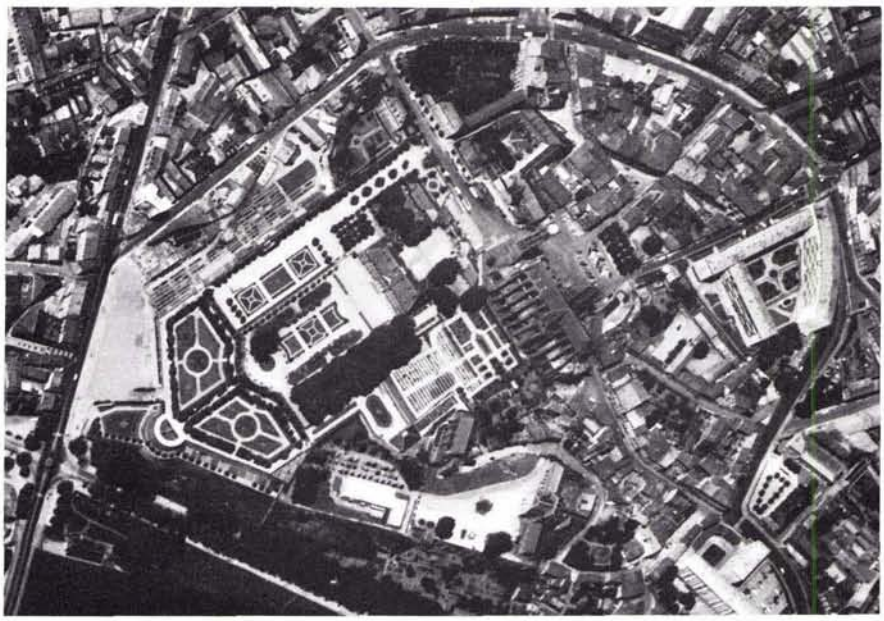

FIG. 1 and 2. A portion of an aerial photograph, located 9 cm from the centers of the photograph from which it was taken. Taken with a lens of 152 mm focal length. Limoges, city area near cathedral. *(South at the top).*

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Historic Center Conservation*

Aerial photogrammetry contributes to the study of important architectural features.

(Abstract on page 1060)

MONSIEUR FRANCOIS SORLIN, Inspecteur Général des monuments historiques, has given the following definition: "An historic center is a term describing those groups of buildings that, due to their homogeneity and historical, archeological, artistic or picturesque interest, have the necessary characteristics to justify their restoration and conservation." Consequently, the term can be applied to a town or, more often, the old sector of a town, a village, a fortified group of buildings, a group of monastic buildings, etc. Their study, conservation and protection requires the following three types of documents:

- Detailed surveys of especially historic buildings if they exist in the center, together with groups of facades on squares and streets, as well as surveys of interiors at a later date, if there are plans to reactivate the sector by modernizing internal arrangements.
- Documents for *overall analysis* of the center, including its historical, town planning and architectural aspects.
- Special surveys for studying the integration of new buildings within the center or, more generally, for studying any transformation of the center or its surroundings.

Photogrammetry can often be of considerable value in preparing these documents.

* Presented to the Congress of the Society of Architectural Historians, Cambridge, August 1973 under the title, "The Contribution of Photogrammetry to the Study and Conservation of Historic Centers".

The detailed surveys are the domain of architectural photogrammetry, which is a well documented discipline. This paper, therefore, concentrates on possible uses of photogrammetry for the overall analysis and the protection of historic centers.

THE BASIC documents for the *Overall Analysis* are aerial photographs: oblique photographs, taken at various altitudes and angles, and more especially stereoscopic vertical photographs. At average scales (1:10,000 to 1:20,000), the latter can be used for studies of the adaptation of the historic center to the site, of old structures which have been conserved or appear beneath more recent structures, of historical evolution and the links between the center and new peripheral sectors. At large scales (1:2,000 to 1:5,000) the vertical aerial photographs allow more detailed studies, e.g., of the form and structure of roofs, the nature of their covering, periods of construction, street systems and traffic, etc., which require techniques of photo-interpretation.

The photographic images are radically deformed by ground relief, if present, but more especially by the vertical dimensions of the buildings. For the same format and photographic scale, these deformations increase as the focal length is shortened or the field of view is widened. On the other hand, the deformations become less if one takes the photographs at a high altitude with very-long focal length cameras, which is what the Institut Géographique National (IGN) has undertaken with its Jet-Falcon Mystere 20 high-altitude aircraft equipped with a 610-mm focal length Carl Zeiss RMK A 60/23 camera*. Figures 1 and 2 are sections taken from 23 × 23 cm format aerial photographs, the first with a 150-mm focal length wide-angle camera and the second with a 610-mm focal length camera. The two sections were located at approximately the same distance (9 cm) from the centers of the photographs. The first shows noticeable perspective deformations, whereas the second is practically equivalent to an orthogonal projection (Limoges, Cathedral area).

HOWEVER, the interpretation of stereoscopic aerial photographs, although the first important phase of an overall analysis, is not sufficient. Precise graphic documents must be prepared using the same photographs and stereophotogrammetric procedures.

The first graphic document, the most generally compiled, is a map of the historic center; e.g., a general map with the urban or rural surroundings at about 1:5,000, or a more detailed map at a larger scale such as 1:2,000, 1:1,000, 1:500 and even 1:250 or 1:200. The relief is shown in the open areas by contours: in the built-up areas, however, generally a network of spot heights along the streets is preferred. At a very-large scale one can also show on the map the heights of the roofs at their different levels and even the chimneys; such a document can, in principle, be the basis for all possible studies.

However, the practical use of such a map showing heights numerically is not easy, especially if it concerns a large historic center. In particular, long and difficult procedures are required if, as is obligatory, one is concerned with the volume of the historic center.

Architects responsible for the conservation and development of urban sites have sometimes found it useful to adopt the normal plan-section-elevation representation used for individual buildings to express the volume of an historic sector or even an entire

ABSTRACT: *Aerial photogrammetry can be used for the overall analysis and protection of historic centers. Besides general maps, the drawings produced by means of photogrammetry include sections and elevations expressing the volume of the historic center and special axonometric views. Examples are shown for the towns of Thiers and Cahors in France. As these drawings have accurate geometric qualities it is easy to add the drawings of proposed new buildings, in either orthographic or perspective projection, and so study their integration into the historic setting in order to consider the protection of that setting. It is also possible to conduct preventive studies to determine maximum building heights so that no discordant new building will be visible from a protected zone, such as the banks of the River Seine in the center of Paris.*

* Orthophotography, which is very useful in terrain and other studies, has little application here because it does not correct the perspective deformation of buildings.

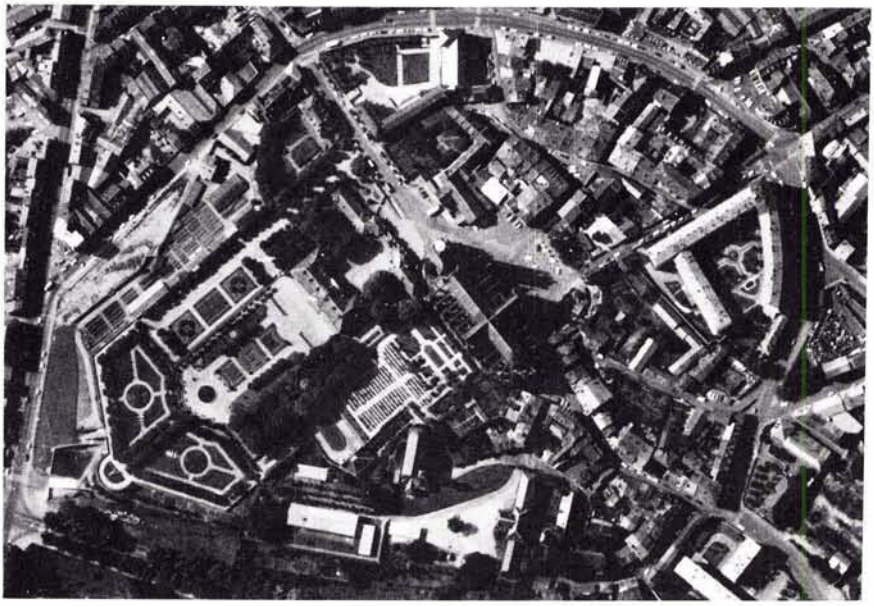

FIG. 2. Similar to Figure 1 except that the photograph was taken with a 610-mm lens. *(South at the top).*

town. This concept, proposed by architect and town planner, M. Bertrand de Tourtier, was used for the first time for the town of Thiers, that he was then studying, and the technical operations were conducted by the IGN Architectural and Archeological Photogrammetry Group. The sections are easily obtained by stereo-plotting of the aerial photographs and all types of variations in choice of section are possible, e.g., a section along a ground undulation, or one defined by streets or even a straight line. The elevations can sometimes be obtained by terrestrial photogrammetry if the historic center can be photographed from the exterior. However, such situations are exceptional and one can never completely avoid some buildings being concealed by others. The most general and complete solution is, again, to plot from aerial photographs.

THE STEREOSCOPIC model produced by a plotting instrument can be explored by the operator in the three dimensions, *X Y Z*, and the required elevation of the block of buildings—the *geometral* of French architectural terminology—is nothing but the projection of the stereomodel on a vertical plane. For analog plotting, one needs special aerial photographs with their flight axes oriented in the directions of the chosen projection planes, or perpendicular to them, and during the plotting the latter must be approximately parallel to the *XZ* or the *YZ* vertical planes of the instrument. The controls of the instrument are consequently modified by interchanging of *Y* and *Z* or *X* and *Z*, and although the operator follows with his floating mark the vertical outline of all the different elements of the volume of the buildings, the required elevation is produced on the plotter tracing table.

The resulting document is a reduced-scale drawing which the architect can afterwards complete and improve as required. He can also, like M. de Tourtier, combine the sections and elevations and later add, because of the geometric accuracy of the plotting, the projection of all proposed new developments such as roads or blocks of offices and flats.

The first undertaking of this kind, as mentioned, was completed for the town of Thiers in the central region of France. Figures 3 to 8 illustrate a succession of cartographic products.

The site of Thiers is hilly, so the results are rather striking. The experiment was tried again with similar success for the town of Moulins which, however, has only a low relief, but the *geometraux* (flat elevations) are nonetheless of great interest. As shown in Figure 9, they present a life-like image (which is also geometrically accurate) of the tier-like structure of the various buildings and of the distribution of the blocks of structures. More recently, at the request of another French architect and town planner, M. Bernard Fonquernie, the elevations of the entire town of Cahors, enclosed in a meander of the River Lot, were also produced. The same

FIG. 3. City of Thiers. Aerial photograph. In line drawing, the sections and planes of reference of the *geometraux* or elevations of the ensemble. *(North at top).*

procedures were also used for an overall survey of the famous historic center of the Athenian Acropolis and its buildings, which UNESCO entrusted to the IGN.

WITH THE AIM of extending to *blocks of buildings* the coverage by various drawings usually made for *individual* historic *buildings*, it seemed equally interesting to prepare photogrammetrically-produced perspective views of them, particularly axonometric perspective views which are perfectly suited because of their conservation of true scale in the three coordinate directions. This experiment, undertaken at the request of M. Fonquernie, was conducted by the IGN for the town of Cahors using aerial photographs. An analog process was used, the Y and Z outputs of the plotter being joined together by a differential which controls the displacement of the tracer on the table in one

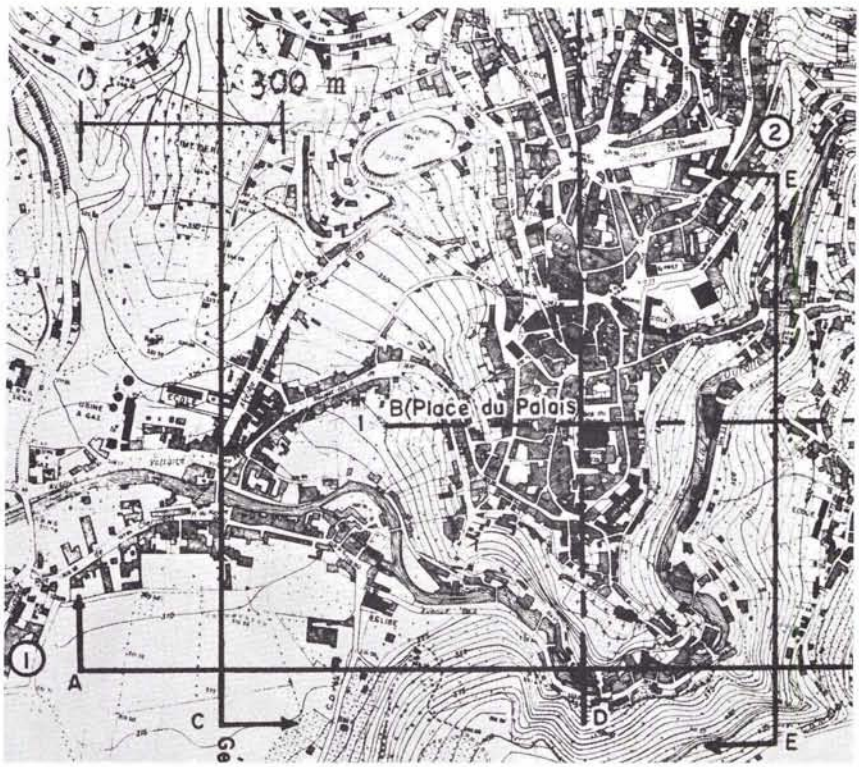

FIG. 4. Thiers. Photogrammetric plan showing elevations and sections.

FIG. 5. Thiers. East-west section obtained by photogrammetric plotting.

of its directions, the other direction being linked to the *X* coordinate. Here again, the axis of the aerial photographs must be adapted to the direction chosen for the axonometric view (Figures 10-14: Town of Cahors).

Analog procedures have the advantage of producing very graphic detailed and accurate documents. Nevertheless, one can consider them as the first stage towards the digital tracing of elevations and perspectives, based on a data bank comprising the three-dimensional coordinates of all the important points of the buildings recorded by digital photogrammetric plotting. This is the next objective which the IGN plans to attain and the

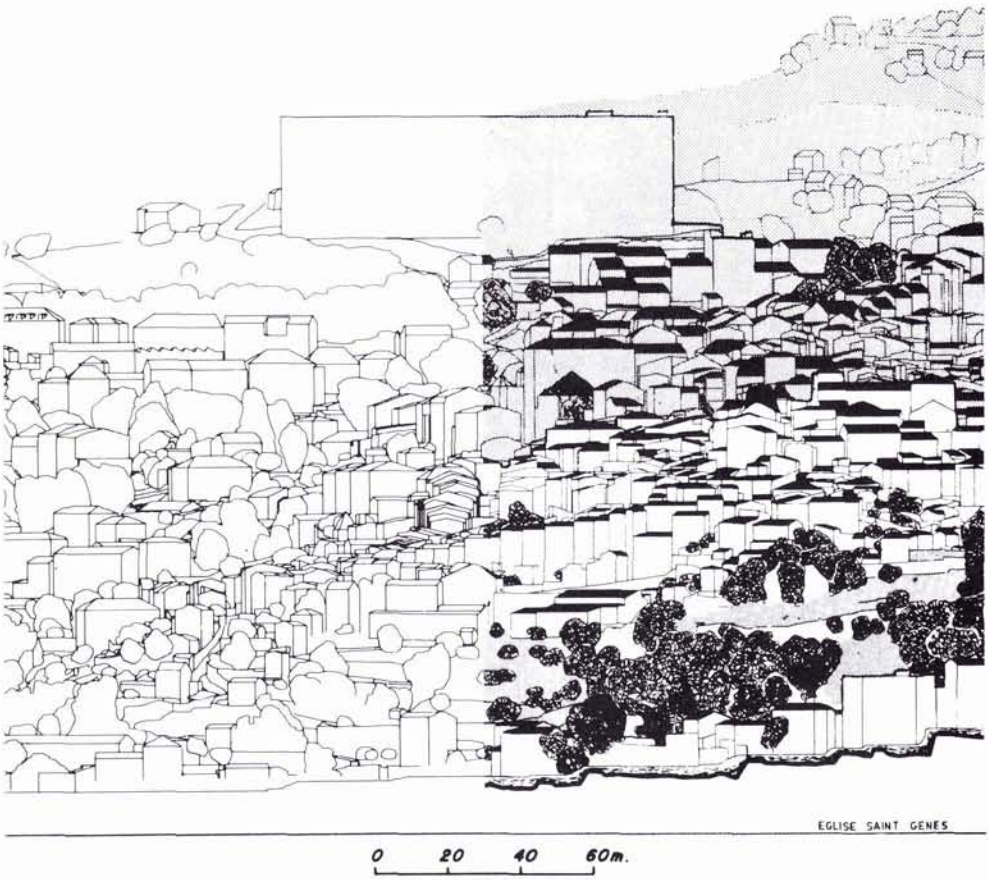

FIG. 6. Thiers. Two elevations of the mass of buildings. *Geometral* South. To the left, the drawing obtained directly by stereophotogrammetric plotting of the aerial photographs. To the right, interpretation and delineation by the Architect-Urbanist B. deTourtier.

necessary research and trials have already commenced. One may consider that this method will lead to more generalized, less detailed drawings, but it will have the advantage that with the same digital data one will be able to produce digital traces in plan, section, elevation and perspective from all possible viewpoints.

As the documents discussed above have accurate geometric properties, it is easy to add the drawings of proposed new buildings and so study their integration into the historic setting in order to consider the *protection* of the latter. Similar studies can be undertaken for engineering works and all kinds of proposed roads, new bridges, viaducts, etc. Consequently, the specialists have excellent data at their disposal for their study.

HOWEVER, it is also useful to produce other kinds of documents which can be more easily interpreted by those who may have to make decisions and have need to judge the proposed transformation of the traditional aspect of a group of buildings. Such is the purpose of photomontage. Very often, however, these photomontages are not very accurate because they are produced by approximate methods, but photogrammetry can resolve this problem in an exact fashion. Knowing the *XYZ* coordinates of the characteristic points of the proposed new development, together with those of the viewpoint, the direction of the optical axis and the principal distance of a photograph taken from this viewpoint, it is easy to calculate the coordinates of the characteristic points on the photograph and to transfer them to a print or an enlargement. The proposed new building is thus drawn on a photographic perspective of the historic center taken from the given viewpoint, and one can see how it will appear, if it is built.

The IGN has applied *inverse photogrammetry* studies of this kind for protecting the site of the Invalides (Figure 15) and the

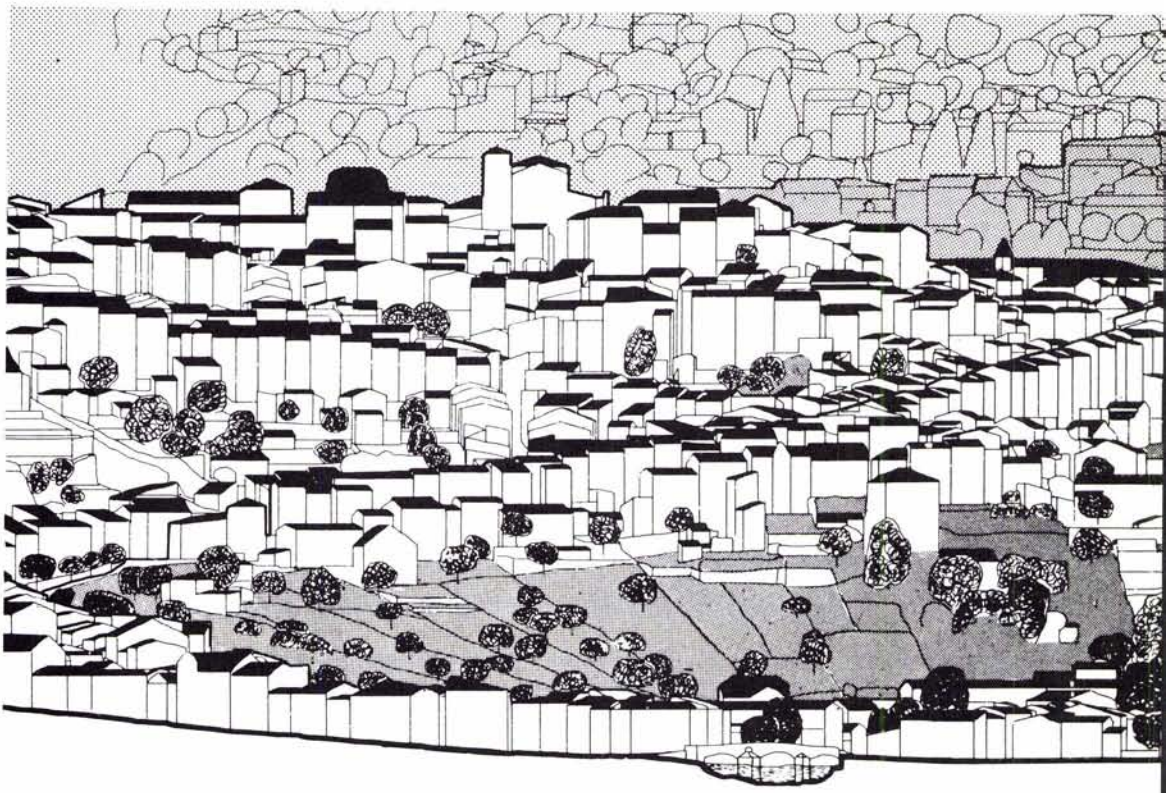

FIG. 7. Thiers. Portion of the *Geometral* West.

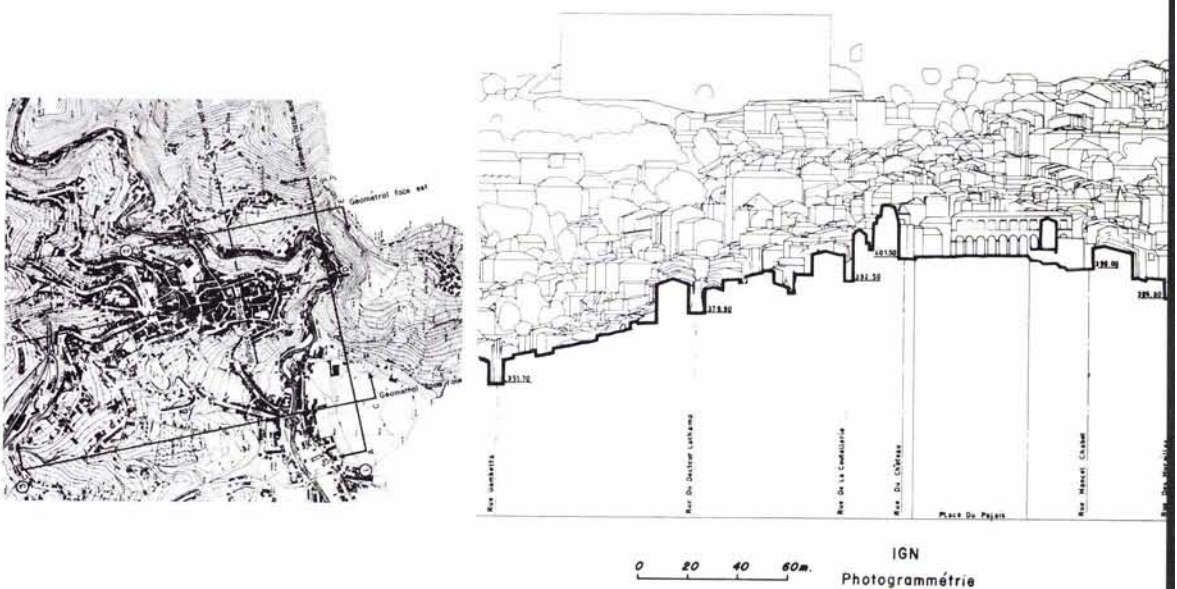

FIG. 8. Thiers. Combination of the East-West Section and the *Geometral* South.

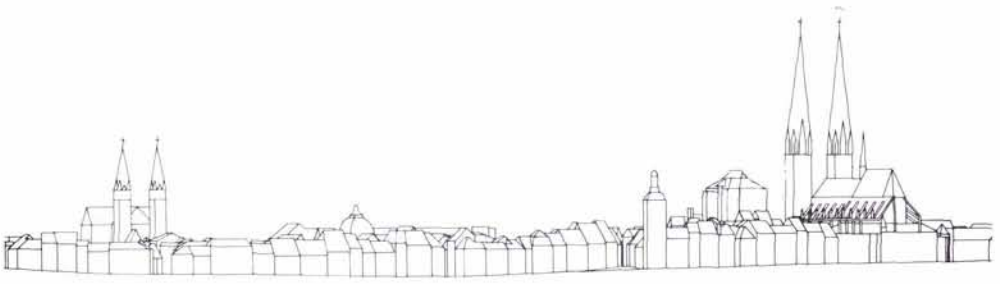

FIG. 9. Moulins. *Geometral* of the city quarter near the cathedral.

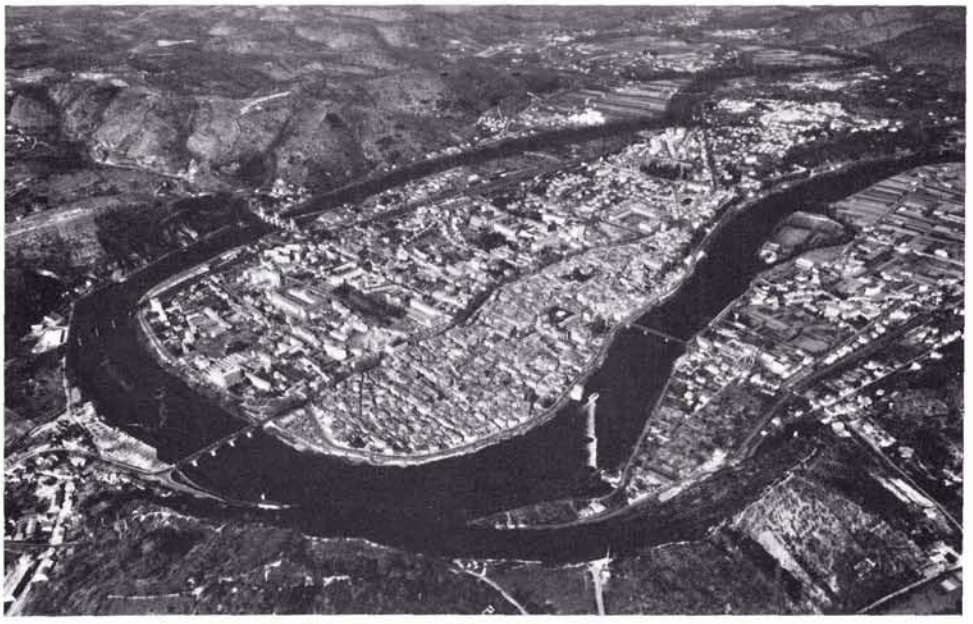

FIG. 10. Cahors. Oblique aerial photograph.

Champs Elysées (Figure 16) in Paris and also, recently, for the site of the Château de Chambord.

One is here mainly concerned with protecting the privileged axes against the construction of proposed edifices. However, it is even more interesting to conduct preventive studies in order to determine, in a given area, the maximum building heights, such that no discordant new building shall be visible anywhere in the zone one wishes to protect. It was in this sense that the IGN made a study of the banks of the River Seine in the center of Paris. Aerial stereophotogrammetry was used to plot the silhouettes of the blocks of flats and offices, etc., which now limit the field of view along the quays, i.e., *masking* blocks. Viewed from the river quays the upper outlines of these masking blocks determine limiting surfaces which allows one to calculate for every point in Paris (more exactly, at the centers of 10,000 squares each having an area of 1 hectare (2.47 acres), covering completely the City of Paris) the height beyond which a new building would be visible from the quays above the present buildings. Figure 17 shows a diagram of the principles of this operation while the Photos No. 18, 19 and 20 show successively the extent of the zone to be protected and the photogrammetric plotting of the "masking blocks."

For certain historic centers occupying privileged sites, it is not sufficient to protect just the site itself; one must also protect the surrounding areas from intrusions. If it concerns a natural setting one must set the limits between the *visible* and *hidden* parts of the ground from certain viewpoints in the historic center and draw a map of them; in addition one can trace on a cartographic base the curves marking the boundaries of the zones of equal permissible building heights, so that

FIG. 11. Cahors. South portion. Vertical aerial photograph.

FIG. 12. Cahors. *Geometral* East.

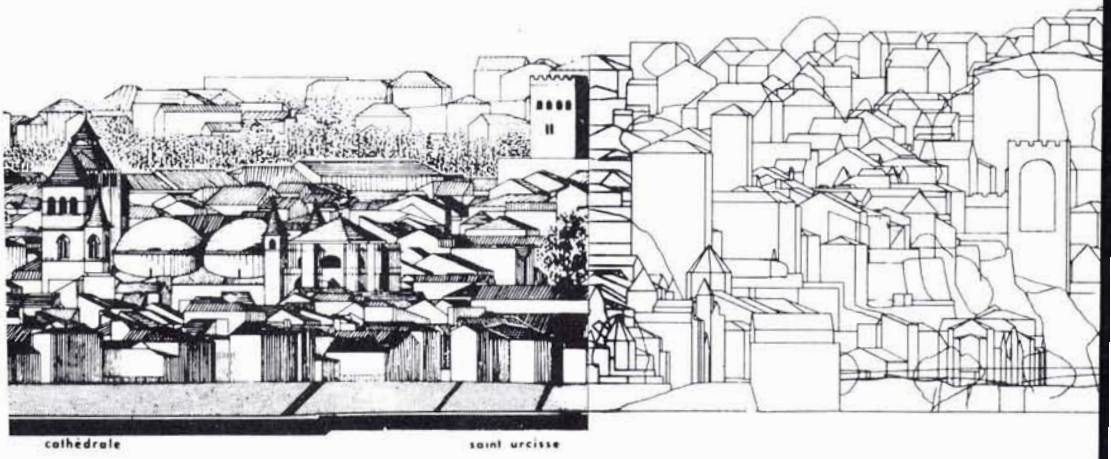

FIG. 13. Cahors. *Geometral* South. To the right, the drawing obtained directly by photogrammetric plotting. To the left, interpretation and delineation by the Architect, B. Fonquernie.

FIG. 14. Cahors. Portion of the axonometric view.

FIG. 15. Protection of the area of the Invalides in Paris. Perspective drawing, by inverse photogrammetry, of outlines of a proposed building project.

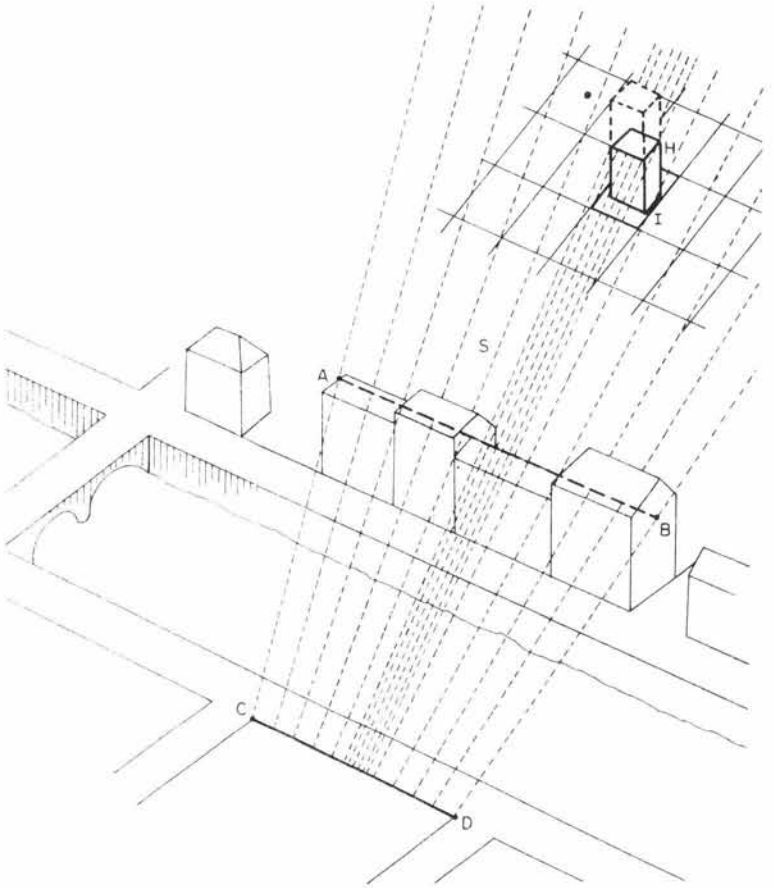

FIG. 16. Study of the protection of views from the banks of the Seine. Principles: *AB*—Masking silhouette of present buildings. *CD*—lines of sight. *S*—limiting surface. *H*—Maximum height of construction in Area I.

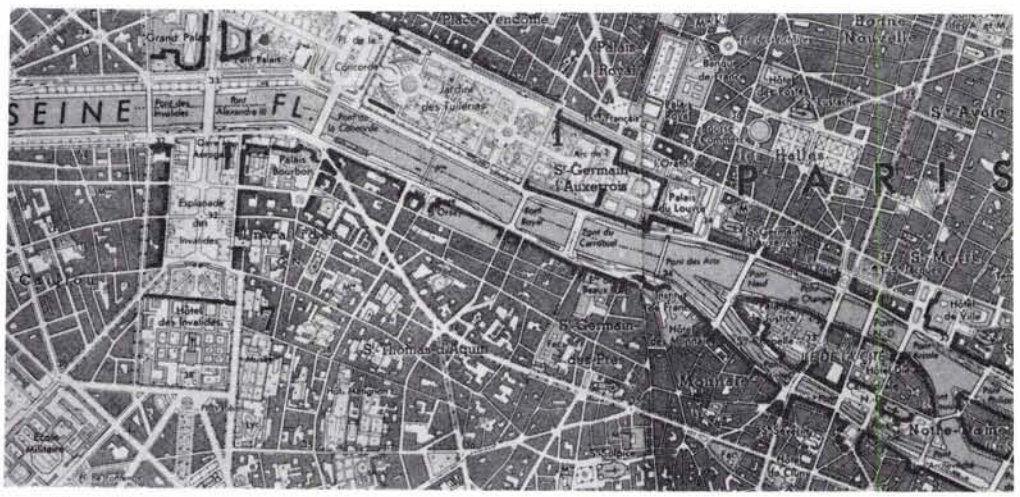

FIG. 17. Zone of protection for the area along the Seine in Paris. Original scale 1:25,000.

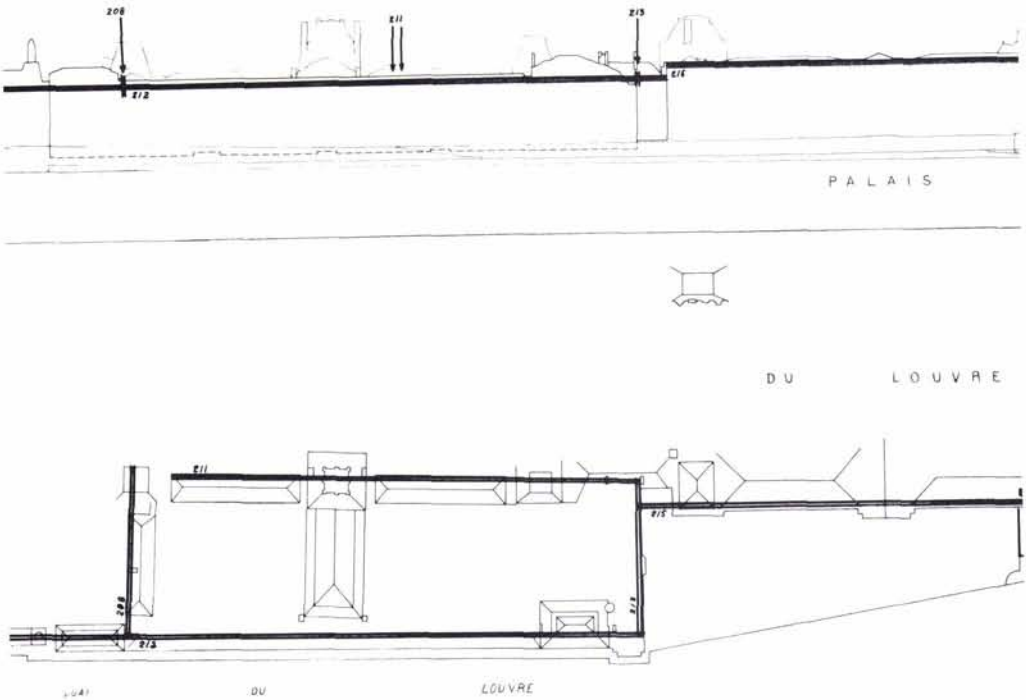

FIG. 18. Photogrammetric drawing of the masking silhouettes limiting the field of vision in the protected zone along the Seine.

no new edifice shall appear in the observed landscape, as seen from the given viewpoints, without the construction having been studied and authorized. Photogrammetry once again enables one to conduct such studies by producing a digital model of the ground by digital stereoplotting. Starting from this model, calculations and the use of an automatic tracing table allow one to obtain the required documents.

Obituary

Marshall S. Wright, Sr.

MARSHALL S. WRIGHT, SR., died July 1, 1974, in Huntington Hospital, Huntington, Long Island, New York.

Born in Toronto, Canada, in 1890, Mr. Wright was reared in Salmon, Idaho, but lived in the Washington, D.C., area for most of the last 50 years. His long federal government career in the field of surveying and mapping included service with the General Land Office, the U.S. Forest Service and the Soil Conservation Service of the Department of Agriculture. Upon his retirement from the Federal Service in 1953, he became the U.S. representative of Zeiss-Aerotopograph of Munich, West Germany, a position he held until the mid 1960's.

Mr. Wright was a pioneer in the use of aerial photography for a wide variety of land management and engineering purposes, and was one of the founders of the American Society of Photogrammetry in 1934; he served as that organization's president in 1939. He was also president of the American Congress on Surveying and Mapping from 1947 to 1949. He was listed in Who's Who in America and was a member of the Cosmos Club.

Predeceased three years ago by his wife, Mildred Smith Wright, Mr. Wright is survived by his son, Marshall S. Wright, Jr., of Huntington, New York, his daughter, Mrs. George W. Childs of Laurel, Delaware, six grandchildren and three great grandchildren.

Services were held at the Everly-Wheatley Funeral Home on Braddock Road in Alexandria, Virginia, on Friday July 5 with interment at Mt. Comfort Cemetary on South Kings Highway in Alexandria.