Keynote Address

The International Society for Photogrammetry and Remote Sensing—75 Years Old, or 75 Years Young

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LADIES AND GENTLEMEN. I am grateful for the distinction of having been asked to prepare the keynote speech for the 1985 Annual Meeting of the American Society of Photogrammetry and the American Congress on Surveying and Mapping.

As a photogrammetrist, I am naturally concerned about matters dear to me and therefore I have chosen as the title of my talk "The International Society for Photogrammetry and Remote Sensing—75 years old, or 75 years young." I have done this for two reasons. Last year I became successor to Fred Doyle, who ably represented the American Society of Photogrammetry as President of ISPRS for four years from 1980 to 1984. Secondly, our organization celebrates this year its 75th Anniversary. We photogrammetrists are officially in our third generation. Reason enough to look back on our accomplishments and to ask ourselves the question, whether we still have a future.

As photogrammetrists and people who are concerned about remote sensing, we cannot work in isolation. We are deeply interrelated with the other surveying and mapping fields, with which, as the long standing tradition of the Annual Meeting shows, we already form an unofficial union of surveying and mapping disciplines. It is in this context, that photogrammetry and remote sensing are also of concern to surveyors, geodesists and cartographers.

We know that surveyors were already in existence, when the Babylonians and Assyrians were delimiting their irrigated fertile lands in the valleys of the Euphrates and the Tigris, which were their very existence. This tradition was continued in the Nile Valley. The Egyptians needed accurate surveys to build the pyramids in an attempt to make their kings immortal gods. Surveys needed mathematical thought, and this is why by pure observation Eratosthenes of Alexandria succeeded from observations of the sun, that the Earth must be like a sphere, and he determined its average radius within 1% of accuracy. He thus became the first geodesist.

Mathematical thought and survey practices spread from Mesopotamia and the Nile to the areas of Greek and Roman culture. Roman land surveys were a highly developed technique. Its practice was interrupted by the fall of the Roman Empire because of invasion from the North and the introduction of Christianity with its upcoming mysticism. Therefore the oriental cultures then became responsible for the further development of our disciplines. In the Arab world, astronomy and navigation became highly developed. Cartography, as a description of the earth's features on its surface, flourished in China, long before this was the case in Europe.

The European Renaissance period brought about a change in the occident. The preoccupation with the observation of the laws of nature permitted Galileo, Copernicus and Newton to lay down the foundations of physics, on which geodesy and cartography are now based, and as a result of which the New World was found, explored and settled. Positional Astronomy was the main observation technique used by the Spanish, the Portuguese, the Dutch and the British the world over in exploratory cartography. But soon more exact models for the figure of the earth were developed, and the new observation technique introduced by Snellius called triangulation began to be used alongside with positional astronomy.

It was the French Academy of Sciences, which initially defined the meter as a natural unit of length, namely the 10 millionth's part of the quadrant of the Earth's ellipsoid. In doing so, it generated the first world wide geodetic research project. After it failed, the meter was redefined by other physical measures. But French academic thought in the survey discipline henceforth persisted in Continental Europe and spread from there into other parts of the world. It was Napoleon I who in the early 19th century imposed on his conquered regions the thought of creating a fundamental geodetic network of a regular map coverage at large or medium scale based on this network, and of introducing an obligatory land register combined with a land parcel map, called a cadastre, which can now be considered as the first land information system.

The reasons why these thoughts were rarely introduced in the New World did not stem from objections to the logical thought introduced by Napoleon. They were brought about by the incapacity of the survey methods of the 19th century to cover large areas fast. It needed, for example, 100 years to establish the Napoleonic cadastre and its large scale map by triangulation and by plane table in Germany.

It needed new technologies to make progress. Such technologies were and are still being developed. To these have counted in the past: *photogrammetry*, which is able to map over large areas at least 10 times faster and 50 times more economically than the plane table; *electronic distance* measurement, which permits control surveys to be done at least 10 times faster and at least 20 times more economically than triangulation; the use of the *computer*, which for the first time permitted to perform simultaneous adjustments of large geodetic and photogrammetric networks and improve the economy, the speed, the accuracy and the reliability of point determination by at least one order of magnitude. More recently inertial and satellite technology have made and are continuing to make an impact in geodetic point determination.

By these introductory remarks I hope to have clarified that we photogrammetrists are, in general, part of the surveying and mapping profession with which we have the same roots. If I now restrict myself to the development of photogrammetry proper I do this as an example for each of the survey disciplines in an attempt to review our past and present role and to see where we are going.

A German proverb says: "Need is the mother of

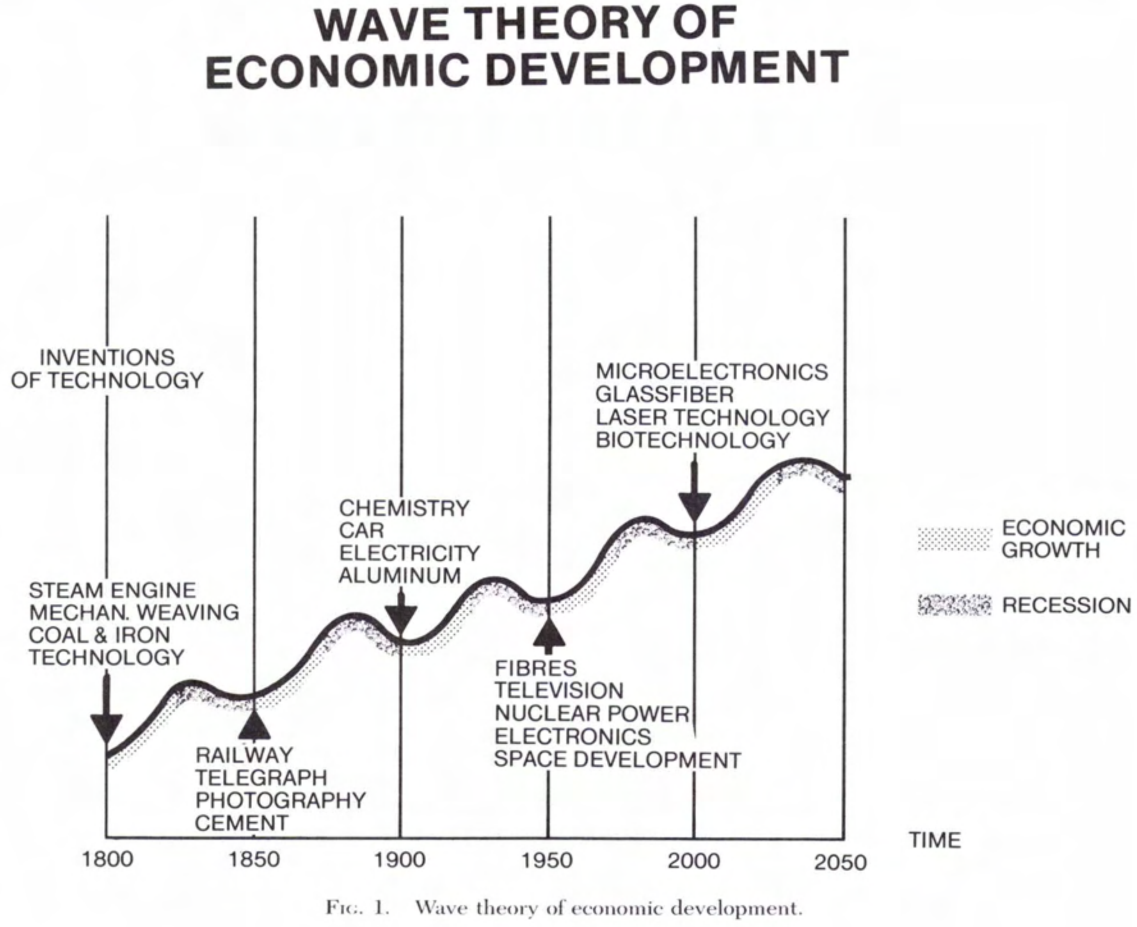


FIG. 1. Wave theory of economic development.

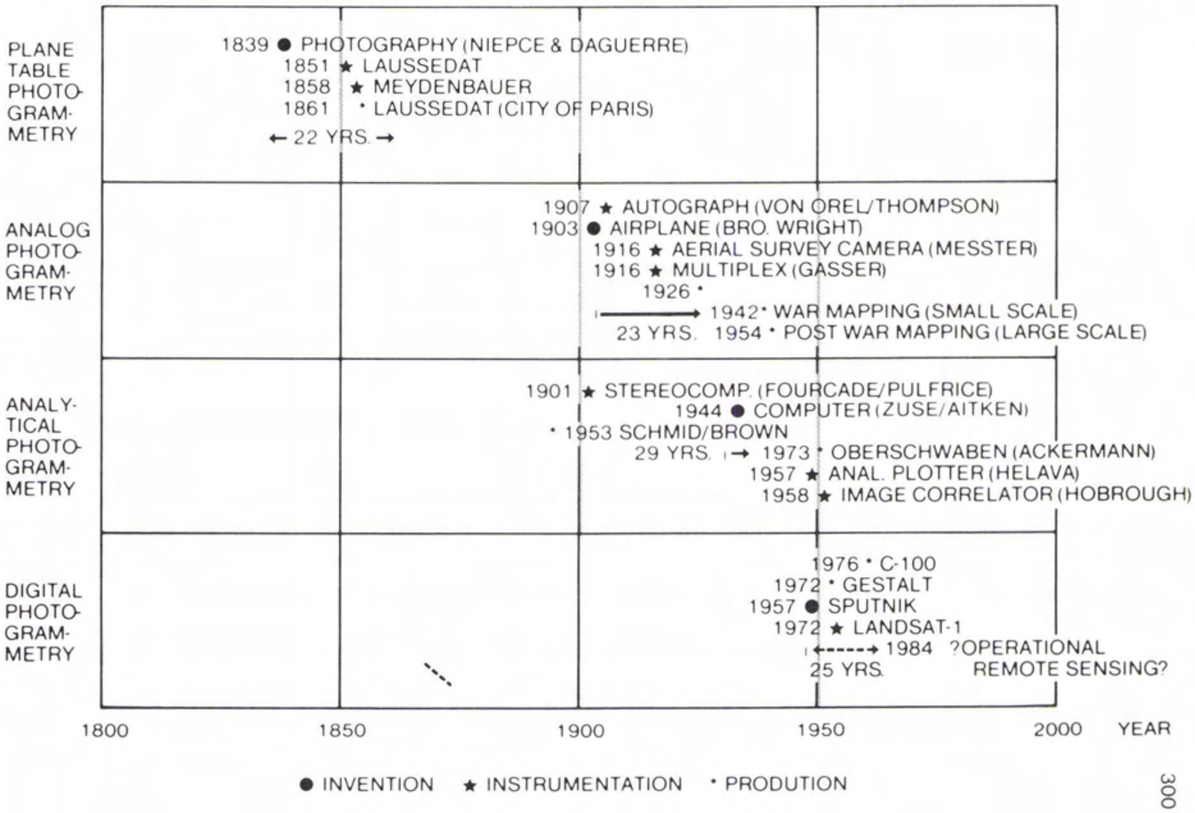


FIG. 2. Stages of photogrammetric development.

inventions." Technical development is brought about by the needs of time, created by wars or by the general economic situation. There have been theoreticians of economics, who have considered economic recession not as random events, but as regular repeating cycles in history.

One of these theoreticians was Kondratjew, who developed the wave theory of economic development in 1925. At that time he was director of the economic research institute in Moscow. Because his theories did not conform with the Marxist economic theories he was sent to Siberia in 1930. His theories have since been adapted by many other economists, especially in Europe (fig. 1).

Kondratjews's theory states: Economic growth is initiated in cycles of about 50 years by new technologies. After 30 years of growth there follows a crisis. During this crisis new technologies are developed, which after 20 years of recession generate a new economic growth. Wars and political events only change the amplitudes of the growth and recession curves. Depending upon political relationships between different parts of the world these amplitudes may be changed in magnitude for different regions of the world, or they may slightly be retarded in time. Mechanical weaving, steamships, coal- and iron-technology were, for example, introduced in 1790. Because of American and the French revolutions these technologies brought their benefits especially to Britain.

The economic growth period of 1843 with the introduction of the railway, telegraphy, cement and photography influenced strongly the entire conti-

FIG. 3. Albrecht Dürer's Device to Reconstruct a Perspective.

FIG. 4. Portrait of Nièpce.

nents of North America and of Europe. Around 1900 electrification, the automobile and the beginning of chemical and light metal industry brought prosperity especially to North America while German economic development became throttled by the effects of the First World War.

Extrapolating Kondratjew's waves into our times, we find that World War II coincided with a period of economic depression, from which the world recuperated in the 1950's when new technologies such as electronics, artifical fibres, nuclear power, television, computer technology and space technology began to be introduced.

The worldwide economic trends of the last 10 years did not, at least in Europe, give rise to optimism. They correspond to Kondratjew's cycle. Differences in the present amplitude of the cycle might stem from the fact, that North America has more economic reserves than Europe and can apply a relatively more advantageous high interest monetary policy.

Even though many economists do not accept the economic cycle theory, and even if we photogrammetrists do not understand enough about economic theories, one is generally of the opinion that a new economic growth period will be initiated by the impact of new technologies such as micro-electronics, fibre optics, laser technology or biotechnology; the sooner the better.

To me, as a photogrammetrist, it has always been fascinating to trace the development of photogrammetry within the framework of general technological development (fig. 2). It is startling that photogrammetry, from about 1850 on, also has had 3 to 4 development cycles, which have dominated it during a more or less 50 year period each. Our development cycles are:

1) from about 1850 to 1900: *plane table* photogrammetry.
2) from about 1900 to about 1960: *analog* photogrammetry.
3) from about 1960 on: *analytical* photogrammetry.
4) We are presently preparing for a fourth development cycle which I will refer to as *digital* photogrammetry, a term which is often used in another context, but which I would like to reserve for the practice of using pixels and image processing techniques to arrive at geometric information.

Each development cycle is preceded by a basic invention. About 10 to 15 years after this invention we find that the first instrumentation for practical use has been developed, and about 20 to 25 years after the basic invention, the technology is introduced into practice, where it is generally employed predominantly for the next 25 years along with the new technology for a further 25 year period.

Let me discuss these developments in more detail: Photogrammetry, the technology to derive measurements of objects from their images, requires two basic elements: the concept of image ge-

FIG. 5. Portrait of Meydenbauer.

Fig. 6. Nadar's balloon, 1858.

Fig. 7. Balloon photograph of Boston 1860.

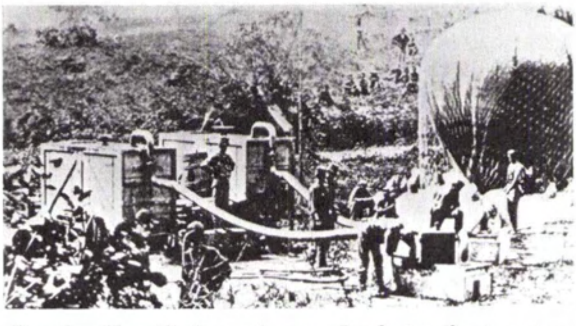


Fig. 8. Use of balloon photography during the American Civil War.

ometry, and the availability of a sensor system, which permits us to obtain the image. Image geometry was already developed by the Renaissance architects and painters such as Brunelleschi and Leonardo da Vinci. Shown in fig. 3 is a device, which permitted Dürer to capture a perspective view for his paintings. In 1830 Nièpce (fig. 4), and independently Daguerre discovered in Paris that an optically projected image could be fixed chemically. Thus photography was invented.

Colonel Laussedat, of the French Army, was the first to utilize photographic images to derive topographic information: He designed a camera, with which he climbed the roofs of Paris to make a city

FIG. 9. Col. Scheimpflug.

map using photographic images. In doing so he used geometrical principles to graphically reconstruct object relations. Thus the first development cycle of plane table photogrammetry was initiated.

Plane table photogrammetry was nothing but an auxiliary survey method. The exposure stations were surveyed by plane table resection and charted on the plane table sheet. After the photographs were obtained, the exposure directions and the directions to the new objects identified in the photographs were transferred onto the map sheet. The surveyor therefore only used photography as a tool to obtain horizontal and vertical directions faster. In Germany it was Meydenbauer (fig. 5), who in 1858 applied this graphical method to survey churches and historical monuments. This was his task as an architect. When doing measurements on the cathedral of Wetzlar from the scaffolding, which had been used for these purposes up to that time, he fell to the ground and decided to use photogrammetry henceforth. In 1885 he established a state institute in Berlin, which was charged with the photogrammetric survey of historical monuments in the German Reich. Many such buildings, destroyed in World War II could be reconstructed in East and West Germany according to these photographs in our days.

But plane table photography also proved useful for the survey during expeditions: when Jordan in 1874 surveyed an Oasis in the Sahara; in archaeology, when Stolze in 1878 surveyed the ancient town of Persepolis; in glacial surveys, when Sebastian Finsterwalder in 1888 surveyed the rapidly retreating Vernagt-Glacier in Austria, which by its retreat had caused a catastrophy when a lake, blocked by the glacier, suddenly had emptied into the Ötz-valley, devastated homesteads by flood, and killed people.

Plane table photogrammetry was also used during the construction of the Gotthardt-railway in Switzerland. Koppe in 1895 developed an image theodolite with which the angles did not have to be transferred graphically into the map, but which could be measured directly with the theodolite in the image, an idea which had already been realized by Porro in Italy in 1865 and utilized in mountain surveys of the Gran Paradiso by Paganini in 1885. During the plane-table photogrammetry period there was equally the development of photographic interpretation, which we now consider as part of remote sensing in general.

Tournachon, called Nadar, was the first one to utilize the hot-air-balloon, invented by Montgolfier in the late 18th century, as an aerial platform. In 1858 he photographed Paris (fig. 6) and in 1859 he was charged to chart the enemy lines in the French-Italian war for Napoleon III for the preparation of the battle of Solferino.

It is most interesting, that Nadar's technique was also utilized in the United States, when Boston was photographed from a balloon in 1860 (fig. 7). A practical use of the balloon, charting enemy lines was also made during the Civil War, starting in 1862 (fig. 8). It was Adams in the United States, who in the 1890's attempted to apply the graphical principles of plane table photogrammetry to balloon photographs, hereby inventing radial triangulation.

In Austria, Colonel Scheimpflug (fig. 9) was occupied with the same problem and in doing so, he invented the principles of optical rectification in the 1890's. At the turn of the century Sebastian Finsterwalder (fig. 10) was probably the only one, who already at that time could comprehend the geometric relationships of spatial photogrammetry with the means of mathematics.

He not only solved the problems of double point

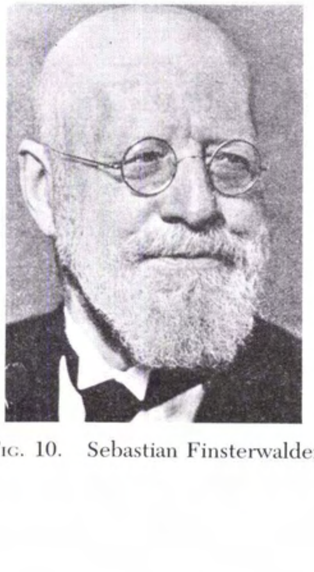


FIG. 10. Sebastian Finsterwalder.

resection and intersection in space in theory in 1899, but he proved their application with two balloon photographs taken over the city of Gars am Inn in Bavaria (fig. 11). As professor of Mathematics at the Technical University of Munich he calculated by hand in several months, point by point, the characteristic terrain points and compiled a topographic contour map from these in 1903 (fig. 12).

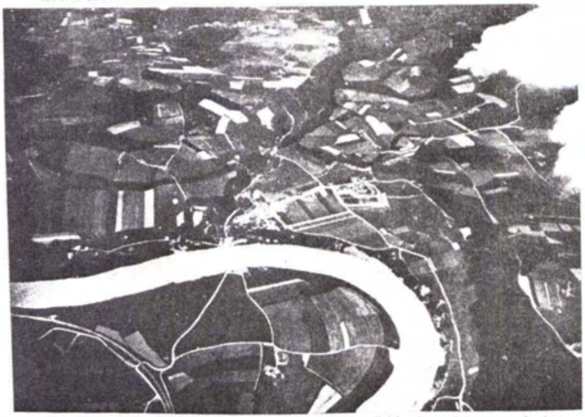
Even though the approach was completely correct, he hardly believed in the realization of the method as a practical tool, due to the immense effort of computation, and due to the difficult and the nonsystematic way in which balloon-photographs were taken. Even when applied terrestrially, the use of plane table photogrammetry was restricted to small mountaineous areas, which could be photographed completely only with immense effort.

The practical use of photogrammetry and the development of photogrammetry as a discipline of its own right required a new technology. This technology came about by the use of two inventions: It was first the wide-spread use of stereoscopy, which around the turn of the century was introduced as a measurement principle for stereo-photogrammetry. And it was second, the invention of a more suitable sensor platform, such as the Zeppelin in 1900 in Germany and the motor driven airplane in 1903 by the Brothers Wright in the USA. The last invention paved the way for analog photogrammetry, the second development phase of our discipline.

Gaston Deville (fig. 13) developed in 1895 in Canada the first instrument for stereo-observation of overlapping photographs, in which details could be interpreted and traced. Proposals for stereoobservation had also been made by Stolze and Hauck in 1883/84 in Germany. In Germany it was Carl Pulfrich at Zeiss, who in 1901 built the stereocomparator for the measurement of image coordinates introducing the floating mark (fig. 14). In South Africa a similar instrument was developed at the same time by Fourcade. Mountaineous Austria was particularly interested in Pulfrich's stereocomparator, and the Austrian military establishment began to use parallel stereophotographs for the topographic survey of mountain areas. One of the officers charged with the task of surveying the Ötscher-

S. Finsterwalder: Grundaufgabe der Photogrammetrie Tafel I

Erste Aufnahme. Gars am Inn aus 2496.2 m. Bildweite 145.2 mm reduziert



Zweite Aufnahme. Gars am Inn aus 2144.8 m. Bildweite 145.2 mm reduziert

Aufnahmen von Dr. R. Emden am 6. Juni 1902

Fig. 11. The first balloon photographs evaluated by Analytical Photogrammetry.

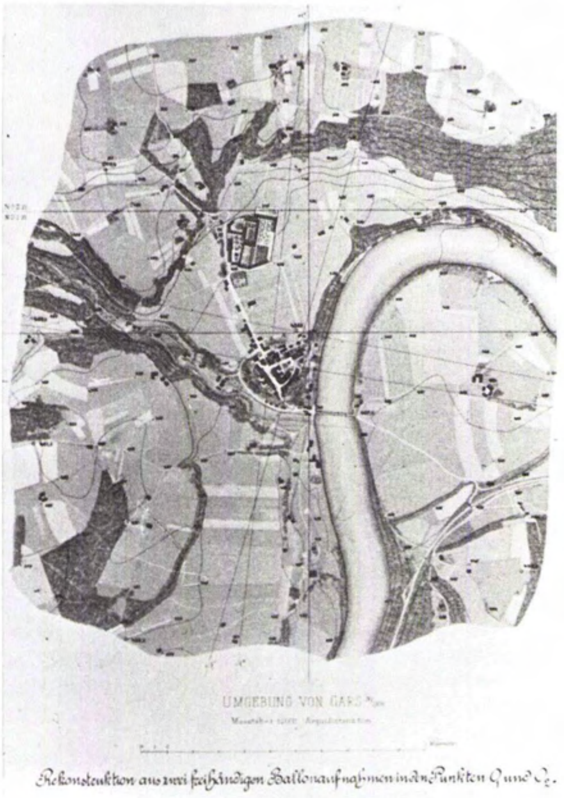


Fig. 12. The first contour map compiled from balloon photographs.

FIG. 13. Gaston Deville.

FIG. 14. Carl Pulfrich.

mountain near Mariazell, close to Vienna in 1907 was Von Orel (fig. 15).

Photography, measurement and the manual computation of the parallax formulae proceeded only very slowly. When Von Orel came down with the flu, his fever dreams pressed him for completion of the job and he suddenly envisaged a mechanical solution for the computation of terrain coordinates, which relieved him of his pressures. He built a first prototype and discussed it with Pulfrich from Zeiss. Von Orel and Pulfrich finally built their first Stereoautograph. As it is very often, a parallel design of a mechanical stereoplotter was made independently by Vivian Thompson in England in 1908 (fig. 16). The stereoautograph for the first time permitted one to trace elevation contours directly, and brought practicability to the use of terrestrial photogrammetry in the mountains, a method which is still used for accurate surveys.

But it was World War I which brought about the increased use of aerial photography with the development of the aerial survey camera by Oskar Messter (fig. 17) with Zeiss, which permitted to take vertical photographs with a regular overlap during the year 1915. In the same year Gasser patented his stereo-projector (fig. 18). This projection instrument utilizing anaglyph filters was later to become the Multiplex.

These developments were the basis of analog photogrammetric restitution. They were modified in numerous refinements starting with the first optical instruments by Umberto Nistri in Italy in 1920 (fig. 19) and by Zeiss in Germany in 1921; secondly by the optical-mechanical instruments of Hugershoff in Germany in 1919 (fig. 20) and of Poivilliers in France in 1923 and by Wild in Switzerland in 1926; thirdly the first mechanical instruments for aerial

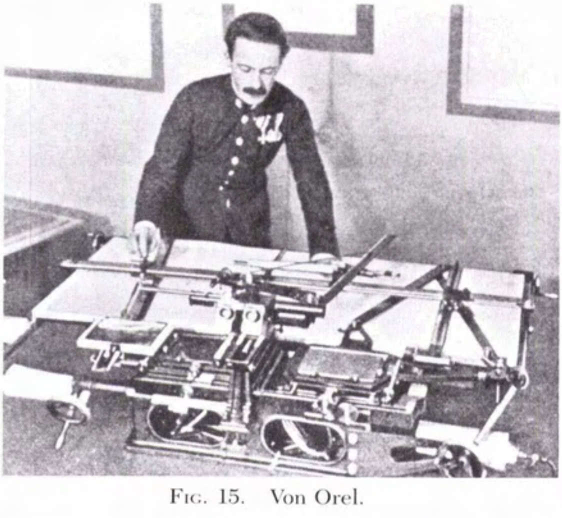


FIG. 15. Von Orel.

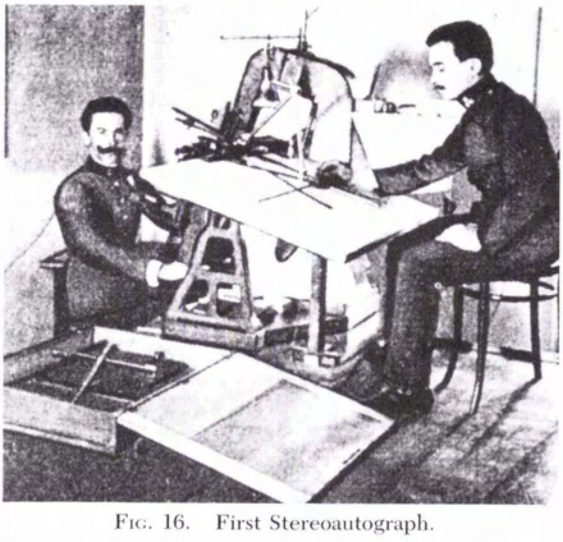


FIG. 16. First Stereoautograph.

FIG. 17. Oskar Messter.

FIG. 18. Gasser.

photogrammetry were developed by Santori in Italy in 1921.

Rectification according to the principles of Scheimpflug already developed in 1896 was made possible by rectifiers built by Wild and Zeiss since 1934 with automatic focussing. Differential rectification was conceived first in Austria in 1924 by Vietoris and realized by Lacmann in Berlin in 1929 (fig. 21) as well as by Ferber in Paris in 1933.

It finally received practical significance when Russell Bean developed the orthophotoscope in the 1950's in the USA. The foundation of the theory of analog restitution and its orientation was laid down by Otto von Gruber in 1924, who also made the first attempts of spatial aerial triangulation (fig. 22). This rapid technological development of analog photogrammetry with new methods and new instruments, requiring new industries and new specialists brought about the necessity to form a discipline.

In Austria Professor Doležal formed a society for photogrammetry in Vienna as early as 1907 (fig. 23). In Germany, the Zeiss factory conducted their first course for photogrammetry in Jena in October 1909 with 45 participants. It was there that the German Society of Photogrammetry was formed. As is usual at photogrammetric meetings they ended up in a wine cellar at night. There the German Gasser became highly enthusiastic about photogrammetry. Doležal, who had founded the Austrian society 2 years before countered him: "What do you Germans

FIG. 19. Umberto Nistri.

FIG. 20. Hugershoff.

FIG. 21. Lacmann.

want; you don't even have a society." It was then that Gasser answered: "We have a society," and pointing at Pulfrich and others he said: "you, you and you are members!"

With now 2 national societies existing, Doležal created the International Society on July 4, 1910 in Vienna. Soon other chapters were formed in France, Italy, Switzerland and Eastern Europe. They united during the First International Congress of Photogrammetry in Vienna in 1913.

Then came World War I, which disrupted the society activities. The second congress, originally planned for 1915 was finally held in Berlin-Charlottenburg in 1926. Doležal writes about this interim period as follows; his quote is from 1932: "The time before and after World War I is characterized by a steady development of the technical sciences in steep progression. This development could have been of the greatest benefit to all mankind. If this has not actually been the case, then this is due to the fact, that the economy was not able to adapt to it quickly. In addition there was the war of 1914 to 1918 which concentrated all intellectual forces of the pioneers of technology in Europe to service world destruction instead of creating values, so that a flood of hatred expanded over the economy of the old world."

Doležal remained, however, optimistic when he expressed "hopes, that the world economy will familiarize itself with the new technical possibilities and that technology will in turn prove itself what it really is: a friend of mankind, and improver of living conditions and a liberator from hard labour." As an internationally minded Austrian, Doležal did not know in 1932 how soon history would repeat itself only 7 years later. Until that time Germany had an undisputed leadership in photogrammetric development, which it lost in World War II.

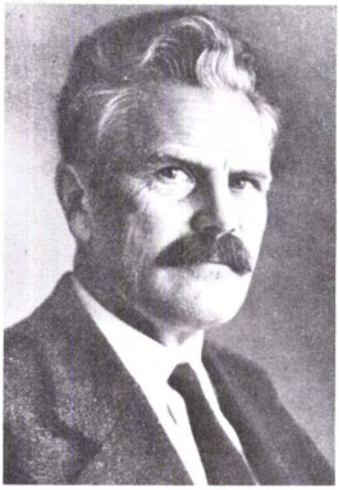


FIG. 22. Otto von Gruber.

Aerial photography became a prime tool in the United States and the USSR to win the war. The images of Dunkirk, where the allies were forced to retreat to England, later images of the V-1 and V-2 installations of Peenemünde where the Germans were trying to recover lost territory by designing new rockets are witnesses of this activity (figs. 24 and 25).

That aerial photographic interpretation had prime importance is shown in fig. 26, where General Eisenhower personally inspects photography. When the war was finally over the United States and the

FIG. 23. E. Doležal.


FIG. 24. Dunkirk.

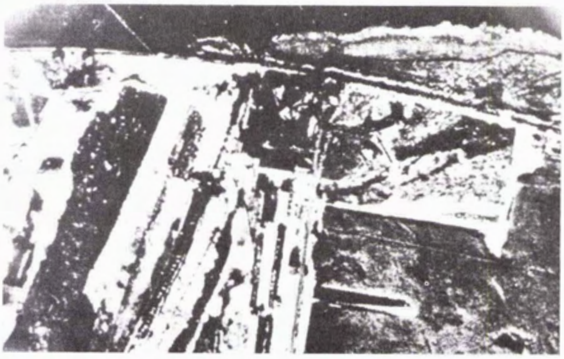


FIG. 25. V-1 and V-2 installations at Peenemünde.


FIG. 26. General Eisenhower.

USSR possessed means to map their countries efficiently, as they had practiced it in mapping enemy territory. This brought about the advent of a new US photogrammetric industry with the firms Bausch & Lomb and Kelsh. Also in the USSR a special instrument production developed. While Zeiss was in shambles in East and West, it was principally Wild in Switzerland, which was able to develop new postwar analog photogrammetric instrumentation in the form of mechanical plotters. When Zeiss was rebuilt in West and East the first production of instruments was optical, but it soon turned to be mechanical.

The spreading of photogrammetry in developing countries is especially due to Willem Schermerhorn (fig. 27); he had as a Dutch been a friend of Otto von Gruber before the war. They both pursued aerial triangulation in New Guinea before the war, which then belonged to Holland. During the war Schermerhorn spent part of his time in a concentration camp, but was keen to reestablish international ties in photogrammetry, including German participation. Schermerhorn had been elected ISP president at the 5th Congress in Rome in 1938. He was unable to reconvene the photogrammetrists of the world until 1948 in the Hague. As post war-prime minister of Holland he was able to set a monument to photogrammetry by establishing the ITC in 1951. Fred Doyle was one of the first 2 graduates. In the meantime, thousands of ITC graduates are active in responsible positions the world over.

In 1952 the 7th ISP Congress took place in Washington. Photogrammetrists the world over were finally able to reap the benefits of photogrammetry, which came about through the instruments produced by Wild, Zeiss in Oberkochen and Jena (fig. 28). Analog photogrammetry, until now, has been characterized by the creation of a professional photogrammetrist, and by the efficient and exclusive use of photogrammetry for topographic mapping.

The invention of the electronic computer by Zuse in Germany in 1941 and independently by Aitken in the USA in 1943 initiated a new development boom after 1950. While Zuse's invention remained rather unnoticed in post-war Germany, Aitken's development was heavily sponsored by the U.S. military, and it brought about a new boom in computer development. With the use of the computer the third cycle of photogrammetric development was initiated, the cycle of analytical photogrammetry.

While already Sebastian Finsterwalder in 1899 and Earl Church in the U.S.A. in 1945 had proposals for the analytical restitution of aerial photographs, it was Helmut Schmid and his collaborator Duane Brown, who in 1953 were able to apply analytical photogrammetry for practical purposes. Helmut Schmid had come to the U.S.A. from Peenemünde as a collaborator of Wernher von Braun, and who was then occupied at the U.S. Army Bal-

FIG. 27. Willem Schermerhorn.

listic Research Laboratories with tracing missiles by photography.

Subsequently European photogrammetric industry began to build Stereocomparators. But non-American institutions were at first unable to have easy access to large computer facilities, therefore their attempts in analytical photogrammetry tried to follow analog principles of restitution. Schut, Rinner, Gotthardt and Thompson followed this approach in the late 1950's.

The general concept of bundle block adjustment laid down by Schmid and Brown merely awaited its application until computer facilities were large enough. I remember well the continuing education efforts of Carper Tewinkel in ASP in the 1960's. They prepared the time, when bundle block adjustment programs became available in the USA, such as those by the U.S. Coast and Geodetic Survey, of Raytheon-Autometric and of Duane Brown Associates.

In Europe one was more aware of the fact that analogue instruments were already available in the world. Therefore Ackermann pursued aerial triangulation adjustment with independent models. His major achievement was to arrange for an international European test for block adjustment in the block "Oberschwaben" in 1973. There Ackermann and others were able to prove in a controlled experiment, that aerial triangulation of signalized points is many times more accurate than one had previously assumed. Follow-up work by Bauer and Müller of the University of Hannover showed in 1973 that this accuracy could even be improved by a factor of 2 including additional parameters for the image deformations into the adjustment, a fact which Schmid and Brown had already proved for stellar photos in satellite geodesy.

Present trends in aerial triangulation are directed toward the automatic elimination of gross errors, the incorporation of other types of data into the adjustment as well as transfer of this technology to terrestrial photogrammetry. Analytical photogrammetry can, however, not only be applied to point images measured by mono- or stereocomparator.

In 1957 Uki Helava had invented the Analytical Plotter, in which the coordinate transformation between map and image was realized by digital computation and servocontrol, rather than by optical or mechanical analogy. The analytical plotter principle permits an added flexibility in the range of the instrument, in image geometry, in compensation of systematic errors, an increase in measurement accuracy and an interactive control possibility for evaluation and the elimination of gross errors during measurement.

The first analytical plotters were produced by O.M.I. in collaboration with Bendix. It was merely a question of time and money until the available process controllers became sufficiently attractive for practice. In military applications this was the case already in 1965. In civilian applications the real breakthrough came at the 1976 Helsinki Congress, when Zeiss and Matra introduced their new analytical instruments. The trend continued in 1980 when Kern, Wild and others showed their analytical instruments.

A parallel development with that of analytical plotters was the development of image correlators. Gilbert Hobrough developed the first operating correlator in Canada in 1958. Correlator development was subsequently sponsored by the US Military to produce digital terrain models and electronic orthophotos rapidly. Notable is particularly the work of Sharp, who produced the first orthophotos by digital image correlation and digital image processing. Later, civilian analog systems have been developed in form of the Gestalt Orthophotomapper by Hobrough in 1970, by Itek in 1968, by Jenoptik in the early 1970's and by Kern and Zeiss in 1984.

A general trend for automation was, however, the digital acquisition of data for line mapping. Already in 1970 McLeod operated such a system at the Ontario Department of Highways, in which coded point coordinates were automatically joined by lines on the plotting table after they had been recorded on magnetic tape. Today most photogrammetric manufacturers offer their microprocessor driven automatic tables, which have led to a production increase by the factor of 2.

Hunting in England, the Australian Army, and Canadian and American government institutions have created data collection systems involving one computer with several stereoplotters in order to facilitate interactive digital data acquisition. Such digital data are processed further and merged with other data for storage and data output in special interactive graphic systems such as those by Intergraph, Synercom, Computervision, Kongsberg, Contraves, Kern and others. Notable are the recent attempts to mirror the graphic data base content

Photo: Byron Hale, Washington.

FIG. 28. Participants of the Washington ISP Congress 1952.

into the oculars of a photogrammetric plotter as this has been shown by Zeiss. The digital photogrammetric acquisition of line data is presently of prime interest in the development of analytical photogrammetry. The fourth development phase of photogrammetry, which I called "digital photogrammetry" is going parallel with the development of remote sensing.

Remote Sensing concerns itself primarily with the acquisition of non-geometric object informations. Up till the 1960's remote sensing was almost exclusively done by photo-interpretation. In the 1960's the U.S. Military declassified some of the newly developed sensors in the microwave and the infrared ranges. Even if the application of these sensors proceeded at first only at research institutes, remote sensing based on these sensors was established in the U.S. as a discipline by the symposia of the Environmental Research Institute of Michigan. The worldwide acceptance of remote sensing as a discipline, however, occurred by the introduction of satellites as sensor platforms.

Ever since the launch of the first Sputnik in 1957 by the USSR there was a concentration of effort in the U.S. to become leader in space technology. This started with the development of weather and communication satellites in the early 1960's and it culminated in the lunar and planetary program initiated by President Kennedy.

Digital image data transmission was used as early as 1965 in the Mars Mariner-program. The Jet Propulsion Laboratory of NASA was the first to manipulate these digital data for radiometric corrections, for filter operations as well as for geometric transformations. This technology was utilized for earth in the multispectral Landsat-program since 1972. The 5 Landsat satellites have been the prime promoter of remote sensing as a discipline the world over. While the interpreters of images have soon learned to utilize the advantages of digital image processing and of automatic multispectral classification, this technology remained, with few exceptions, generally unused by classical photogrammetrists.

The reason for this was evident, since the initial Landsat MSS pixel size of 80 m was not suitable to replace the techniques of analog and analytical photogrammetry in topographic mapping. And yet, digital methods became of interest, when the Thematic Mapper of Landsat 4 and 5 yielded 30 m pixels, when the German sensor MOMS gave 20 m pixels and when the French satellite program SPOT promises to give 10 m pixel images from space. Even if it is not yet clear how cost-effective such high resolution digital satellite images can be processed and whether their present limitations with respect to pixel size and data transmission can be overcome to be attractive for medium scale mapping and map revision, it is very evident that the new sensor and processing technology offers a magnitude of challenges. The Defense Mapping Agency of the U.S. was perhaps forged ahead most into the unknown and already knows about these challenges best. A technological boom in digital sensing and digital photogrammetry is to be expected, in which digital methods will most likely be applied in small scale thematic mapping, and in which classical photogrammetry will be applied in parallel mainly for large scale mapping.

We are amidst most interesting competing developments in sensor technology. ESA's metric camera experiment on Spacelab-1 in 1983 and NASA's Large Format Camera experiment on the Space Shuttle in 1984 have returned to Earth photographic stereo images with pixel size equivalents far beyond those achieved by Landsat. These systems will compete in cost-effectiveness with future digital sensors of higher resolution. This will not only be the case for satellite imagery, but at the same time in the area of close range engineering applications and robotics.

The development of the disciplines of photogrammetry and remote sensing will most likely follow these trends. How quickly the development will take place will depend on demand and on the economic situation. Photogrammetry will most likely remain a map-making discipline. Maps, in whatever form, are a prerequisite for economic development and the management of natural and human resources (fig. 29). Up to date maps are a model of the Earth that can be visualized and understood by the decision maker.

The higher the level of the economy of a region, the greater the need for mapping. While in purely agriculturally interested economies of our history, maps were principally required for transportation, for defence or for taxation, an industrial economy requires a complete medium scale map to plan and to manage the natural resources. A service-oriented urban type of economy leads to the need for a land information system. We see in fig. 30 that the world mapping task has by no means been completed. It is only by modern technology that we will be able to solve the mapping problem.

A United Nations statistic of 1980 shows that the small and medium scale mapping task for the countries of the world has merely been completed to 42%. An annual progress of 1.2% for mapping at 1:50 000 shows that existing technology cannot provide the desired mapping progress within our generation. At a revision rate of only 2 to 3%, even the existing maps must be greatly out of date.

An exception is certainly the work conducted by one of the most effective mapping organizations in the world, the USGS, which has been able to do a formidable job in mapping a country as big as a continent. The situation is more difficult in large scale mapping, where only few European countries such as Great Britain and Germany have been able to establish a multipurpose large scale map at scales 1:2 500 or 1:5 000.

The question is often posed, whether the maps currently produced actually do satisfy the demands for planners and decision makers, and whether their thematic content should not be increased. Such a data content could, however, only be properly man-

TYPE OF ECONOMY (PREDOMINANCE)	SMALL SCALE	LARGE SCALE
AGRICULTURE PREINDUSTRIAL	TRANSPORTATION 1:200,000 MILITARY 1:50,000	TAXATION 1:2,000-1:10,000
INDUSTRIAL PRODUCTION INDUSTRIAL	RESOURCES 1:50,000	PROJECT MAPPING (1:500-1:10,000)
SERVICES POST INDUSTRIAL	GEOGRAPHIC INFORMATION SYSTEM (1:25,000-1:50,000)	PARCEL BASED LAND INFORMATION SYSTEM (1:500-1:5,000)
TRENDS:	PHOTOGRAMMETRY → REMOTE SENSING	ANALOG PHOTOGRAMMETRY → DIGITAL PHOTOGRAMMETRY
NEED:	ALL LAND AREAS	ALL URBAN & SUBURBAN AREAS

FIG. 29. Need for mapping.

U.N. 1980

CONTINENT	SCALES		
	1:25,000	1:50,00	1:100,00
AFRICA	2%	24%	17%
ASIA•	11%	51%	62%
EUROPE•	91%	91%	77%
NORTH AM.●	34%	61%	7%
OCEANIA★	13%	42%	42%
SOUTH AM.	10%	27%	42%
USSR	5%	61%	100%
WORLD	13%	42%	42%
ANNUAL PROGRESS	0.28%	1.20%	0.28%
ANNUAL REVISION	3.2%	2.7%	2.7%

• WITHOUT USSR

● WITH CENTRAL AMERICA

★ WITH AUSTRALIA

FIG. 30. World status of mapping (U.N. 1980).

aged by a digital data system, which cannot be sensibly managed by photogrammetrists alone. The main problem in establishing such a data system lies in the organizational effort in which surveyors, cartographers, computer scientists, planners and photogrammetrists must find new structures of cooperation.

It is startling that the best progress in data integration is normally made in those countries where firm organizational structures do not yet exist. Someone asked recently at our ISPRS Council brainstorming session: "When we celebrate our 75th ISPRS anniversary this year, are we the last of the photogrammetrists?" Having traced our historical development in 3 generations and having pointed to the many unsolved tasks of the future I can only conclude, that we will be last of the photogrammetrists, if we are not able to adapt to new technologies which some are already beginning to utilize in remote sensing and in interactive graphics. If we do adapt, then indeed our International Society is not 75 years old, but 75 years young.

The adaptation requires, however, a renaissance of mind with respect to our sister societies in order to redefine our roles. It is for this reason that the International Society for Photogrammetry and Remote Sensing has cooperated with their sister societies FIG, IAG, ICA and ISM in forming a joint board at which problems of mutual interest were discussed. There is hope that at least 3 of these organizations will form a Union, the Union of Surveys and Mapping consisting of FIG, ISPRS and ICA.

The guiding principles of this union are intersociety coordination concerning activities and meeting dates; the formation of joint committees or working groups and the holding of joint symposia. It is felt desirable that each society maintains its separate identity.

But it is necessary that the union makes strong joint representation in the United Nations, in the International Council of Scientific Unions and in the Committee on Space Research. As future activities we envisage:

- the establishment of a central office
- joint publications, such as a multilingual dictionary
- an information retrieval system
- and intensified contacts to other related organizations in remote sensing, such as IGARSS, IAF, EARSeL, AARS and others.

This is a framework, which societies can create; but surveyors, geodesists, cartographers, photogrammetrists and remote sensing experts fill it with substance to be of mutual benefit. I have hopes that in this context ISPRS can celebrate its 100th Anniversary in the year 2010.