

SUMMARY REPORT ON THE SYMPOSIUM

From July 4 to 6, 1968, the International Council of Monuments and Sites (ICOMOS) held a symposium on the application of photogrammetry to historical monuments at the French Institut Géographique National in St. Mandé.

On the invitation of ICOMOS, a group of twelve experts - eleven of whom had been requested to read papers - met together for a critical examination of the contribution of photogrammetry to the architect's work, with more special reference to work in connection with historical monuments. The President (Professor Piero Gazzola) and the Secretary-General (Professor Raymond Lemaire) presided as organizers and hosts, and the meeting was attended by representatives of UNESCO, of the International Centre for the Study of the Preservation and the Restoration of Cultural Property, the International Union of Architects, the International Union of Official Tourist Agencies and the International Society for Photogrammetry, as well as by observers from the Tunisian and Swedish national committees of ICOMOS, and several French photogrammetrists who, together with representatives of the French Ministry for Cultural Affairs, had also come as observers. In all about forty people were present.

Two days (July 4 and 5) were devoted to discussions, which were chaired by Professor R. Chevallier, representing the International Society for Photogrammetry. The procedure adopted by ICOMOS, which consists in bringing together a small group of experts to study a given subject, with each member of the group responsible for reporting on a specific aspect of that subject, works extremely well (The observers, while not themselves reading papers, take part in the discussion). The problems can thus be given a thorough examination, ample time can be devoted to discussion, and conclusions can be reached. It should be added that in this case the presence at the same conference of photogrammetry experts and experts on historical monuments was a factor which facilitated the exchange of ideas and favoured the progress of work on "architectural photogrammetry".

The actual purpose of the meeting was to define the requirements of the architect at the present time and to attempt, in the light of these requirements, to discover the orientation to be given to photogrammetric methods as applied to architecture, and more particularly as applied to historic monuments. However, it was necessary to start by giving a summary of the situation as it stood and to draw up a list of the positive and negative results achieved; this was the subject of the introductory report presented by Mr. M. Carbonnell (France) [1], at the first of the working sessions, following President Gazzola's opening speech and an address of welcome by Mr. Georges Laclavère, Director of the Institut Géographique National, who stressed the enormous extent to which his own Institute was also interested in architectural photogrammetry.

Though the use of photogrammetry for architectural surveys was as old as the technique itself, which originated in the middle of the 19th Century, it did not become a regular practice, said Mr. Carbonnell, till the Second World War, except in Germany, at the Messbildanstalt founded in 1885 by Albrecht Meydenbauer. Interesting work had been done in a number of countries, but it had been of a sporadic and individual character; however, such work helped the method to progress and gradually the system of hand-drawn lines enabling a series of points to be obtained from the plates had been replaced by stereophotogrammetry, so that now a highly accurate unbroken drawing of the basic architectural forms of a building could be obtained and non-geometric surfaces could be objectively represented. This progress could be read about in the minutes of the successive congresses of the International Society for Photogrammetry (in the proceedings of the Sub-Committee on Architecture), at which Eduard Dolezal had ceaselessly urged that a "crusade" be undertaken for the building-up of international stereophotogrammetric archives on historical monuments. Gradually the hand-drawn line system based on the use of intersections had come to lose its advocates.

Modern methods consisted in rectification in the case of plane surfaces, or stereophotogrammetric plotting from pairs of plates, and with the introduction of analytical photogrammetry their potentialities could now be still further increased. These methods had been widely tried out, and for several years now had been in regular use in certain countries, more particularly in Central Europe. World statistics showed the very considerable extent to which their use had increased and in the light of these figures a synthesis could be made of the principal types of survey, i.e. general surveys of individual monuments; surveys of architectural features with a view to restoration or to a particular study; surveys of an archaeological nature; systematic surveys of façades in ancient quarters of towns or villages where complete streets or squares required to be covered.

These four types of survey had a significance when examined statistically (the relative frequency of each varying from country to country); they together answered a three-fold need which was the study, the conservation and the enhancement of historical monuments.

Surveys can, however, also be classified according to the degree of accuracy demanded. Mr. J. P. Paquet (France) [2], who has long been an advocate of architectural photogrammetry, approached the problem on the economic level and sought to introduce into the practice adopted for the use of stereograms a "reasonable degree" of approximation, leading in some cases to a "widening of tolerances"; he distinguished the diagrammatic type of drawing, the approximate drawing, the "expressive" drawing (giving a general impression rather than an accurate reproduction), and the accurate drawing. This last was full-scale and must be obtained by stereo-plotting; the approximate drawing and the "expressive" drawing, on the contrary, were on a scale of less than 1:100 and could be obtained from photographs by rectification, or even by hand-drawn lines and simple calculations, on the basis of certain assumptions. This final point was strongly contested by those present, particularly on the level of objectivity and economy; however, it was said in conclusion that - assuming that it remained an absolute rule for stereophotograms to be systematically recorded with photogrammetric cameras and that they were subsequently made available for miscellaneous uses - extremely simple methods could be used in the case of surveys made for the purpose of a "preliminary and superficial examination of the problems", or the obtention of a drawing primarily intended to give a "very true impression of the aesthetic quality of a building".

The attempt to find a system for classifying surveys which could serve as the basis for a chart covering the requirements of the architect specializing in the conservation of historical monuments was the main business of this first part of the symposium. From the discussion which followed Mr. Paquet's paper there emerged an initial approach to such a classification. Three headings for the different types of survey were suggested, i.e. summary surveys (tolerance 5%), taken on ancient towns with a view to their renovation and revival; detailed surveys (tolerance 1 to 2%) as a preliminary to restoration schemes; "absolutely" accurate surveys enabling the progressive distortions in a building to be perceived and their development followed up. A fourth category was added, covering surveys to be used for the making of inventories; these would be diagrams, or rapid drawings to as high a degree of accuracy as possible. More detailed conclusions were later worked out in the course of the discussion, resulting in the classification to be found in the chart appended to this report. At the same time, an alteration was introduced into the notion of the accu-

racy of an architectural survey, which is generally expressed in terms of the relative accuracy of lengths; allowance was now made for the actual nature of a stereophotogrammetric survey, in the case of which it is truer to speak of absolute accuracy in terms of the position of each feature plotted, the degrees of relative error on the lengths varying very considerably according as these are great or small.

The scientific study of monuments and the history of architecture from the technical point of view, which are now considered as an essential part of a knowledge of art, demand "scientifically correct surveys ensuring that every part of the building has been measured with the strictest accuracy". In connection with this requirement Professor R. de Vita (Italy) [3], drew the conclusion that the requisite scientific survey, complete, accurate and necessarily detailed, could not be obtained at minimum cost by any other means than photogrammetry; photogrammetry offered "a new way of acquiring a thorough perception of the architectural forms of a building, by means of data described with graphic precision instead of being merely sketched or reported on". The making of such surveys must be extended to cover every monument from ancient times to the present day, in every country. The Institute of Architecture of Bari University had embarked on this task for the monuments of Apulia.

In the report presented by Mr. A. J. Donzet (France) [4], the same stress was laid on the need for stricter accuracy. ("We must get ever closer to the reality of each structure, of each form, of each surface texture"). He also gave a very full picture of the requirements of architects working in the field of historical monuments, which he divided into three main groups, as follows :-

- 1 Restoration and conservation of monuments : Archaeological excavations; execution of surveys and controls in the case of any operation involving disassembly and reassembly; problems of "survival", sometimes involving the partial reconstruction of a monument; consolidation work, the plans for which necessitate a highly accurate knowledge of the distortions which have occurred; study of changes in volume, both in the structures and in the materials themselves; surveys of volumes not accessible for measurement; calculation of cubic content; official recognition of damage, inspection of conservation work; surveys of sculptures, decoration, and any other areas of the walls whose value "is derived from the elusive arrangement of curved forms" (including, in particular, wall-paintings). Mr Donzet held the use of photogrammetry to be absolutely essential in each of these connections,

Analysis and care of ancient towns : These required aerial photographic coverage, and a contour map of the urban area must be made, as well as outline drawings and typical cross-sections; all the buildings must also be drawn in complete series, street by street. For these latter surveys a progressive use of the photographs might be envisaged: they could be interpreted, rectified and assembled, or partially or completely plotted; but at the outset the whole sector would require stereoscopic coverage. Lastly, where any new building was envisaged in an ancient quarter of a town its future outlines must be drawn in, by "inverse photogrammetry", on photographs taken from several different camera stations.

Protection and improvement of rural sites : Discovery of areas in which buildings could be hidden from view; fitting of new buildings or civil engineering structures into the existent landscape.

Architects were thus now resorting to photogrammetry - using either aerial or ground-level photographs - in every branch of their activity in connection with the restoration of monuments and the study of urban and rural sites. In these different spheres a very considerable amount of research remained to be done, as well as a great deal of adaptation to suit equipment and methods. The field was an enormous and a most exciting one.

Even if it is to cover no more than the requirements arousing out of day-to-day conservation work it is already a very vast field, and Mr. M. Jirinec (Czechoslovakia) drew a picture of it in his report [5], taking as his illustration the instructions drawn up by the State Institute for the Protection of Historic Monuments and of the Countryside (Prague); these covered surveys of monuments, archaeological research, surveys of façades along the, whole side of a street, and the acquisition of full data on the outside and inside of all buildings in the case of certain historic sites in towns. An attempt was always made to achieve the best possible combination of topometric and photogrammetric methods. Mr. Jirinec considered that in many cases the ideal guide for architects, art historians, designers of renovation schemes and town-planners consisted in an assembly of rectified photographs.

In view of the extreme diversity of the various requirements, it may be wondered whether it is conceivable for a single photogrammetric photograph to be used in all the different ways appropriate to all the separate cases, and it was the duty of the symposium to examine this problem. The architectural and conservation specialists hoped that it was, while the photogrammetrists were more hesitant, and stated that, for

technical reasons, the scale of the photograph to be taken and its degree of accuracy must depend on those of the survey to be obtained from it, and even in some cases on the nature of the monument or site. Another question was : what, precisely, is to be photographed? Are the plates to serve purely as a basis for all and any overall surveys of the monument, or are they to serve at the same time for accurate and detailed surveys of all its architectural features taken singly? Obviously one or the other type of plate must be chosen, and it was well that this fact should be stated.

It is almost impracticable to obtain complete photogrammetric archives covering the very minutest detail when the subject is a major building. Defining the specific purpose of a survey is certainly one of the most important of the tasks over which architects and photogrammetrists must help one another.

The need to define the manner in which they were to be obtained did nothing, however, to decrease the importance of the architectural photogrammetric archives themselves; this was the opinion very strongly expressed by Mr. R. W. McDowall (Great Britain) [6]. It was now admitted, he said, that ancient buildings should not be altered as they used to be during the past centuries; they should be preserved in as unaltered a state as possible and consolidated and faithfully restored if necessary. However, one could restore something only when one knew exactly what it had been like before it was damaged or destroyed. The building-up of photogrammetric archives provided the means of obtaining the necessary data as rapidly and as fully as possible, while there was still time.

There was no longer time, said Professor C. Erder (Turkey) for many monuments condemned to disappear owing to the construction of dams and other civil engineering works [7]. However, it was not too late to take action in the case of the numerous Byzantine, Seljukian and Ottoman monuments and the fifty-two prehistoric tells endangered by the building of the Keban Dam, on the Upper Euphrates. (Here the lecturer showed some admirable slides which rapidly convinced his audience). At the Middle East Technical University in Ankara, the Department for the Restoration of Historical Monuments was making every effort to promote the use of photogrammetry, the very short time now remaining leaving no possibility of any other arrangement for preserving an accurate memory, at least, of the monuments in jeopardy. "Photogrammetry", said Professor Erder, "presents the possibility of being able to confront modern technologies of destruction with the equally efficient modern technique of recording, specially appropriate to the difficulties of developing countries".

These, then, were the requirements of architects and of those working on the conservation of historical monuments, as listed by ICOMOS during the first part of the symposium. In the course of the discussion numerous answers to the various questions raised were given by the photogrammetrists present, and these answers were developed in greater detail during the second part of the proceedings.

Where, by good fortune, photogrammetric archives exist, it was said, they must be usable; it would be ridiculous if archives dating from the past were to be rendered unusable owing to later developments which altered photogrammetric equipment - in fact, this would be a negation of their very reason for existing. The problem existed at the present time in the German Democratic Republic, in the case of Meydenbauer's plates at the Messbildanstalt. It could, however, be solved by the use of analytical methods in which the old-fashioned hand drawings providing a series of points were replaced by measurements made with a comparator and processed by electronic computer. The principle remained exactly the same, though the processing of the data contained in the plates was now effected by more rapid and up-to-date methods requiring a smaller number of staff. The paper to have been read by Mr. R. Meyer [8] - which was summarized in his absence by Mr. Carbonnell - stressed that hand-drawn lines traced out in the traditional manner must, if they were to provide a large number of points, "involve so large an amount of dull manual work that there would be little hope these days of finding assistants prepared to do it".

Following the next report [9], prepared by Dr. H. Foramitti (Austria), and the information provided in the course of the discussion on it, it was found possible to draw up, side by side with the chart covering the different types of survey, a second chart showing the potentialities of photogrammetric methods. The distinction suggested by the agenda of the meeting between surveys of major buildings and miscellaneous surveys of a more everyday type was shown to be a correct one; neither the photographic and plotting equipment, nor the control measurements, nor the difficulties involved in the obtention of a drawing to a given standard of accuracy, nor the cost of the work, could be absolutely identical in the two cases. For "ordinary day-to-day" work, Mr. Foramitti's procedure - the basic principles of which were already familiar to his audience - was unanimously approved; he systematically adopts "normal case" methods, with the axes horizontal, vertical or inclined on the reference plane at a given angle (30 or 70 grades) and uses wide-angle cameras with focal length of lengths 60 mm., using double and single cameras either separately or in conjunction with one another; he effects control measurements on lengths only, and has plotting equipment simple in design and easy to use. For surveys of whole series of façades, walls,

and flat or vaulted ceilings, for the detection of damage or distortions, and for the compilation of archives with a view to the making of an inventory - in short, for all the day-to-day tasks of the architect working on conservation - this procedure was held to provide a rapid and economical means of fulfilling all the requirements involved, provided that the building or architectural forms to be surveyed were not too large. In this latter case there was no avoiding the use of larger plates, and a topometrical network was essential for the purpose of providing liaison between all the various features of the building, as was the use of plotting equipment of a more universal type; all of this necessarily involved the aid of more highly specialised photogrammetry technicians. However, the discussion was to emphasize most strongly the need for increased collaboration between these technicians and the architects.

The chart which will be found appended was originally drawn on a blackboard in the course of an extremely animated discussion while the symposium was in progress, and was subsequently worked out in detail by Dr. Foramitti and Mr. Carbonnell. It represents an attempt to find scales for indexing the cost of the work effected both directly on the building (for the building-up of the archives) and in the workshop (where the finished photographic, line-drawing or numerical surveys are made), and also the cost of the different pieces of equipment used. Accuracy is visibly an expensive thing, though its cost varies very considerably with size, accessibility of the parts to be surveyed, and the purpose of the survey.

The interest attaching to one of these possible purposes was fully brought out in the paper read by Professor Gomoliszewski (Poland), who took as his illustration the baroque church of St. Anne in Cracow [10]. Here the object of the survey was the discovery and measurement of any "refinements" or optical corrections deliberately introduced into the original plans for the building in order to obtain a more aesthetically satisfying visual impression. Such a piece of research would have been impossible without a means of determining the true shape of the parts concerned, with a tolerance of about ± 1 cm. on uniformity.

Another use to which photogrammetry can be put is the measurement of deformations in architecture. Professor P.E. Borchers (U.S.A.) uses a differential method consisting in the adoption of a stereocomparator to measure the movement of image-points on two plates taken at dates separated by a certain lapse of time from identical camera-stations and with identical camera-axis orientation, and then calculating the structural movement of the building, with all due allowance made for possible causes of error [11]. This method is suited

to highly accurate surveys for the purpose of the minute study of the development of slight deformations, and provides an example of one way in which photogrammetry can serve the architect. In his paper Professor Borchers also dealt with two other possible uses of photogrammetry, one of which was the restoration of the original appearance of a monument through the examination of stereoscopic photographs, and the other the reproduction on flat surfaces of mosaics or wall-paintings originally executed on a surface forming a quarter of a sphere.

In one of the neighbouring rooms an exhibition was on view illustrating the work of the Institut Géographique National, the Société Française de Stéréotopographie and the Vienna Bundesdenkmalamt. At the close of the second day two short films in helivision were shown, followed by "Nubie 64", the I.G.N. film on the work of salvaging the Nubian temples of Egypt. On the first evening a reception was given in St. Mandé by the Director of the I.G.N.

Except for an interruption for a lunch given by ICOMOS, the whole of July 6 was devoted to a tour of certain Paris buildings of which photogrammetric surveys had been made, in the company of qualified commentators. Those attending the symposium were thus taken to the Hôtel des Invalides (the southern façade of which has been surveyed), the Sainte-Chapelle (rose window, vaulted ceiling, and one wall), and the "Marais" district (Places des Vosges and Hôtel Lamoignon); as the comments and explanations were by eminent specialists - Messrs. Paquet, Sonnier and Minost - the visits were particularly worthwhile. At the end of the afternoon a closing session was held at the Hôtel de Sully, and the following recommendations to the Executive Council of ICOMOS were adopted :-

The systematic creation of an archive of photogrammetric records of monuments, as an essential part of an inventory for their protection;

Improved collaboration between photogrammetry technicians, architects, archaeologists and art historians;

The creation of a joint committee composed of representatives of ICOMOS and of the International Society for Photogrammetry; Action on the part of the ICOMOS National Committees to inform both students and the official departments in charge of the protection of the nation's cultural heritage of the potentialities of photogrammetry;

The creation of an international centre of architectural photogrammetry to carry out research, train technicians and perform practical work;

The inclusion of an architectural and archaeological photogrammetry section in the future ICOMOS Documentation Centre in Paris.

Wider use of all methods of photographic recording and development of the appropriate equipment;

The holding of a symposium in the near future on the importance of aerial photography for the integration of photogrammetrical surveys of monuments into the surroundings of the latter and for the establishment of schemes for the preservation of whole sites.

List of papers read at the symposium.

1. M. Carbonnell, "History of the application of photogrammetry to architecture and present position in the matter".

J. P. Paquet, "General view of the possible uses of photogrammetry in the different fields of architectural theory and practice. Potentialities and inadequacies".
3. R. de Vita, "Present-day requirements arising out of the scientific study of monuments and the history of architecture on the technical level. Usefulness of photogrammetric survey methods".
4. A. J. Donzet, "The architect's requirements in connection with the restoration of monuments and the analysis of urban and rural sites".
5. M. Jirinec, "Contribution of photogrammetry to the day-to-day work of conservation".
6. R. W. McDowall, "The Importance of photogrammetric archives of monuments and works of art".
7. C. Erder, "The rôle of photogrammetry in surveys of works of art endangered by extensive public works".
8. R. Meyer, "Modern methods of exploiting architectural photogrammetric archives made in the past".
9. H. Foramitti, "Experiments in the use of photogrammetry for ordinary tasks in connection with historical monuments".
10. J. Gomoliszewski, "Possibilities and usefulness of a complete survey of the actual form of a building with all its irregularities".
1. P. E. Borchers, "Photogrammetric methods of measuring deformations in architecture".

DIFFERENT TYPES OF SURVEY USED FOR THE STUDY, CON- SERVATION FOR ENHANCEMENT OF HISTORICAL MONUMENTS		POTENTIALITIES OF THE VARIOUS PHOTOGRAMMETRIC METHODS				
Type of Survey	Maximum Tolerances	Recording of Data- Plates (2) and Control Measurements	Invest- ment Index (6)	Plotting (on the building) (7)	Exploitation of data (for preparation of photographic, Invest- ment Index (6)	Plotting (in the plotting room (7)
1) Simple and rapid surveys made with a view to expressing the general character of buildings (including summary surveys of whole rows of façades), for the purpose of preparing first drafts of restoration projects, preliminary studies, etc.	5 % on main dimen- sions or 10-20 cm. absolute error	Photographic method and equipment: single or double cameras on fixed stand. Small size plates (6.5x9 to 9x12) Short focal length of lens (50-70 mm.) Type of photograph: - Isolated photograph..... Non-steroscopic photograph..... Stereoscopic photograph (preferably normal case (3))..... Control measurements Checking of horizontal and vertical directions (4) + measurement of lengths only.	1	1	Finished survey obtained by line drawing Optical rectification by sketchmaster Photographical rectification Photoplans Line-drawing method Stereo-plotting with simplified apparatus	0,5 0,2 10 10 10-20 10-20 1 5-15 10
(2) Detailed and accurate surveys made with a view to restoration work, enhancement, or the study of the exact outlines of a building (1) a) All ordinary surveys of monu- ments, architectural features taken singly, rows of façades in ancient quarters of towns, not including overall surveys of large buildings or very large single architectural features.	0,5 tot 2% on main dimensions or a few cm. absolute error	Photographic method and equipment: Equipment as under (1) above, or larger cameras of simple design. Type of photograph:- Isolated photograph..... Stereoscopic photograph (preferably normal case (3))..... Control measurements, Simplified topometrical measurements, Checking of horizontal and vertical directions (4)	1-3	1,5 - 3	Photographical rectification Photoplans Line-drawing method Stereo-plotting, preferably with simplified apparatus	10 10 10 1-2 10-20 10-20 10-15
b) Surveys of large buildings and large single architectu- ral features	Ditto	Photographic method and equipment: wide- angle single cameras (plate sizes 10 x 15 to 24 x 24, focal length of lens 100 - 150 mm.) + cameras with focal length of lens 300 to 600 mm (5) Type of photograph: stereoscopic Control measurements Topometrical network	5-10	4-10	Stereo-plotting, using first- class equipment Analytical plotting of a very large number of points, using a stereocomparator and a computer (measurement and computation of points, involving execution of a complete drawing) Possible use of orthophotography (to be examined further)	20-35 to 35 30 60 20-25 10 10 10-20 (9)
c) Surveys of an archaeological nature	Ditto	For visible features see under a) and..... b) above For features not visible, new methods..... of recording still to be worked out For overall surveys of large sites, aerial photography	1-10 - 150	1,5 - 10 - (8)	See under a) and b) Research to be continued; serious need for further research to be undertaken Aerial stereo-plotting	10-35 - 10-35 1-40 - (8)
(3) Highly accurate surveys made for the purpose of a minute study of the progress of slight distortions	1mm. to a few mm.	See under 2b) above; maximum accuracy required. Differential photographs	5	10	Numerical or analytical plotting	- -
(4) Surveys of polished surfaces, including, in particular, sculptures (surface texture), where maximum accuracy is required	0,1 mm. to a few tenths of a mm.	Equipment not yet in existence	-	-	Methods and equipment to be devised	

- For the purpose of such studies, the survey must be as homogeneous as possible.
- All photographs referred to on this chart are necessarily taken with photogrammetric cameras
- "Normal case" means that axes are parallel and perpendicular to the base line
- With precision levels.
- In certain cases it is preferable to use pairs of cameras
- Index of cost of equipment is based on 1 = cost of one single small-size photogrammetric camera. The specifications regarding equipment are given in the light of the data supplied at the XIth International Congress of Photogrammetry (Lausanne, July 8-20, 1968).

- These indices relative and are independent of the investment index. The basis is the same for plotting on the building and in the plotting room.
- This figure varies greatly according to the size of the site and its position.
- It would appear that the use of orthophotography may be envisaged only in the case of architectural features not involving too much discontinuity. In view of its high cost, orthophotography is certainly of no interest where the ultimate aim is to obtain a complete line-drawing.
- This figure varies greatly according to the number of measurements to be taken.