

FROM ANALOG TO DIGITAL PHOTOGRAMMETRY IN ROMANIA

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ABSTRACT

Brief presentation of The Romanian photogrammetric tradition.

The development of the analog photogrammetry as the main technology compiling topographical plans and maps, equipment, methods, specialised staff, institutes having photogrammetric technology, development stage, and achievements.

The Romanian analytical photogrammetry presentation, used equipment and methods, institute having used analytical photogrammetry, results.

The present-day Romanian digital photogrammetry stage. Digital map as a result of the digital photogrammetry and a basis for Land Information Systems (LIS), as well.

Outlook of the Romanian digital photogrammetry development.

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Photogrammetry as a science and technology has been largely applied in the Earth's surface survey and representation and in other fields of activity as well. In any field of activity photogrammetry considered geometrically has a basic concern: rebuilding the model of some objects and phenomena based on their images. The land photograph is a huge data and information source. Their processing has been the photogrammetry object from the very beginning.

We may say that photogrammetry began at the same time with the perspective law discoveries. The mathematician S.H. Lambert presented the bases of the central perspective rebuilding and of the space intersection in his book *Free Perspective* published in Zürich in 1759.

In the course of time there were several achievements paving the way for photogrammetric development. We mean, in 1839 photograph as an optical procedure making rigorous central perspective was discovered; in 1859 A. Laussedat made the first metric photograph camera and the last, but not the least a special surveying procedure appeared.

After C. Pulfrich built Stereocomparator at the beginning of this century (1901), a new measuring principle using only the photograph data has come into being; a theodolite to measure directions was no longer necessary. This principle stereoscopically measuring point-by-point over a photograph pair field is, in fact, the analytical photogrammetry basis. The huge data volume and poor calculation methods prevented from largely using it at that past time.

The stereoscopic ground photograph plotting has been extended after E. Orel invented Stereoautograph in 1908 and Carl Zeiss Jena Company has built it since 1911. Although their use in topographic mapping was reduced.

Airplane development and after the automatic aerial photogrammetric camera was built in 1915 by O. Messmer, aerial photographs on strips could be made up.

In 1915 M. Gasser built the double projector based on Th. Scheimpflug principle, which enable to make up the first stereoplotter and the first graphical (analogical) photograph orienting and plotting procedures, respectively. In 1923 Carl Zeiss Jena Company made up the first precise Stereoplotter, i.e. Stereoplanigraph, based on W. Bauersfeld project using the optical projection principle.

The optical, optical-mechanical and mechanical principle rebuilding the photogrammetric beam during photograph taking has been used to make up various precise stereoplotters. Wild Heerbrugg Autographs could be especially mentioned.

In our country, the first trials to use ground photographs in some topographic sketch compilation were done during 1877-1878 Independence War. Progresses related to the flying means gave the possibility to get the first balloon photographs made by P. Văitoianu in 1889 and aeroplane photographs made by Aurel Vlaicu in 1911.

Regarding the Romanian photogrammetry activity, it is worth mentioning the establishment of a Cadastral Service in 1924 within the Civil Air Force Department, which has used photogrammetric methods in topographic mapping. In 1929 a Photogrammetric Service within the Mining Cadastral Department and a Photogrammetric Unit within the Army Geographic Department were established.

During 1933-1941 the existing photogrammetric services were unified under the name of the Hydrographic and Photogrammetric Office having special air photograph taking planes, aerial photogrammetric cameras and graphical (analog) photograph processing equipment at its disposal. In 1942 it became the Aerial Photogrammetric Institute. In 1946 all its photogrammetric equipment was ceded to the Military Geographic Institute which later has been renamed the Military Topographic Department. In 1950 an Aerial Photogrammetric Unit was established within the Military Topographic Department. Since 1951 the Romanian 1:25,000 scale map has been compiled using Gauss-Krüger projection and photogrammetric technology. From the very beginning, the Photogrammetric Unit within the Military Topographic Department had Zeiss C5 Stereoplanigraphs, aerial cameras and photographic laboratory equipment, as well.

In 1952 the first civil photogrammetric sector within the Geological Committee after the Second World War was established to compile topographic plans required by the geological prospecting works. Wild A5 Autographs, Rectifiers and Wild RC5 aerial cameras (all up-to-date equipment of that time) were used.

A very important event related to the photogrammetric development in Romania was the establishment of the Centre of Photogrammetry in February 1958, the present-day the Institute of Geodesy, Photogrammetry, Cartography and Land Management (I.G.F.C.O.T.). Its main concern had in view to compile and maintain topographic and cadastral maps covering the whole country territory.

After 1958 photogrammetry has been also used more and more in other units using topographic maps in their study and designing activities; namely: The Institute of Forestry Research and Management (I.C.A.S.), The Institute for Land Improvement Studies and Designing (I.S.P.I.F.), The Institute for Auto, Naval and Aerial Designing (I.P.T.A.N.A.), The Institute for Railway Designing (I.P.C.F.), a.s.o.

Although we could say that photogrammetric activity had existed in Romania from its very beginning, this technics was largely used in topographic mapping only after the great photogrammetric units have been established ever since 1950 (Zegheru, 1984).

Photogrammetry has known a progressive evolution concurrently with the development of some essential sciences, such as, mathematics, physics, chemistry and some technical sciences, i.e. electronics, informatics, automation, optics, mechanics, aircraft construction, data logging, a.s.o. In this way, special achievements related computing technics and informatics have revived the interest for analytical aerial triangulation (Turdeanu, 1997). The coordinate accuracy based on this method could be compared with the geodetic coordinate accuracy of the bridging point network.

The most analytic aerial triangulation methods having single and double models or photograph as a basic unit is based on vector ray coplanarity principle, given as:

$$\begin{vmatrix} b_x & b_y & b_z \\ A_X' & A_Y' & A_Z' \\ A_X'' & A_Y'' & A_Z'' \end{vmatrix} = 0 \quad (1)$$

vector ray colinearity principle, given as:

$$\begin{bmatrix} X - X_0 \\ Y - Y_0 \\ Z - Z_0 \end{bmatrix} = \lambda \cdot \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{bmatrix} \cdot \begin{bmatrix} x' \\ y' \\ -f \end{bmatrix} \quad (2)$$

Is less used; results derived from colinearity principle having photograph as a basic unit are more rigorous but require larger computations.

The photogrammetric specialised units in our country have 50 photograph analogical plotters altogether at their disposal in good running conditions. Half of them are assisted by automatic measuring data recording equipment.

The following figure presents an old numerical cadastral measuring process based on photogrammetric methods.

During the 70 decades more than 20 Stecometers were purchased. Their use enabled to generalise analytical photograph plotting aiming at cadastral data and map compilation over rural localities and areas of great economic growth and importance.

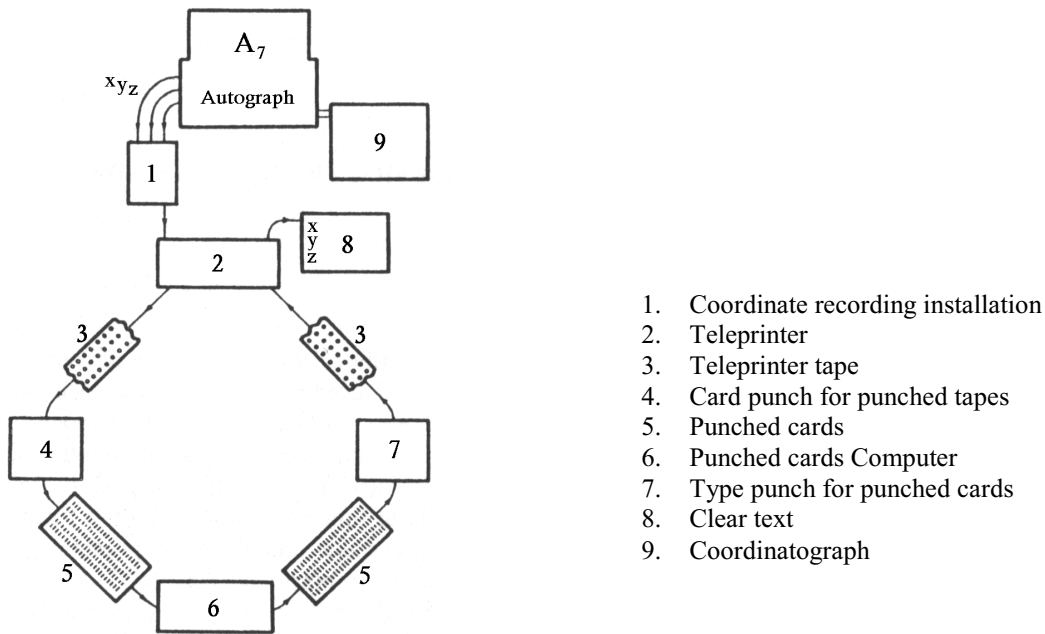


Figure 1. Numerical measuring photogrammetric process developed in 1960^s.

In the above-mentioned period of time such an automatic photogrammetric system compiling cadastral maps was carried on within I.G.F.C.O.T. That system contained Stecometer measurements, computer-assisted, data preparation and processing and plotter-assisted cadastral mapping (Zegheru & co., 1982a). At the same time, conventional sign atlases for digital cadastral map storage were also carried on.

In the course of many decades, stereoscopic optical and mechanical equipment was used in map compilation. Using pairs of photographs (stereophotographs), stereoplotters and measurements data and information for map compilation could be derived.

Although during the 70 decade some analogical stereoplotter improvements using measurement recording equipment and the existing small computers had been attempted the outcome of this action was not good. So, as we have already mentioned, the photograph analytical plotters were still in existence.

Many of the optical and mechanical parts reaching to hundreds kg. Altogether (stereoplanigraphs, stereometrographs, a.s.o.) have been replaced by computers; thus, flexibility and productive capacity have been increased.

Based on this concept, manufacturing companies have made digital photogrammetric equipment. A new stage of the photogrammetry is to be approached.

Instead of physical images on film, glass or paper, the very digital photogrammetry uses digital images in computers. That is why we need a digital image. In this development stage, it means that an image should be digitised or scanned. This scanning process is made by a Digital Scanning Workstation. During scanning an image is divided in a number of very minute of equal surface. Such a surface called pixel contains proper information regarding colour and hue density. As regards digital photogrammetry, accuracy is increased depending on scanning resolution. The smaller pixel is the more accurate results are. Each pixel metric and radiometric data processing gives information for rigorous representation and features of the objects and phenomena recorded on image $Q(x, y, k)$.

Thus, digital photogrammetry enables a larger outcome range as against the traditional photogrammetry. It is worth mentioning triangulation using image comparisons for stereoscopic measurements, simplified Digital Terrain Model

(D.T.M.) generation, digital maps and orthophotomaps, Geographic Information Systems (GIS) and Land Information Systems (LIS) among others.

In the sketches below a complex technological flow to derive the above mentioned outputs and a Leica digital photogrammetric system are given (Leica AG, 1982, 1993).

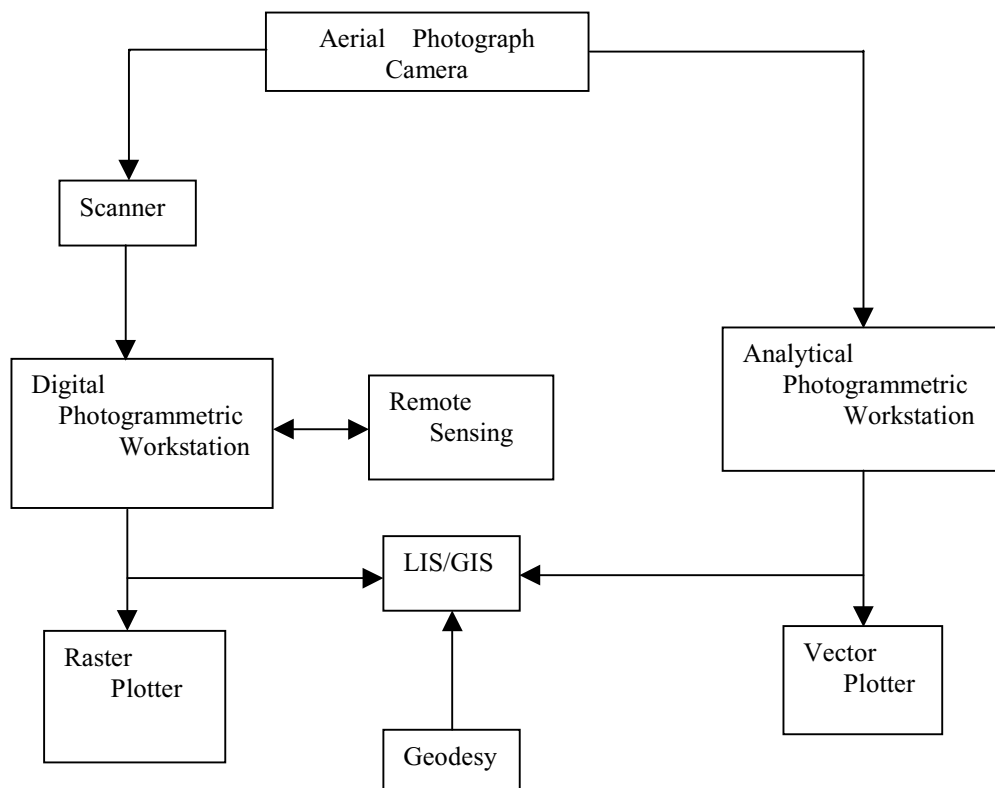


Figure 2. Technological process to get LIS/GIS

In the last decades Romanian photogrammetric units having various analogical equipment and less analytical one at their disposal have obviously succeeded to reach a high development level which could be compared to that of any developed countries, especially by the agency of I.G.F.C.O.T.

During a 30 year activity 1:5,000 scale topographical maps covering more than 80 per cent of the country surface (about 190,000 km²) and 1:2,000 and 1:1,000 scale maps for high economic important settlements and areas have been compiled. Nowadays, we cannot say the same thing about the digital photogrammetry state-of-art.

The old analogical photogrammetric technologies having required large investments and the existence of tens of robust equipment still in running are to be undoubtedly used in the future after some improvements will be made concurrently with the update digital photogrammetric technologies. These new technologies are slowly implemented in Romania. Nowadays, there are only a few digital photogrammetric equipments scattered in various units and few highly skilled specialists.

Now, we hope for both, state units and private companies, will understand that digital photogrammetry and numeric topographical completions should support topographic and cadastral works over large surfaces. Thus this field of activity will be given the attention it deserves.

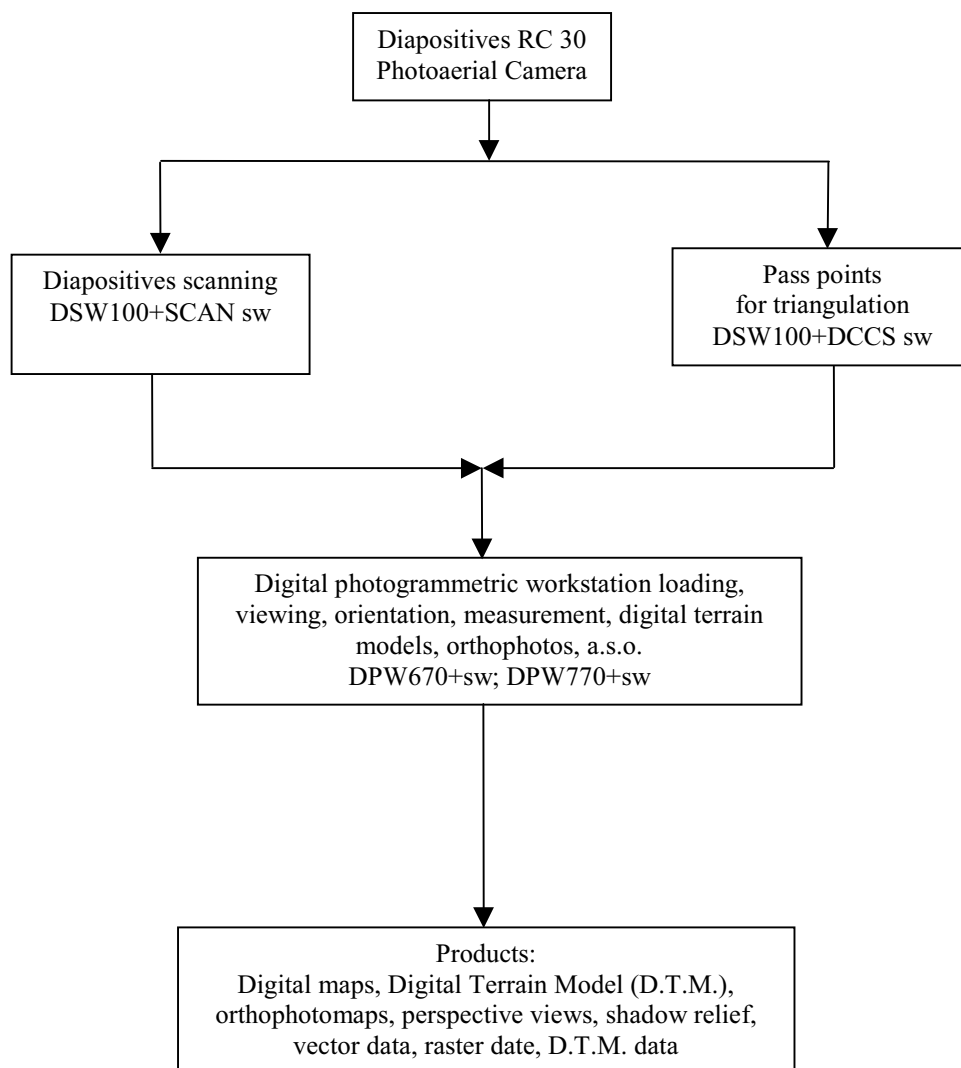


Figure 3. Digital Photogrammetric Systems by Helava

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