and variable magnification for each ocular (to permit viewing of convergent photography). An automatic readout on IBM cards is planned by USAERDL so that all the necessary computations including the coordinate transformation, corrections, triangulation, and adjustments can be performed as one operation in the computer.

Future Instrumentation

Analytical triangulation offers at least two attractive prospects for the future. First, it introduces an effective tool for tracking down and destroying the photogrammetric gremlins that consistently sabotage most photogrammetric triangulation efforts. Ingenious instrumentation on the way should materialize this, as well as the other impressive potential advantages of the analytical system.

The second prospect is of greatest concern to the military. Analytical methods offer hope for solution of one of the most urgent military needs—rapid processing of maps and target location data. The remaining obstacle to automation, that of pass-point selection, is a great one, but surely not insurmountable.

Review of The Ottawa International Photogrammetric Conference on Aerial Triangulation

An International Conference on aerial triangulation was held at the Canadian National Research Council in Ottawa, Canada, during the period, August 28–31, 1957. The conference was jointly sponsored by the National Research Council and the Canadian Institute of Surveying.

The opinion of many of those attending was that the program, under the direction of Mr. T. J. Blachut of U. R. S. was very fine, and the hope was expressed that more such conferences would be possible in the future.

The evening hours and Saturday were taken up with an elaborate social program, typical of the Canadian Hospitality.

A complete account of the conference is to be published in a forthcoming special issue of "Photogrammetria." The following are abstracts of papers on subjects connected with aerial triangulation, that were presented at the conference by several well known photogrammetrists.

Abstracts of Papers

GENERAL CONSIDERATIONS ON ANALYTICAL AERIAL TRIANGULATION

PROFESSOR E. H. THOMPSON
University College, London, England

THE ultimate accuracy of aerial triangulation will be limited by the combined effect of aircraft movement and refraction. Aircraft movement makes a short exposure time necessary. This prevents the elimination of the effect of random local refraction, which would be effected if a mean image position were obtained through time exposure. Since the size of the air masses involved is not known, a multiplicity of redundant points in the same neighborhood may not eliminate this effect either.

With a film base, a high accuracy is only possible if film distortion is corrected by means of a reseau. The reseau is also necessary to detect and correct undulation of films and even of plates. It is unrealistic to talk of measuring equipment having a standard error of 3μ without its use.

Development of further methods of computation in analytical aerial triangulation is fruitless unless it is directed toward one or more of the following: the most efficient use of redundant information, the most efficient use of the electronic computer, or the most efficient way of organizing the work. Redundancy arises if more points are measured than are necessary for relative orientation and if, in addition to the condition of coplanarity of corresponding rays, use is made of the space coordinates of points fixed on the previous overlap. The second possibility poses the problems of assigning correct weights to the various data. Also, accurate identification of points on successive overlaps is here imperative. Identification is less critical if the relative orientation is performed by making use of the condition of coplanarity only, and those points are used only for scaling. Furthermore, mistakes of any sort in any model affect all subsequent models. This can invalidate large amounts of work and precludes examination of individual models for errors. Therefore, computation and examination of independent relative orientation, followed by joining the models into strips, makes the office organization much more flexible.

The Cambridge Stereocomparator has three main short-comings, so far as analytical aerial triangulation is concerned. First, the readings must be made by the operator and manually recorded. Second, the instrument is not sufficiently flexible, especially in range of x and y movement. Third, it is not as accurate as required. A new instrument is being developed for the Ministry of Supply by Messrs. Hilger and Watts. Rotation of the photographs will only be possible optically by means of Amici prisms between the photographs and the measuring marks. The accurate measuring range will be 20 mm. In case the photograph does not carry a reseau, a gridded glass plate can be placed over it. The scale readings will be picked up by a photoelectric cell for recording on punch cards, paper tape or magnetic tape. They will also be displayed visually. The magnification of each photograph can be changed independently from $5\times$ to $20\times$.

A SYSTEM OF ANALYTICAL BRIDGING INCLUDING CANTILEVER EXTENSION

PROFESSOR A. J. MCNAIR
Cornell University

Analytical aerotriangulation has become practicable by the widespread availability of electronic computers. For strips of more than a few miles in length the earth curvature must be taken into account. For this purpose a rectangular geocentric coordinate system provides a convenient reference system. After the triangulation is computed in this system the geocentric coordinates must be converted to geographic coordinates. Formulas are presented for conversion in both directions.

The orientation of photographs is best defined by the tilts of the x and y photographic axes and the azimuth of the x photographic axis. The triangulation makes use of differential expressions in an iterative procedure. The problems to be solved analytically are: 1) relative orientation; 2) differential scale restraint (carryover); 3) absolute orientation; 4) block adjustment. A certain amount of non-redundant information is required in order to make the bridge solvable. This information consists in the coordinates of corresponding points in two or three consecutive photographs and in coordinates of ground control points. A table included in the paper shows this amount for a simple photograph, for two, and for three photographs. Use of redundant information will increase the accuracy of the result.

The method, devised at Cornell University, makes use of vector notation as initiated by Dr. Paul Herget. It is adaptable to the general problem of aerial triangulation and to special cases—space resection and orientation of a single photograph, cantilever extension and bridging.

Analytical aerotriangulation will permit a reduction in the required amount of ground control points. It will also greatly lift the restrictions on the placement of ground control, on tilt, focal length, differences in flight altitude, amount of relief and curvature in flight lines.

AN ANALYSIS OF METHODS AND RESULTS IN ANALYTICAL AERIAL TRIANGULATION

G. H. SCHUT
Canadian National Research Council

The methods of analytical aerial triangulation published in the photogrammetric literature of recent years fall into three groups. The first group performs strip triangulation by independent relative orientation of each model. The position of points in the preceding model is used only for scaling. The second group also performs strip triangulation, but in each model the positions of points in the preceding model are used for the determination of all orientation elements. This enforces the position of these points in the new model. The third group performs the orientation of all photographs of a strip simultaneously.

The difference between the methods of each group consists in the condition of intersection of corresponding rays which is used. The merits of each method can be judged by the required amount of computation. The condition of coplanarity, combined with linearizing by means of the MacLaurin series, has been employed at the National Research Council of Canada in a method of the first group. Two iterations are sufficient for relative orientation. This condition is the most economical one if the points are not chosen in fixed positions.

A method which uses y parallax in the model has been applied to the first group by the British Ordnance Survey. Treating only the special case of six points in each model, situated in the usual positions for numerical orientation, they make use of the simple formulas for this orientation. From 8 to 11 iterations are considered necessary. Variants of this method are given by Prof. Thompson and by Wassef.

A method which uses y parallax in the photographs has been developed by Jerie for the first group and the six point case. The photograph coordinates are converted to coordinates on fictitious photographs situated in a straight line with rotations equal to zero.

A method of the second group, using equality of angles, has been set up by Church and by Bartorelli. In this method space resection and orientation of a photograph can be computed separately.

A method which uses the minimum distance of corresponding rays has been constructed by Herget for the third group and has been modified by McNair for use in the second group.

A method of the third group has been devised by Schmid, who uses the condition of coplanarity combined with linearization by means of the Taylor series.

AERIAL TRIANGULATION USING THE SOLAR PERISCOPE

DR. E. SANTONI

Italy

In this paper the author reviews the main characteristics of the solar method and gives some indications of results achieved.

For the three degrees of freedom normally represented by the rotation of the axes K, ω, ϕ, the solar method substitutes one only—rotation around an axis represented by a solar ray penetrating the camera. This rotation, however, can be broken down into the three rotations, K, ω, ϕ, which remain correlated by well-defined incremental ratios. Because, in bridging, the rotation K is the one that is transmitted in the best way, the normal method of solar triangulation is based on the transfer of K. From the value of K the values of ω and ϕ are computed in two or three minutes using the "Solar Computer." When compensating the bridging, the correction of the azimuth (dK) for each model is first deduced from the results of planimetric compensation. Corrective rotations $d\omega$ and $d\phi$ can then be computed for each model and used for altimetric compensation. The extreme simplicity of the method allows results which are largely independent of the ability of the operator and of the nature of the ground, and permits the use of purely mathematical computations for special high precision purposes.

In an aerial triangulation of about 100 kms., with a flying height of about 14,000 feet, over terrain of average ruggedness, with elevation differences up to 2,000 feet and with no intermediate points known, the mean square error after compensation were less than 2.5 meters in elevation and 3 and 6 meters in planimetry.

COMPENSATION OF AERIAL TRIANGULATION USING OPTICAL-MECHANICAL AIDS—NEW PROPOSALS

DR. E. SANTONI

Italy

This paper describes three optical-mechanical devices for the compensation of aerial triangulation which have recently been designed and perfected by the author.

The first device described is designed to record the planimetric position of pass points and control, at the scale of the model, on a stable surface, e.g., a lacquered glass plate.

The second is a co-ordinatograph which is to be superimposed on the glass plate used in the first device, and which can be oriented in relation to it so as to account for azimuth errors. This instrument allows us to view points marked on the plate, to read the x and y co-ordinates of the points and to determine altimetric corrections due to the ϕ and ω rotations of the model.

The third device, which is to be used before the co-ordinatograph, is designed to improve the graphical method compensation. It is capable of tracing a family of parabolic curves by means of a metal tape and screws having an appropriate pitch or rotation ratio.

USE OF AUXILIARY DATA IN AERIAL TRIANGULATION OVER LONG DISTANCES

T. J. BLACHUT
National Research Council

From the theoretical point of view, there is no difference between aerial triangulation over long and short distances. Basic errors and their propagation are exactly the same. However, there is a quantitative difference which enters the picture immediately when one is confronted with a practical operation over vast territories containing only a very sparse network of ground control. A detailed study of errors and their propagation is very important, but it does not solve the fundamental problem; it merely allows us to minimize closure errors and flatten curves of error. The final answer would be a method that would allow us to take into account errors "as they are and not as one would like them to be." A possible solution may be found in the use of various auxiliary data. In most cases "auxiliary data" refers to the elements of outer orientation. In the method of airborne controlled aerial triangulation, developed with particular concentration on the solution of the problems outlined above, "auxiliary data" refers to the strip or ground coordinates. Data recorded during the flight include:

1. Distances from the aircraft to the ground.
2. Profile of the terrain along the flight line.
3. Oblique photographs fore or aft in the flight direction.

Using these data the accumulation of errors in x, y and z coordinates may be controlled.

The method has been tested and used several times, for example, over distances of 300 km., 240 km. and 60 km. The mean square errors for these three tests are shown in the following table.

300 km.	*240 km.*	*60 km.*
$m_z = \pm 2.4$ m.	± 5.6 m.	± 2.2 m.
$m_x = \pm 6.7$ m.	± 6.4 m.	± 2.8 m.
$m_y = \pm 8.0$ m.	± 9.5 m.	± 2.4 m.*

The 60 km. test was made over mountains reaching an elevation of over 1000 m

Although it is felt that more statistical material is needed, the results indicate that the choice of auxiliary data used for the airborne controlled meth-of of aerial triangulation was expedient and that application of these data gives very good results. With further instrumental improvements and with the advantages of analytical treatment, it is possible that many of the secondary geodetic operations will be performed by photogrammetric means.

* In this case oblique photographs were not available and y coordinates were adjusted by using ground control.

PROCEDURE OF MECHANICAL PRESERVATION OF REFERENCES

DR. B. DUBUISSON
France

Scientific and technical progress comprises an uninterrupted succession of improvements that complicate the previous procedures and introductions of new simplifying principles that in turn will be perfected and complicated by further evolution. Aerial triangulation is certainly no exception to this rule and the present paper is a contribution towards simplification of the problem of aerial triangulation. Use of a "Twin Free Gyro Reference Keeper" is proposed. Free gyro maintains the direction in space of its axis of rotation with a precision of 5.5c per minute and it is estimated that in the case of photographs made at eight sec. intervals the directions of two arbitrary axes, e.g. ϕ and ω, can be determined to about 0.5c. This makes possible establishing relative orientations faster and more accurately than by conventional methods. Use of the free gyro method for bridging purposes is possible because of the extremely long natural period of such a gyro. This means that the possible errors are very nearly linear over a relatively long time, say for 15 minutes. During this time a strip of photographs about 70 km. long may be made. A method for correcting the gyro indications for the speed of the aircraft is given, and two different methods for performing actual aerial triangulation using the free gyro data are proposed. As yet no practical experiments based on the above suggestions have been carried out. However, gyro equipment of this type is being manufactured, for example in England and in France, enabling experiments to be performed.

GENERAL PROBLEMS IN AERIAL TRIANGULATION

MR. A. J. VAN DER WEELE
Netherlands

Dealing with the preparation of photographs for aerial triangulation, Mr. van der Weele points out some of the weaknesses of the usual procedure in selecting and marking points for connection of adjacent strips. For the most economical solution it is necessary to reduce the work done in the first-order instrument used. Therefore, each time consuming operation, such as point identification, that can be done elsewhere should not be left to the operator at the instrument. A check on identification errors is possible only at the computation stage, and it is often impossible to identify the same point of detail on both strips with great precision. He maintains that the accuracy of transfer of connecting points from one strip to the next should be at least equal to, but preferably greater than, the corresponding observational precision of the topographical detail to be plotted and he outlines a stereoscopic method by which this accuracy may be attained.

Going on to consider the character of errors in aerial triangulation, the author shows that the problem of separating systematic and accidental errors has not been completely solved. He concludes that there is not much point in continuing to invent new methods or systems that eliminate instrumental errors until more of the errors inherent in the photographs themselves have been closely investigated and means found to diminish their influence. This conclusion also applies to the analytical treatment which can be considered as the last step in avoiding instrumental errors. The author thinks that, for the time being, no considerable gain in precision is to be expected. Rather, the advantage of analytical treatment is found in the possibilities for extreme automation of the triangulation procedure. He sees possibilities for further progress in the separating of systematical and accidental errors by the use of such auxiliary data as that provided by the solar periscope, radar profile, etc., in the improved adjustment methods of single strips and in the appropriate treatment of block adjustment.

L'EVOLUTION DE L'AEROTRIANGULATION A L'INSTITUT GEOGRAPHIQUE NATIONAL FRANCAIS

MASSON D'AUTUME*
France

Methods of aerotriangulation used at IGN are discussed. Research toward attempting to better triangulation methods by improving the methods of outer orientation is described. Use of a recording gyroscope for this purpose is suggested.

Gyroscopes of the recording type are compared with those of the slaving type. Experiments have shown that significantly greater accuracy may be obtained with the recording gyro, at less expense, due to the relatively small size of the recording gyro.

Use of a pendulum in conjunction with a gyro provides a better control over the more sudden changes in aircraft attitude.

The computation involved in the utilization of gyroscopes is rather cumbersome, and a mechanical analogue system of compensation has been developed at IGN for the performance of block adjustment.

* Mr. d'Autume was unable to be present, and his paper was presented by a colleague, Mr. M. Baussart.

GENERAL CONSIDERATIONS ON ERROR PROPAGATION AND ADJUSTMENTS IN STRIP TRIANGULATION—ATTAINABLE ACCURACY

DR. A. J. BRANDENBERGER
Ohio State University

Dealing with the relation between systematic and accidental errors in strip triangulation, Dr. Brandenberger shows that, while the closing errors in longer strips are caused principally by systematic errors, both kinds of errors have about the same magnitude in any one model of a strip. Propagation laws for systematic errors are well known, but those for accidental errors present some difficulties.

One method of determining error propagation laws is the analysis of a sufficiently large number of actual strip triangulations. The author presents the results of such an analysis as made by the Institute of Geodesy, Photogrammetry and Cartography of Ohio State University. Eleven strips were used, with flying heights ranging from 6,000 to 20,000 ft. and ground elevations varying from 0 to 5 per cent of the flying height. The number of models varied from 6 to 14 and length of strips was from 6 to 52 kilometers. Results are presented in the form of graphs representing the average error propagation and closing errors as functions of the number of models and flying height. Average closing errors of x over 20 models range from 15 meters for $H=1{,}000$ meters to 240 meters for $H=15{,}000$ meters (heights up to 15,000 meters were statistically extrapolated). The corresponding range for closing errors of y is from 18 to 270 meters, and in elevation (after elimination of earth's curvature) 20 meters to 200 meters. These graphs are useful for cantilever triangulation used for military purposes but for civilian purposes it is more important to know the residual x, y and elevation errors after the strips are adjusted.

The eleven strips mentioned were adjusted on the basis of a standard dis-

tribution of a given ground control and according to the graphical method which is based on parabolic deformations of the strip areas and which uses three cross profiles and three longitudinal profiles. The standard residual errors for a single model with given ground control points (the first model of a strip or a strip with only one model) represent the remarkably high accuracy for individual picture coordinates of ± 4.5 microns. From this Dr. Brandenberger concludes that if analytical strip triangulation is to attain the accuracy of a strip triangulation carried out by first-order stereoplotter, the picture coordinates will have to be measured to an accuracy which is very difficult to attain, considering the quality of pictures taken with most aerial cameras at present. Standard residual position errors after adjustment, shown in graph form, range from 0.45 meters for $H = 1,000$ meters to 6.7 meters for $H = 15,000$ meters, and for standard residual elevation errors the corresponding range is from 0.27 meters to 4.02 meters.

The institute of Geodesy, Photogrammetry and Cartography of Ohio State University plans to carry out further such analyses of strip triangulation on a more extensive scale.

DETERMINATION AND CORRECTION OF SYSTEMATIC ERRORS IN THE FUNDAMENTAL OPERATIONS OF AERIAL TRIANGULATION

B. HALLERT

Sweden

For photogrammetric measuring procedures, as for all measuring procedures, the determination of the systematic sources of errors of the fundamental operations must be carefully performed if reliable results of high precision are wanted in the final results.

The determination must be performed under conditions which are as similar as possible to those of the practical application of the measuring procedure. The method of least squares is the finest tool for the detection and determination of systematic errors.

On the other hand, the application of the method of least squares for the adjustment of the discrepancies of triangulation with superfluous control points and for the study of error propagation, necessarily requires that at least the most important systematic errors and discrepancies of the fundamental operations be corrected, optically, mechanically or numerically.

There is little to gain in accuracy from analytical aerial triangulation if those systematic errors that are still present today in the aerial photographs are neglected. Even if the accidental errors of instrumental measurements can be decreased from 4–5 microns (the A-7) to 1–2 microns (the stereocomparator), this means very little in comparison with uncorrected systematic errors of the magnitude of 10 to 20 microns or larger, depending upon the camera, flying altitude, etc.

For special investigations of varying sources of systematic errors, camera tests from high towers may be used. Results are presented for one such test from a tower 125 meters high. A system of control points was constructed on the nearly flat ground under the tower and the camera was adjusted very accurately above the center of the control point figure. The inner orientation could then be directly determined from simple image coordinate measurements and computations, and the radial distortion was easily determined from the scale variations of the circles into which the control points could be combined.

In order to determine the systematic disturbances of the bundles of rays under actual flying conditions, the grid method is used in camera tests from the air. For this purpose one test field has been constructed on the island of Oland, with 25 points forming a grid on an area about 4 miles square. Results of one test on this field are presented.

The actual quality of the relative orientation can be determined from residual *y*-parallaxes by direct measurements (in the plotters) or by computation (in the analytical procedure). This enables the photogrammetrist to check all individual models directly in connection with the plotting.

NEW PRINCIPLE FOR PHOTOGRAMMETRIC PLOTTERS

U. V. HELAVA
National Research Council

All the existing photogrammetric plotters capable of solving the main photogrammetric problem are actually based on the same principle, which may be called the simulation principle. In this method real physical projection,—optical, mechanical or optical-mechanical—is used. A critical study shows that this principle can not be considered as ideal since it results in inflexible and bulky instruments that require extremely high precision in manufacture. In addition, the economical factors, particularly the application of automation and the possibilities offered by electronics, should be considered. These thoughts were the starting point for studies which led to a new principle in which the physical projection is replaced by a mathematical one.

In the new principle the photographs or measuring marks are shifted in the *xy* plane by amounts corresponding to the displacements caused by central projection and by various other factors. These amounts are computed by a special computer and are executed by servo-mechanisms. Thus the plotter consists of two main parts—a viewing-measuring device and a computer. The viewing-measuring device resembles the stereocomparator except for the servo-mechanisms incorporated in the new instrument. The computer for the prototype instrument employs electronic analogies. This instrument which is called the Analytical Plotter, is now being built by the National Research Council.

The new principle has several advantages over the simulation method and opens up new possibilities. For example, all known errors may be corrected, focal length and distortion characteristics of the camera used are easy to take into account, the size of the instrument is relatively small, etc. In addition, the new principle lends itself well to automation of various operations. A semi-automatic relative orientation is planned to be incorporated in the prototype plotter.

CONSIDERATIONS IN THE DESIGN OF AN ELECTRONIC COMPUTER FOR A PHOTOGRAMMETRIC PLOTTING INSTRUMENT

WILLIAM J. M. MOORE
National Research Council

Electronic analog computation techniques provide a very versatile and flexible means of solving mathematical equations. If the equations are known by which unknowns are related to a number of constants and variables, a circuit may be designed that continuously solves the equations and gives the values of the unknowns. Basically, the circuit consists of components capable of performing certain algebraic operations such as summing, multiplication, etc. By proper combination of components the required functioning may be obtained. The operational quantities are usually voltages and therefore the mechanical displacements involved in the problem must be converted to voltages for computation purposes, and if the result is required in mechanical form the voltages representing the unknowns are finally transferred to a mechanical displacements by servo mechanisms. When these methods are applied to the photogrammetric problem a very high degree of accuracy is the overriding requirement. The electronic analog computation components normally are capable of giving an accuracy of approximately 0.1% of the output although 0.01% may be reached.

The circuit for the proposed Analytical Plotter is given in this paper. It was tested using a standard electronic analog computer and sufficient accuracy was obtained. The flexibility of electronic methods enables us to use special solutions, such as function generations for correcting all known errors, and makes future developments toward greater automation of photogrammetric processes feasible

NEWS NOTE

New Book on World War II Photo Intelligence Outlines Basis for Present Aerial Surveys

The story of photo intelligence in World War II, which laid the basis for present-day aerial survey and geophysics, is excitingly told for the first time by Constance Babington-Smith in "Air Spy" (Harper & Brothers, New York. Price: $4.00). Both article and book are well illustrated with photographs. The author started the Aircraft Section of the Central Interpretation Unit at Medmenham in England and was in charge of it until VE-Day. She was then transferred to USAAF Intelligence to continue interpretation work on photographs of the Pacific Theatre.

"Air Spy" provides a new behind-the-scenes angle on some of the most dramatic and important events of the war in Europe: the Bismarck chase, the Commando raids, the great Allied bombing offensive, D-Day itself, incredibly accurate forecasts of U-boat and aircraft production and the analyzing of the German V-weapon threat months before the first buzz bomb appeared over England.

The part played in the discovery of V-weapons and other threats by means of photo intelligence under Wing-Commande Douglas N. Kendall, officer-in-charge o the Central Interpretation Unit, is detailed. The author introduces him early in the book: "Within a few days a young pilot officer named Douglas Kendall was taking the French interpretation course. This arrangement meant more for the future than was obvious at the time."

The book ends with Wing Commander Kendall's comment when he found that the Germans employed non-commissioned photo interpreters who used single photographs rather than stereo pairs; "Old von Fritsch was right when he said that the side with the best photographic reconnaissance would win the war. But it seems that Hitler and his pals didn't know what 'best' meant, and didn't care much anyhow. They never found out that what counts most in P.I. (Photo Intelligence) is the people who are in it. They made all the mistakes we might have made if it hadn't been for our team of individualists."

Wing Commander Kendall left England in 1946 to found The Photographic Survey Corporation, in Toronto, to carry to peacetime use the techniques learned in wartime. Today he is the operating head of the Canadian Hunting companies, which in association with other Hunting companies throughout the world are the largest aerial surveyors in the world.

Semi-Annual Convention
American Society of Photogrammetry

ST. LOUIS REGION

ST. LOUIS, MO.—OCTOBER 2, 3, 4, 1957

The Program

WEDNESDAY, OCTOBER 2

AFTERNOON

Registration Desk Opened
Official Opening of Exhibits

EVENING

Exhibits Closed
"Getting to know you" Reception—Cocktails

THURSDAY, OCTOBER 3

MORNING

Introductions, *Glenn A. Harper*, General Chairman
Official Opening, *Kenneth E. Reynolds*, President, American Society of Photogrammetry
Remarks, *Louis J. Reed*, President, St. Louis Region
TECHNICAL PAPERS—*Louis J. Reed*, Presiding
- Tracking the Earth Satellite and its Significance to Photogrammetry—*Dr. J. Allen Hynek*, Smithsonian Astrophysical Observatory Institution
- Hiran Surveying in the U. S. Air Force—*Archer M. Wilson*, USAF Air Photographic and Charting Service
- Resolution as a Measure of Interpretability—*Dr. Duncan E. Macdonald*, Boston University
- Aerial Surveys and Mapping by Photogrammetric Methods for Highways—*C. Robert Wright*, Bureau of Public Roads

AFTERNOON

TECHNICAL PAPERS—*Dr. Albert Frank*, Presiding
- Organization for Air Force Chart Production—*Thomas C. Finnie*, USAF Aeronautical Chart and Information Center
- Photogrammetric Education and Research at MIT—*Charles L. Miller* and *D. R. Schurz*, Massachusetts Institute of Technology
- Evaluation Report on the Accuracy of Trimetrogon Compilation Techniques—*Winston Sibert*, U. S. Geological Survey
- Increased Base:Height ratio—*Joseph B. Theis*, U. S. Army Map Service

PANEL—THE FUTURE OF ANALYTICAL AERIAL TRIANGULATION
- Moderator: *Edwin A. Roth*, USAF Aeronautical Chart and Information Center
- Participants:
  - *Dr. Paul M. Pepper*, Mapping and Charting Research Laboratory, Ohio State University
  - *G. C. Tewinkel*, U. S. Coast and Geodetic Survey
  - *Dr. Hellmut Schmid*, Ballistics Research Laboratories, Aberdeen Proving Ground
  - *B. J. Bodnar*, U. S. Army Engineer Research and Development Laboratories
  - *V. A. van Praag*, Bendix Computer Corporation
  - *G. H. Schut*, National Research Council, Canada