether a monument, an archaeological site, a cultural landscape, or various moveable or immovable objects. As cultural heritage belongs to all humans, we have a common responsibility to look after it and take all necessary actions for its preservation.

Have you ever paid attention to why one feels so much pain watching a video or seeing a picture of a devastated monument anywhere in the world? I believe it is because the ruination of a monument reminds one of their mortality. Everybody is aware that people are mortal; however, not everyone has the same perception about and attitude towards tangible structures or intangible cultural heritage. The destruction of a monument touches our emotional mechanisms. Such exceptional structures are built to celebrate humanity. They are an inspired attempt to touch eternity.

**Figure 1.** Parthenon, Greece (Source: pixabay).

**Figure 2.** Taller Buddha of Bamiyan before and after destruction by the Taliban in 2001 (Source: Wikipedia | CC BY-SA 3.0).

## 2. The role of documentation and technology

Documentation of cultural heritage, an essential and irreplaceable part of the preservation cycle, should be a high priority. Cultural heritage should be documented accurately and constantly prior to any physical harm or loss that might impair its integrity. It is of paramount importance to keep detailed records of any cultural heritage object that contains all the proper data and information. The existence of such a complete record can facilitate physical or virtual reconstruction. In addition to that, such a record is a valuable source of knowledge that can be handed to future generations. Documentation is a unique part of the preservation chain, as it provides all the necessary information for understanding the object in question and leads to the adoption of the best practices for safeguarding it. Documentation ensures some form of cultural heritage preservation. It also functions as a tool to communicate and raise awareness, for professionals and experts, public authorities, and the wider public.

Nowadays, documentation of cultural heritage is achieved by using digital tools. However, not all the authorities, scientists and professionals have access to advanced technology, due to economic, educational, or technological gaps. The practice of creating traditional paper drawings is not only still alive, but it is used extensively in many archaeological campaigns and architectural metric survey projects.

Nevertheless, the evolution of digital sensor technology has changed the way we document cultural heritage, in terms of application methods, software, and hardware tools. Digital sensor technology has broadened the spectrum of applications, introducing new products in the market on a daily basis. Any type of sensor can be used practically everywhere, and there is not a single technological sector which is not influenced by this technology. The life cycle of sensor technology is controlled by user preferences. However, the technological gaps between developed and developing countries are always a matter of concern for humanity and the international community, and ways to bridge these gaps should be constantly sought.

The industry of sensor technology is driven by a single slogan: the smaller, the better. In fact, some sensors that are on the market are nearly the size of a needle's tip. There is an endless supply of products related to the documentation process; imaging, time-of-flight (ToF), global navigation satellite systems (GNSS), gyroscopes, accelerometers, and free standing or mounted on drones.

Over the past years, geospatial technologies such as photogrammetry, remote sensing and geographical information systems (GIS) have witnessed great achievements, mainly due to technological, economic, environmental factors but also societal changes across the world. Climate change, population growth, and above all globalization, have dramatically changed the way we are approaching the natural and human-made environment.

Innovations in photogrammetry and image-based modelling have also been influenced by the amazing developments in information and communication technology (ICT), computer vision, and robotics. In addition to that, use of active remote sensing techniques (light detection and ranging (LiDAR) and radars) for acquiring enormous amount of data (e.g. point clouds), have increased the opportunities for data collection, analysis, integration, or even data fusion.

All geospatial data is acquired, processed, stored and disseminated depending on the application and the user's needs. Specific circumstances make it possible to capture data with high spatial, spectral, radiometric, and temporal resolution, pushing technology to move ahead faster. This is reflected in the developments in photogrammetric image processing for generating high-quality and high-fidelity 3D (geospatial) information. Dense matching, in particular, increased the capabilities of photogrammetry for generating high-density 3D data. Cloud computing and geospatial infrastructures can be used to support the processing, storage, and data visualization of representation of large data sets.

## 3. Looking ahead

*What can one expect in the years to come?*

The first industrial revolution (Industry 1.0) is known as the period of the transition from hand production methods to mechanical production methods, powered by steam and water.

The second industrial revolution (Industry 2.0) is better known as the technological revolution. In the heart of this period lies the introduction of railway networks and the telegraph. These inventions allowed the faster transfer of people, commodities, and ideas. Moreover, electricity allowed the development of industry and the modern production line.

The third industrial revolution (Industry 3.0) took place in the late 20th century, after the end of World War I and II. Industry 3.0, called the digital revolution, was caused by a slowdown in industrialization and technological advancements. The development of communication and computer technologies was one of the most outstanding advances, resulting in the extensive use of these technologies in the production process.

Industrial production is in the middle of a momentous transformation thanks to the digitization of manufacturing. As this restructuring occurs, Industry 4.0 is being born. From Industry 1.0 and the mechanization of production using water and steam power and Industry 2.0 and the mass production and assembly lines using electricity, Industry 4.0 is happening because of the technological advancements of Industry 3.0, utilizing smart and autonomous systems fueled by data and machine learning.

Industry 4.0 consists of many different but connected parts, and is a complex technological ecosystem. It embraces a series of digital, cutting-edge technologies, such as mobile technology and devices, Internet of Things (IoT), smart sensors, location-based services (LBS), big data analytics, augmented reality, artificial intelligence (AI), machine learning, cloud computing, 3D printing and many more.

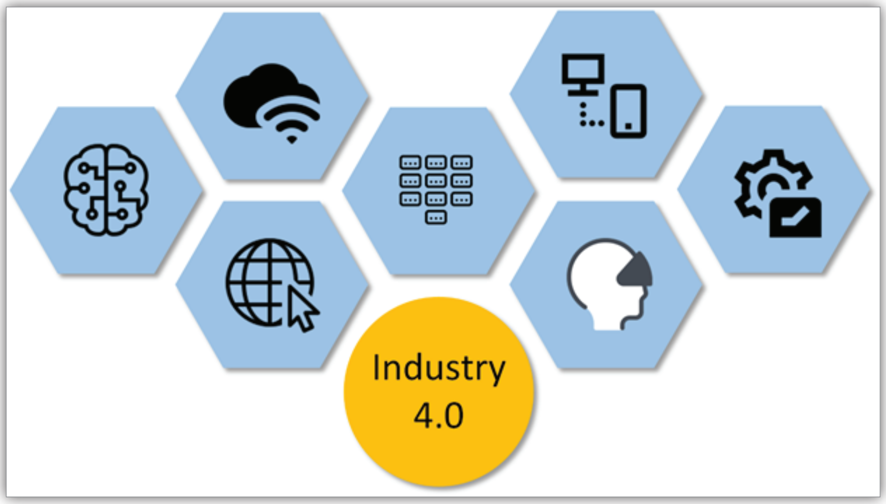


**Figure 3.** Industry 4.0 ecosystem.

This new revolutionary framework will introduce new principles that will affect people's lives, as well as the natural and human-made environment. The ability of devices, sensors, and people to connect and communicate with each other via the IoT, will develop new interconnection workflows. A new notion, the "citizen as sensor", is being created and the inter-connectivity will allow the operators to collect massive volumes of data and information.

Smart and autonomous systems will be able to support people in decision making by providing clustered and visualized information. Moreover, Industry 4.0 envisions environmentally friendly and sustainable fabrication by means of green processes and green products.

As safeguarding of cultural heritage must be humanity's perpetual goal, it is unavoidable that Industry 4.0 will be the next domain of influence for cultural heritage documentation. Various processes, like data and information collection, data processing, and data sharing and dissemination, will be greatly influenced by Industry 4.0 technologies.

## 4. Educate more people – share knowledge – bridge technological gaps

There is no doubt that the number of monuments suffering from climate change and human-caused destruction has increased significantly in the last years. It is imperative to increase our collective efforts towards preserving cultural heritage, as well as to educate people to respect it and preserve it.

Technology is expanding through schools and classrooms as developers, in close collaboration with tutors and moderators, are creating more and more products designed to reinforce education and facilitate the learning process.

New technologies like AI and machine learning will not only alter the educational and training ecosystem but will create new intellectual models of teaching. In reality, technology is providing a pathway for learning models to become more and more personalized.

Technology and the Internet are game-changers and a great enabler for people across the world who are facing technological gaps. The equal access to technology and training for all professionals, experts and authorities worldwide, will maximize the impact of documentation on cultural heritage preservation.

Some people have less access to technology, particularly in developing countries. It is hard to guarantee equal participation in the cultural heritage documentation community without equal access to technology and the Internet. Holding back people from technology and training, affects their professional lives, including their ability to familiarize themselves with technological developments.

Cultural heritage documentation is a demanding, challenging and interdisciplinary endeavor, embracing different disciplines and technology in terms of software, hardware, and systems. People should stay abreast of technological developments. For this reason, the design and implementation of educational and training activities is crucial. The development of technical infrastructures and the provision of financial aid to the less prosperous societies by the international community is a necessary measure to serve this purpose.

# CIPA slides on architectural photogrammetry: applying contemporary technologies from its early years

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## 1. Introduction

In 1968, immediately after the international colloquium on the «Applications of Photogrammetry to Architecture», promoted by Maurice Carbonnell (1923-2015) in order to improve the links between photogrammetric experts and architects, the Comité International de Photogrammétrie Architecturale (CIPA) was created. CIPA was a new international scientific committee of ICOMOS in collaboration with the ISP (International Society for Photogrammetry). CIPA was officially formed and established in 1969. Its mission was to bring the then known and developed contemporary technology used for cultural heritage documentation to the world of conservation and the humanities. To bridge the gap, as Robin Letellier ingeniously described it 35 years later. Maurice Carbonnell (Figure 1) was elected as the first president of CIPA and remained president for another 20 years[1]. A few days later, during the ISP convention in Lausanne (July 1968), the Congress elected Maurice Carbonnell as Chairman of the ISP Technical Commission V for non-topographic applications of photogrammetry.

**Figure 1.** Maurice Carbonnell, Ingenieur Geographe, founder of CIPA.

[1] A very interesting speech by M. Carbonell may be found at https://www.youtube.com/watch?v=Gce5vhf4Gyo

There was a need for education and dissemination of the valuable knowledge being produced by the technological Universities and Research Centres in the crucial field of cultural heritage documentation. This became especially clear after ICOMOS and the cultural heritage community adopted the Venice Charter, which in its article 16 clearly states that any intervention to a monument or archaeological site, must be preceded by a thorough documentation. CIPA, abiding to its mission made every effort possible to serve this cause. Its first attempt to disseminate information about Photogrammetry was the publication of a 36 page booklet entitled "*Photogrammetry of Monuments and Sites*", which was published by ICOMOS in four languages (FR, EN, GE and SP) in 1972 (Figure 2).

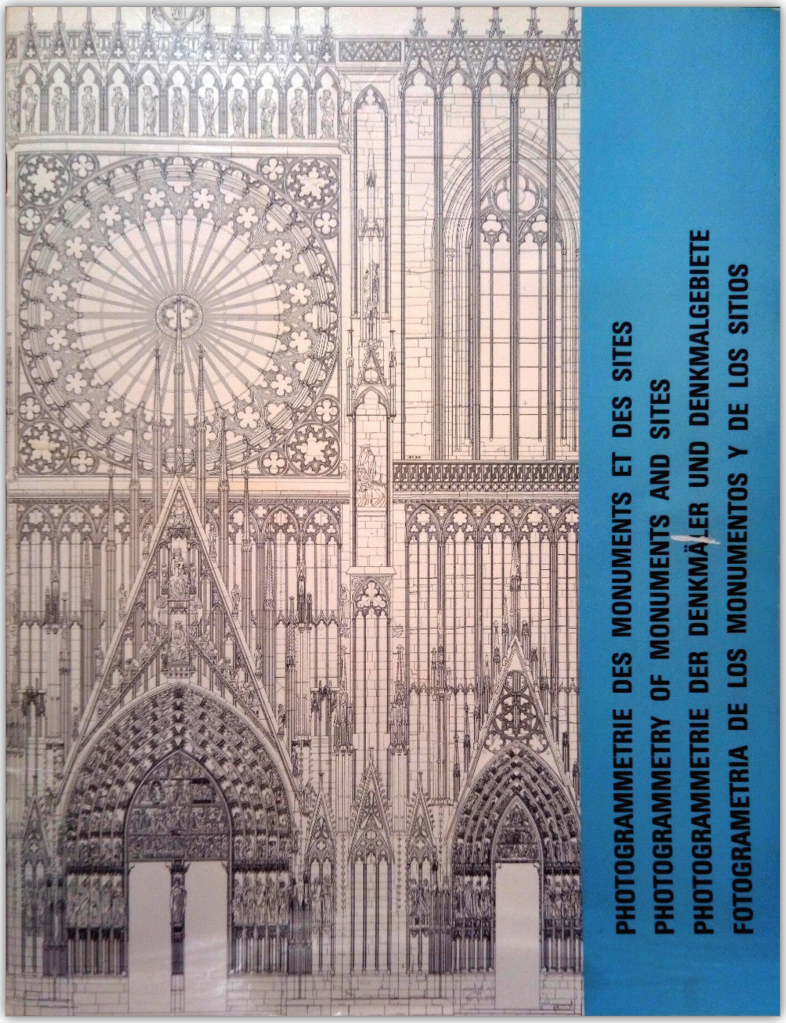



**Figure 2.** The CIPA booklet published in 1972.

CIPA's flagship event was, and still is, the International Symposium, which started as a major event. The inaugural symposium took place in Saint-Mande (1968), followed by Brno (1971), Lucca (1973), and Athens (1974). This International Symposium was the first of three organized in Greece (The other two in 1991 and 2007), and it is probably then that the Lab of Photogrammetry of the National Technical University of Athens (NTUA) and Professor John Badekas (1929-2017) – who later became the first Greek scholar to be appointed CIPA President (1992-1996) – undertook the task of creating a series of educational slides in order to help CIPA's cause.

Colour slides with enlightening text were, at the time, probably the most advanced technological means for disseminating information and educating audiences. The main initiative was, of course, undertaken by CIPA President M. Carbonell and the realization of the slides and the text were carried out by Irene Aubertin and Collete Le Bruno. Unfortunately, no further information about these two colleagues could be retrieved. As stated in the preface of the little booklet (Figure 3) which accompanied the slide series "*The publication of this slide collection is the result of the continuous efforts of CIPA and especially its President M. Carbonell, as well as of the increasing interest of the Laboratory of Photogrammetry of the NTUA in Architectural Photogrammetry*".

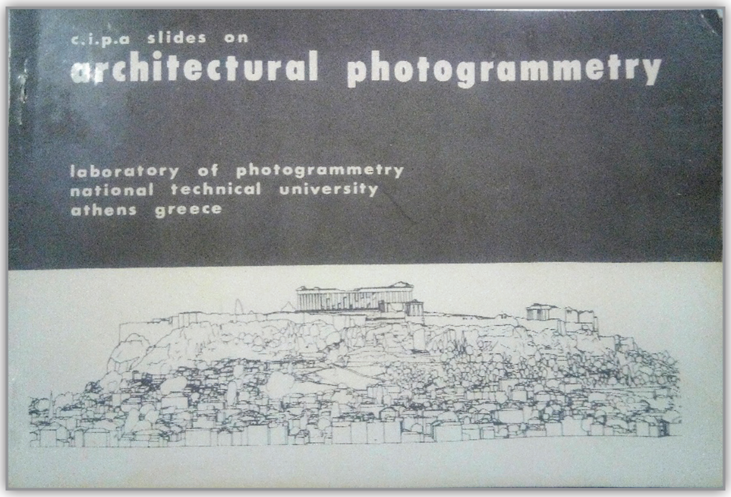



**Figure 3.** The booklet accompanying the CIPA slide series, 1976.

The booklet accompanied a collection of 48 slides divided into two series consisting of 24 slides each:

**Series A** is concerned with principles, equipment and methods of photogrammetry. The slides give a simplified – yet, accurate, and in many ways still useful – explanation of the fundamental techniques of photogrammetry. It is aimed principally at those who are not technical specialists but nevertheless need to understand the basic principles, either because they are responsible for the execution of photogrammetric surveys, or because they need to explain the technique's potential to their colleagues or students. For this reason, it was thought necessary to give such importance to Series A and to provide a full commentary to go with it.

**Series B** is devoted to the field of application and examples. It is clear that it was made as broad as possible in the variety of works presented, and the diversity of the countries in which these works have been executed. This series should have been of interest, not only to photogrammetrists, but also to archaeologists, architects, conservators, art historians, and in a more general way, to all who are concerned with the study and the conservation of monuments and sites – which all depend on accurate surveys. It is right at the heart of CIPA's mission!!

This slide series definitely has important historic value as it clearly shows that CIPA was set, right from the beginning, to educate and disseminate technological knowledge to the conservation community and thus … bridge the gap.

## 2. Architectural photogrammetry in the 70's

Architectural photogrammetry, and indeed photogrammetry, has a broad theoretical background as well as a strong technological character that is not easily grasped by most. It requires some knowledge of geometry, mathematics, and certainly the ability to think in 3D space. It also requires imagination skills by the user.

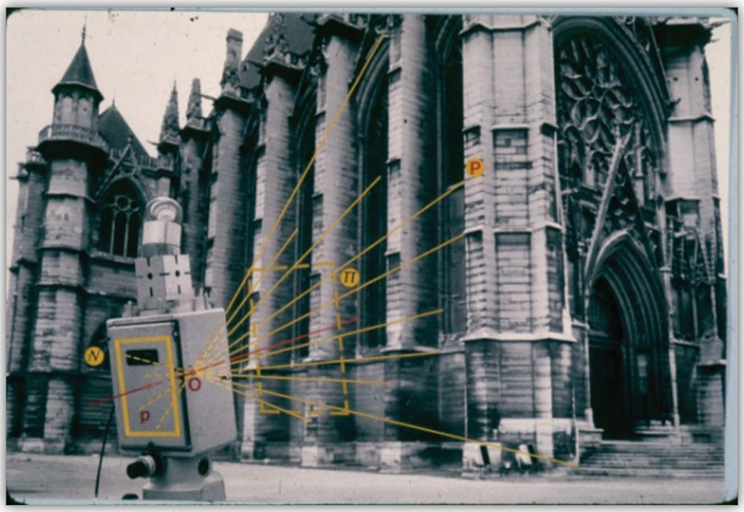
Nowadays, with full automation *ante portas*, these requirements seem obsolete. However, the results of automatic software are not always correct and may lead to blunders. Background knowledge of the photogrammetric mechanism is a prerequisite for successful implementation of the method, even with automated software.

In that sense, these slides are still useful as a brief introduction of a novice to the science, art and technique of architectural photogrammetry. With the exception of the mechanical constraints imposed by the instruments of that era, all principles are simply and elegantly explained and illustrated in the Series A slides. Consequently, they might still be considered "up-to-date" 50 years later!! Series B presents some prominent examples of implementation of architectural photogrammetry, thus showing the prospective users of today what results can be expected with modern to technology – focusing especially on the quality and excellent draughtsmanship of the examples.

## 3. Series A of the CIPA 1976 slides[2] - Principles, equipment and methods

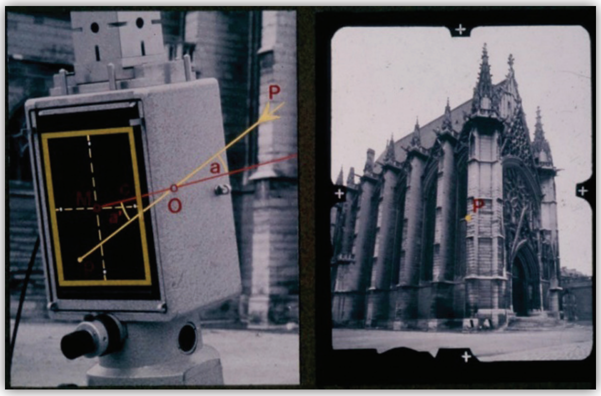
In Series A of the CIPA slides the basic principles of photogrammetry are explained in a simple manner, without introducing too many technical, or mathematical concepts. All in all, it addresses people and experts from other disciplines in order to introduce them to photogrammetry. Some explanations are valid today and could well be used in related classrooms and textbooks.

Photogrammetry is a method of indirect survey using photographs and measurements made from these photographs. The principal application of photogrammetry is in the preparation of maps and topographic plans from aerial photographs. But it also as numerous applications in civil engineering, industry science and medicine, as well as in architecture, archaeology and the study of monumental sites. These facts are stressed in the preface and in slides A1, A2, and A4 which give a brief introduction to geometrical notions and especially to the central projection, or – as it is referred to –the conic perspective.




***A1** A photograph is a conic perspective, that is to say plane section cutting through the perspective bundle of all the rays of light coming from the subject and converging at the centre of perspective O. The perspective plane (picture plane) is the plane of the negative N, behind the centre of perspective: each point P of the subject has its corresponding image point p. The positive images π, obtained by drawing or by enlargement of the negative, are perspectives comparable to those of the original picture and whose position is sited between the centre of perspective and the subject.*

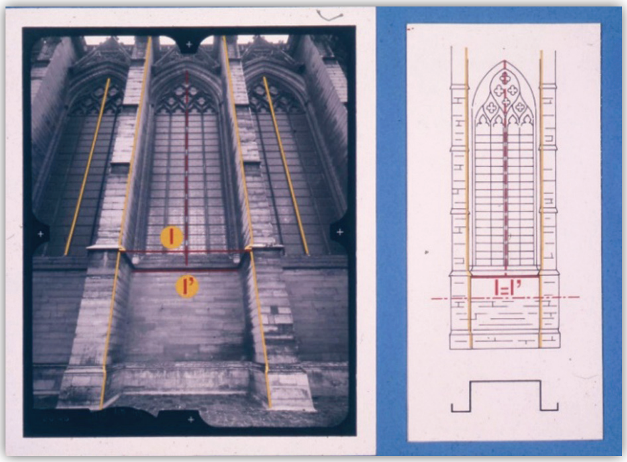
[2] In the following the original text in the accompanying booklet is reproduced with italics.




***A2*** *To produce an accurate elevation from perspective photographs it is necessary to know the characteristics of the perspective geometry with great accuracy. So photogrammetry needs special photographic equipment, that is to say metric cameras which have been calibrated in the laboratory.*

- *The principal point M, that is the point where the principal axis OM cuts the plane of the negative, the axis and the plane being at right angles, the principal axis is the same as the optical axis of the lens of the camera. The position of the principal point is defined by the intersection of lines joining opposite fiducial marks on the body of the camera (for example in the middle of each side of the body) and recorded on the negative at the moment of exposure (right hand photograph).*
- *The principal distance c=OM; the position of M and the value of c must be known to an accuracy equal to or better than 0.01mm; the principal distance differs from the focal length of the lens if the camera is not focused to infinity. The principal distance of the metric camera is calibrated for finite object distances.*
- *The distortion, that is the geometric displacement of the rays of light of the perspective when they pass through the lens (angles a and a' are different); in modern metric cameras this distortion is very slight, the displacement of the image point not exceeding 0.01mm.*

*The perspective plane of the photograph is defined by the frame at the back of the camera. To maintain absolute flatness over the whole surface, metric cameras used for architectural photogrammetry normally use glass plates which are firmly pressed into position before being exposed.*
*Slides 1 and 2 show a TMK 6 metric camera made by Carl Zeiss (Oberkochen) with 9x12cm format and principal distance of 60mm.*

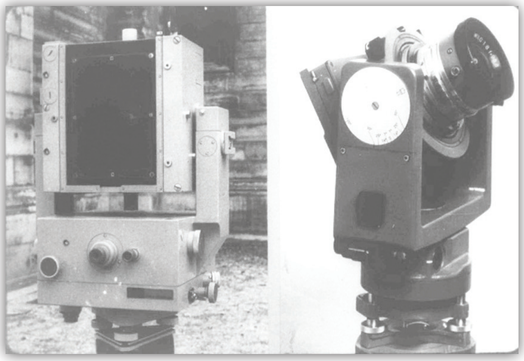


***A4** The conic perspective or photographic image, even when taken with a metric camera, shows certain perspective distortion due mainly:*

- *To the inclination of the principal axis, which tends to make parallel lines in the subject to converge*
- *To the depth of relief ib the subject, which makes the images I and I' of two parallel and equal elements unequal, if they are not at the same distance from the centre of perspective, the scale of the photograph varies with the depth of the subject.*

*It must be understood that these distortions generally exist simultaneously, and their effects are cumulative: a photograph only conforms exactly to the subject if the subject is flat and the principal axis is perpendicular to it. The art of photogrammetry is to produce accurate surveys from photographs with these perspective distortions.*

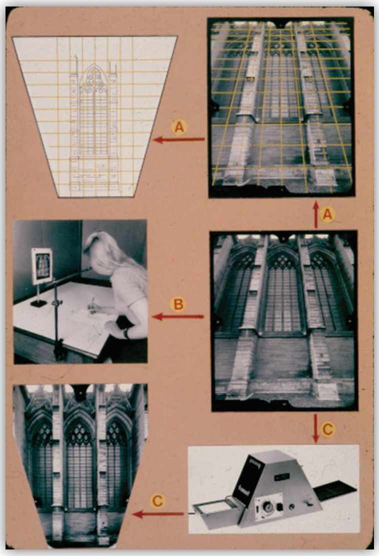
With slide A3, the notion of the photogrammetric, or metric, camera is introduced. Photogrammetric cameras are the special instruments which produced stable "conic perspectives" for each photograph taken, thus ensuring the necessary geometric stability. Slide A3 depicts the two famous cameras of the time: the UMK 1318 (Zeiss Jena) and P31 (Wild Heerbrugg).



***A3** There exist numerous metric cameras, designed for different types of survey. Here are two cameras with a principal distance of 100mm. On the left is the UMK 10/1318 by Carl Zeiss (Jena), with format 13x18cm. The view is of the back without the slide carrier showing the four fiducial marks of the camera. On the right is the P31 by Wild Heerbrugg, with format x5 inches, three quarter view, in tilted position. Metric cameras can rotate about a vertical axis and may also be tilted by amounts which vary according to the model of the camera.*

*In most cases, metric cameras have a fixed principal distance. Some, however, have an adjustment allowing the principal distance to be altered by known quantities to suit subjects at very different distances. The two cameras shown here are of that sort.*

Photogrammetric rectification is introduced in four slides (A5 to A8). At that time, complicated optomechanical instruments were needed to perform the computations. This caused the fast perspective transformation of images of planar objects – an easy to grasp method – to become a very popular photogrammetric technique. Restitution of planar, or nearly planar, objects thus became an important part of architectural photogrammetry.




***A5** A first group of photogrammetric methods is applicable to the particular case of flat subject (or one that can be considered as flat, within certain tolerances) photographed at right angle: These are methods of rectification.*

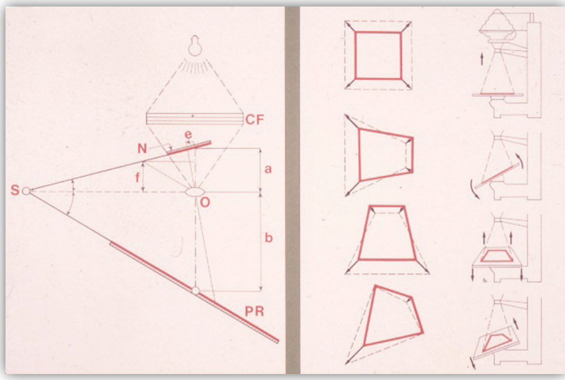
*Let us consider for example the central part of the previous slide (reproduced here centre right), that is to say, the wall and the window framed between the two buttresses. Rectification can proceed:*

A. *By graphical construction: knowing the conditions of tilt of the principal axis, one can draw over the photograph a perspective grid corresponding to the elevation required. The true elevation is then drawn by inspection of each square in the grid.*

B. *By an optical method, using a small instrument called a camera lucida with which one can see simultaneously a rectified image and the paper on which the elevation is to be drawn; the rectification is carried out by making several points of the photograph, the positions of which have been measured, coincide with the same points set out in true elevation; the drawing then follows the image.*

C. *By a photographic method with a special instrument which, by projection, gives a rectified print from the oblique negative. Here is a KEG 30 rectifier made by Karl Zeiss (Oberkochen) (bottom right).*

*However, it is done, it is clear that rectification corrects only distortions of perspective due to tilt and does not correct distortions arising from relief in the subject, if any. In this case it is necessary to give individual consideration to each flat surface (for example in the slide the three windows or the two planes between the buttresses) and to put together the various rectified parts at the same scale.*



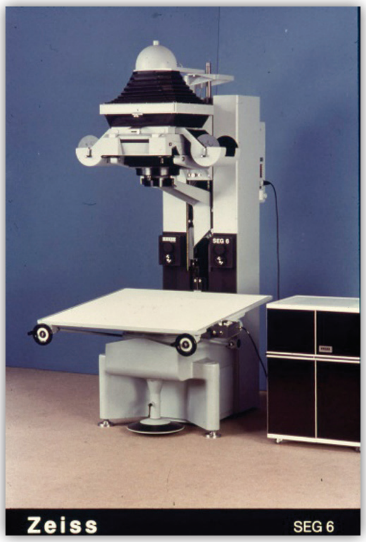

***A6** This slide explains the principle of photographic rectifier. It is a special enlarger in which certain conditions must be satisfied:*

(i) *The plane N of the negative, the plane of projection PR and the principal planes of the lens (reduced to a single plane) must come together to the same straight line S;*

(ii) *The image projected must be sharp* ($\frac{1}{f} = \frac{1}{a} + \frac{1}{b}$) *(f being the focal length of the projective lens).*

(iii) *The principal point of the negative adjusted to a consequent tilt in the negative must be offset by a certain distance e to match the optical axis of the rectifier lens.*

*The tilt of the plane of projection adjusted to a consequent tilt in the negative of the instrument, both of which are different from the tilt of the photograph, makes it possible so to distort the projected image that it is correctly rectified and brought to the right scale (right hand side of the slide).*

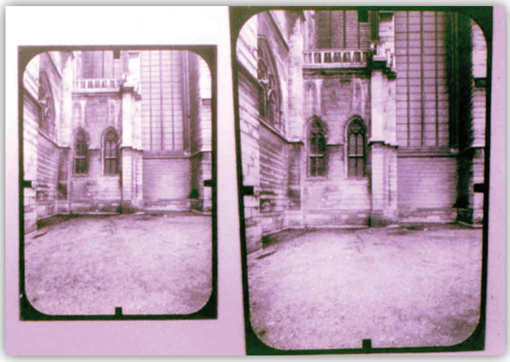



***A7*** *Rectifiers are complex pieces of photographic equipment, nowadays entirely, or almost entirely, automatic. The slide shows one, the E4 rectifier made by Wild Heerbrugg*[3]*. It should be pointed out that there is no way to achieve highly accurate rectified plans, i.e. eliminate all significant distortions, by using approximate photographic procedures.*

*It must always be remembered that rectifiers can at one time correct for tilt and alter the scale of the image being rectified, but there are definite limits on the amount of tilt that can be corrected for by using a regular rectifier: a maximum of 15º. For greater tilts there are special instruments designed for a given principal distance and a given format.*

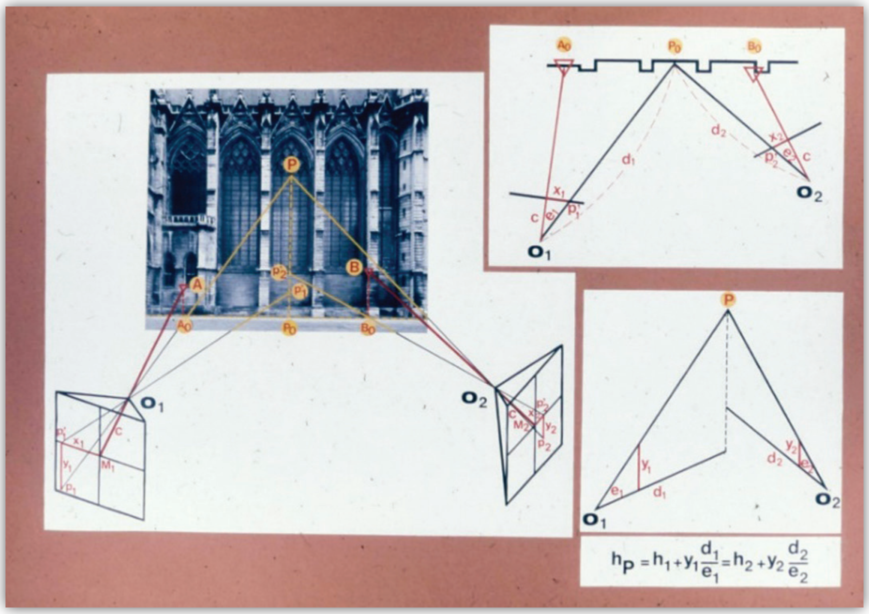
*In the KEG 30 for instance (slide A5) these factors must be 30 grads, 60mm and 9x12cm; the scale must then be adjusted in a separate operation, after rectification.*

***A8*** *Example of rectification. On the left the original photograph, taken with a UMK 10/1318 camera at a slight tilt, on the right the photograph rectified and brought to scale of 1:50. This procedure is obviously valid only for a flat surface of the subject, here situated at the centre of the photograph (with two windows and the balustrade). To the right, the wall at the bottom and the window, being on a plane parallel to the one containing the window and balustrade, equally well rectified but they are not at the same scale since further away.*



The next five slides (A9 to A13) take the knowledge a step further, and show the methods behind documenting non-planar objects with photogrammetry. Binocular vision is explained and two difficult principles are introduced: ray intersection in 3D space, and stereophotogrammetric restitution. The text accompanying these five slides is inevitably longer in order to explain the notions of relative and absolute orientation. Simple stereoscopic instruments (e.g. the classical mirror stereoscope with the parallax bar) are also briefly presented, and with them the floating mark and the principle of parallax are also explained.

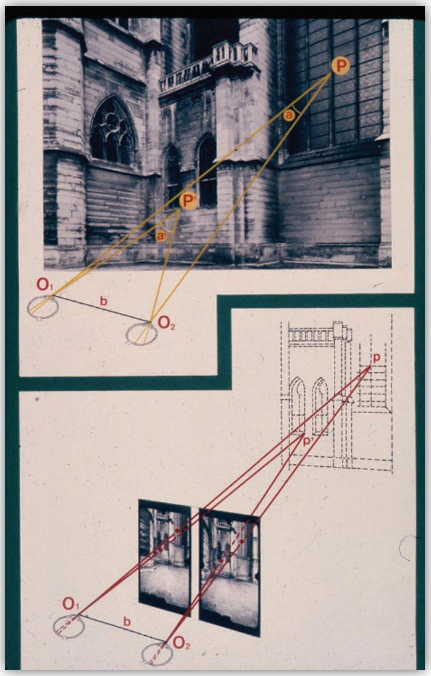
3 As the original slide could not be retrieved, a more modern instrument, SEG 6 rectifier, using the same principles is depicted here.




***A9*** *Photographic rectification can give satisfactory results for subjects which are more or less flat when an elevational survey is wanted (or a plan for a flat ceiling, or a mosaic floor). But rectification gives no possibility of measuring depth of relief. For a survey in three dimensions of a subject exhibiting relief it is necessary, for each part, to use two photographs taken from different viewpoints which will allow the position of each point in the subject to be identified by the intersection of two homologous rays of light relating to the point.*

*This method has been applied since the beginning of photogrammetry (that is since the middle of the 19th century) to the survey of monuments (Laussedat in France, Meydenbauer in Germany). These two photographs are taken from two viewpoints $O_1$ and $O_2$, of known position, with the principal axes horizontal, and directed to the two points A and B, their direction being measured. This allows the recording on a whole drawing, to the scale required, of the viewpoints $O_1$ and $O_2$ and the projections of the principal axis on a horizontal plane of reference: $O_1A_o$ and $O_1B_o$. The positive images of the two photographs are then formed at a distance c from $O_1$ and $O_2$.*

*Each point P in the subject has two homologous images, $p_1$ and $p_2$; their coordinates on the photographs are respectively $x_1$, $y_1$ and $x_2$, $y_2$. By plotting $x_1$ and $x_2$ on the horizontal projections of the planes of the photographs, one obtains the two homologous rays $O_1p'_1$ and $O_2p'_2$ and the intersection of these two rays gives the position in plan of point P which we call Po. In the same way the identification of $y_1$ and $y_2$, completed by a few simple measurements on the working diagram ($e_1$, $d_1$, $e_2$, $d_2$), permits the construction or calculation of the height h of point P. So, point by point, it is possible to construct the plan and the elevation of the subject being surveyed and from them to deduce sections.*

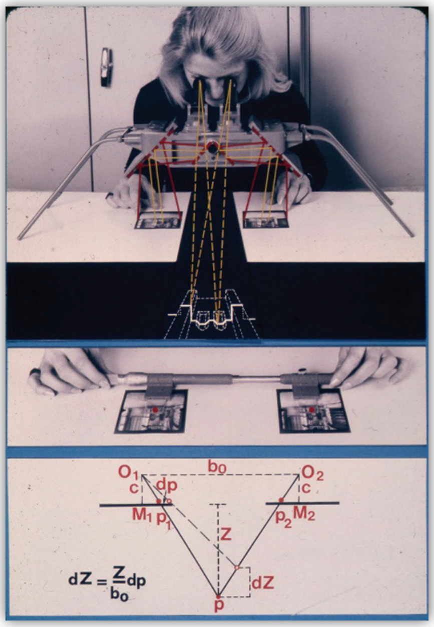



*__A10__ The method of graphic intersections thus proceeds point by point and it is analogous to methods of traditional ground survey by theodolite intersection. It does not provide for tracing out continuous lines of the subject. On the other hand, it does provide a high degree of accuracy.*

*Another idea already old but introduced into photogrammetry at the beginning of the 20th century, which has allowed progress towards survey by continuous plotting is stereoscopy.*

*Looking at a subject which has relief, the two eyes see two different images, because at their different viewpoints, separated by the base b (about 65mm). The brain fuses these two images into one three-dimensional image, provided that the difference between the angles a and a', relating to the furthest and nearest parts, do not fall below a certain value.*

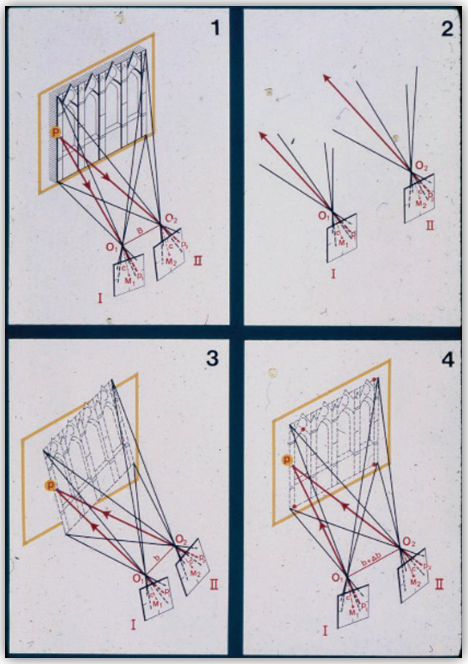
*The phenomenon of three-dimensional binocular vision can be reconstructed from two photographs, under the condition that they were taken with their axes parallel or only slightly convergent. Looking simultaneously at the left hand photograph with the left eye and the right hand photograph with the right eye, one sees an image in three dimensions and the relief will be accentuated as the distance between the viewpoints is made larger.*




*__A11__ Stereoscopic examination is made easier using a stereoscope through which the two photographs are observed, and which allows for the enlargement of the image seen in relief. There are different types of stereoscopes: here a mirror stereoscope.*

*If one puts over the two photographs an instrument carrying two markers (as is shown in the centre of the slide) and if by changing their position one places these markers exactly on the homologous images of one point in the subject photographed, the observer sees only one marker in one three-dimensional image and the marker appears to lie on the surface of this image.*

*By adjusting the position of the markers, one can make stereoscopic pointings on neighbouring parts of the subject sited at different depths and measure these depths by simple calculation using the distance between the viewpoints reduced to the mean scale of the photographs (bo), the distance separating the viewpoints from one of the two points whose depth difference is wanted (Z) and the difference of parallax (dp), that is to say the variation of the difference in setting between the two markers. An instrument like that shown in the middle of the slide, called a parallax bar, allows the measurement of dp.*

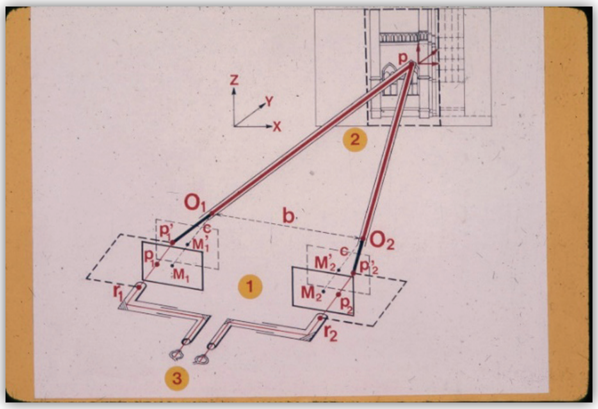



***A12*** *Stereoscopy brings two photographs together to give a relief image of the subject which is, however, not an exact replica of the subject due to perspective distortion, exaggeration of relief, but on it one can use a measuring device.*

*At the same time, it is possible, starting from two perspective photographs to reconstruct a model of the subject which will be true representation of the subject at a given scale. To do this one must proceed as follows:*

1. *Exposures made with a metric camera of principal distance c at two viewpoints $O_1$ and $O_2$ situated at a distance B from each other (B=base between viewpoints) gave two photographs I and II of a subject whose plane of reference is represented on the slide by a yellow outline. To each point P in the subject there are corresponding points $p_1$ and $p_2$ and two homologous rays $PO_1p_2$ and $PO_2p_2$. An infinite number of homologous rays from two perspective bundles.*
2. *One can, with suitable apparatus, reconstruct the two perspective bundles of rays, thanks to a very precise knowledge of the characteristics of the metric camera: its principal distance, its principal point, the position of the negative (using the fiducial marks in the camera). This reconstruction can be made mechanically, or optically, or by a combination of the two.*
3. *One orients the two perspective bundles of rays in relation to one another to give the two axes and the two pictures the same relative orientation as at the moment of exposure; one introduces between the two viewpoints a base b. The figure so formed in space (photographs, centres of perspective, bundles of rays) in similar to the figure formed by the same element sat the time of exposure. The homologous rays intersect each other and give by this intersection an infinite number of points p of which the whole forms a model similar to the subject at a scale given by the proportion b/B.*
4. *This model cannot always be conveniently oriented to the plane of reference, nor to the exact scale wanted. There remains then a further operation called absolute orientation, which consists of removing these deficiencies, on the one hand by rotating the whole figure (photographs, viewpoints, perspective bundles and the model) and on the other by adjusting the base by the necessary amount Δb. For this last operation it is necessary to now some details of the external orientation, such as the directions and lengths or XYZ coordinates of a number of points in the reference system of the survey plot.*

*The simultaneous achievement of the above operations and the stereoscopic examination of the two photographs constitutes the stereophotogrammetric method. The establishment of a three dimensional reconstitution by this method is called stereophotogrammetric restitution.*




***A13*** *Putting the stereophotogrammetric method into action makes use of plotting instruments which achieve the process described. There are various types. The slide gives the basic principles of one type of instrument. One can see:*

1. *The two photographs with their principal points $M_1$ and $M_2$.*
2. *A mechanical linkage formed of two rods pivoted at the two points $O_1$ and $O_2$ corresponding to the centres of perspective and between which the desired base b is introduced. These two rods, which give material form to the homologous perspective rays, intersect at p, the continuous movement of this point building up the model.*

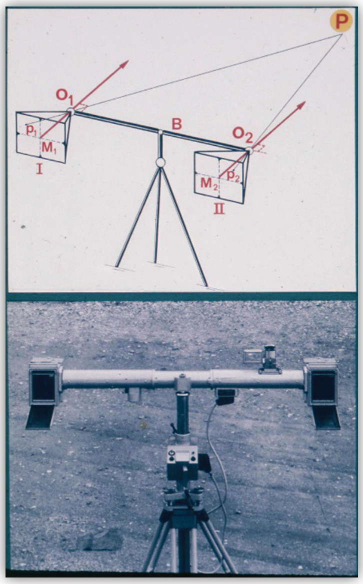
   *At the other end of the rods (which we must suppose running on in front of $O_1$ and $O_2$), joints $p'_1$ and $p'_2$ are designed to move in two planes parallel to the planes of the photographs and situated at a distance c from the centres of perspective ("imaginary Photographs"). The exact centering of the principal points $M_1$ and $M_2$ on the principal axes and the orientation of the photographs in their plane are otherwise assured. Finally, the photographs (real and "imaginary") can be given the necessary angle of tilt for relative orientation and the whole mechanical system can pivot to achieve absolute orientation in a rectangular system of three axes XYZ, the reference system in which the model is finally formed. So, a geometric pattern of the photography is reconstructed by mechanical means.*
3. *An optical system providing for the stereoscopic examination of the photographs and carrying two markers $r_1$ and $r_2$, forming by stereoscopic fusion one single marker. This optical system is constructed in such a way that every movement of the two rods and consequently of the two joints $p'_1$ and $p'_2$ causes an equal movement of the viewing system and of the markers $r_1$ and $r_2$, all the time keeping the stereoscopic mark on the corresponding images $p_1$ and $p_2$ in the two photographs.*

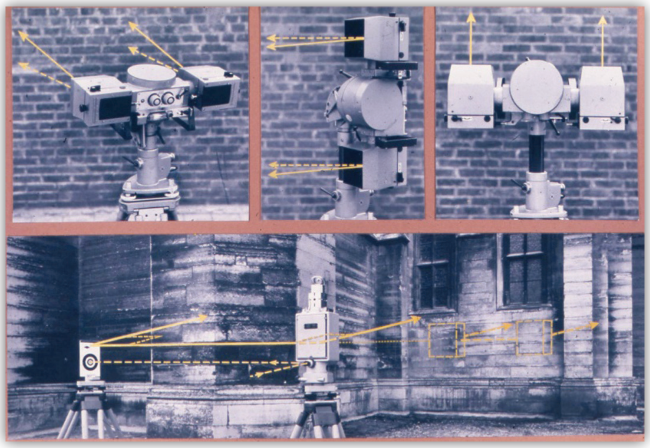
*In effect, the instrument being suitably set up for a pair of photographs, it is this floating mark which the operator controls and which is going to draw out at the point p the whole model and continuously control all the mechanical and optical movements. It only remains to measure the movement of p in the system of the XYZ axes or to transmit these movements in relation to two axes (XZ, XY, YZ) to a drawing table on which one can directly obtain elevation, plan or vertical section.*

Terrestrial stereocameras are introduced in the next two slides (A14 and A15). The slides show the concept of ensuring a given relative (and absolute) orientation which makes all previously presented actions easier for non-experts – this is based on the fact that the users of architectural photogrammetry have (almost) full control of the position of the cameras on the ground (or even on a platform). Hence, the stereocameras with fixed base are described and presented as the standard way of talking stereopairs. Alternatively, this was also possible using a single camera, or a phototheodolite, but special care would need to be taken to achieve the correct orientation of the so called "normal case".

*__A14__ The photogrammetric procedure is simplified as far as relative orientation is concerned if the two principal axes are parallel to each other and perpendicular to the base. The special case is called by photogrammetrists the normal case.*

*To achieve this an ideal solution consists in fixing two identical metric cameras on a rigid bar forming a base of accurately known length; this apparatus is called stereometrics camera. There are a number of models, the bases being most commonly 40cm and 120cm and sometimes 60 and 200 cm. The camera shown on the slide is an SMK made by Carl Zeiss (Oberkochen); base 120 cm, two cameras of principal distance 60mm, and with 9x12cm format. The principal axes are horizontal. The cameras are viewed of the back without the slide carriers.*



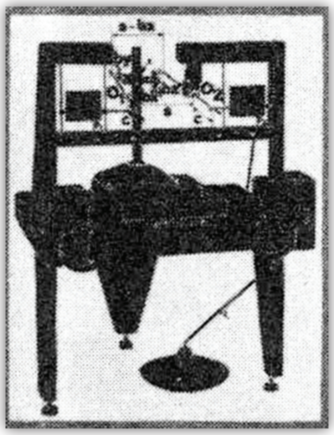
*__A15__ The normal case can be equally well achieved in different positions of the base and the principal axes permitted by the appropriate movements in the stereometrics cameras. Here is a C40 camera by Wild Heerbrugg (above from left to right): with the base horizontal and the axes inclined; the base vertical and the axes horizontal, at an angle to the plane of reference (photography from the slide); the base horizontal and the axes vertical. Tilts must generally be of fixed amounts, either 30º or 60º.*

*One can also achieve the normal case with a single metric camera, by means of a diagonal eyepiece (as generally supplied with these cameras) through which one can observe a target set on a tripod at the second station, assuring that the principal axis and the vertical plane of the base are at right angles. A difference of level can still exist between the two viewpoints.*

*This second possibility is important because it allows the normal case to be achieved with bases of greater lengths than those imposed by the limitations of stereometrics cameras. Increasing the base is an essential factor for precision, for it is necessary to maintain a proper relationship between the base and the distance separating the viewpoints from the subject; photogrammetry, depending on intersections, too short a base leads to too narrow an angle of intersection of corresponding rays, which is incompatible with accurate restitution.*

*One can also extend this possibility by setting out several cameras (single or stereometric) on one base line and maintaining the normal case. If the photographs so taken are combined two by two one can obtain different base lengths. This arrangement has interesting possibilities for subjects with great depth of relief.*

Having explained the basic principles of the 3D geometry of photogrammetry and the ideal way that the photographs should be taken, it is high time to explain how to measure on them and how the intersections of the rays are calculated. As there was no software available at the time, computations were carried out using optomechanical devices, called photogrammetric instruments. They were complicated combinations of prisms, threads, metal rods, lenses, handles, and foot disks which offered the users the possibility to stereoscopically observe a pair of photographs, put the floating mark (i.e. the 3D pointing device) on a point in the stereoscopic model, and let the instrument calculate its position in the reference system chosen. All photogrammetric instruments offered the possibility of plotting the positions of all points measured on a chosen orthogonal projection, thus producing the photogrammetric drawing on-the-fly.



***A16*[4]** *The construction of plotting instruments can be simplified if they are intended to deal only with photographs taken in the normal case. There are several instruments of this sort. Here is the mechanical layout of the A40 autograph by Wild Heerbrugg. This can be compared with the diagram of general principles in slide 13. One can see only two differences, due to the mechanical solutions adopted by the designer:*

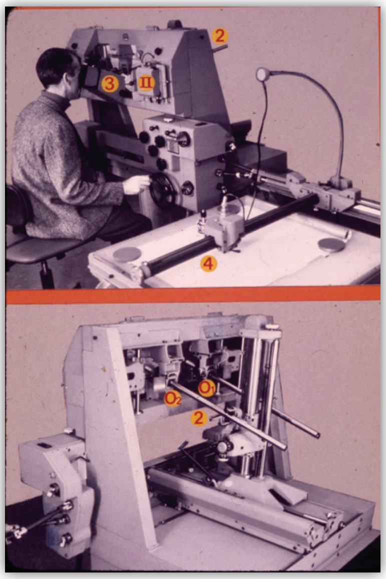
- *The photographs are not moved towards the front of the machine but sideways to the left and to the right.*
- *The two rods representing the perspective rays are not only joined by a single point p, but this articulation is doubled by the introduction of a constant s between the two viewpoints (which is another way of saying that one of the rods undergoes a movement s); the result is that the base is introduced between the two joints (s-bx); also, the small components of the base and bz can be brought in; they correspond to a difference of the viewpoints with respect to a reference plane of the model and a difference of level between the two viewpoints.*

4 Slide A16 unfortunately could not be retrieved and has been scanned from the booklet.

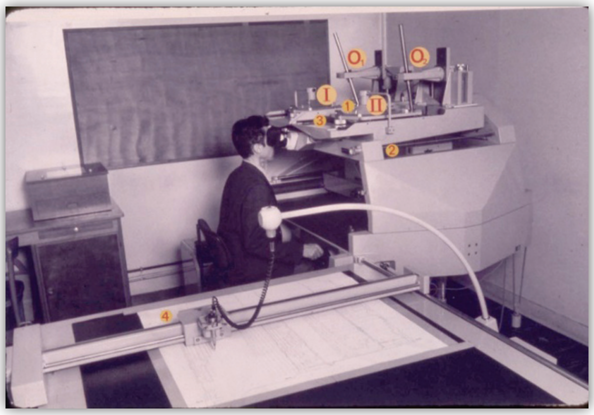
***A17*** *Here is the actual Wild A40 with the photograph carriers (only one for photograph II is visible), the mechanical linkage (2) the optical system (3) and the drawing table (4) to which movements in the model are transmitted, with a change of scale if necessary.*

- *The operator, using all three controls at once, explores the model either point by point or continuously, following in the stereoscopic image each line of the model which he wishes to record. He makes the floating mark appear to move over the image so that movements to the carriage below the rods outline the model.*

*N.B. Note above the right handwheel, a device called a "tilt calculator", to which we shall come back later (A21).*




***A18*** *It is not, however, always possible to work with the normal case, nor to be sure of the orthogonality of the principal axes to the reference plane of the model, obstacles to photography, due to the surroundings of the subject, often make it necessary to take photographs with the principal axes more or less oblique. According to the nature of the model to the achieved it can also be advantageous to use metric cameras of greater or smaller principal distance. After the proportion of base to distance (brought out in the commentary on slide A15) we meet here the second factor of precision: it is necessary that the scale of the photographs should not be too small in relation to that of the model to be achieved. So, because of the size of the subject or its complexity, of the difficulty of the finding suitable viewpoints, on may be obliged, for the sake of the precision, to use a camera with a greater principal distance and, more often, of larger format.*

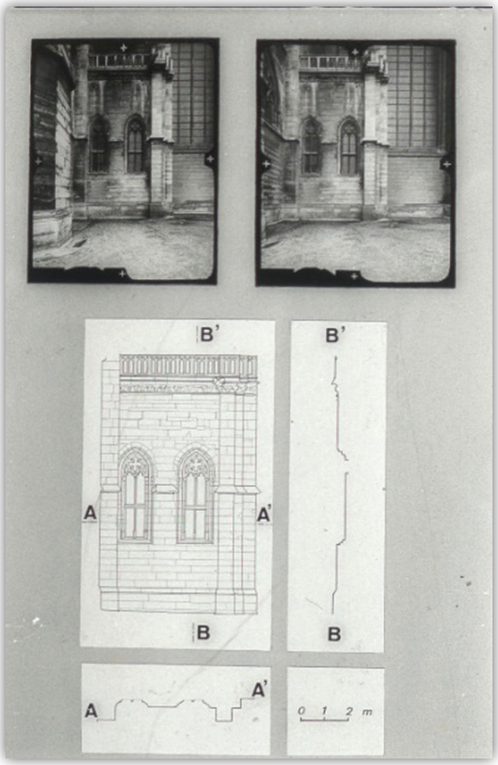



*These various limitations demand, for the restitution, instruments of greater flexibility that are able to handle photographs taken with cameras of different principal distances and with different formats, and which allow a tilt of the photographs with respect to the reference plane within certain limits appropriate to each instrument.*

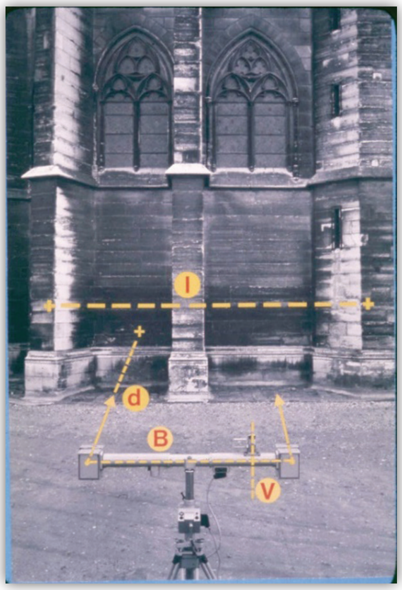
*The instrument shown in this slide is a Planimat D2 by Carl Zeiss (Oberkochen). It contains the principal elements of all plotting instruments: (1) photographs I and II – (2) mechanical linkage with rods pivoting around the two perspective centres, $O_1$ and $O_2$ – (3) optical system – (4) drawing table, here drawing a model in elevation.*

Further to that, slides A19 to A22 explain some more details on photogrammetric restitution and fieldwork. Firstly, the difference between stereoscopic restitution and single image rectification is shown on the same object as was shown in slide A8. In this way, the reader may easily grasp how the two techniques are implemented differently.

In the next three slides, some elaborations on fieldwork are given in cases where the user is confronted with larger and taller objects. The alternative of using special platforms to elevate the camera is also offered, as is the notion of the photogrammetric network.

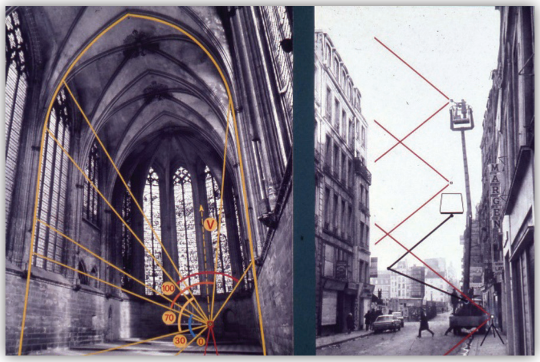



***A19*** *So starting from a pair of photographs, one can set up, by photogrammetric restitution, a very accurate and detailed model in elevation, horizontal sections and vertical section, these sections being multiplied as many times as necessary. The horizontal sections made at chosen levels, give the elements of the model in plan.*
*Here one can see the same subject as in slide A8 (example of rectification). But the model need not be restricted to the part which is approximately flat between the buttresses. These are included in the model which is three-dimensional.*




***A20*** *From what has gone before, it follows that photogrammetric survey can be broken down into two parts, linked together by the scale of the model, the choice of reference plane, the accuracy required and so on, but quit independent in time and place: on the one hand the operations on site (taking the photographs and the necessary survey work) and on the other the work n the drawing office, that is the photogrammetric restitution or the rectification and the assembly into a photoplan. Operations on site can be used to build up a photogrammetric archive of the subject which can be used at a later date as the necessity may arise.*

*The organisation and the extend of the site operations can vary widely according to the importance of the survey. For simple architectural subjects, for example, one can often manage with just a pair of photographs in the normal case as in the slide. Verticality (V) will be ensured by a spirit level fixed t the camera; if this is stereometrics, the base (B) is known, otherwise it must be measured. It will suffice then, by some appropriate means, to orient the base parallel t the reference plane and to measure one or two control lengths, for example the distance (I) between two targets placed on the subject and the distance of one of the viewpoints (d) from a point on the subject on the principal axis of this viewpoint.*



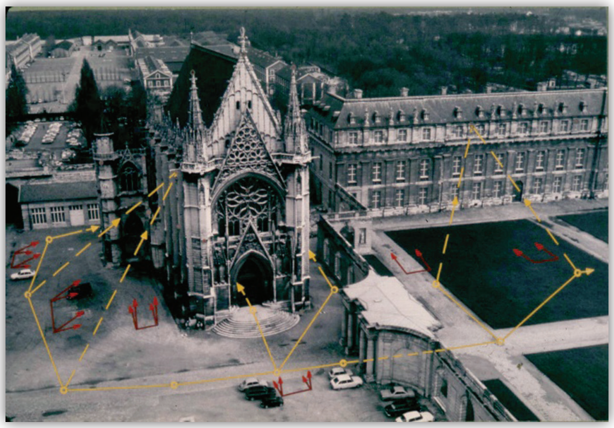

***A21*** *A special case which occurs often enough is that where fairly simple subjects are of considerable height relative to the distance available for photography. Several solutions, keeping the advantages of the normal case, can be selected, namely:*

*(i) -left hand side of slide- rotating a stereometrics camera on its base so as to give the two principal axes a tilt of known value, e.g. 30 and 70 grads, on can then cover the whole height with a few pairs of photographs (including vaulting with tilts of 70 and 100 grad); the tilts are controlled with a graduated level, a toothed segment etc.*

*Plotting instruments, even the most flexible, are not able to accept photographs tilted as much as 30 and 70 grad, and so designers have invented devices called tilt calculators which can be inserted between the plotting instrument and the drawing table and which, for tilts of values recorded at the time of photography, can make the necessary corrections during plotting.*

*(ii) -on the right of the slide- when for reasons of accuracy or the extent of the survey (higher parts set back, for example, and not visible from the ground) one cannot use the previous solution, one can make use of a hydraulic platform and take a series of stereopairs at different levels.*

*NB For the highest parts of high buildings it might be possible to use a helicopter.*

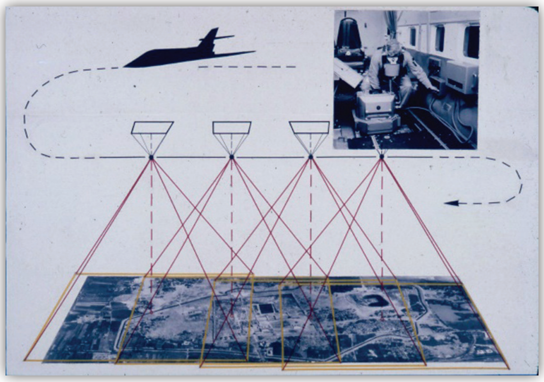


***A22*** *The organisation of site work gets more complicated with the importance and the complexity of the subject to be surveyed. It soon becomes necessary to work as follows:*

- *Take enough pairs of photographs (with axes horizontal or tilted, shown by red arrows) to cover all surfaces to be recorded, reducing hidden areas to a minimum, while always paying attention to the limitations of precision: proportion of base to distance focal length etc.*

*Carry out the control measurements: traversing and triangulation (yellow lines) with the object of establishing on the subject the necessary reference points for the photogrammetric survey (orange points); these points will generally be established in a unique system of coordinates, but they need to be adapted, before plotting, to the different reference planes appropriate to each architectural element.*

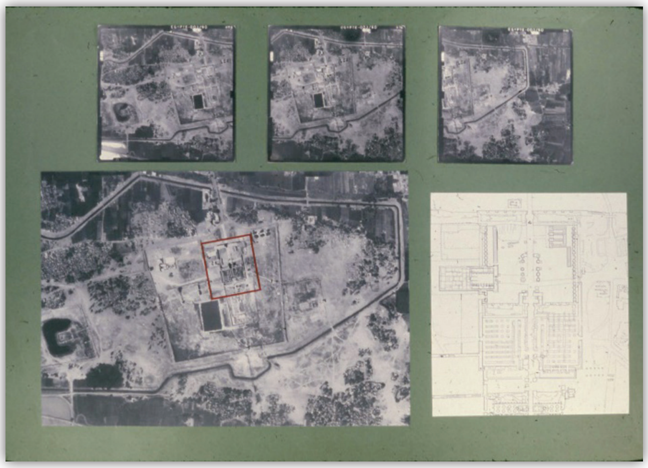
Finally, in the two last slides of series A (A23 and A24) the notion of aerial photogrammetry is touched by a brief description of the flight planning, examples of aerial photographs from an aerial metric camera, and a restitution of photogrammetric aerial images.



***A23*** *We have so far considered photography from the ground. For surveys of archaeological sites, historic centres, etc. aerial photogrammetry is equally widely used. It makes use of photography, with the camera axis approximately vertical, taken from an airplane in the following manner:*

- *The airplane follows as straight a flight path as possible at a more or less constant height; the photographs are taken at regular intervals spaced so that each photograph overlaps its neighbor by about 60%; stereoscopic cover of the ground is thus assured and all the photographs from one line of flight form a photographic strip.*
- *if it is necessary to cover a wider area, two or more parallel strips are flow forming a block of photographs, the distance between the lines of flight being calculated so that each strip overlaps the one next to it by about 20%.*

*The focal length of the camera and the flying height of the airplane are chosen to suit the characteristics of the site (and particularly its relief) and of the survey to be made (scale accuracy required etc.). The mean scale of the aircover is given by the proportion of the principal distance of the camera to the mean height of the airplane.*
*Aerial metric cameras have large formats (principal distances going from 85 to 310 mm) with very high quality lenses their operation is automatic. Unlike ground cameras, they use roll film, the flatness of the film at the moment of the exposure being assured by pressure. On the slide (top right) is an RC10 camera by Wild Heerbrugg set up in an airplane.*



***A24** This slide shows the first three aerial photographs of one strip. When the ground is accidentally flat and there are not high buildings on it, it is possible, as in terrestrial photogrammetry, to deal with the photographs of a strip or a block by rectification and to bring them together to a given scale as a photoplan (bottom left).*

*The most common use of aerial photogrammetry will always be for photogrammetric plotting for which instruments designed only for the normal case will not be adequate but, because of the conditions under which the photography is carried out, plotters of more or less universal capabilities will be needed. In the example shown here, the part outlined in red on the photoplan is plotted (bottom right); because f the height of the remains of monuments there, it is the only solution which will give a sufficiently accurate plan on the one hand and allow heights to be measured on the other.*

As clearly remarked in the booklet, the pieces of apparatus shown in the slides are only some examples of equipment produced by different manufacturers of photogrammetric instruments. For a detailed list of equipment and appropriate fields of use, the interested reader is advised to search in the Annual Report of the International Committee for Architectural Photogrammetry from 1972 (https://www.icomos.org/publications/bulletin1975/bulletin1975-6.pdf). For the realization of the slides, the Sainte Chapelle of the Royal Chateau de Vincennes, near Paris, was used with the exception of slide A21 (right) which shows the Rue Saint Martin in Paris, and slides A23 and A24 which depict the site of the Temples of Karnak in Upper Egypt.

## 4. Series B of the CIPA 1976 slides[5] - Applications and examples

These applications of photogrammetry are presented in three main groups. The first two deal with two different aspects of architecture: monuments and historic centres. The third group gives examples of architectural surveys and the recording of works of art.

This grouping is still valid today! Single monuments, historic centres and archaeological works of art are approached differently as they present different properties which drive the methods of documentation to be used and are documented with different specifications. It should be noted that universally accepted and applied specifications do not exist, and this gap should also be addressed by organizations like CIPA.

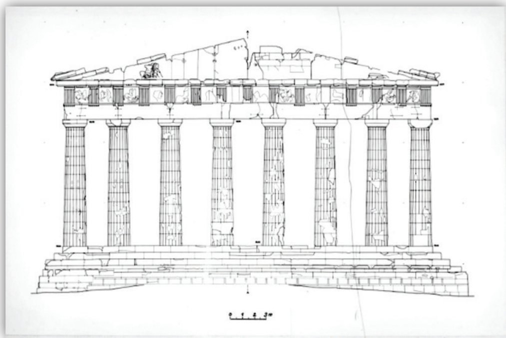
This B series presents interesting and representative cases for illustrating the presentation of the possibilities of photogrammetry. In the first group, "*Architecture – Monuments*", the examples concern emblematic monuments mainly in Europe (Greece, Germany, Turkey, Italy, UK, Austria and France) but also elsewhere (Nepal). This shows that in its first years, CIPA was more Europe-centric, as most of the documentation activities were generated in Europe. Gradually this has changed and, nowadays, CIPA is truly an International Scientific Committee.

### 4.1 Architecture – Monuments

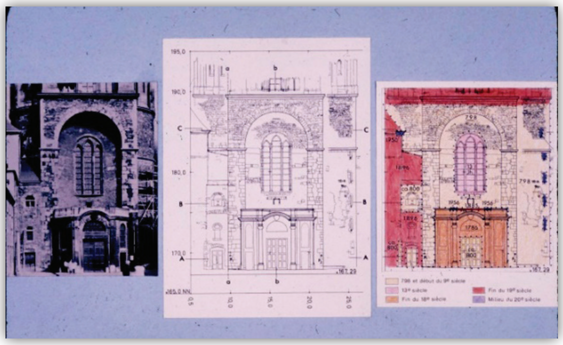
***B1*** *Photogrammetry is especially suitable for recording monuments in elevation. The worldwide collection of surveys of this sort is very important. It will include the great and famous buildings like the Parthenon on the Acropolis of Athens, of which the west side is shown here.*

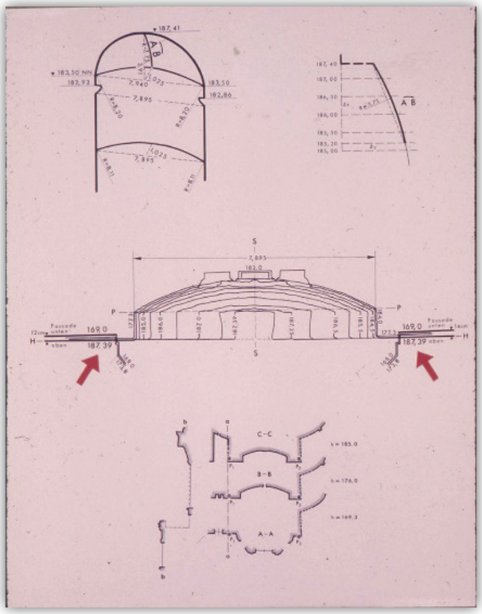
5 In the following the original text in the accompanying booklet is reproduced with italics.

*__B2__ The photogrammetric plot, which was drawn at a scale of 1:50, gives the actual form of this west side at the time of photography with great precision and all necessary details (architectural form, details of construction, cracks, fissures, etc.). (Survey made by IGN, France, for UNESCO).*



*__B3__ Here is another elevation of a building of great archaeological interest. It shows the palatine chapel of the cathedral in Aachen, West Germany. Built about 800 A.D., this façade has undergone many modifications through the centuries. This plot, which was drawn at 1:50, shows clearly the different parts of the construction and provides a survey of the stonework with a faithfulness and detail that could not be achieved by any other method. (Survey by the Geodetic Institute, Technische Hochschule, Aachen). On the right is an archaeological interpretation by Dr. Kreusch, showing the periods of construction.*





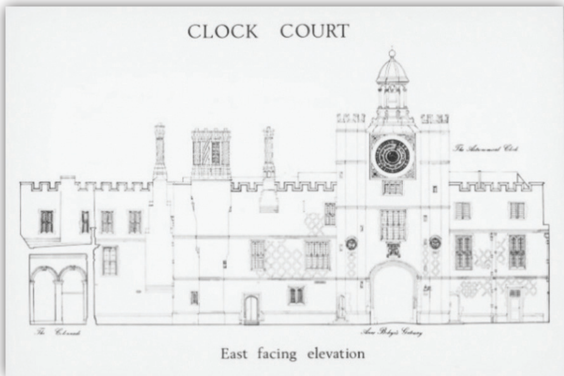
*__B4__ But Photogrammetry, as we have already said, offers further possibilities in addition to the plotting of elevations. For the same subject as in the preceding slide we see here, starting at the top, a plot of the principal characteristics of the central niche, obtained by numerical analysis; then a contoured plot of the vault of the niche (we shall come back to this later) which shows distortion and asymmetry as well as the variations in inclination of the walls of the façade (red arrows); lastly a section on the vertical axis and three horizontal sections and plans. (Plotted by the Geodetic Institut, Technische Hochschule, Aachen).*

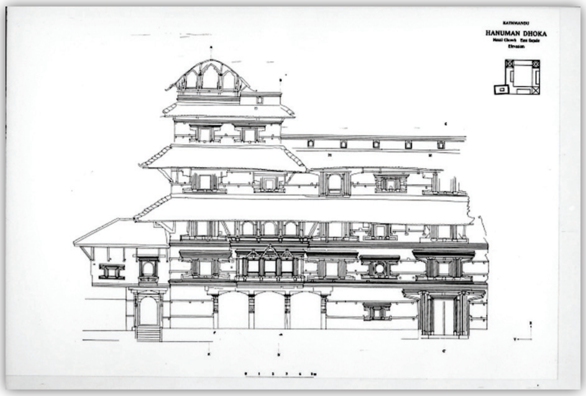
***B5*[6]** *These parts of an 1:50 survey of the Roman Amphitheatre at Side in Turkey show further possibilities of photogrammetric techniques associated with ground surveying which can provide a background against which various elements can be related one to another.*

*On the right a detailed plan. Below left, a sectional elevation of the steps and the gallery. Top left, a developed external elevation. This last drawing was achieved by plotting from a series of stereopairs, the bases of which were at different orientations as they followed the curve of the façade. (Plotted by the Restoration Department, Faculty of Architecture, Middle East Technical University, Ankara).*

***B6*** *Through its wide possibilities and adaptability, photogrammetry is particularly well suited to typological studies of a particular period or a particular region. Here it is less a matter of recording the smallest details by rather of seeking a definitive survey (the "restitution finalisee" of Prof. R. de Vita) to record the essential character of monuments. Such a study has been undertaken by the Photogrammetry Section of the Architectural institute at Bari (Italy) for the medieval castles of Pouilles. Here are three examples: (1) Bari, (2) Acaja, (3) Conversano.*

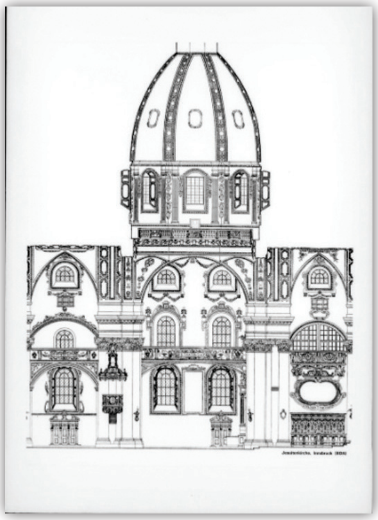
***B7*** *If metric photographs are taken at a suitable scale and with good definition, the model reconstitution in the plotting instrument and the image seen by the operation allow the exploitation of great richness of detail. On the other han,d an alternate application is to select from the available detail. So, in this elevation of the east façade of Clock Court, Hampton Court, near London, all the brick coursing has not been plotted. Only the features that define the architectural style and the decorative elements are plotted. (Surveyed for the Ministry of Public Building and Works, London).*



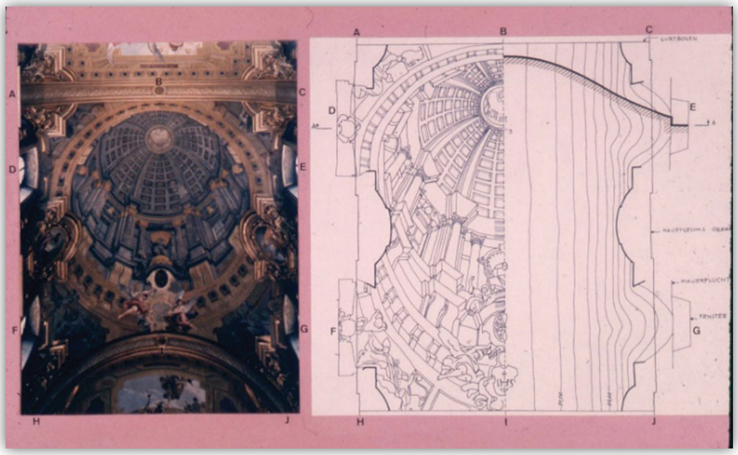




***B8*** *complete restoration of a monument requires for a start an exact knowledge and detailed documentation. There is an extra strong need when the building has been distorted as much as the Palace of Hanuman Dhoka at Katmandu (Nepal), a structure of timber and brick: one façade is shown here. (Survey by IGN, France, for UNESCO).*

6 Slide B5 unfortunately could not be retrieved and is not presented here.

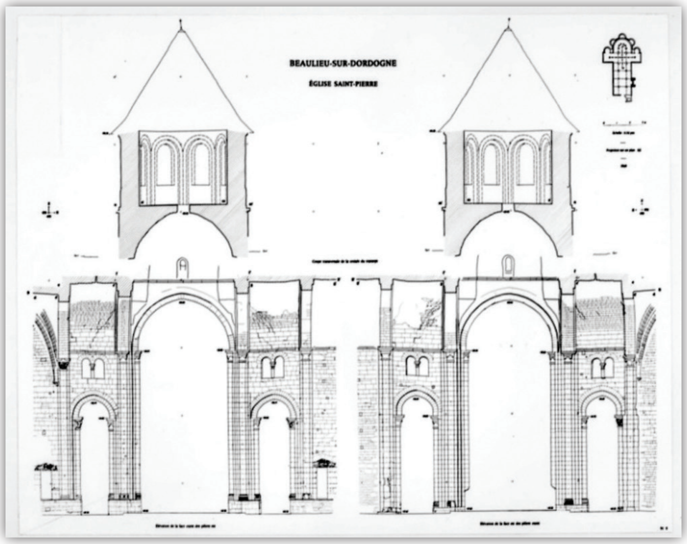


***B9*** *Photogrammetry finds a place in interior surveys as well as exterior. A group of stereopairs of photographs, with axes horizontal, vertical or tilted, their number and disposition adjusted to suit the building in question, will, for example, allow the plotting of sectional elevations with great accuracy and detail. Here for instance is the Jesuit Church at Innsbruck. (Survey by the Bundesdenkmalamt, Vienna).*



***B10*** *Recording of interiors, ceilings and vaultings provide an excellent field for the application of photogrammetry. Photographed from the ground they can be plotted in plan and section. Their surfaces can be shown with contours: the operator moves his floating mark over the surface of the vaulting, keeping it at a constant height. For each change in height introduced into the plotting instrument he can follow a contour whose plan is drawn on the plotting instrument he can follow a contour whose plan is drawn on the plotting table. The actual forms of the vaults are thus produced accurately and geometrically.*

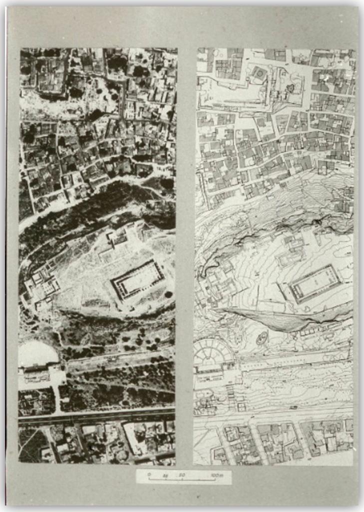
*From this follows the possibility of measurement and calculation with a view to their restoration or consolidation, if that be necessary, and also to studies of architectural techniques, and the analysis of mosaics, frescoes and painting with which they may be covered. The Jesuit Church at Vienna gives a good example of a study of this sort. A contoured photogrammetric plot in plan shows the shape of the vaulting (a barrel vault of nearly regular shape interrupted by the window openings). On this vault Andrea Pozzo painted astonishing perspectives at the beginning of the $18^{th}$ century. The photograph on the left is taken from a viewpoint indicated by Pozzo himself. (Bundesdenkalamt, Vienna).*



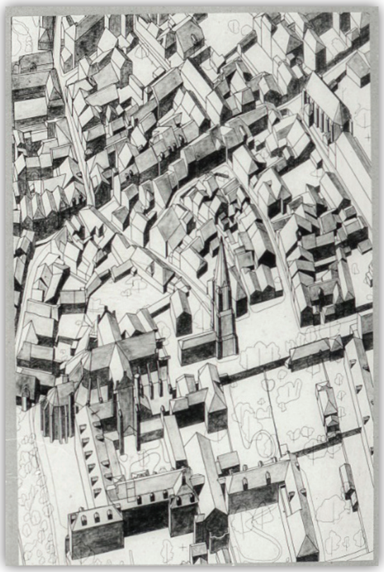

***B11*** *This slide shows a sectional elevation across the Romanesque abbey at Beaulieu on the Dordogne in central France. The survey was carried out at 1:50 scale in preparation for a restoration of the crossing. The survey also included longitudinal sections, a ground plan and a contoured plan of the central dome and the vaulting around it. Two features emerged: one, the great fidelity of detail in plotting distortions and the condition of the stonework, with its breaks and cracks, and second, the joining together of the section of the lantern tower to the section of the main interior, the plots of the two parts being related to each other by control surveys. (IGN, France, for Direction de l' Architecture). Surveys of this type are especially valuable in areas subject to natural disturbances such as earthquakes and hurricanes. If they have not been carried out beforehand, they should be executed immediately after the disaster.*

## 4.2 Architecture – Historic centres

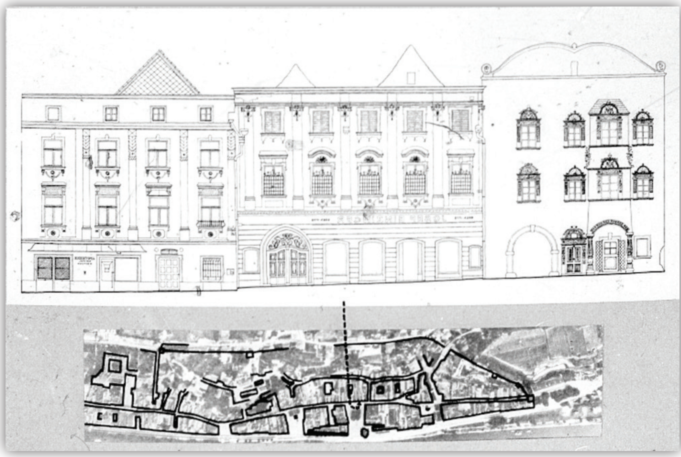
***B12*** *Aerial photogrammetry is the best method to employ for a general survey of a historic centre. The model formed in the plotting instrument from one pair of air photographs will provide a wealth of information. It will give the exact geometry of the centre in its smallest detail. Projected vertically the model gives an accurate plan with contours or with heights. This representation is in fact a classing topographic survey and topographic survey is the principal application of photogrammetry. Shown here is part of an air photograph of the Acropolis of Athens and its immediate environment (original scale 1:6000, principal distance 210 mm) and the corresponding part of the photogrammetric plan which was drawn at 1:1000 (IGN, France, for UNESCO).*




***B13*** *By means of various devices in the plotting instrument the model can also be used to produce vertical sections (the operator follows the relief of the historic centre keeping his floating mark in one vertical plane), or it can be projected horizontally in a chosen direction. In the last case an elevation of the whole historic centre is obtained directly. One can thus express the geometry of the centre in plan, sections and elevations, all accurate geometric statements which offer interesting possibilities for studying modifications of their form arising from the incorporation of new elements (buildings, new roads, etc.).*
*As in the previous slides, the example for section and elevation shown here related to the Acropolis of Athens. (Plotted by IGN, France, for UNESCO from a pair of photographs supplied by the Greek government).*



***B14*** *With rather more complex modifications to the plotting instrument and suitable orientation of the air photographs it is possible to produce directly by photogrammetry axonometric drawings of a historic centre, supplementing the drawings already described. These drawings can be used for studying and planning the management of the centre.*
*Here is an axonometric view of pat of the town of Auxerre, Bourgogne, (France) (plotted by IGN). It must be added that a computer in conjunction with an automatic drawing table can also be used (in a rather more basic manner nevertheless) starting from a numerical analysis of the main features of the buildings.*



***B15** The documentation of an historical centre can also include developed elevations of groups of houses lining the roads and squares, if these houses are of architectural interest. Here again photogrammetry generally applied by simple and flexible methods offers a solution which is ideal in view of the work on site and the excellence of the results. This slide shows, below, an aerial view of Stein and Donau in Austria (photograph by Bundesamt fur Eich – un Vermessungswesen, Vienna) which includes all the groups surveyed, and, above, an example of developed facades facing one of the squares of this little town. (Plotted by Bundesdenkmalamt, Vienna).*
*A survey of this type satisfies very well the requirements and the directives of international agreements for the protection of cultural possessions.*

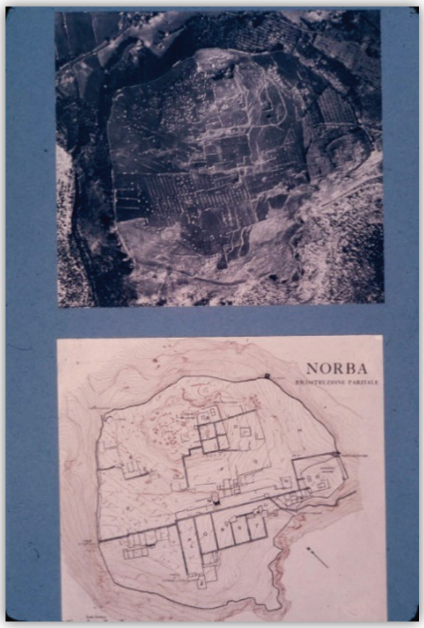

***B16** Photogrammetric methods used to produce developed facades can be of various kinds. Here is a group of houses fronting a square in Lublin, Poland, treated (1) by graphical plotting methods, (2) as a photoplan, that is a group of rectified photographs, and (3) in the same photoplan form but with additions drawn in to show the true form of the roofs. Details for the drawing could be obtained either by photogrammetric plotting or by construction based on control, by using the basic rules of perspective. (State Enterprise for Conservation of Art, Warsaw).*

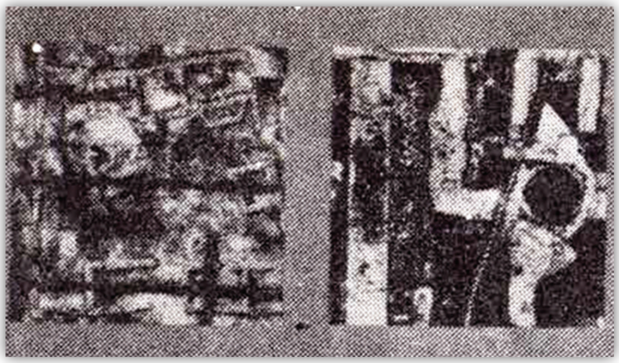
***B17*** *The rules of perspective are more easily applied today using a computer and automatic drawing table and they allow one to introduce into a photograph of an urban or rural scene which is to be protected the appearance in perspective of a proposed construction. This "photogrammetry in reserve", to be accurate, requires photography with a metric camera, numerical analysis of the plans of the project, and calculations for the points necessary to give an accurate representation of the masses involved. This method can be very useful for the appreciation of the impact of a new construction on the existing landscape.*

*The example shown here is one of the oldest; it relates to proposed law courts in the middle of Athens, which were not in fact built (Work done c. 1930 by Prof. Sokos, Athens).*

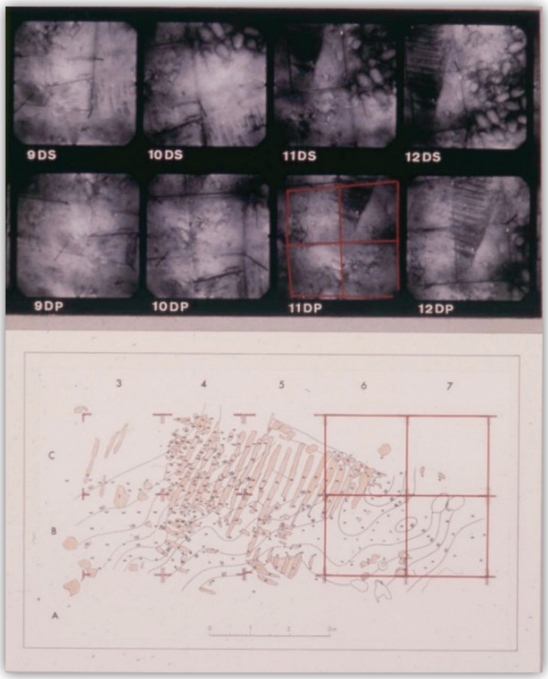
## 4.3 Archaeology and works of art

***B18*** *For a general survey of an archaeological site we come back to aerial photogrammetry, which is very suitable for this type of work. Air photographs themselves, viewed under a stereoscope, provide a wealth of information about the configuration of the site and how it fits into the natural relief of the area. Photogrammetric plotting provides an accurate survey in plan and of heights. The slide shows an aerial view of the city of Norba (Italy), a Latin fortress of the 4th century B.C. this photograph with two adjacent ones from the same strip was used in two stereopairs which were plotted to give the plan shown in the lower part of the slide, as well as measurements of the heights of the walls. On the plan a partial reconstruction of the city has been attempted (drawn in black). (By EIRA, Florence).*





***B19** Detailed archaeological surveys, particularly plans of successive levels in excavations can be produced, by "aerial photogrammetry" at low level by photography from a helicopter, from captive balloons, or any other system of elevation, such as tripods, hydraulic platforms etc. The examples shown here are photoplans; the photographs were taken from a height of about 20 m. It shows excavations of a medieval village in Czechoslovakia. All the finds, especially the burials found in the excavation, are recorded in situ. (Survey by the State Institute for the Protection of Historical Monuments, Prague).*

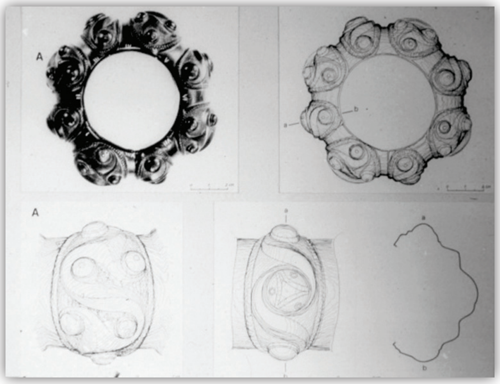


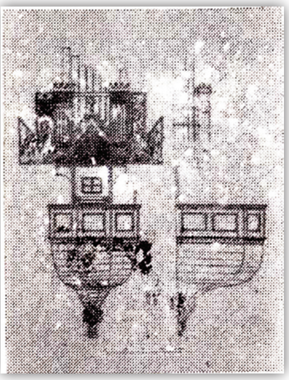

***B20** Again it is with a vertical axis that photogrammetry is used under water for the survey of wrecks or submerged sites. The cameras are mounted in watertight containers and special lenses allow for the difference of media between the lens and the subject (water) and the lens and the film (air). Different methods have to be used for moving camera stations, whether simple or stereometric cameras are used, to achieve a complete photographic cover in parallel strips. We can see on the slide a photogrammetric survey of a Roman wreck related to a grid set up on the bottom of the sea with cords stretched between posts (in red). (American Institute of Nautical Archaeology).*

***B21** Photogrammetric plotting of contours used to record the shapes of vaults and domes can equally well be applied to sculpture. The reference plane will normally be vertical rather than horizontal and we can represent mas by contours which give in effect equidistant vertical sections. This method is widely used for recording statues whether on standing monuments, in archaeological sites, or in museums. On the left is one of the caryatids of the Erechtheion on the Acropolis of Athens (by IGN, France, for the Antique Architecture Service). On the right a beautiful Gothic statue in the Amsterdam museum (de Waal Archifoto, Holland). From such surveys it is possible to produce copies of the statue, or, if the surveys are repeated at regular intervals of time, to follow the deterioration caused by weather, pollution or decay of stone.*

***B22** The contour interval must be appropriate for the scale of the survey as well as for the size and relief of the subject. Here it is only 1 mm. the subject is a bas-relief of the Little Temple at Abu Simbel (Egypt) representing the "coronation" of Queen Nefertari by the goddesses Isis and Hathor. One can see the degree of delicacy that can be achieved with photogrammetry. (IGN, France, for the Centre for the Study and Documentation of Ancient Egypt, Cairo).*

***B23** If the photographic materials are good enough one can achieve even greater precision for recording objects of art, where very accurate documentation is wanted. The gallo-roman bracelet shown here has been plotted at full size, the interval between the contours which define the shape being only 0.5mm: the section and the details were plotted at a scale of 2:1. (IGN, France, for the Louvre, Paris).*





***B24** It is interesting to notice that photogrammetry has been used to record ancient musical instruments (violins, flutes, etc.). In this field, however, its main use is for recording organ cases, such as the Gothic organ of Valere, Sion (Switzerland), of which the front and side elevations have been plotted. (Technische Hochschule, Zurich).*

## 5. Concluding remarks

It has been shown that CIPA's contribution to disseminating technological knowledge has been its prime aim right from its formation 50 years ago. These two educational slide series are the first vivid example of that fact. This effort has continued in the following decades in initiatives inspired by the first pioneers of CIPA. So far 26 successful international symposia have been organized. At the beginning, European cities were mainly their venues. Lately, however, CIPA symposia have been organized in Japan, Taiwan, Canada and there are plans for other host countries outside Europe. This has made CIPA a truly international committee.

The effort of disseminating technology has additionally continued with the RecorDIM initiative[7] the publication of relevant books and relevant documents, as e.g. the CIPA-GCI series[8], the publication of the CIPA 3x3 rules[9] and its update in 2013[10]. At the same time in the last 5 or 6 years a series of summer schools has been organized in Italy (Paestum), in Spain (Valencia), in Cyprus (Paphos), and in Croatia (Zadar), Korea (Gyeongju). These schools have also been replicated twice in China (Beijing), and will be organized in the Philippines (Manila) and in Georgia (Tbilisi).

It is left to the future administrations of CIPA to devise alternative ways to continue this successful effort, which has made our Committee so successful among other ICOMOS International Scientific Committees. It is not known if that will be through web-based tutorials, videos, or other contemporary means, but it will definitely happen!!

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7 http://www.getty.edu/conservation/our_projects/field_projects/recordim/

8 http://www.getty.edu/conservation/publications_resources/pdf_publications/recordim.html

9 http://cipa.icomos.org/wp-content/uploads/2017/02/Waldh%C3%A4usl-Ogleby-3x3-rules-for-simple-photogrammetric-documentation-of-architecture.pdf

10 http://cipa.icomos.org/wp-content/uploads/2017/02/CIPA__3x3_rules__20131018.pdf

# Foundation and fundamentals of CIPA
# In memory of Maurice Carbonnell (1923-2015) and Hans Foramitti (1923-1982)

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In 1964, about beginning of June, the days after the 2nd International Congress of Architects and Technicians of Historic Monuments in Venice, I met Dr. Hans Foramitti, the head of the photogrammetric department in the Federal Office of Conservation (BDA) in Vienna. He told me with a beaming face that the Venice Charter had been adopted at the end of May. In a long talk he convinced me to cooperate with him to further the development of architectural photogrammetry.

The Institute of Photogrammetry of the Technical University Vienna was founded in 1964, by and for Professor Ing. Karl Neumaier (1898-1999), the just retired President of the Austrian Federal Office of Standards and Surveying (BEV). Between the two World Wars, Karl Neumaier introduced Photogrammetry to China. From 1929 to 1938 he worked in Chekiang and Nanking and was teaching at the universities Nanking, Woosung, and Shanghai. (Blaschitz et al. 1998)

In 1964, I still had my occupation in the photogrammetric department of the BEV and additionally a contract as assistant for photogrammetry at the THWien, the later Technical University Vienna. In 1965, I got a full position as a University Assistant at the newly founded Institute.

Hans Foramitti informed Professor Neumaier and me about the foundation of ICOMOS (18.04.1965) and was enthusiastic about a great future for the architectural applications of photogrammetry he was further developing together with CARL ZEISS in Oberkochen, Germany, and with several top experts of ICOMOS and ISP. The cooperation with Foramitti started to intensify. Neumaier and I decided to buy terrestrial photogrammetric measuring cameras, a P32, a P31, a C40 and a C120 from WILD Heerbrugg. Later, in 1970, we got a JENA large format Camera UMK and a Topocart as a universal analogue restitution instrument. We had a SEG IV, a Multiplex, a Triplex, and soon also a Wild B8 and a WILD AC1. Thus, we were fully equipped for teaching photogrammetry to geodesists and architects, but also for practical terrestrial applications and for cooperation with the BDA. Intentionally, our above-mentioned equipment was fully compatible with the ZEISS equipment of Foramitti in his architectural photogrammetric department of the BDA. Specially, the transformation tooth wheels of the Topocart and the inclination angles of the stereo cameras for oblique (stereo-) photography were the same.

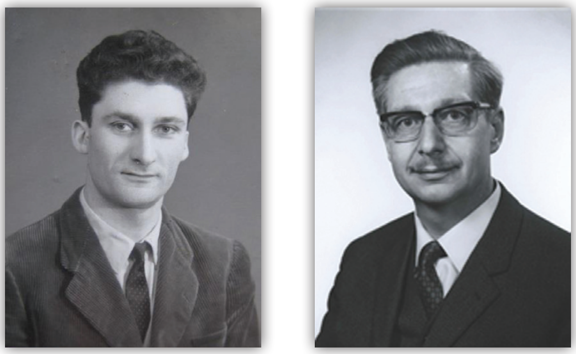
The interoperable transformation tooth was our common provision for emergency cases. The partnership included also the delivery of all architectural photographic and derived documents, negatives and plans of TU research, and student work to the monument archives of the BDA.

In 1968, July 4-6, the days before the ISP Congress in Lausanne, eight protagonists met at the Institut Géographique National (IGN) in Saint Mandé near Paris. All of them were in important leading positions at home. They officially founded the International Scientific Committee CIPA of ICOMOS during this first Colloquium on Applications of Photogrammetry to Architecture. Maurice Carbonnell had prepared the Colloquium and was elected as first President of CIPA (Carbonnell 1972).

The founding members of CIPA were eight; the first four of them were representing the new ICOMOS, the second four the older International Society of Photogrammetry (ISP):

- Doz. Dr. DI. Hans Foramitti (Austria, BDA Vienna),
- Robert (Robin) William McDowall (UK, Royal Commission on Historical Monuments, York and London),
- Prof. Arch. Dr. Cevat Erder (Turkey, METU Ankara; Dir. Gen. of ICCROM in Rome, Italy),
- Lev A. Arch. Petrov, Arch h.c. (USSR, Moscow),
- Prof. Maurice Carbonnell (France, Ingenieur Général Géographe IGN, Saint Mandé),
- Miloslav Jirinec (CSR, Prague),
- Prof. Dr. DI Fritz Löschner (Germany, TH Aachen, an Austrian in Germany),
- Guido Schmiedt (Italy, IGM, Florence).

Some days later, during the ISP Congress in Lausanne (July 8 – 20, 1968) the Congress elected Maurice Carbonnell also as President of Commission V on Non-topographic



Maurice Carbonnell and Hans Foramitti

Applications of Photogrammetry and adopted the well prepared Resolution on the foundation of CIPA as a mixed Committee of ISP and ICOMOS, formally as an ISC of ICOMOS, in order to forward architectural photogrammetry. I was a congress participant and witness of the foundation.

The first programme of CIPA can be read in the proceedings of Saint Mandé as well as in Archives of ISP Vol. XVII after Lausanne (Carbonnell 1972). In short words it concerned:

1. Dissemination of information about the great progress in architectural photogrammetry among archaeo-logists and conservationists.
2. Patronage on education and training worldwide.
3. International and national Colloquia and Symposia.
4. Publications.
5. Participation in the UNESCO-ICOMOS Documentation Centre (Hans Foramitti was its first Director).
6. Teaching architectural photogrammetry in Rome at ICCROM and worldwide at Universities.

In the coming years, Carbonnell and specially Foramitti were tremendously busy as they worked to forward architectural photogrammetry as a basis for interventions after earthquakes or similar disasters. They believed that all monuments should be virtually saved as precaution for the case of destruction or damage. Foramitti's dream was a transportable restitution instrument, a difficult problem during the time of analogue photogrammetry. He founded specialized archives for stereo images of architecture – separately for originals and duplicates for safety reasons – and started systematic documentation of all architectural monuments according to the old idea introduced in 1858 by Germany's Albrecht Meydenbauer (1834-1921) (Albertz 2001, Driesch 1994). Foramitti was a consultant around the world and recommended the foundation of photogrammetric institutes, centres like his own. He pushed a new renaissance of terrestrial photogrammetry. Vienna became

Albrecht Meydenbauer (1834-1921)
Das klassische Vorbild der CIPA-Gründer

a town of pilgrimage, and many new centres for architectural photogrammetry have been erected: in France (Paris), Germany (Bonn), Japan (Tokyo), Mexico (Mexico City), Turkey (Ankara).

Foramitti had an incredible enthusiasm that infected his staff, colleagues, and students. He spoke perfectly in German, Italian, English, and French (his wife was French). As a result, he dominated CIPA together with his friend Maurice Carbonnell, who may have been the better organizer. The other six members of the first CIPA committee forwarded the ideas of the two main enthusiasts in their countries. CIPA became more and more influential and promoted the development of architectural applications of photogrammetry all over the world. CIPA organized and organizes an international scientific symposium every two years, and in the years in-between the Committee met and still meets for a working session.

Today, CIPA is a living community of friends full of idealism and enthusiasm inherited from its founders. We all have to say thank you to the founders of CIPA. Thank you, Maurice Carbonnell, thank you Hans Foramitti and your first CIPA colleagues. Your enthusiasm and idealism are an excellent model for new generations.

Much has changed since the birth of CIPA 50 years ago. CIPA had to cope with the rapid development of technology:

- From analogue stereo-photogrammetry with special measuring cameras to digital multi-image block modelling even with amateur-cameras;
- From normal case photogrammetry to free bundle block restitutions;
- From mere image data adjustment to simultaneous adjustment of all types of measuring data;
- From manual hand-wheel plotting to fully automatic multitask restitution;
- From 2D to 4D,
- From Brunsviga calculator to Apple or IBM computers,
- From 2k Bits to Tera-Bytes storage capacity,
- From one façade per day to one town per day,
- From analogue photo-archives to digital point cloud archives, …

An incredible development. And it seems that this will go on.

This extremely fast technological development had and has con-sequences. CIPA no longer considers just photogrammetry, but all kinds of measurement as needed by ICOMOS, from simple to professional tools: surveying, geodesy, scanning, GPS, aerial and satellite images, GIS, and Heritage Information and Management Systems (HIMS). CIPA was restructured and has modern statutes. The Executive Committee grew from 8 to 20. Membership is open for experts of all related fields. They are adapting, testing, and developing new technology. They restructure the teaching, training, and working processes. However, the almost monthly introduction of new hardware and software is often also bothering. Many users prefer to continue working with their usual methods and reject the new; they prefer to go on with uneconomical methods, are unable to keep pace, and are waiting for the next generation to come. Thus, CIPA is not only trying to bridge the know-how-gap between users and providers of measuring and documenting technology, but also between the fast changing development steps of methodology and technology. It is a great and difficult task to introduce new methods without friction losses. It is a huge task to keep generations of experts up to date and to provide them with the best possible means for their work.

CIPA changed its name to "CIPA-Heritage Documentation". CIPA remained, that means continuity; and heritage documentation (HD) says that CIPA today has to deal with all measuring technologies for the preservation of historic monuments, not only with photogrammetry. That is the consequence of information technology (IT). In the CIPA-HD Symposia, top experts present the measuring technology actually available and best practice examples. Here is the possibility to bridge the gap between users and providers of documentation technology, to initiate special developments and to discuss and solve actual practical problems. CIPA-HD is co-organizing several Workshops and Symposia together with other International Scientific Committees. Not only CIPA has changed, but also ICOMOS has been upgraded. It has now a Scientific Council for coordination of the ISC's work. This is due, in part, to the tireless work of the CIPA representatives in the Advisory Committee meetings from Dubrovnik in 2001 to Xi'an in 2005. (Letellier 1998, Waldhäusl 2001). CIPA-HD is working multi-directionally and with many disciplines of conservation. Therefore, CIPA-HD detects more frictional problems in ICOMOS than mono-directed specialist-ISCs, with the consequence that CIPA's cooperation is useful, more: necessary in the Executive Board of ICOMOS. I welcome therefore that Mario Santana Quintero, a former CIPA President, is now one of the Vice-presidents in the Executive Board of ICOMOS international.

CIPA-HD is ready to work for the future generations and for the future of cultural heritage. Never-ending international conflicts are reasons for destructions even of World heritage sites. Volcanism, climate change, weather catastrophes, and the growth of population are other reasons for enormous damages. This proves that the founders of CIPA-HD were completely right, when they proclaimed in their first publication: "We need fast, exact and complete measurements and visualization of the actual situation, but also knowledge about any changes after interventions or impacts by wars, revolutions, or natural disasters." Today we know that we need knowledge also about the changes of changes by means of systematically planned permanent monitoring processes – and we know the great difficulties emerging from incompatible data sets. The demand for CIPA as mediator in and for ICOMOS is still growing. CIPA shall never stop to assist ICOMOS not only technically, but also politically by providing defined methods and limits for better protection of the World heritage sites. Preservation and conservation offer many working places, for experts as well as for the still too many workless who could help saving the values of the past for a still more valuable and beautiful future.

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# Setting the record straight – Some personal thoughts

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This volume will be a valuable record of the history of CIPA.

In the way of such records, it will tend to a certain blandness – what we might call a papering over of the cracks. As well, such reporting is normally done by third parties – not those actually involved at the time.

I would like to tell you my own story, for the development of CIPA was actually not quite so straightforward. But I don't have to put much ink to paper, for the story is contained in the following document, written exactly and unaltered from when I penned it and presented it to the CIPA committee in 1988. I hope you will not mind reading it through.

At this time, CIPA was facing a bit of a crisis. The excellent Maurice Carbonnell had done a superb job in getting CIPA going and raising its profile in the conservation and surveying world.

Here, we should also not forget the substantial amount of work put in by Hans Foramitti from Austria. He was a hugely important ambassador for architectural photogrammetry and shared the load with Carbonnell in running the CIPA committee. Very sadly, he died quite suddenly in 1982, aged just 59 (Waldhäusl).

Thus, Carbonnell was left, in effect, to run the CIPA committee single-handed. He soldiered on, but made clear at our CIPA committee meeting in York in 1985 that he wished to step down. He asked me privately if I would be prepared to take over as President. I couldn't agree ‘on the spot’, but after consultation with my sponsors, English Heritage, I agreed.

The following year at our CIPA Committee meeting in Strasbourg, he put forward this proposal. Unfortunately, I was ‘black balled’ by a certain Committee member. Neither Carbonnell nor myself could believe it. I walked out.

But I was not going to give up, for I could see what Carbonnell could also see – that without him CIPA was going to become a cosy little club, an excuse for a pleasant few days away in an interesting location.

So I came back at the CIPA Committee meeting in Sofia in 1988 and presented the paper you have just read. While full of technical proposals, it also had two basic aims – one, to democratise the Committee and, two, to get round the dead wood clogging up the Committee.

As I saw it, the cause of this was the original 'rule' that if a Committee member resigned, they had to be replaced by a new member from the same country. No doubt, it seemed quite sensible at the time, but it stopped the Committee from getting the best persons from around the world. For example, I had been trying for several years to have the excellent Robin Letellier from Canada appointed to the Committee, but he fell foul of the 'original member' rule.

Anyway, as you can imagine, my paper went down like a lead balloon! Nobody in the history of CIPA had ever before put forward such proposals. There were a lot of mutterings and nothing was decided.

But all credit to Maurice Carbonnell – he could see that I was right and that this had to be the way forward. He entirely agreed with my proposals. But, there was no point in leaving it there. As in the paper, at that point I was Co-Chairman of the ISPRS V 'Working Group on Architecture and Archaeology', my third senior Commission V Board appointment. The then President of Commission V was Professor Armin Gruen from ETH Zurich.

I took the paper to him, explained in considerable detail how the CIPA Committee was becoming moribund and that Carbonnell wanted to resign. He immediately saw the sensibility of my proposals. Professor Gruen began to liaise with ICOMOS, and go forward with revitalising the Committee with new Statutes to incorporate the principles stated in my paper.

At that point, I really rather dropped out of it, for two reasons. The direction of the Committee had always been under the joint organisation of ISPRS and ICOMOS – to make significant changes required input at that level.

In truth, from the 'photogrammetry' side, we (that is ISPRS) had the greatest interest and Professor Gruen took the task forward. Professor Kennert Torlegård, then President of ISPRS and formerly a President of Commission V, also took a strong interest in the matter. Our principal contact in ICOMOS was Herb Stovel, then the Secretary-General of ICOMOS and a keen supporter of all matters to do with recording.

Secondly, I had been appointed Chief Surveyor of the English Heritage 'Measured Survey and Photogrammetry' team of fifteen people. My hands were completely full with that task, and as per my paper, I could not at that point even consider taking on such a large task as being President of CIPA.

If you read the paper through, you will realise that many of my detailed proposals were not carried out directly, but my fundamental aim – to democratise the Committee – was absolutely achieved.

The CIPA Committee has gone from strength to strength, and of course has widened to take in all aspects of recording of historic buildings and sites.

Would many of these changes have taken place in any case? I am sure they would, but it would have taken quite a lot longer! Did others become involved? Yes, I recall they did after my paper.

Did my paper act as a catalyst to bring about the necessary changes? Yes, it certainly did. The CIPA Committee you see today is a direct consequence of that paper of thirty years ago.

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Ref: Q121 30 September 1988

**PRIVATE AND CONFIDENTIAL** - CIPA COMMITTEE ONLY

To The President
All Members of the CIPA Committee

Dear Colleagues,

**REFORMING THE CIPA COMMITTEE**

As you know, we are expecting at this Committee Meeting of CIPA to consider the question of electing a new President. However, I feel that it is not just a new President which we need in CIPA, but a total overhaul of the whole structure.

(I regret that I was not able to post these proposals to you well in advance of the meeting, but as you know in Britain we have suffered from a postal strike for the last month which meant that letters would not have got through to you.)

Mr Carbonnell has done an enormous amount of good in promoting the use of Architectural Photogrammetry over some twenty years. Indeed, he was largely responsible for founding the CIPA Committee and has been it's President since it's inception. However, three years ago Mr Carbonnell made it clear at our meeting in York that he wished to resign the Presidency, and allow others to take over the work of the CIPA Committee.

Following the York meeting, Mr Carbonnell asked me if I would like to become the President of CIPA. I agreed to this, and 'English Heritage' who sponsor me agreed to provide me with time and funding, but unfortunately when it was put to the Committee at Strasbourg in 1986 one particular individual deliberately obstructed this proposal. This paper sets out the proposals for changes which I would have put in place if elected to the Presidency in 1986.

I have the greatest of respect for Mr Carbonnell's work in Architectural Photogrammetry. However, it has been my feeling for some years that the CIPA Committee needed to be radically overhauled in terms of the way in which it works and in the form of its membership, in order to meet the newer and much wider interests Internationally in scientific conservation.

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Also, and quite simply, **we will never be able to replace Maurice Carbonnell with one individual who will be able to put the time, effort and dedication into the running of the Committee which he has.** The way forward must be to share the work, through a democratically elected Committee.

Before the discussions on the Presidency at our meeting this year I therefore wish to put these main proposals in front of you. I would also like to mention at this point that due to increasing work pressure during the last two years, I have no wish to be sole President of the CIPA Committee myself at the moment.

**NATIONAL CIPA REPRESENTATIVES**

As an International Committee, it has always seemed to me that our biggest problem is communication. We need an effective network of contacts and correspondents in as many countries as possible who will do work locally and keep us in touch. It was my proposal a few years ago to set up the system of National CIPA Representatives, which is now in place.

It should be one of the major activities and planks of our Committee to keep in touch with these people by regular correspondence, and so generate interest in each Country. However, I propose that this system should be extended by having two representatives or a small Committee in each Country, with ICOMOS representatives, who would normally be Architects or Archaeologists, and secondly ISPRS representation from photogrammetrists.

**COMMITTEE**

EITHER
The Committee of CIPA should be enlarged to between twelve and fourteen persons, and these people should be elected from the national representatives. However, there should be a time limit on the length of time for which a person can serve on the Committee. I would propose a three year term, with the option of being elected for a second three year term. After six years however a person would have to step down from the Committee completely, or take up a named post.
OR
We should scrap the current Committee completely, and all national representatives should be entitled to take part in an annual general meeting to discuss the affairs of CIPA. A small Secretariat of say four or five people would administer the decisions.

**SECRETARIAT**

In any case, from our Committee, we should elect a Secretary/Treasurer. We should also have other named areas of responsibility, for example ISPRS Correspondent, ICOMOS Correspondent, National Representative Correpondent, Technical Correspondent, International Symposium Correspondent.

**PRESIDENCY** I propose that we:

EITHER
Have a joint Presidency, one person being a Photogrammetrist and one person being an Architect/Archaeologist representing ICOMOS. The term of Presidency would be for four years maximum and the appointment would alternate each two years to give continuity.

Alternatively, I propose that we have a President, and a Vice-President. The President would be elected for a maximum of three years and it would then be understood that he would be replaced by the Vice President who in turn would be elected for three years. The Presidents could be either from ICOMOS or ISPRS but if possible the post of President should alternate between a Photogrammetrist and an Architect/Archaeologist.

**CO-OPTING**

We should have a rule which allows us to co-opt particular individuals on to the CIPA Committee. I am very conscious that over recent years we have not had available the resources and work of some very enthusiastic individuals who have not been able to be on the Committee since their Country was already represented.

**OTHER POINTS**

- The policy of appointing a new Committee Member from a Country because their predecessor was also from that Country should be scrapped.

- Funding. We must accumulate some funds centrally to support the work of CIPA, eg to pay for Publications, or to sponsor Symposia without being reliant on the goodwill of individuals in different countries. We should have a working group to examine this matter.

- Relations with ISPRS should be put on a more formal basis. I have been the principal link with ISPRS for a number of years, and will be the Co-Chairman of the new Working Group on Architecture and Archaeology which Professor Gruen, President of Commission V, wishes to establish.

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These are the principle proposals which I wish to put forward for now. Architectural Photogrammetry has become a well established technique and a world-wide field, and we owe an enormous debt of gratitude to M. Maurice Carbonnell.

However, there is still much to be done. If CIPA is to go forward and more effectively disseminate its message, this will not simply be done by electing a new President. It must be done in conjunction with a whole package of new ideas to rejuvenate the Committee, and bring on to it many of those enthusiastic individuals who so far have not been adequately represented. I hope that you will endorse my proposals.

Yours sincerely,

Ross Dallas

R W A DALLAS

NB These are my personal views and not those of my organisation.

# Towards a heritage documentation standard: The English Heritage Metric Survey Publication Programme 2000-2009

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## 1. Introduction

The advent of digital draughting in the late 1990s required a fresh look at drawing standards. '*The Presentation of Historic Building Survey in CAD*', published in 1999, addressed this by presenting, not only a layer protocol for CAD but also, clear examples of the use of line weight, rendering and perspective drawing in CAD.

Resolving problems in the procurement of heritage appropriate work from the geomatics sector resulted in the '*Metric Survey Specifications for English Heritage*' (2000) (expanded and retitled as '*Metric Survey Specifications for Cultural Heritage*' in 2009) which established a mix of performance and method based approaches to data acquisition and presentation. Case studies of best practice appeared in '*Measured & Drawn: Techniques & Practice for the Metric Survey of Historic Buildings*' (2003).

Recent guidance from Historic England: *3D Laser Scanning for Cultural Heritage* (2018) and *Photogrammetric Applications for Cultural Heritage* (2017) and *BIM for Heritage* (2017) continues the success of the outreach programme and, in addressing new approaches to building recording, seeks to find ways to embed draughtsmanship into the metric workflow.

Guidance is needed to resolve difficulties in drawing production from new capture technologies as the accessibility of these technologies places ever greater pressure on draughtsmanship. A miss-match between ideas of 'reality capture' and the documentation needs of  conservation means drawing standards, the key to clarity of presentation, need to address change in data acquisition methods.

## 2. The English Heritage photogrammetric programme

Conservation works programmes at English Heritage in the '90s generally required two distinct drawing types: *record of condition* and *works schedule* both of which require a metric base for accurate costing. Photogrammetric surveys were accepted as a method of drawing production because they proved to be cheaper and more efficient than traditional measured drawing methods.

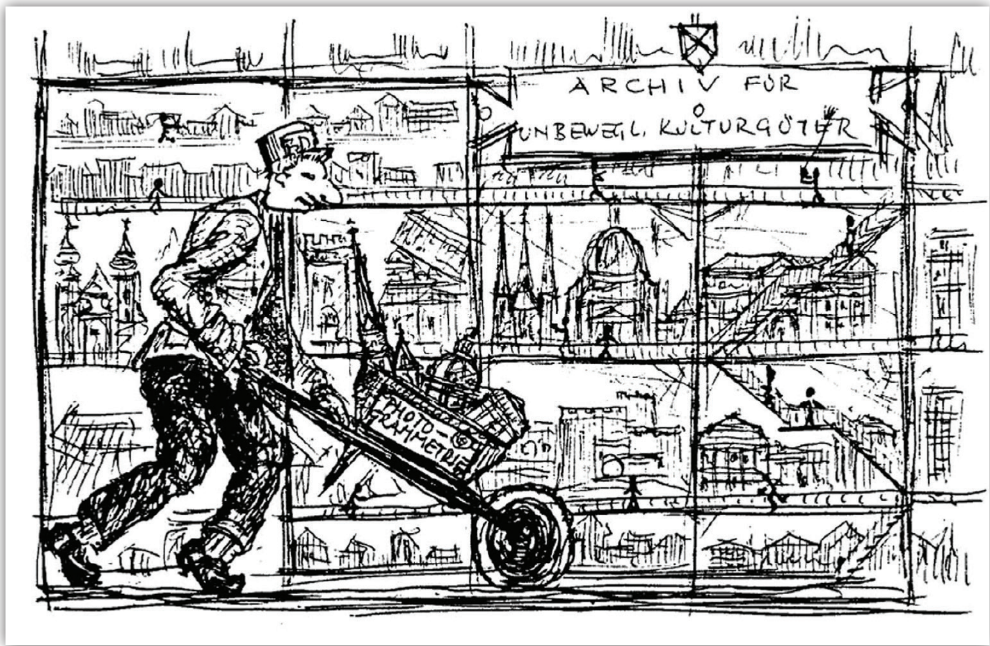


**Figure 1.** The concept of preservation through documentation was key to pioneers of architectural photogrammetry. Hans Foramitti's caricature of himself as curator of monuments (1963).

The case for metric records was largely driven by the ICOMOS 1965 Venice charter, and the work of pioneers such as Hans Foramitti (Figure 1) and Maurice Carbonell. In 1983, Carbonell showed how the technology could meet the requirements of modern conservation practice:

> '..*When, in 1968, the ICOMOS took the initiative of convening the first international symposium on the application of photogrammetry to historical monuments, a number, of eminent experts were able to show how the current requirements of the scientific study of historic buildings, and conservation and restoration were*

*creating an imperative need for surveys that were accurate and reliable. It is primarily as a result of this trend in the direction of a stricter attitude towards the idea of conservation and of stricter standards for the documentary records which must serve its needs that these last twenty years have seen such revolutionary progress in architectural photogrammetry.'*

This clear endorsement of the technology lead to the commission of a series of photogrammetric surveys from the 1970s onward by the Historic Buildings and Monuments Commission for England. The Institute of Advanced Architectural Studies at the University of York Photogrammetric Unit, under the direction of RWA Dallas, established a systematic provision for the English Heritage property portfolio, and developed a framework for photogrammetric provision from the commercial geomatics sector. The work of the York Unit was able to set standards, by example, which would underpin future specifications. Despite the demonstration of the power of photogrammetric recording and the value of the Albrecht Maydenbauer (1834-1921) 'ante-disaster' approach, the strong drawing board tradition developed under the Ministry of Works Historic Buildings & Monuments division, found, despite consistent precision, failures of draughtsmanship with photogrammetric drawings involving issues of completion, interpretation and feature abstraction.

Developing a strategy to address metric drawing quality became central to both the practice and publication programme of the survey section of the Ancient Monuments Drawing Office (AMDO) – led by Terry Ball ARA, MBE (1931-2011) – and its successor the English Heritage Metric Survey Team. Photogrammetric recording provided by the University of York established a metric basis for major projects, which provided stone by stone analytical, condition, and schedule drawings (e.g., Fountains Abbey Figure 3, and Dover Castle keep Figure 6). This practice was able to provide a single measured base for the evaluation of significance, the assessment of condition assessment, the design of the interventions and the monitoring of the amelioration.

## 3. The English Heritage Metric Survey Team 1991-2010

In 1991 under the direction of John Fidler, architect and Ross Dallas, surveyor a remarkable integration of skills was achieved. By bringing together, at English Heritage AMDO and the York University Photogrammetric Unit a combined drawing office and photogrammetric unit had three important effects on drawing production:

1. **Measured drawing was freed from mass capture and became detail focussed:** The economy of photogrammetry meant that for the first time draughtsmen and women with a tradition of measured drawing could be released to focus on the details, which define architecture.

2. **Digital drawing**: The 'digital drawing board' of CAD could be used to bring measured drawing and photogrammetry together as a single 3D entity, and the standards of the drawing board era could be brought to the precision of the digital age.

3. **Procurement practice based on a drawing standard**: The volume of work required to meet major conservation projects (e.g. Norwich Cathedral Figure 2) was such that specifications for contract work were developed based on the standards in practice at the time. This was (and remains) a graphical standard which requires a precision commensurate to the scale of reproduction.

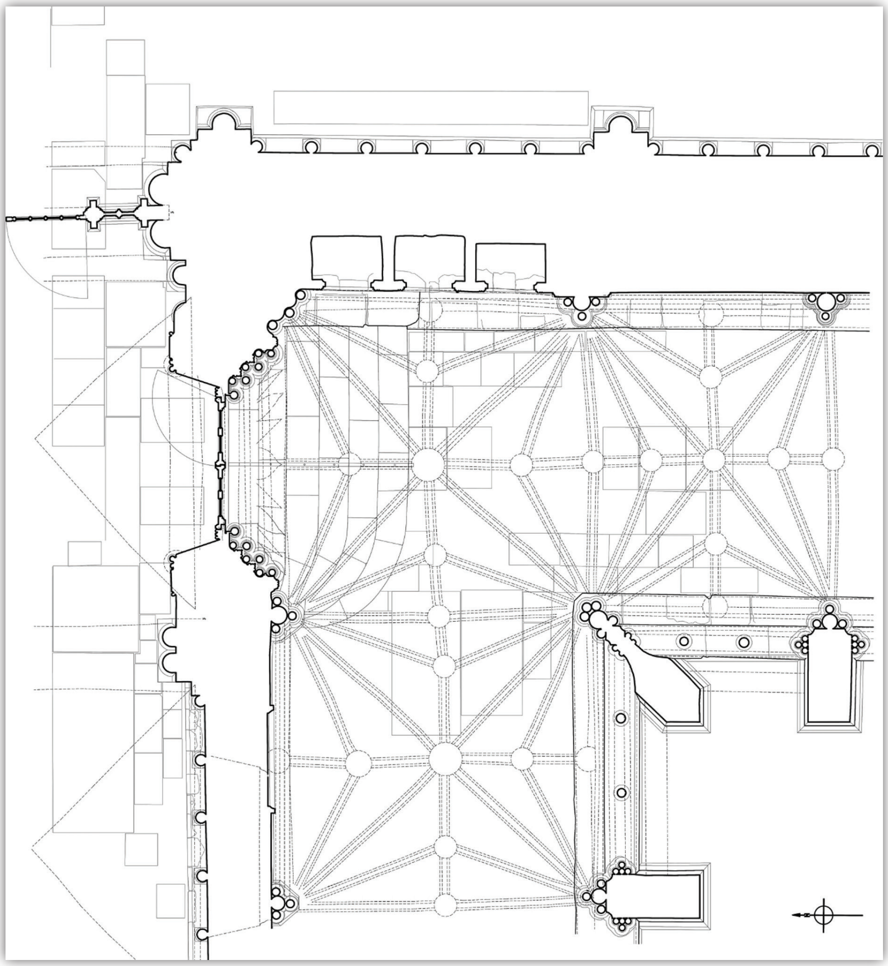

**Figure 2.** Detail plan of Norwich Cathedral Cloister by EH Metric Survey Team (1997). The plan revealed previously unrecorded historic vault deformation. Template survey to guide contract survey.

The survey, conducted by TST and measured drawing, laid down the 3 key elements of a 1:50 scale drawing standard: line weight, line scale, completeness of detail from full size measurement in plan at high and low level. An early application of direct to CAD reflectorless EDM measurement by TST demonstrated the flexibility of TST as a close range tool for building surveys.

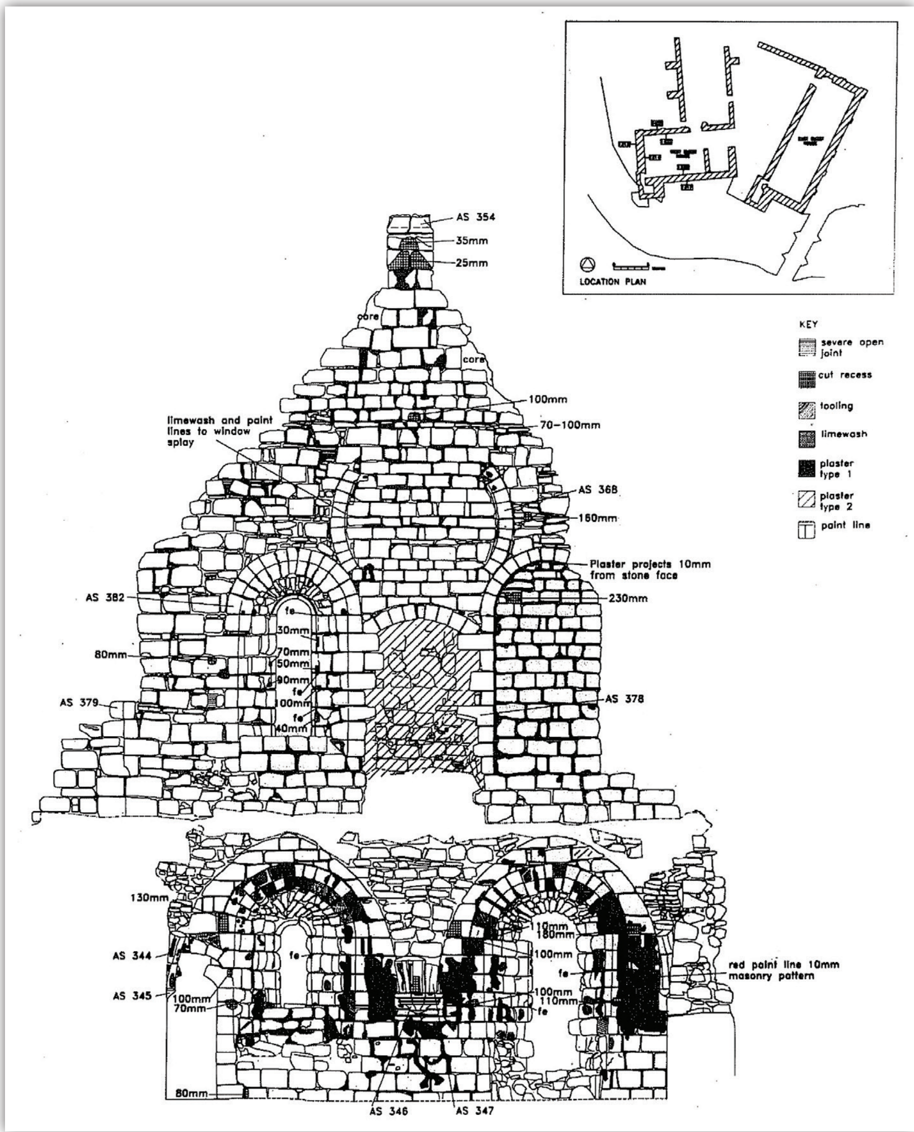


**Figure 3.** Photogrammetric elevation drawing enhanced with condition and archaeological analysis by K. Wilson, and K. Emmerick on a base 1:20 scale survey by EH Metric Survey Team, Photogrammetric Unit. As published in the AAI&S Technical Paper No.12 1995.

# 4. Training initiatives

## 4.1 Training need

There were consistent failures of draughtsmanship with photogrammetric drawings that involved interpretation and feature abstraction. This indicated that there was a gap of knowledge: architectural form was not well known in the geomatic sector. However, the difficulties of applying the observational skills of architectural historians to geomatic processes suggested two solutions:

1. **Integration** of architectural drafting skills into the photogrammetric process.
2. **Training** in measured drawing for both operators and data users. The first Survey Summer School at Stowe in Buckinghamshire in 1989, under the direction of architect Robert Chitham, demonstrated the benefits of a practical 'learning by doing' approach to developing measured drawing skills for both archaeological and architectural practitioners.

## 4.2 A measured drawing summer school

Following the publication of *Measured Drawing for Architects* in 1980 and the commissioning of its author, Robert Chitham, for the inspection of the monuments at Stowe Park, the first measured drawing summer school was organised, assisted by M Sutherill in 1989. Drawings of the garden buildings were conducted by rod and tape. This practical, 'hands on' approach was to become the model for subsequent summer schools convened by English Heritage. *Measured Drawing for Architects* was the textbook for these early training initiatives because of its clear examples, prepared for a variety of end uses by measured drawing, photogrammetry and rectified photography. However, the book was out of print by 1995, prompting the preparation of new guidance.

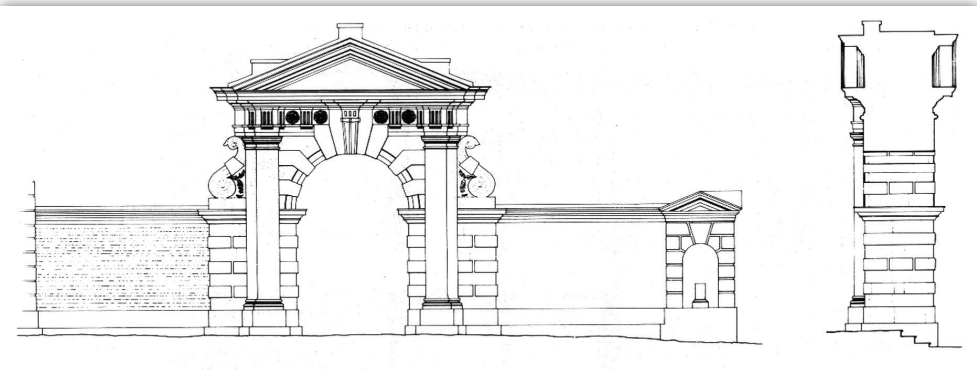

**Figure 4.** The Leoni gate. Stowe Park Bucks. Student work from the first measured survey summer school. Published in *Guide to Recording Historic Buildings* ICOMOS 1990.

### 4.2.1 ICOMOS UK guidance

The publication of the ICOMOS UK *Guide to Recoding Historic Buildings* (Figure 5), edited by R. Chitham, contained a selection of drawings, including student work from the summer school (Figure 4), and text by Nicholas Cooper, the historian of the Royal Commission on Historic Monuments in England (RCHME). In 1990, Cooper emphasised the value of measured drawing skill:

> *'The great advantage of hand measurement is that it can be carried out by those familiar with the techniques without recourse to specialists or to specialized and expensive equipment. This means in addition that the practitioner - the architect, surveyor, planner etc. can himself control the extent and scope of the information he needs to record for any specific purpose while the very process of measuring gives him a familiarity with the building that he can never achieve by studying records made by others. Nor are the techniques involved basically difficult.'*

However, the value of the camera was not overlooked:

> *'Hand measurement is often in valuable for filling in essential data unrecorded by other techniques (such as by photography) or where by their employment small- scale detail could only be recorded at disproportionate cost (e.g. by photogrammetry).'*

*Nicholas Cooper*
*ICOMOS guide to recording historic buildings (1990)*

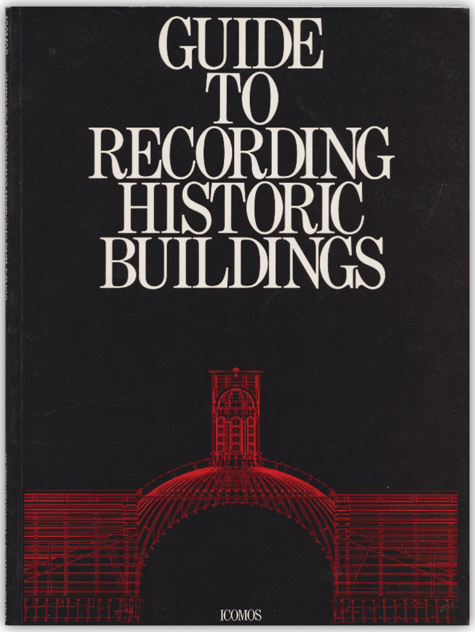


**Figure 5.** ICOMOS UK Guide to Recording Historic Buildings (1990). The primary text for training until out of print by 1995.

Nicholas Cooper used a 'why' 'when' 'what' 'how' 'who' and 'where' structure (which Robin Letelier was to use in' *Recording, Documentation, and Information Management for the Conservation of Heritage Places Guiding Principles'* the RecorDim principles in 2007).

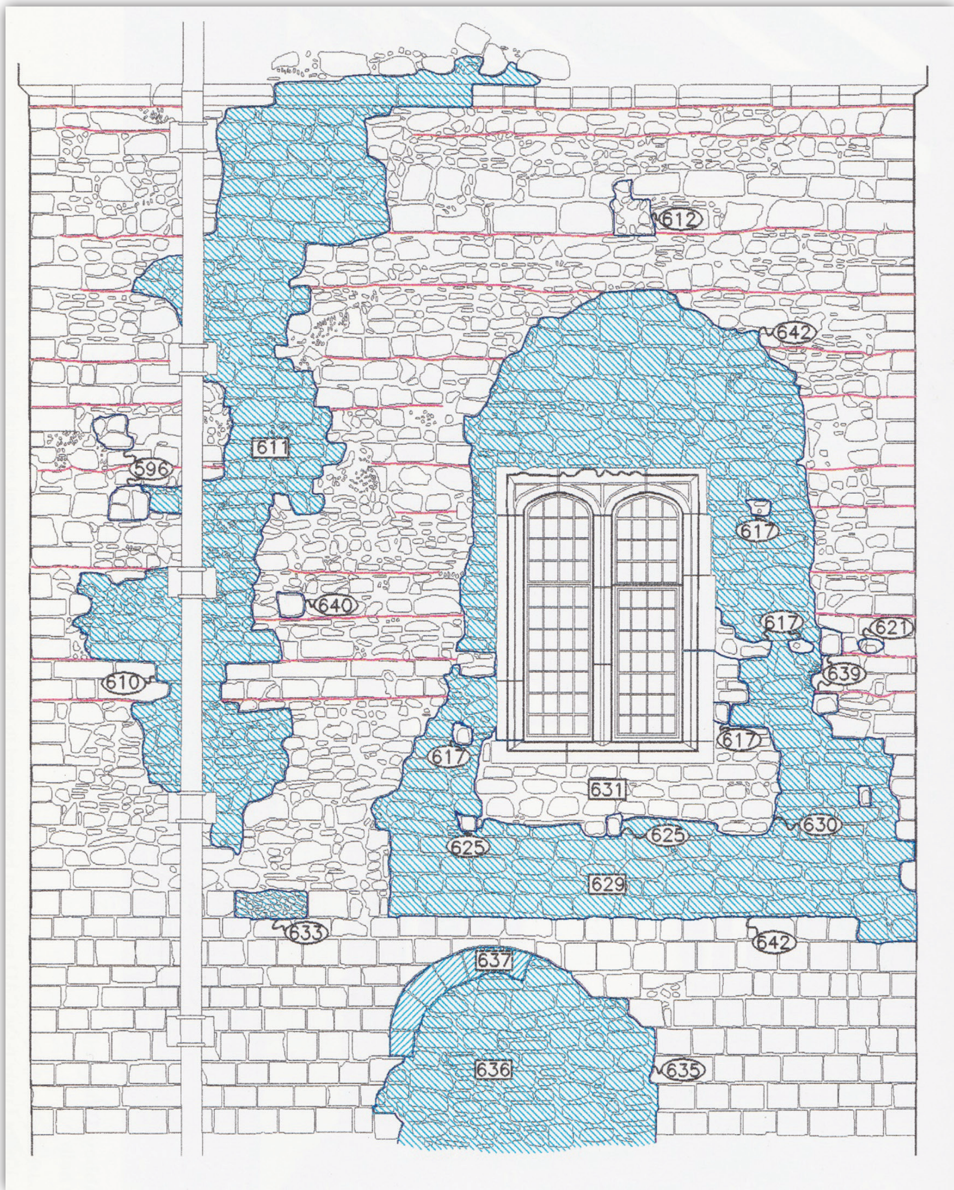


**Figure 6.** Photogrammetric plots became a standard base for scheduling masonry elevations for conservation works and analysis by the 1980s.

As well as displaying a variety of drawing types the guide gives practical advice such as the distinction between dimensioned sketches or site notes and 'direct plot' measured drawing. The observation that site notes, requiring experience, should be conducted 'after one has reached one's understanding of the of the structure' not before' is, like the suggestion that *hand measurement is invaluable for filling in essential data unrecorded by other techniques* is as valid today as it was then.

## 4.3 Capacity building

The Town & Country planning Act 1990 created a new pressure on building recording. Contract archaeology became the norm for *record in advance of works* requirements, and the skill gap in measured survey became apparent as CAD replaced drawing board practice. The Metric Survey Team, having direct experience of resolving the integration of digital methods with traditional draughtsmanship, was able to provide a framework for training.

The annual Summer Schools run by the team from 1990 had, by 2000 developed a robust teaching technique making use of common tools and a developed 'learning by doing' method that introduced practitioners and data users alike to both traditional and digital recording methods. Specialist skills in drawing, photography, photogrammetry and TST were provided in a 'live' recording setting. By experience with equipment and seeing the application of a mix of tools, both practitioner (survey skills) and user (procurement skills) were addressed in a balanced package.

## 4.4 Exemplar projects: showing what can be done

The challenge of demonstrating drawing standards in CAD was met by the team undertaking exemplar projects with a view to publication. Getting across the benefit of data handling and integration as well as the 3D utility of mass capture data in setting up multiple views produced drawings (Figure 7) which bridge across the traditional graphical standard and digital products.

## 4.5 Recording for understanding

Prior to 2000, the only heritage specific specification was the RCHME descriptive spec, which presented a principally archaeological approach to recording. Archaeological methods, when applied to buildings, tend toward analytical and investigative processes driven by descriptive 'levels' of record rather than metric or scalar performance. The four levels of record, as set out in the RCHME descriptive specification (now replaced with Historic England's *Understanding Historic Buildings A guide to good recording practice)* did not anticipate works use for the drawings and although updated still fails to address the critical relationship between precision, cost, and scale. The present guide to good recording practice acknowledges the


**Figure 7.** A hybrid drawing showing techniques in transition: CAD drawing rendered in watercolour. Capture by a mix of rectified photography, reflectorless TST and measured drawing. 1:50 scale survey at 1:20 survey presented at 1:50 (1996).

issue without addressing the fundamental concept of information capture and presentation *commensurate to a scale*. Conservation functions are suggested as beyond the scope of the guidance:

> *'While the levels specified ... will cover most eventualities when a building is recorded for historical purposes, there will be circumstances in which more detailed records may be desirable. The type of record required by an architect, builder or engineer to monitor a major conservation project or to reconstruct a severely fire-damaged historic building will be very different from those described. The purpose of the record must always determine its scope.'*

For the purposes of investigation and analysis, metric performance is still misunderstood, as evidenced by statements in current guidance like:

> *'CAD drawings are produced in a virtual 1:1 environment and can be plotted at any required scale.'*

*Understanding Historic Buildings: A guide to good practice, English Heritage (2006)*

> With the work of RCHME completed in 1999 after 90 years, it's drawing standards – principally used for thematic and analytical work – became incorporated into guidance published by English Heritage.

## 4.6 CAD guidance for heritage survey

With *The Presentation of Historic Building Survey in CAD* (1999) it was decided that survey practitioners needed examples to follow. The Metric Survey Team undertook the task of showing that drawings of quality can be achieved in CAD and reproduced examples at scales appropriate to conservation to use as means to set a standard.

A number of exemplar projects were presented to show how a base photogrammetric drawing could be usefully enhanced to show architectural features, hidden details, completion of obscured zones, and planar line weights. These could be added to improve legibility and utility of the drawings. Key aspects of draughtsmanship such as treatment of detail, depiction of damage and perspective views were reproduced to show CAD was not a bar to drawing quality.


**Figure 8**. 'The Blue Book' with 14 examples of CAD Figure draughtsmanship including advice on text placing, line-weight and layer protocol (1999).

The booklet, known as the 'Blue Book' (Figure 8) became teaching material for a number of training initiatives. It included examples of a photogrammetric base survey used for archaeological analysis (Figure 6), TST survey, 3D modelling, and a layering protocol. Written descriptions of the node density required for accurate depiction of any given line at any given scale proved difficult, so plotted examples were carefully selected to demonstrate appropriate line styles (Figure 9).

The examples included hybrid products whereby a CAD plot was rendered in watercolour to indicate depth, shade, and texture (Figure 7). Material from analytic work included perspective component, reconstruction, and development drawings.

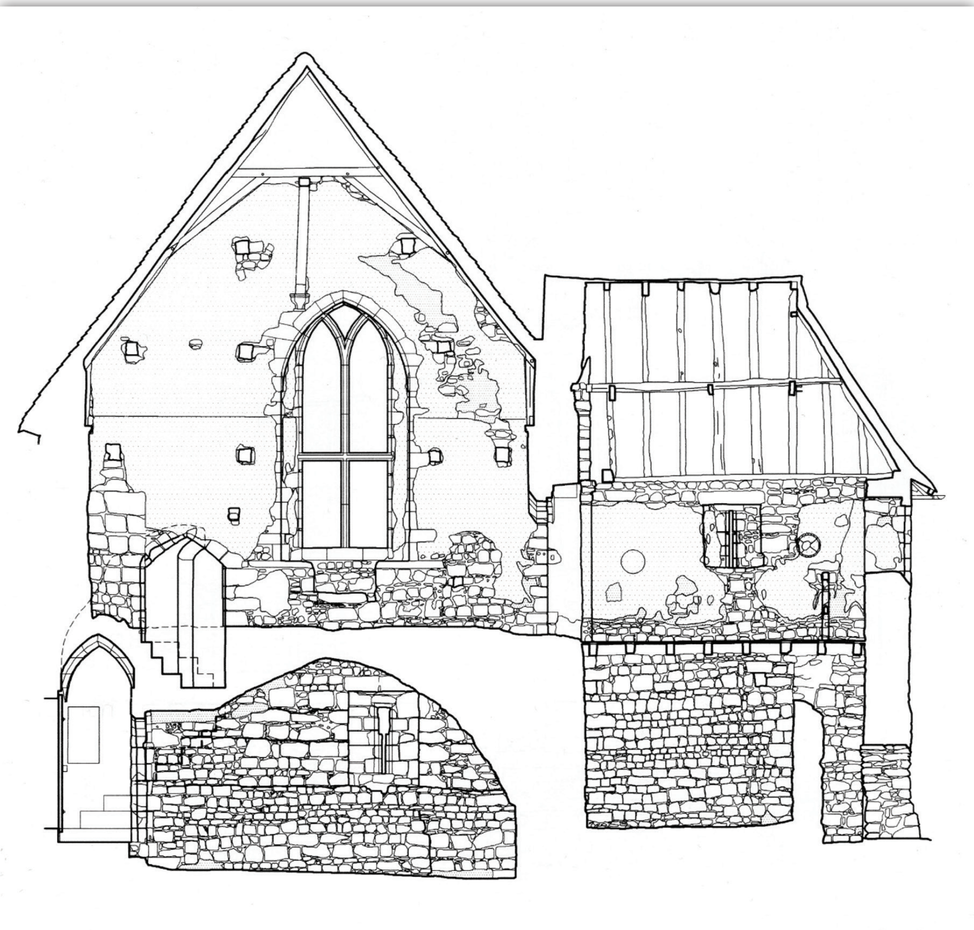

**Figure 9.** Illustration from “The presentation of Historic buildings in CAD 1999: Old Soar Manor, Kent”. Photogrammetric plot enhanced by measured survey to add hidden stair detail, line weights, floor and joist sections.

## 4.7 Technique selection guidance

Whilst examples of drawings addressed the CAD issues of the day, the selection of recording technique was addressed by *Measured & Drawn: Techniques and practice for the metric survey of historic buildings* 2000 (Figure 11). This sought to inform survey commissioners on the value and appropriate application of both direct and indirect methods by technique description and case studies of a selection of documentation projects. The procurement process was explained by use of a combination of brief specification with advice on the effect of a given technique on data resilience. The techniques covered included laser scanning and aspects of 3D data utility including surfacing and reconstruction modelling.

**Figure 10.** Extract from sectional elevation of St Mary's Church Whitby incorporating photogrammetric, rectified photographic, TST and measured drawing content at 1:20 scale. Included in “Measured & Drawn” as an example of a multi-faceted approach to building recording (1997).

Measured & Drawn, with a revised for a 2nd edition in 2009, set out to emphasise the importance of integration of methods (Figure 10) and included a laser scanning case study with advice on point cloud performance.

### 4.7.1 Emergence of laser scanning

The growth in laser scanning as a rapid capture method for architectural recording ran into the same problems of accurate depiction of form as photogrammetry in the 1960s, but with the added problem of novel data formats and propriety processing methods. Procurement of laser scanning had thrown up new problems in controlling survey outcomes; the relationship between speed of capture and point density being a pinch point in procurement costs.

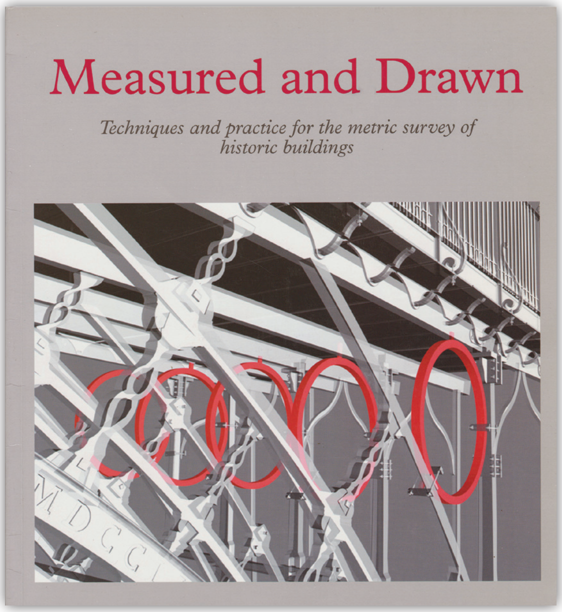


**Figure 11.** Measured & Drawn: Techniques and practise for the metric survey of historic buildings 2003, second edition 2009.

For optimum utility, a balance between point density and surface resolution has to be achieved; a point density to scale formula developed by Eric Lang was included in the 2nd edition. By considering the problem of point density as a sampling problem, the Nyquist frequency equation was adapted and presented as the 'Nyquist-Lange' formula. Point density remains a serious issue in laser scan capture as site time pressure can lead to poor decisions on the duration of scans for a given out come.
A simple guide to point density is the ratio between the object size and the point spacing in the point cloud. This is described by the 'Nyquist-Lange' formula:

$$Q = 1 - (M/i)$$

where

Q = quality ratio
m = post spacing (point separation or density)
i = the smallest size target object

A positive value of Q of between 0 and 1 indicates a sampling rate that would be expected to be a good match between point spacing and minimum object size.

The relatively low point densities of the scanners hamstrung early scan projects in the 1990s, and in the present era, attempts to speed the scanning process have the same effect. With indirect techniques, the lack of a visual check on the scale effect of capture means great care must be taken at the capture phase.

## 5. Passive capture technologies impact on drawing standards

The advent of passive or indirect capture methods – beginning with photography in the 1850s, progressing through 'classical' photogrammetry in the 1960s-90s, to laser scanning and structure from motion (SFM) photogrammetry today – has presented an argument for abandoning drawing altogether and simply working with the raw captured data. After all Ruskin (a promoter of The Ancient Monuments Protection Act in 1882), he said, in 1845 of the daguerreotype: *'It is very nearly the same as carrying off the palace itself- every chip in the stone is there and, of course, there no mistake about proportions.'*

The widespread adoption of passive or indirect capture methods has led to a shift in data supplier attitudes to feature selection or abstraction. It has been suggested that the selection and presentation of the required architectural definition is no longer the work of surveyors, and that clients prepare their own drawings from supplied point cloud or orthophoto products. Despite the maturity of photography (Figure 12) and photogrammetric technique where surveyors, tasked with drawing production, are uninformed (see Figures Figure 13, Figure 15, Figure 16) on matters of architectural depiction (e.g. Figure 14) drawing production can fail to meet the required standard.

Common failures are:

- inaccurate moulding profiles
- missed glazing details
- roof details such as flashing, ridge and hip capping
- incomplete lines in 'hidden' planes
- jointing and coursing details inappropriate to scale
- not using line-weights to indicate planes
- missing fitting and fixture details such as rainwater hoppers

**Figure 12.** 1846 Daguerreotype of Santa Maria della Spina, Pisa from the Ruskin collection. From the dawn of photography, John Ruskin (1819-1900) understood its value as an architectural recording tool.

**Figure 13.** No1 Greek St Soho, Grade 1 listed rococo plaster ceiling.
Left drawing derived from laser scan, right oblique photograph of same detail.

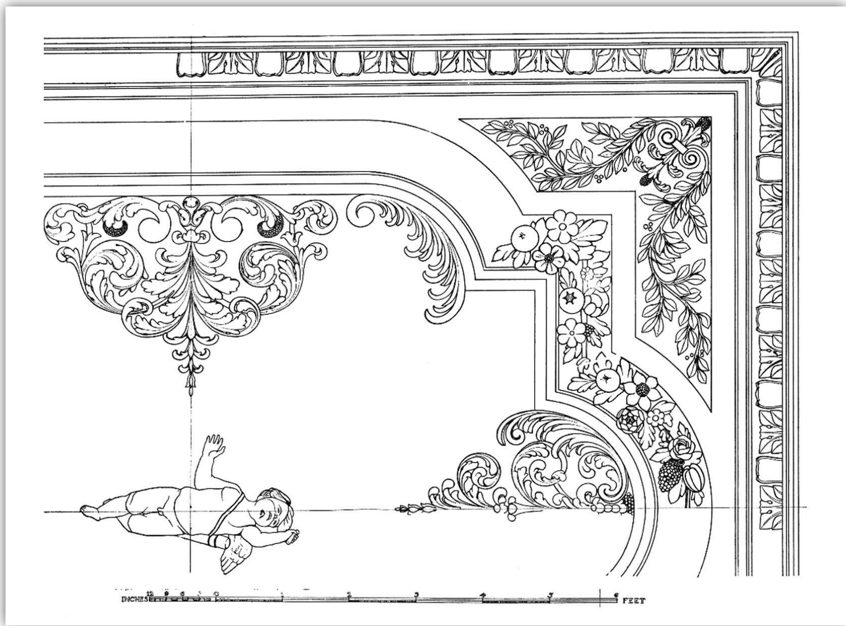

**Figure 14.** Example of measured drawing of ceiling plaster decoration by T Scott ARIBA 1928.

- misapplied orthogonal line work
- poor anticipation of plot size at scale
- confusion of plane of section
- oversized text

The need for standards and training in architectural draughting has been apparent since the development of photogrammetric recording in the 1960s, recognised here as, not a failing of technology but a layman's lack of understanding the basic language of architecture:

> *'It is surprisingly difficult for the layman, or the student embarking for the first time on a course of study in architecture, to appreciate from the start the three- dimensional nature of buildings. Such basics as the overhang of eaves, the reveals of windows and doors, the very solidity of buildings, seem not to be commonly observed.'*
>
> *Measured Drawing for Architects*
> *Robert Chitham (1980)*

The metric value of a laser scan survey (Figure 13, Figure 15, Figure 16) is debased by poor delineation, compared to the HABS work of 1999 the laser scan derived work demonstrates a lack of architectural understanding which is inappropriate to the significance of the structure. Possible failures in point density, data slicing, and drawing specification show the dangers of passive data collection. Indirect or passive capture technologies, without skilful interpretation or direction by specification, are likely to generate costly undifferentiated data. The speed and volume of capture may well exceed traditional drawing production rates but capture alone does not form an adequate record.

## 6. Specifications for heritage recording

The two units of the Metric Survey Team: Measured Survey and Photogrammetry, having been tasked with preparing a specification for metric survey, were able to draw on both mass capture and measured drawing experience. Two of the most widely used specifications – the RCHME thematic 'levels' specification (*Understanding Historic Buildings A guide to good Practice 2006*) and the Historic American Building Survey *Recording Historic Structures & Sites with HABS Measured Drawings* (Figure 17) – provided both descriptive and manual method based examples without reference to digital requirements or conservation applications.

The preparation of the specification was built on the structure of the RICS *Specification for Measured Surveys of Land Buildings & Utilities* (1990-2014), and various project briefs and checklists developed in response to major conservation projects – such as the Battle Abbey and Windsor Castle (1992) surveys. The specification from 2000 broke the documentation set down into:

**Figure 15.** US National Historic Landmark: Tudor House Washington DC. Top: Laser scan elevation. Centre: Measured drawing derived from point cloud by Cyark 2007. Bottom: Measured survey at an approximate scale 1:96. HABS survey (1999). Library of Congress.

**Figure 16.** Left: detail from HABS survey no. DC 171 (1999) showing line-weight, rainwater goods, glazing, moulding and roof detail. Right: detail from Cyark survey (2007). The architectural training expressed in the HABS drawing and its lack in the Cyark work is clear.

- control performance for topography, photogrammetry, rectified photography and building plans and sections
- topographic survey line styles, layer and height depiction
- rectified photography
- photogrammetric production
- measured building survey (plans & sectional elevations)

This presented a mix of performance requirements for capture method and drawing type; a source of confusion born out of the requirements of the organisation for site management and maintenance. The application of technique on a case-by-case 'check list' basis was replaced by a description of a general case based on the performance of methods tried and tested by the Metric Survey Team: the publication of *Metric Survey Specifications for English Heritage* allowed procurement to a consistent standard for conservation projects.

## 6.1 Performance vs method

A 'pure' performance specification for all means of capture is yet to emerge, the variety of deliverables ranging from a photograph or point cloud to a scale drawing require a variety of approaches to control quality. Passive data ingestion may generate post process data, which has re-interpretation value, direct or selective capture will not have the same data resilience.

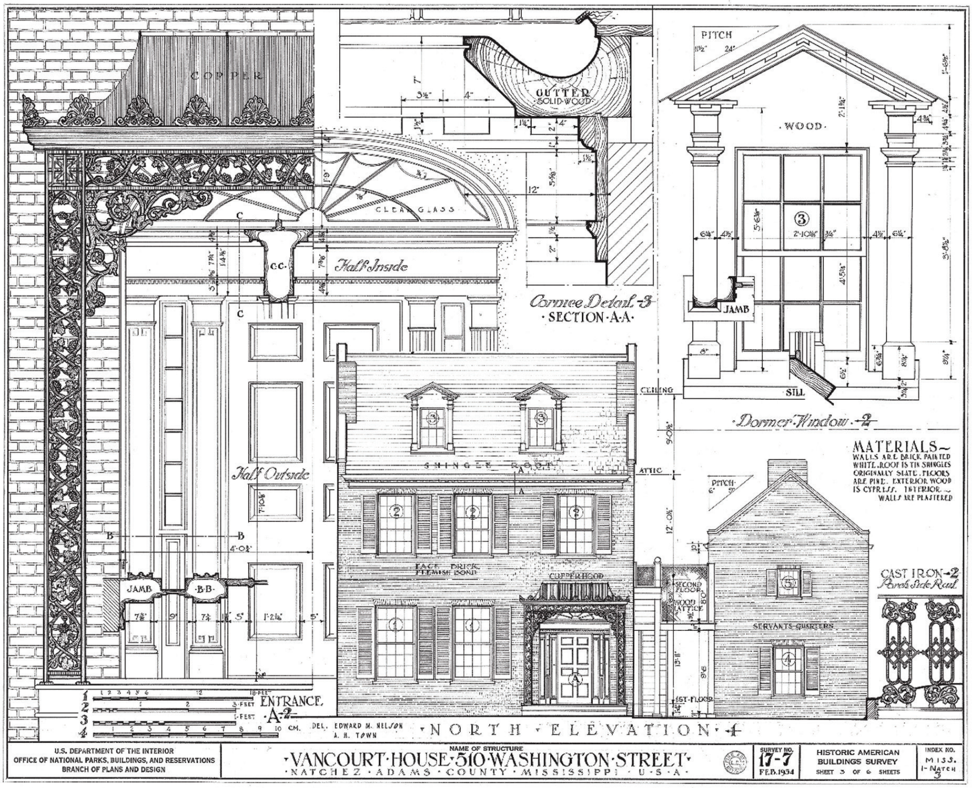


**Figure 17.** Graphical standard for 4 scales of drawing 1:98, 1:48, 1:24 and full size recording. Historic American Building Survey (1934-2008).

The specification of measured survey in *Section 5 Standard Specification for Measured Building Survey (2009)* did not stipulate technique but emphasised drawing content, structure, and presentation to define the required performance. The English Heritage experience in developing its specification for metric survey placed the scope of digital capture methods and their presentation firmly in the public domain, with examples. For the first time a standard for metric heritage documentation was available for both practitioners and providers alike.

## 7. Defining conservation information need

### 7.1 Informed conservation

The publication of *'Informed Conservation'* by Kate Clark in 2001 made clear a hierarchy of information need and made explicit how metric survey is an essential basis for the control of conservation processes such as recording condition and scheduling works. As a principle of practice, a clear distinction was made between metric and analytical drawings a distinction, which causes confusion to this day:

the differences between 'inquiry' 'analysis' 'investigation' and 'recording' show how different disciplines use similar techniques to answer very different questions about the historic environment. The gap between the expectation of conservators and the delivery from capture – particularly laser scanners but also photogrammetry – was recognised as a problem by Getty Conservation Institute (GCI) and the RecorDIM initiative, which investigated the information needs of conservation extensively in a number of 'round table' sessions between 2002 and 2007.

## 7.2 CIPA Potsdam 2001

The integration of photogrammetric, TST, and measured drawing (including a trial of laser scan data) at Ironbridge was presented as a reference project at CIPA Potsdam 2001. English Heritage delegates confirmed engagement with the RecorDIM initiative based on the Metric Survey Team's practical experience in specification and training.

## 7.3 Partnership in learning: Archdoc

At the Potsdam conference, the Metric Survey Team began a partnership with Mario Santana Quintero of the Raymond Lemaire International Centre for Conservation (RLICC) to disseminate best practice in heritage survey by taking the metric survey-training package to RLICC. Since 2002 (Figure 18), the training partnership between English Heritage and RLICC has expanded to provide an international team of experts and provide a template for CIPA training initiatives at Paestum, Italy in 2015;

**Figure 18.** Draughtsmanship meets metric measurement with real-time TST to CAD at the first 'partnership in learning' practical at RLICC, KU Leuven 2002.

and Valencia, Spain and Leiden, Netherlands in 2016. The documentation skills module at RLICC (named ArchDoc in 2015) incorporated historical analysis under the direction of professor of architectural history Krista de Jong and conservation architect Barbara van de Wee, and is a key module in the post graduate Integrated Project Work.

## 8. RecorDIM TG 16 beginning an international standard for heritage documentation

### 8.1 RecorDIM initiative

Task Group 1 produced two volumes published by GCI in 2007: *'Recording, Documentation, and Information Management for the Conservation of Heritage Places Guiding Principles'* & *'Illustrated Examples'*.

The Guiding Principles describe 12 principles covering project design, inventory, method selection, data types, and institutional responsibility. They do not specify tolerance, performance, or a drawing standard but rather a framework for documentation project design. The work in preparing the TG1 publications created a unique multi-disciplinary international forum, which recognised a need for the internationalisation of standards like the HABS and English Heritage specifications as well the integration of archaeological, metric and conservation documentation standards.

### 8.2 TG16

Task Group 16 was formed in 2006 with the goal of improving, harmonising, clarifying, and integrating the standards and best practices in the key areas of work practice, technical standards and information management. The documentation achieved by one project is often unusable by others because of differing thematic, technical, or data standards. The recommendations of this report are a reaction to the need for a common framework that offers a consistent approach across disciplines in cultural heritage to improve the effectiveness of documentation.

The series of round table discussions convened by RecorDIM explored the failures of integration between the geomatic sector and heritage. Task groups (TG) for techniques and applications in a variety of disciplines emerged addressing both technical and procedural aspects of heritage documentation.

Under the direction of Robin Letellier (CIPA) and Francois LeBlanc (GCI), the RecorDIM initiative approached the problem of integrating standards at the CIPA/VAST 7 symposium at Nicosia on 4th November 2006. At the open meeting, 36 delegates from 12 countries agreed to work with the definition of heritage documentation as:

> *'Heritage documentation is a continuous process enabling the monitoring, maintenance and understanding needed for conservation by the supply of appropriate and timely information. Documentation is both the product and action of meeting the information needs of heritage management. It makes available a range of tangible and intangible resources, such as metric, narrative, thematic and societal records of cultural heritage.'*

A task group meeting to develop the report was convened at the British Academy London, hosted by English Heritage on March 29th, 2007. At the meeting, the principal content of the report was defined and subsequently agreed on by 43 International delegates. The content was developed collaboratively online between March 29th and July 18th 2007 using a Google Group moderated by Mario Santana Quintero and edited by Fulvio Rinaudo, Jon Bedford and Bill Blake with contributions from Marc Wilhelm Kuster and Minna Lonnqvist at Politecnico di Torino on 18th July 2007[1].

The Task Group acknowledged that:

- Heritage documentation seeks to secure the adequate care of cultural heritage for future understanding and enjoyment.
- Heritage documentation has a central role in establishing the significance and integrity of cultural heritage.
- Heritage documentation is a multi-disciplinary activity and requires the application of technical, scientific and analytical skills.
- Heritage documentation encompasses activities conducted for inquiry and analytical processes (e.g. archaeological), as well as those conducted for curatorial or conservation needs including the processes of recording, inventory, description and archive.
- The three tasks of measurement, selection and communication common to documentation activities require appropriate understanding, specification and application to be effective.
- Documentation project design (strategy) must be structured so that resources are used wisely and that tasks are carried out in a timely and appropriate manner.
- Practitioners need clear, agreed briefs, technical standards and clear statements of information performance.
- Standards for heritage documentation will reflect the need for information that is consistent in its performance across all stages of the conservation process with the aim of enabling protective and preventive maintenance by recording condition and providing a basis for monitoring condition change.

1 See Appendix 2: Authorship of the report.

- Heritage documentation is the ground for monitoring and preventive maintenance strategies (it is a cost effective tool, since it helps evaluating the impact of conservation in the heritage fabric).

## 8.3 Identifying the needs for standards

The recommendations of the report follow from a description of the topics raised by the task group at the London meeting based on the division of:

- Work practice
- Technical specifications
- Data standards

and subsequently posted online by contributing members of the task group. The preparation of the topic list revealed common themes across the subject areas from which the principal topics for concern are described here. This represents the common assertion from the task group that "International Heritage Documentation Standards" should address the key issues of consistency, continuity and data transparency across all areas of heritage documentation practice.

## 8.4 The topics of concern

"International Heritage Documentation Standards" are needed to improve:

1. Internationalisation
2. Project management to integrate documentation into heritage management (including rapid-assessment and monitoring, preventive maintenance programmes), encourage interdisciplinary data accessibility, and to engage specialists appropriately
3. Skills through targeted training
4. Copyright, patent and intellectual property rights management
5. Data management by specification and brief
6. Digital heritage accountability & information management

### 8.4.1 Internationalisation

National standards in heritage documentation are diverse: there is a clear need for convergence because the core principles of heritage documentation are subject to local interpretation according to resource and the variety of responses to cultural heritage. An internationally expressed set of best practices in information capture and information management is needed to reinforce the work of practitioners in heritage documentation with clear templates and goals.

Internationally recognised standards for heritage documentation should present:

- an outline of recommended work practices
- examples of technical specifications for common recording techniques and products
- guidance on how documentation fits into heritage project management

Heritage documentation standards, which clearly and unambiguously explicates model work practice, will benefit the international cultural heritage conservation community. Such standards must:

- take into account differences in societies irrespective of language, ethnicity, religion, wealth and nature of political regime
- should apply work practices based on easily accessible and translatable information norms and formats
- internationally promote and build awareness of standardised heritage documentation work practices

**Recommendation**: Documentation practitioners and heritage institutions need an international heritage documentation standard framework to enable the sharing of data. The recommendation is that such a framework is produced.

### 8.4.2 Standard lexicon

A standard lexicon of conservation documentation terms should be established for the translation and dissemination of best practices and standards in specialised approaches, so that they serve the cultural heritage community.

This work should aim to overcome barriers to adoption of good practice that arise from language and the difference between cultural heritage and related disciplines. Translation of key documents into an appropriate range of languages will be needed to support their use internationally. In addition, documents aimed at related disciplines (for example civil engineering) will need to be considered and provided with an introduction to allow cultural heritage specialists to understand the language and approaches used in the related discipline.

**Recommendation:** To develop a multi-lingual; standard lexicon of terms used in heritage documentation to define unambiguously those terms that aid translation and dissemination of best practices and standards using specialised terms and to achieve clarity and consensus.

### 8.4.3 Project management

It is the responsibility of the institutions licensing or contracting work on cultural heritage to ensure the use of appropriate standards and to make such standards available. The use of shared heritage documentation by the different bodies and specialisms involved in heritage management as a common basis for records of actions planned and achieved will enhance the utility of data and its exchange.

Heritage documentation is planned according to:

- the availability of resources (e.g. time/money/skills/people)
- the required level of documentation detail
- the information needs of the project

The conservation team should address documentation by:

- Including documentation needs at the proposal, design-initiation, implementation and monitoring stages of the project.
- Ensuring documentation is structured to provide the right information at the right time.
- Making shared knowledge and shared outcomes the norm rather than the exception.
- Early briefing of the documentation practitioners - this will focus resources and skills better.
- Re-use of documentation for monitoring and evaluation.
- Good mapping: this will deliver strong baseline data that validates conservation when used for monitoring.
- Use of specifications and briefs to control the work.
- Documentation should be planned according to intervention needs.
- Environmental and biological implications have to be understood and integrated.
- Ensuring that the provenance of data is transparent: its initiation must include description of its function, performance, constraints, traceable authorship and disciplinary dependency. Practitioners need to have access to the background and reference sources including:
    - Metadata
    - Controls: metric, procedural and thematic
    - Statements of method repeatability
    - Authorship

**Recommendation:** That heritage documentation needs to improve the transparency of its products and therefore guidance on project management issues with regard to heritage documentation be produced.

### 8.4.4 Training

In line with the ICOMOS Colombo 1993 Guidelines for education and training in the conservation of monuments, ensembles and sites[2] standards for heritage

2 Appendix 3 ICOMOS Training initiatives in Heritage Documentation.

documentation seek to establish and maintain both a minimum educational achievement and the specialist technical skills required for practitioners.

Standards for heritage documentation, which includes recommended work practice, acknowledge that:

- long-term planning is part of sustainability in documentation
- long-term planning concerns standardisation of data capture, performance, dissemination and storage
- shared data standards are essential for long-term planning.

Therefore, qualification, experience and training in heritage specific skills is required for practitioners in documentation. In addition to basic literacy, numeracy and IT skills, basic training is needed in the following areas:

- Fundamentals of surveying
- Site capture and field drawing
- Awareness of archaeological inventory, prospecting, excavation and investigative skills
- Understanding of national, local and regional cultural styles and their development (e.g. history of architecture)
- Information in use in conservation practice and preventative maintenance
- Information management
- Digital archiving
- Robust and reliable capture methods
- Rapid assessment survey
- Preparation and performance of ante-disaster records
- Disaster recovery techniques
- Cultural resource management
- Conservation practice and preventative maintenance.

**Recommendation:** That training is made available for basic heritage documentation skills.

**Recommendation:** That the contribution of documentation experts to training initiatives needs to broadcast the three core principles of heritage documentation:

- respect for heritage significance and value
- transparency of data provenance
- meeting heritage management needs.

National heritage laws vary with regard to the technical performance of documentation therefore an understanding of common base levels of record and of fields such as surveying, excavation and material conservation need to be included in training for heritage documentation. Understanding heritage values (e.g. respect of ownership and patrimony of cultural heritage), whether in reference to landscapes, monuments, sites or artefacts, is a basic requirement for all the parties involved in heritage documentation and should to be included in training for heritage documentation. Training in the use of international codes and charters[3] concerning cultural heritage is a key requirement for understanding and applying an effective standards for heritage documentation.

**Recommendation:** That a summary list of current international heritage conservation conventions and charters be made available for teachers.

### 8.4.5 Copyright, patent and intellectual property rights management

Legislation of copyrights, patents and intellectual property rights varies between national and geographical areas. The principle outlined in the Venice Charter that heritage records should be disseminated and shared subject to contractual, national and international legal constraints needs to be supported by guidance on the matter of the rights of the originators of documentation. The obligation to 'assert the moral right' as author is not explicit for drawings, collaborative or derivative work: clarification is needed.

The separation of original work from technical format is a concern, as digital information is inseparable from the technical formats it uses, proprietary or otherwise.

Work practice requirements in heritage documentation standards include:

- adherence to applicable laws protecting intellectual property (applied to published work, programs, software, imagery,
- audio-visual data and digital data in general)
- adherence to patent laws (e.g. documentation software)
- intellectual property rights, i.e. use of cultural heritage for industrial and commercial purposes; documentation publication rights etc.

**Recommendation:** That a best practice guide is prepared which will examine common principles with regard to copyright, patent, moral and intellectual property rights, and that a list of appropriate agencies to contact is compiled.

## 8.5 Data management by specification and brief

### 8.5.1 Specifications

Specifications must be established to protect data suppliers and users from misapplied data capture. The performances of capture technologies must be controlled by a description of the expected data and the standard it must reach. The specification for the performance of data capture must respect the requirement for archive and its future re-interpretation.

3 Listed at Appendix 1.

### 8.5.2 Performance/method specifications

The emphasis on either product performance or technique performance must be made clear in using specifications to control documentation outcomes[4]. The deployment of both method and performance specifications requires practical experience of both techniques and products. By making reference examples available along with a technical description of both method and performance the balance between economical and technical performances can be demonstrated. Cultural Heritage managers must make informed choices when commissioning documentation so that the most effective techniques are selected for use, not only to meet immediate information needs but to act as a basis for long term records of condition and as controls for long term site management.

**Recommendation:** Guidance for using specifications is needed.

### 8.5.3 The brief

Getting the right information to the right person at the right time is a key responsibility of the practitioner; this is not possible if there is no agreement between the parties on the exact project specific requirements. A brief explains to all what is agreed to be done, why, and when. International Heritage Documentation Standards can offer standard clauses and descriptions of services.

**Recommendation:** Provide examples of model briefs by way of guidance as to how to write a brief.

### 8.5.4 Method & resource statement

The response to a brief need to make consistent use of task descriptions with clear descriptions of the skills and duties of the team, the equipment to be used (and its condition, calibration etc.), the project timetable and the deliverables.

**Recommendation:** Provide guidance on how to produce a method and resource statement with examples.

### 8.5.5 Research project planning

Heritage documentation work is often undertaken for research and educational projects. Documentation is devalued without planning outcomes beyond immediate

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4 An example is: *Metric Survey Specifications for English Heritage* (ISBN 1873592 574 published in 2000, revised 2003 and 2007) which provides a description of the products required for the supply of base metric data for heritage asset management in England. The specification is both method- and performance-based as photogrammetric products are considered a baseline record determined by method. The requirements for control, line selection (including illustration by example), CAD layering is described.

research needs. A standard is needed to ensure consistency of documentation produced across research institutions.

**Recommendation:** That a minimum of three research institutions identify common documentation standards for testing that will demonstrate international interoperability and exchange of research data.

### 8.5.6 Role of technical standards in best practice

In the scientific and technical sector (geomatics, geodesy, geophysics, chemistry, etc.) international and national bodies (e.g. CEN[5], ISO[6], DIN[7] etc.) have approved many standards governing the performance of metric capture. The function of such technical standards in heritage documentation is the underpinning of information selection with robust measurement and data recovery performances. The harmonisation of the existing standards and the setting up of manuals (best practices etc.) in order to translate existing accepted standards into the cultural heritage documentation process is needed to improve the application of the sciences in the heritage sector.

### 8.5.7 Data acquisition and technique selection

Guidance is needed to offer the user community informed advice on the range of techniques available and their appropriate application. Cultural heritage documentation experts usually define the required outcomes as useful in assisting the comprehension of an object; but the methods required are not usually specified. In some cases, there is insufficient knowledge of the different approaches available to produce a given outcome. In the past, this has allowed ‘uneconomic’ approaches to the problem. Despite the relatively few techniques available today their misapplication is all too common. Matching end user data requirements with the correct capture method needs an understanding of the selection, or ‘analysis and filtering’, of captured data which is an essential process in making data effective for a given conservation outcome. The potential of multi-use data that meets the needs of more than one project stage or discipline needs careful collaboration in the project team and rigorous specification to achieve. Post capture feature selection and interpretation is dependent on the capture methods deployed (for

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5 CEN European Norm Committee: The European Committee for Standardisation, was founded in 1961. CEN contributes to the objectives of the European Union and European Economic Area with voluntary technical standards which promote free trade, the safety of workers and consumers, interoperability of networks, environmental protection, exploitation of research and development programmes, and public procurement.

6 ISO The International Organisation for Standardisation: It is an international standard-setting body composed of representatives from various national standards organisations. The organisation promulgates worldwide industrial and commercial standards.

7 DIN Deutsches Institut für Normung the German Institute for Standardisation: It is the German national organisation for standardisation and is that country's ISO member body.

example metric data can be recovered from historic photography whereas historic drawings have their selection aspect frozen in time) requiring careful evaluation of the anticipated data performance and its use by the heritage conservation community. Data integration and interdisciplinary working benefit from carefully managed digital techniques; making the right choices has an impact on workflow and data flexibility. Data from different sources can be used in different ways and each way allows different integration paths with other techniques.

By using the body of published knowledge (books, manuals and best practices etc.), it is possible to build up a schedule of possible solutions achievable by current techniques and offer clear advice on the performance of the data outputs for each technique. Similarly, it should be possible to list the information requirements for classified cultural heritage documentation types and show how they describe existing standards for cultural heritage documentation. By indicating data types that can guarantee maximal data re-use the risks and benefits of a given technique can be understood (e.g. the potential of re-use and repeatability of the measurement cycle can be demonstrated for a given technique).

**Recommendation:** Guidance for technique selection is needed.

The minimum requirements for the correct use of capture techniques (in terms of accuracy and usability of the data) are variable according to the subject and the resources available, but the consistency of some capture techniques over others (for example the ante-disaster vale of photogrammetry) needs to be made clear. Definitions of ‘outline’ and ‘detailed’ survey need clarity. Descriptions of appropriate survey products for topographic surveys, building plans & sections, using orthophotography, and laser scan (added 2007) need to be developed. The frequent need to use a combination of techniques to achieve a required outcome is poorly understood and guidance is lacking on the different techniques and their integration.

Technical specifications require integration of data capture and information management.

The data from physical and chemical analysis techniques can be considered as “objective” data, however, descriptions of geometry tend to be selective. This means different kinds of procedural controls are needed to achieve geometric and analytical consistency. Finding the right mix of specifications to integrate geomatic and physical or chemical analysis so that repeated capture cycles can be achieved for condition monitoring is important for successful conservation practice.

### 8.5.8 Data quality assessments: base line records

A method of ranking information quality and a better understanding of base line record performance is needed. Being able to add a quality ‘score’ to technical data, which can be managed inside Geographical Information System (GIS), needs a standard method of weighting from base line upwards in order to achieve comparability between GIS datasets. The variability of GIS data quality needs a set of quality measures to enable quantifying the value of derived information.

### 8.5.9 Integration of work practices and information management

Technical specifications, guidelines and standards should integrate with work practices so that properly informed use of the most appropriate practices and techniques available is made. Work practices should integrate with information management standards to ensure that data created by a particular technique can be archived in a documented, stable and accessible format to support future research work.

For example:

- where work practice requires a specific technique to be deployed its performance can be clearly stated,
- where a documentation outcome is described it can be in a standardised form and language,
- when a task is described in terms of skill, the skill can be clearly defined using standard language for tasks,
- the performance of materials described in the brief meets the technical standard for its purpose.

The conservation specific information requirements (e.g. condition, mineral content, monitoring etc.) must be included in the data performance requirement. The density of points and the selection of information from data sets should be specified according to the conservation requirement. The use of selected or interpolated information to describe aspects of cultural heritage (e.g. art historic in wall painting, architectural history in buildings) must be based on clear traceable input from the relevant expertise. Data structure and terminology (e.g. GIS, database asset register) should be organised to meet the needs of the heritage conservation community.

**Recommendation:** A reference guide to technical standards is needed to translate existing accepted technical standards into the heritage documentation process.

**Recommendation:** To produce a checklist of requirements for compliance with the technical standards with accompanying explanatory notes. To explore the issue of a certification of compliance with recommended technical standards by a panel comprising members of ICOMOS, CIPA and a representative from an appropriate standards organisation.

### 8.5.10 Digital heritage accountability and information management

Background: what do we mean by 'digital heritage'? For the purposes of this report, digital heritage is taken to mean the digital products of heritage documentation. The issue of documenting our digital culture as a whole is considered beyond the remit of this report. Digital data presents its own challenge both as a tool and as a record: it is transient in format, volatile in archive and costly to maintain. Guidance is needed to achieve the obvious benefits of digital data.

We have relatively short experience of the long-term performance of digital data and its behaviour is different from paper equivalents. Some digital records (e.g. GIS) can only exist in a digital medium, whereas others may have hard copy equivalents that respond to traditional archive management. For the purposes of this report, formats and products are considered on an 'as existing' basis so that standards may be proposed that are based on actions that can be taken with the data we have now.

The principal needs of international heritage documentation standards with respect to digital data performance are identified as:

- Digital archiving standards to enable managing the digital data life cycle: including migration strategies, and long-term accessibility.
- Definition of data curation and stewardship responsibilities.
- Ensuring data interoperability and transparency of provenance.
- Defining appropriate standards that support empirical, interpreted and visualised data.
- Disaster recovery, security, authenticity.

Topics of concern for heritage documentation practitioners are:

- The need for an open, tolerant, adaptable metadata standard.
- How to embed metadata throughout workflow, from field to archive.
- Need to influence research and development to provide tools that are easy to use and adapted to heritage community.
- Digital fingerprinting of heritage assets: UUID: (Universally Unique Identifier) Persistent identifiers for heritage and digital assets.
- Alternatives to information management in the absence thereof.
- Long-term storage guarantees.

Digital archiving standards for cultural heritage documentation can be subdivided into three principal groups:

- Archiving of textual data (e.g. verbal site descriptions, reports of digs).
- Archiving of digital data (e.g. photography, CAD drawings etc.).
- Archiving of empirical, interpreted and visualised data.

### 8.5.11 Using common formats

For digital data formats, one format of choice will have to be selected for each individual type of record to be archived (e.g. photography, vector drawing, CAD drawing, 3D model, film etc.). Preference should be given to openly standardised, non-proprietary formats where possible. For textual data XML-based formats and notably those conformant to the guidelines of the Text Encoding Initiative (TEI)[8] 15 are an obvious choice. It is necessary to define a profile of the TEI for the core elements that are needed for reliable archiving of data. For empirical, interpreted and visualised data, specific data formats need to be defined.

### 8.5.12 Data interoperability

Data interoperability is closely related to data archiving, but not identical. Whereas data archiving standards are chosen with the paramount goal of long-term data accessibility, data interoperability can take into account factors such as ease of modification, current tool availability etc. Whenever possible, however, both formats should be identical and in the mid-term tools should be developed to ease the handling of data archiving formats.

### 8.5.13 Metadata standards

Metadata standards cover the description of data objects through explicit annotations either inside the data objects themselves (embedded metadata) or referencing them (external metadata). The former can be found e.g. in the case of metadata inside a JPEG 2000 image, the header of a TEI file or RDF[9] triplets inside a text file, the latter e.g. through external topic maps (cf. ISO/IEC 13250)[10] a suitably configured registry or with OWL (Web Ontology Language)-based ontology. Metadata standards within the cultural heritage arena and more specifically for cultural heritage documentation will build on these existing metadata specifications and describe both a suitable ontology and vocabularies. In the case of cultural heritage objects themselves the former is specified in ISO

8 http://www.tei-c.org/ The Text Encoding Initiative (TEI) Guidelines are an international and interdisciplinary standard that enable libraries, museums, publishers, and individual scholars to represent a variety of literary and linguistic texts for online research, teaching, and preservation.

9 Resource Description Framework (RDF) is a family of World Wide Web Consortium (W3C) specifications originally designed as a metadata model but which has come to be used as a general method of modelling information, through a variety of syntax formats.

10 http://www.jtc1sc34.org/repository/0008/draft27.htm
This International Standard provides a standardised notation for interchangeably representing information about the structure of information resources used to define topics, and the relationships between topics. A set of one or more interrelated documents that employs the notation defined by it is called a Topic Navigation Map (TNM). In general, the structural information conveyed by TNMs includes: groupings of addressable information objects.

21127: CIDOC[11] Conceptional Reference Model (CIDOC CRM), cf. http://cidoc.ics.forth.gr/, and pertinent vocabularies exist in considerable numbers. However, it will be necessary to give guidance on their actual use in embedded and external metadata. For the documentation, data objects it will be necessary to complement the metadata relating to the cultural heritage objects themselves with metadata on the documentation objects. This includes technical metadata, e.g. for photographic data typically contained in the EXIF header[12], archiving and bibliographic metadata, e.g. in Dublin Core[13] and / or FRBR[14], administrative metadata etc.

**Recommendation:** A working group must consider metadata for heritage documentation in detail and elaborate a map of existing standards and vocabularies together with a gap analysis. In a second step, concrete standardisation activities should be identified and discussed with suitable standardisation forums.

### 8.5.14 Digital fingerprinting

Digital fingerprints can function as a special type of metadata in uniquely associating (a version of) a heritage documentation with a specific originator. It can also make sure that this version is unaltered.

In relation to long-term data archiving, digital fingerprinting as digital signatures pose significant problems, though (e.g. the problem of refreshing the protection). It may be necessary to monitor the standardisation scene e.g. in eGovernment and in archival practice, where similar problems are tackled, until a clear state of the practice emerges.

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11 CIDOC (Le Comité International pour la DOCumentation des musées) is the forum for the documentation interests of museums and related organisations. It has more than 450 members in 60 countries. Established in 1950 as one of the international committees of the International Council of Museums (ICOM) it is dedicated to the documentation of museum collections. CIDOC has produced several international standards for museum documentation, most recently the CIDOC-CRM (accepted as ISO 21127 in September 2006).

12 Exchangeable image file format (Exif) is a specification for the image file format used by digital cameras. It was created by the Japan Electronic Industries Development Association (JEIDA). The specification uses JPEG, TIFF, and RIFF WAVE file formats, with the addition of specific metadata tags. It is not supported in JPEG 2000, PNG, or GIF.

13 The Dublin Core metadata element set is a standard for cross-domain information resource description. It provides a standardised set of conventions for describing things in ways that make them easier to find. Dublin Core is widely used to describe digital materials.

14 Functional Requirements for Bibliographic Records. http://www.frbr.org

### 8.5.15 Tools for the heritage community

While not part of the standards themselves, it is important to influence research and development to provide supporting tools that are easy to use and adapted to the heritage community. For textual data such tools are currently under development e.g. in the TextGrid[15] 22 project (http://www.textgrid.de) or in projects such as EPPT[16] (http://beowulf.engl.uky.edu/eppt/) or Tapor (http://portal.tapor.ca/)[17], in the case of TextGrid in cooperation with archives and libraries. Digital library resources are becoming available and structures enable interoperability emerging e.g. Bricks (http://www.brickscommunity.org/) which works for the creation of the BRICKS[18] Cultural Heritage Network or 'European Digital Cultural memory'.

**Recommendation:** Specific heritage documentation research applications using the developing data analysis tools should be investigated. By identifying missing tools for data interoperability and finding solutions it will be possible to address selected projects and plan the handling of heritage documentation, e.g. in the data format specified for joint research applications.

**Recommendation:** That guidance be produced on "good housekeeping" for archiving, description and storage of digital data.

15 TextGrid is a platform for distributed and co-operative scientific text data processing: a community grid for the arts and humanities: it establishes a workbench for joint philological treatment, analysis, listing of publications, editing and publication of text data for philology, linguistics and adjacent sciences. TextGrid creates an interdisciplinary, international and interlaced virtual research platform in collaboration with e-Humanities initiatives in the study of arts and humanities.

16 Edition Production & Presentation Technology is an integrated set of XML tools designed to help humanities editors prepare image-based electronic editions. Following emerging standards (XSLT, XPath, XQuery), EPPT is testing its broad application to external projects that preserve texts in Old English, Middle English, Old French, Old Slovene, ancient Assyrian, Greek and Latin, on parchment, vellum, paper, papyrus, clay and stone.

17 TAPoR (Text Analysis POrtal for Research) is a gateway to tools for sophisticated analysis and retrieval, along with representative texts for experimentation

18 The BRICKS (Building Resources for Integrated Cultural Knowledge Services) project researches and implements advanced opensource software solutions for the sharing and the exploitation of digital cultural resources. The BRICKS Community is a worldwide federation of cultural heritage institutions, research organisations, technological providers, and digital libraries services. The Community orientates and validates the project results, and co-operates towards the creation of the BRICKS Cultural Heritage Network that will provide access to and foster the European digital memory.

| TG16 agreed definition of terms | |
|---|---|
| Archaeology | The study of past human cultures by analysing the material remains (sites, buildings, artefacts and ecofacts) that people left behind. |
| Authenticity | Those characters that most truthfully reflect and embody the cultural heritage values of a place.* |
| Base line record | A set of information captured in recognition of heritage value in anticipation of monitoring condition and further detailed recording as resources permit. |
| Brief | The description of the specific service required, the site, extent, scale, scope, and reasons for the work. |
| Chemical analysis | Procedure for determining material content, especially the content of deleterious materials e.g. salts carbon, excess acid etc. |
| Code of practice | A set of written rules that state operating requirements for specified activities. May form a standard against which performance can be assessed. |
| Condition survey | Description of condition mapped. |
| Conservation | Preservation or restoration from loss, damage, or neglect. |
| Data standard | An agreement on what data should be recorded, and how it should be formatted, to meet a specific objective, for example interoperability between different information systems. |
| Digital heritage records | Information stored in a digital medium. |
| Guidelines | Documents published by relevant authorities for the purpose of informing working practice. Specifically guidelines may clarify the provisions of a law, regulation or standard. |
| Heritage, Cultural<br><br>Heritage | All inherited resources which people value beyond mere utility.<br>Inherited assets which people identify and value as a reflection and expression of their evolving knowledge, beliefs, and traditions and their understanding of the beliefs and traditions of others.* |
| Heritage asset management | The process required to manage physical assets to maintain their cultural heritage significance. |
| Heritage conservation community | Specialists working in cultural heritage, including conservators, site managers, archaeologists and allied technicians. |
| Information Management | The process of identifying, defining, evaluating, protecting, and distributing structured data. |
| Method & Resource statement | Response to brief explaining how a proposed performance requirement will be met. |
| Method specification | Description of required performance of a method. |
| Metric survey | 3D geometric survey with a known accuracy and precision carried out by reliable and repeatable methods. |
| Objective record | A theoretical property of records: captured without influence from human judgements. |

| | |
|---|---|
| Orthophotograph | (A mosaic of) photographic images corrected for scale and perspective errors i.e. a photo-map. |
| Performance specification | Description of required performance without a specific method. |
| Photogrammetry | The science and technology of obtaining reliable and accurate measurements from images |
| Product | Deliverable or outcome. |
| Project Management | The discipline of organising and managing resources in such a way that the project is completed within a defined scope. |
| Recording | Information capture. |
| Significance | Significance The sum of the cultural and natural heritage values of a place including evidential, historical, community and aesthetic values.* See also the Nara Document on Authenticity. |
| Specification | Description of required performance. |
| Standard | Document, established by consensus and approved by a recognised body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. (ISO/IEC Guide 2:1996) |
| Technical specifications | Descriptions of technical performance. |
| Work Practice | Processes, tasks and procedures. |
| | *Definition from English Heritage Conservation principles 2007 |

# 9. Conclusions

The culmination of TG 16 was to identify the next steps needed to achieve an international standard. The report presented to the CIPA executive board at the Athens symposia on 6th October 2007 stated that the three underlying principles of heritage documentation:

- respect for heritage significance and value;
- transparent data provenance;
- meeting heritage management needs

require support in the form of codes of practice, guidance, and standards. The work of RecorDIM Task Group 16 had determined the most urgent needs of documentation practitioners.

## 9.1 The report recommendations

A standard or code of practice for heritage documentation will comprise a body of knowledge, consisting of:

**guidance** on:

Information transparency

The principles of intellectual property rights and their management

Using specifications, briefs and method & resource statements

Best practice in digital data management

Project management in heritage documentation

**training** in basic heritage documentation skills, including:

Understanding cultural heritage and its values

Documentation techniques

Information management

Core skills: practitioners must be literate, numerate and IT capable

**publication** of:

Reference examples of good practice

Model specifications and briefs

A lexicon of technical terms in heritage documentation practice

A certification statement based on a checklist of required products and procedures for heritage documentation projects

**research** in:

Effective interoperability of data sets

Robust methods of digital data curation

Bill Blake
Chair, RecorDIM Task Group 16

## Appendix 1: International Heritage Charters

CHARTERS ADOPTED BY THE GENERAL ASSEMBLY OF ICOMOS[19]

- International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter)
- The Florence Charter (Historic gardens and landscapes)
- Charter on the Conservation of Historic Towns and Urban Areas
- Charter for the Protection and Management of the Archaeological Heritage
- Charter for the Protection and Management of the Underwater Cultural Heritage
- International Charter on Cultural Tourism
- Principles for the Preservation of Historic Timber Structures
- Charter on the Built Vernacular Heritage

RESOLUTIONS AND DECLARATIONS OF ICOMOS SYMPOSIA

- Resolutions of the symposium on the Introduction of Contemporary Architecture into Ancient Groups of Buildings
- Resolution on the Conservation of Smaller Historic Towns
- Tlaxcala Declaration on the Revitalization of Small Settlements
- Declaration of Dresden
- Declaration of Rome
- Guidelines for Education and Training in the Conservation of Monuments, Ensembles and Sites
- The Nara Document on Authenticity (Nara Conference on Authenticity in Relation to the World Heritage Convention, held at Nara, Japan, from 1-6 November 1994)
- Declaration of San Antonio at the InterAmerican Symposium on Authenticity in the Conservationa and Management of the Cultural Heritage Principles for the recording of monuments, groups of buildings and sites (The Sofia principles 5 to 9 October 1996)
- The Stockholm Declaration: Declaration of ICOMOS marking the 50th anniversary of the Universal Declaration of Human Rights (adopted by the ICOMOS Executive and Advisory Committees at their meetings in Stockolm, 11 September 1998)

CHARTERS ADOPTED BY ICOMOS NATIONAL COMMITTEES

- The Australia ICOMOS Charter for the Conservation of Places of Cultural Significance (The Burra Charter) (Australia ICOMOS)
- Charter for the Preservation of Quebec's Heritage (Deschambault Declaration) (ICOMOS Canada)

19 http://www.international.icomos.org/e_charte.htm

- Appleton Charter for the Protection and Enhancement of the Built Environment (ICOMOS Canada)
- First Brazilian Seminar About the Preservation and Revitalization of Historic Centers (ICOMOS Brazil)
- Charter for the Conservation of Places of Cultural Heritage Value (ICOMOS New Zealand)
- A Preservation Charter for the Historic Towns and Areas of the United States of America (US/ICOMOS)

OTHER INTERNATIONAL STANDARDS

- Athens Charter for the Restoration of Historic Monuments (First International Congress of Architects and Technicians of
- Historic Monuments, Athens, 1931)
- Normas de Quito, Final Report of the Meeting on the Preservation and Utilization of Monuments and Sites of Artistic and historical Value held in Quito, Ecuador, from November 29 to December 2, 1967
- Declaration of Amsterdam (Congress on the European Architectural Heritage, 21-25 October 1975)
- European Charter of the Architectural Heritage (Council of Europe, October 1975)
- UNESCO Conventions and Recommendations

## Appendix 2: Authorship of the report

Robin Letellier convened the RecorDIM initiative in 2002 to address heritage documentation issues and supported the work of this Task Group.

The content collated and edited by Jon Bedford (who was also recorder at the editorial meeting hosted by Politecnico di Torino) and Bill Blake from content was prepared by 3 contributing subject editors:

- Work Practice: Minna Lonquist
- Technical standards: Fulvio Rinaudo
- Data standards: Marc Wilhelm Kuster

The access to content was moderated by Mario Santana Quintero who facilitated and recorded the Nicosia meeting. Michael Ashley compiled the content headings from contributions at the London Task Group meeting. The content has the assent of the following who either attended and agreed to the proceedings of the two meetings or registered as members of the Heritage Documentation Standards Google Group[20] with access to the report content between November 2006 and August 2007:

20 http://groups.google.com/group/heritagedocstand now closed.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
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## Appendix 3:

## ICOMOS guidelines for Education and Training in the Conservation of Monuments, Ensembles and Sites[21]

The General Assembly of the International Council on Monuments and Sites, ICOMOS, meeting in Colombo, Sri Lanka, at its tenth session from July 30 to August 7, 1993; Considering the breadth of the heritage encompassed within the concept of monuments, ensembles and sites; Considering the great variety of actions and treatments required for the conservation of these heritage resources, and the necessity of a common discipline for their guidance; Recognizing that many different professions need to collaborate within the common discipline of conservation in the process and require proper education and training in order to guarantee good communication and coordinated action in conservation; Noting the Venice Charter and related ICOMOS doctrine, and the need to provide a reference for the institutions and bodies involved in developing training programmes, and to assist in defining and building up appropriate standards and criteria suitable to meet the specific cultural and technical requirements in each community or region; Adopts the following guidelines, and Recommends that they be diffused for the information of appropriate institutions, organizations and authorities.

AIM OF THE GUIDELINES

1. The aim of this document is to promote the establishment of standards and guidelines for education and training in the conservation of monuments, groups of buildings ("ensembles") and sites defined as cultural heritage by the World Heritage Convention of 1972. They include historic buildings, historic areas and towns, archaeological sites, and the contents therein, as well as historic and cultural landscapes.  Their conservation is now, and will continue to be a matter of urgency.

CONSERVATION

2. Conservation of cultural heritage is now recognised as resting within the general field of environmental and cultural development. Sustainable management strategies for change which respect cultural heritage require the integration of conservation attitudes with contemporary economic and social goals including tourism.

3. The object of conservation is to prolong the life of cultural heritage and, if possible, to clarify the artistic and historical messages therein without the loss of authenticity and meaning. Conservation is a cultural, artistic, technical and craft activity based on humanistic and scientific studies and systematic research. Conservation must respect the cultural context.

21 http://www.icomos.org/guidelines_for_education.html

EDUCATIONAL AND TRAINING PROGRAMMES AND COURSES

4. There is a need to develop a holistic approach to our heritage on the basis of cultural pluralism and diversity, respected by professionals, craftspersons and administrators. Conservation requires the ability to observe, analyze and synthesize. The conservationist should have a flexible yet pragmatic approach based on cultural consciousness which should penetrate all practical work, proper education and training, sound judgement and a sense of proportion with an understanding of the community's needs. Many professional and craft skills are involved in this interdisciplinary activity.

5. Conservation works should only be entrusted to persons competent in these specialist activities. Education and training for conservation should produce from a range of professionals, conservationists who are able to:

   a) read a monument, ensemble or site and identify its emotional, cultural and use significance;

   b) understand the history and technology of monuments, ensembles or sites in order to define their identity, plan for their conservation, and interpret the results of this research;

   c) understand the setting of a monument, ensemble or site, their contents and surroundings, in relation to other buildings, gardens or landscapes;

   d) find and absorb all available sources of information relevant to the monument, ensemble or site being studied;

   e) understand and analyze the behaviour of monuments, ensembles and sites as complex systems;

   f) diagnose intrinsic and extrinsic causes of decay as a basis for appropriate action;

   g) inspect and make reports intelligible to non-specialist readers of monuments, ensembles or sites, illustrated by graphic means such as sketches and photographs;

   h) know, understand and apply UNESCO conventions and recommendations, and ICOMOS and other recognized Charters, regulations and guidelines;

   i) make balanced judgements based on shared ethical principles, and accept responsibility for the long-term welfare of cultural heritage;

   j) recognise when advice must be sought and define the areas of need of study by different specialists, e.g. wall paintings, sculpture and objects of artistic and historical value, and/or studies of materials and systems;

   k) give expert advice on maintenance strategies, management policies and the policy framework for environmental protection and preservation of monuments and their contents, and sites;

   l) document works executed and make same accessible;

m) work in multi-disciplinary groups using sound methods;

n) be able to work with inhabitants, administrators and planners to resolve conflicts and to develop conservation strategies appropriate to local needs, abilities and resources.

## AIMS OF COURSES

6. There is a need to impart knowledge of conservation attitudes and approaches to all those who may have a direct or indirect impact on cultural property.
7. The practice of conservation is interdisciplinary; it therefore follows that courses should also be multidisciplinary. Professionals, including academics and specialized craftspersons, who have already received their normal qualification will need further training in order to become conservationists; equally those who seek to act competently in historic environment.
8. Conservationists should ensure that all artisans and staff working on a monument, ensemble or site respect its significance.
9. Training in disaster preparedness and in methods of mitigating damage to cultural property, by strengthening and improving fire prevention and other security measures, should be included in courses.

Traditional crafts are a valuable cultural resource. Craftspersons, already with high level manual skills, should be further trained for conservation work with instruction in the history of their craft, historic details and practices, and the theory of conservation with the need for documentation. Many historic skills will have to be recorded and revived.

## ORGANIZATION OF EDUCATION AND TRAINING

11. Many satisfactory methods of achieving the required education and training are possible. Variations will depend on traditions and legislation, as well as on administrative and economic context of each cultural region. The active exchange of ideas and opinions on new approaches to education and training between national institutes and at international levels should be encouraged. Collaborative network of individuals and institutions is essential to the success of this exchange.
12. Education and sensitization for conservation should begin in schools and continue in universities and beyond. These institutions have an important role in raising visual and cultural awareness - improving ability to read and understand the elements of our cultural heritage - and giving the cultural preparation needed by candidates for specialist education and training. Practical hands-on training in craftwork should be encouraged.
13. Courses for continuing professional development can enlarge on the initial education and training of professionals. Long-term, part-time courses are

a valuable method for advanced teaching, and useful in major population centres. Short courses can enlarge attitudes, but cannot teach skills or impart profound understanding of conservation. They can help introduce concepts and techniques of conservation in the management of the built and natural environment and the objects within it.

14. Participants in specialist courses should be of a high calibre normally having had appropriate education and training and practical working experience. Specialist courses should be multidisciplinary with core subjects for all participants, and optional subjects to extend capacities and/or to fill the gaps in previous education and training. To complete the education and training of a conservationist an internship is recommended to give practical experience.

15. Every country or regional group should be encouraged to develop at least one comprehensively organized institute giving education and training and specialist courses. It may take decades to establish a fully competent conservation service. Special short-term measures may therefore be required, including the grafting of new initiatives onto existing programmes in order to lead to fully developed new programmes. National, regional and international exchange of teachers, experts and students should be encouraged. Regular evaluation of conservation training programmes by peers is a necessity.

RESOURCES

16. Resources needed for specialist courses may include e.g.:
    a) an adequate number of participants of required level ideally in the range of 15 to 25;
    b) a full-time co-ordinator with sufficient administrative support;
    c) instructors with sound theoretical knowledge and practical experience in conservation and teaching ability;
    d) fully equipped facilities including lecture space with audio-visual equipment, video, etc. studios, laboratories, workshops, seminar rooms, and staff offices;
    e) library and documentation centre providing reference collections, facilities for coordinating research, and access to computerized information networks;
    f) a range of monuments, ensembles and sites within a reasonable radius.

17. Conservation depends upon documentation adequate for understanding of monuments, ensembles or sites and their respective settings. Each country should have an institute for research and archive for recording its cultural heritage and all conservation works related thereto. The course should work within the archive responsibilities identified at the national level.

18. Funding for teaching fees and subsistence may need special arrangements for mid-career participants as they may already have personal responsibilities.

## References


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# The "O. Wagner Pavillon Test" and the "RecorDIM Initiative": Two actions to fit CIPA-HD's goals

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## 1. Introduction

One of CIPA-HD's main goal is encouraging and promoting the development of principles and good practices for recording, documentation, and information management of cultural heritage. During the first years, CIPA-HD's efforts were more devoted to the diffusion of photogrammetry as the best way to provide metric information about cultural heritage assets. The biannual Symposia and the promotion of books and other material were the ways that CIPA promoted knowledge to ease the use of photogrammetry for architectural objects.

The analytical development of photogrammetry, which started after the replication of the analogical approaches and the automatization of the photogrammetric triangulation – opened the possibility to use semi-metric and non-metric mages after a calibration process. By considering the real accuracies required in many cases for architectural surveys, the scientific community proposed many simplified plotting solutions, and CIPA made significant efforts to diffuse those methods inside the International Council on Monuments and Sites (ICOMOS) community. In the framework of these efforts, CIPA proposed an initiative to state the level of reachable accuracies by using non-photogrammetric cameras (see par. 2).

The introduction of the digital images as primary data in 1984, allowed, in the following years, the simplification of the plotting instruments and a significant reduction of the costs and of the manual skills required to manage a photogrammetric survey. This "digital revolution" gave an indisputable contribution to the diffusion of photogrammetry among the cultural heritage community.

This large diffusion of the digital photogrammetric techniques and the rapid growth of terrestrial LiDAR and aerial systems drove the CIPA community towards a new perspective, which suggested the integration of the CIPA's goals with a more extensive subject: the documentation of cultural heritage assets. Inside this new topic, the metric survey plays a fundamental role but it must be adapted (both in terms of accuracy and deliverables) to integrate other kinds of data that are useful to define the real conditions of a cultural heritage asset at specific time (building, urban centre, garden, natural landscape, etc.). The idea of the “documentation” can already be seen from the first statements contained in the various International Charters, but CIPA felt the need to better define the concept of the documentation by supporting a special project funded by Getty Conservation Institute (GCI) (see par. 3).

In the following paragraphs, the main results of the two cited initiatives managed by CIPA are briefly described as a testimony of the work done so far by the CIPA (now CIPA-HD) community.

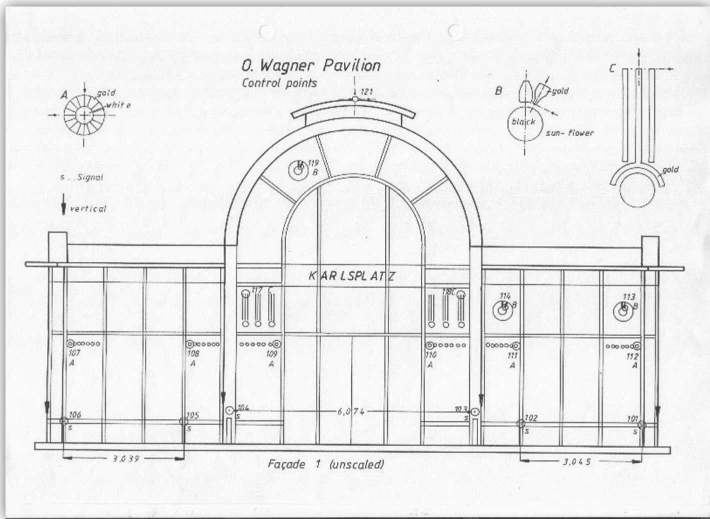
## 2. The "O. Wagner Pavillon" test

During the XIV International Symposium of CIPA, held in Delphi (Greece), CIPA launched an international test on the new potentialities offered by non-photogrammetric cameras (e.g. semi-metric and non-metric cameras of different formats) (Waldhäusl, 1991). The Technical University of Vienna, under the coordination of Peter Waldhäusl, built up the benchmark (Figures 1 and 2).



**Figure 1.** Semi-metric and amatorial images: amatorial Hasselblad camera (up), semimetric LEICA Elcovision camera (down).

The benchmark produced a set of images taken by using two different calibrated semi-metric cameras (medium and small format) and two non-metric cameras (one of medium format equipped with a calibration certificate and one of small format without any calibration), as well as a network of control points to allow for autonomous calibration, orientation, and check of reachable precision and accuracy (Figure 2).



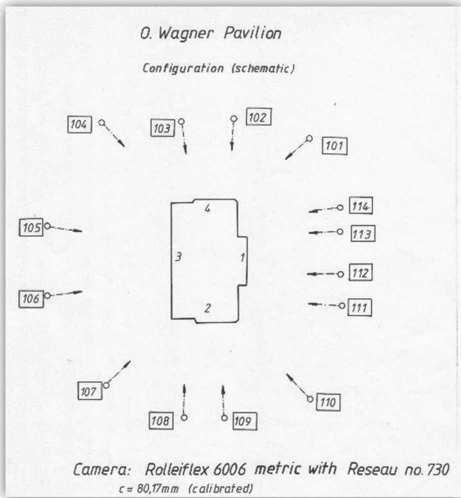




**Figure 2.** Provided metric information by 3D point's sketches and distances (up). Image acquisition scheme (down).

Twelve different research centers, from six different countries, provided the results of their elaborations and the Aristotle University of Thessaloniki, under the responsibility of Petros Patias, took care about the analysis of the results. Petros Patias and his collaborators analyzed the results from the participants and inferred that by assuming enough control, proper pre-calibration or careful self-calibration and proper photogrammetric procedure, adequate results for architectural use could be obtained (0.5 cm) even with small-format non-metric cameras. It must be noticed that all the images were taken by considering the traditional scheme of the photogrammetry (e.g. normal case) and by respecting the base/distance ratios recommended for correct photogrammetric applications. Finally, an experimental formula was proposed to predict the achievable precision by taking into consideration the basic properties of the used equipment.

By considering state of the art at those times, the test and the achieved results opened a rapid diffusion of the photogrammetric metric surveys to the ICOMOS community by reducing the use of metric cameras and by assuming, as a practical tool for image acquisition and control information, the proposed “CIPA 3x3 rules”.

Some of the participants also used the achieved results to start testing digital photogrammetry and Terrestrial Laser Scanner (TLS) technologies (Figure 3). In the following years, those techniques pushed a different approach of the metric survey: from the manual selection of the needed points to build up a 3D model


**Figure 3.** The first architectural true-orthophoto generated by using the "Otto Wagner Pavillon" test material integrated with first point-clouds surveyed by Terrestrial Laser Scanning systems (Boccardo et all, 2001).

toward the automatic acquisition of irregular point clouds and the consequent segmentation and modelling phases that today represent the standard approach in a 3D architectural metric survey.

## 3. The RecorDIM initiative

During the XVIII CIPA Symposium (Postdam – Germany, 2001) Robin Letellier reported about an initiative developed in the previous five years: the CIPA "5-Year outreach Workshops" Program (Letellier, 2001). Three outreach workshops took place (Austria 1996, Sweden 1997, and Brazil 1999): those meetings brought CIPA to reflect on its activities, to question its operations, and to work towards re-structuring itself with a new framework of activities. This activity represented a forum for metric surveyors (the information providers) and conservation specialists (the information users) to discuss and integrate recording, documentation, and information management principles and practices to cultural heritage conservation activities. In other words, CIPA wanted to push the research of metric survey techniques towards a real satisfaction of users' needs. In this framework, the concept "Bridging the Gap" was developed in concert with the GCI during the year 2000, to assist CIPA with increasing "information users" participation to CIPA's activities.

During the same CIPA Symposium, François Le Blanc and Christopher Gray (GCI) expressed the interest of their organization to work – in partnership with ICOMOS and CIPA – on a five-year initiative to identify and define the gaps between the information users and providers, and to support CIPA in its efforts to find partners that will take on the task (Le Blanc, 2001). The initiative was entitled "Recording Documentation and Information Management (RecorDIM)." Robin Letellier and Bill Blake were appointed as International Coordinators of the initiative, and the partners were represented by François Le Blanc and Rand Eppich (GCI), Peter Waldhäusl (CIPA-HD), and Giora Solar (ICOMOS). Round-table discussions and partner meetings were organized to define the gaps between information users and providers, and guidelines were published for heritage recording, documentation and information management.

Those meetings took place in Los Angeles, Wien, Leuven, Paris, Istanbul, and Turin jointly to CIPA Symposia, ICOMOS General Assemblies, and other meetings to ease the participation of different stakeholders. Sixteen Task Groups worked actively to discuss the problems, to underline possible solutions, and to produce final reports. Beside internal reports of the activities (e.g. partners meetings, round-tables, etc.) some major products were realized and published.

The two-volume *Recording, Documentation, and Information Management for the Conservation of Heritage Places*, with an international focus, was published by the GCI in 2007. *Guiding Principles (vol. 1)*, is directed toward heritage managers and stresses the importance of documentation. It discusses the basic documentation

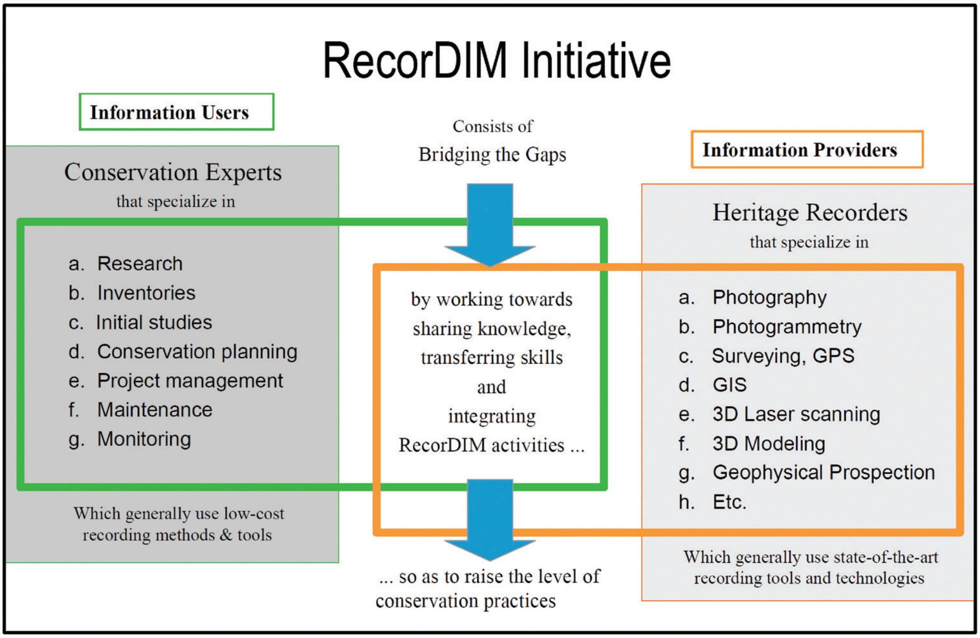



**Figure 4.** Long-term purpose and objectives of the RecorDIM Initiative.

principles and approaches. *Illustrated Examples (vol. 2)*, is a series of eighteen short case studies on successful projects around the world where documentation was crucial to the conservation.

The third volume, *Metric Survey for Heritage Documentation*, presents a practical guide that teaches basic metric survey skills for conservation activities. English Heritage continued to upgrade and publish this last outcome, eventually expanding the experience by publishing handbooks on most of the techniques. Those publications are now accessible through Historic England website and are periodically updated as technology develops. The fourth publication, *A Guide to the Use of Geographic Information Systems (GIS) at Cultural Heritage Sites,* is directed toward expert users of GIS software. A fifth report, *Guide to Creating Inventories of Cultural Heritage Places for India*, was printed on a limited basis and made available in India.

Conservation education concerning documentation was accomplished with a series of four courses in partnership with the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), which were held between 2003 and 2009. These courses, named “ARIS: Architectural Records, Inventories and Information Systems for Conservation”, trained 59 mid-career

**Figure 5.** Participants to the RecorDIM partners meeting in Leuven (2004).

professionals from over 46 countries and involved over 29 instructors from over 18 countries. Support in the form staff time was also given to existing educational institutions under this project from 2004 to 2010: Raymond Lemaire International Center for Conservation at the Katholieke Universiteit Leuven, University of Pennsylvania School of Design, Politecnico di Torino, the UCLA/Getty Master's Program on the Conservation of Ethnographic and Archaeological Materials, and the UNESCO World Heritage Center.

## 4. Final remarks

The described activities show the efforts made during the years by the CIPA-HD members to update structures and goals by considering technological advances in the evolution of conservation strategies. Cultural heritage documentation is not a self-defined discipline but a common effort of different skilled experts who are pushed to work together at an interdisciplinary level. To obtain the maximum possible results in this effort requires that the main experts in all the disciplines involved in the documentation can share their ideas and perspectives.

CIPA has shown in the past that it can promote and support interesting initiatives that enable significant progress to be made in the development of documentation for the World's cultural heritage.

All this was possible thanks to the competence and generosity always demonstrated by those who actively worked to achieve this aim.


**Figure 6.** RecorDIM deliverables: the three handbooks and the leaflet of the ARIS Course in 2009.

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Historic England:
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