

DEFINITIONS OF TERMS USED IN PHOTOGRAMMETRIC SURVEYING AND MAPPING*

Preliminary Report

*Prepared by the Committee on Nomenclature of the
American Society of Photogrammetry*

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PREFACE

IT is important that every art and science have a clearly defined and accepted nomenclature if ambiguity and misunderstanding are to be avoided. This is particularly applicable to photogrammetry due to its rapid development in recent years. So much effort and thought have been given to this new subject that it is not strange that carelessness in the use of terms peculiar to the art has arisen or that new and ambiguous terms have sometimes been proposed for older ones which were entirely satisfactory.

It was for the purpose of avoiding this confusing situation that the American Society of Photogrammetry has had its Committee on Nomenclature engaged for several years in defining those terms that were acceptable for use. This study has now progressed to a point where it seems advisable that the results be made generally available as a first and important contribution toward the eventual standardization of photogrammetric terms.

In preparing these definitions it has been the primary purpose to select and define the more fundamental photogrammetric terms and eliminate many duplicate and superfluous ones. The approval of certain terms and the disapproval of others has been based on a careful study of general photogrammetric usage, usage in other fields of endeavor and the relative simplicity of the terms when used in oral and written discussion. In some cases it was necessary for the Committee to be somewhat arbitrary in selecting a particular term in preference to another but this has seemed preferable to the continued use of several terms where one would suffice.

In many cases definitions have been amplified to include somewhat detailed explanations of the meaning and use of the terms. This has been done deliberately with the thought that such explanation will be useful to the student or practitioner, particularly until such time as the terms used in photogrammetric textbooks are more nearly standardized.

In addition to the strictly photogrammetric terms, a number of words and terms in allied fields of endeavor such as Optics, Cartography, Surveying, etc., have been included. In general, these are terms most often encountered in the various operations of practical photogrammetry and for which definitions are not readily available. It is believed that the inclusion of these terms will make the report on nomenclature more useful to all who may have occasion to refer to it.

In many cases the definitions of related terms have been grouped with the thought that this arrangement will serve to emphasize the different shades of

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meaning as between closely related terms. This correlation has the effect of cross-referencing an appreciable number of terms but on the whole it is felt that the advantage gained by so grouping them more than outweighs the disadvantage accruing from cross-referencing.

These definitions represent a very considerable amount of research and study on the part of the Committee. It is realized that the list is not complete nor are the definitions final and absolute. The membership of the American Society of Photogrammetry is urged to familiarize itself with the definitions that have been recommended and make it a point to use them as defined. It is very important that all comments on the list be forwarded to the Committee for its future guidance. These comments should include not only the terms listed but also all others that may have been overlooked or which may be introduced in the future.

The Committee on Nomenclature should be continued from year to year for the purpose of receiving these suggestions and modifying and expanding the list as seems necessary from time to time, as only by so doing can an eventual standardization of photogrammetric terms be attained.

The Committee is deeply indebted to the Committee on Definitions of Surveying and Mapping Terms of the Federal Board of Surveys and Maps, whose reports were placed at the disposal of the Chairman of the Committee. Acknowledgment of the definitions used has been indicated in the text in a suitable manner.

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Definitions recommended to the Federal Board of Surveys and Maps by its Committee on Nomenclature have been marked with an asterisk (*).

Definitions prepared by the same Committee but not formally reported to the Board of Surveys and Maps have been marked with two asterisks (**).

Figures referred to in the definitions will be found at the back.

Aberration—*Optics*: A defect of an optical image caused by the fact that essentially no lens system can form a perfect image. **Astigmatism**—An aberration affecting the sharpness of images caused by the fact that for objects off the axis the rays passing through different meridians of the lens come to a focus in different planes. Thus an extra-axial point object is imaged as two mutually perpendicular short lines located at different distances from the lens. **Lateral Chromatic Aberration**—An aberration which affects the sharpness of images off the axis because different colors produce different magnifications. **Longitudinal Chromatic Aberration**—An aberration which affects the sharpness of all parts of the image because different colors come to a focus at different distances from the lens. **Coma**—An aberration affecting the sharpness of images off the axis—caused by the fact that rays from an object point off the axis passing through a given circular zone of the lens come to a focus in a circle rather than a point, and the circles formed by rays through different zones are of different sizes and are located at different distances from the axis. The image of a point object is comet shaped. **Curvature of Field**—An aberration affecting the longitudinal position of images off the axis in such a manner that objects in a plane perpendicular to the axis are imaged in a curved or dish-shaped surface. **Distortion**—An aberration affecting the position of images off the axis, caused by the fact that objects at different distances from the axis undergo different magnifications; frequently referred to as **Lens Distortion**.

Absolute Ceiling—*Air Navigation*: The height in the standard atmosphere at which the rate of climb of an aircraft is reduced to zero. The maximum height above sea level at which a given airplane can maintain horizontal flight. Not **CEILING**. See also **SERVICE CEILING**.

Absolute Fore and Aft Tilt—Not approved. See Y-TILT under TILT.

Absolute Humidity—See under HUMIDITY.

Absolute Lateral Tilt—Not approved. See X-TILT under TILT.

Absolute Orientation—See under EXTERIOR ORIENTATION.

Absolute Stereoscopic Parallax—See under PARALLAX.

Accommodation—The faculty of the human eye to adjust itself to give sharp images for different object distances.

Accuracy**—Degree of conformity with a standard. Accuracy relates to the quality of a result, and is distinguished from precision which relates to the quality or refinement of the operation by which the result is obtained. The standard of reference may be (1) an exact value, such as the sum of the three angles of a plane triangle is 180°; (2) a value of a conventional unit as defined by a physical representation thereof, such as the international meter, defined by the international prototype meter (bar) at the National Bureau of Standards; (3) a survey or map value determined by refined methods and deemed sufficiently near the ideal or true value to be held constant for the control of dependent operations, such as the adjusted elevation of a permanent bench mark. For example, the accuracy attained by field surveys is the product of the instructions to be followed in the execution of the work and the precision with which those instructions are followed.

Achromatic Lens—Refers to a lens which has been partly corrected for chromatic aberration. Such a lens is customarily made to bring green and red light rays to approximately the same point focus. Also called an *Achromat*.

Aerial Camera—See under CAMERA.

Aerial Map—Not approved. Maps are not classified by the method of obtaining the data. See SURVEY and MAP.

Aerial Mosaic—See MOSAIC.

Aerial Photogrammetry—See under PHOTOGRAMMETRY.

Aerial Photograph—A photograph made from an aircraft.

Aerial Photography—The taking of photographs from aircraft.

Aerial Photographic Mosaic—Not approved. See MOSAIC.

Aerial Survey—See under SURVEY.

Aerial Triangulation—Not approved. See RADIAL TRIANGULATION.

Aeronautical Chart—A map especially designed for the aviator, on which, in addition to essential topography, are shown obstructions, aids to navigation, and other information to assist the aviator in navigating.

Air Base—*Photogrammetry*: The line joining two air stations. See AIR STATION under CAMERA STATION.

Air Base Inclination—Not approved. See BASE TILT under BASAL ORIENTATION.

Air Coordinates—See under COORDINATES.

Air Speed—The velocity of an aircraft relative to the surrounding atmosphere.

Air Station—See under CAMERA STATION.

Altimeter—*Air Navigation*: An instrument which utilizes relative pressure of the atmosphere to indicate the vertical distance above a specified datum plane.

Altitude—*Aerial Photography*: Vertical distance above the datum, usually mean sea level, to an object or point in space.

Amici Prism—A prism which deviates the rays of light through 90° and, because of its shape which is tetrahedral, inverts the image. The inversion of the image is the same as when a convex lens forms an image of a distant object. An amici prism is often called a ROOF PRISM. See also definition of ROOF PRISM.

Anaglyph—A picture printed or projected in complementary colors and combining the two images of a stereoscopic pair, and which gives a stereoscopic image when viewed through spectacles having filters of corresponding complementary colors. The same effect can be obtained by using polarized light and filters.

Analytic Nadir Point Triangulation—See under RADIAL TRIANGULATION.

Analytic Radial Triangulation—See under RADIAL TRIANGULATION.

Anastigmatic Lens—A lens which has been corrected for astigmatism and curvature of field. See ABERRATIONS.

Aneroid Barometer—See BAROMETER.

Angle of Convergence—See under PARALLAX.

Angle of Incidence—*Optics*: The angle measured from the normal at which a ray of light strikes a surface.

Angle of Reflection—*Optics*: The angle measured from the normal at which a reflected ray of light leaves a surface.

Angle of Refraction—See under REFRACTION.

Ångström Unit (Abbreviated A. U. or Å)—A standard of measurement of wave length of light equal to one ten-millionth of a millimeter; for example, the visible spectrum is said to extend from about 4000 Å to 7000 Å (0.0004 to 0.0007 mm.).

Angular Calibration Constants—In a multiple lens camera, the interior orientation of the plate perpendiculars of the several lens-camera units to a common origin of direction.

Angular Magnification—See under MAGNIFICATION.

Angular Parallax—See under PARALLAX.

Angular Parallax Difference—See under PARALLAX.

Aperture—See RELATIVE APERTURE and APERTURE STOP.

Aperture Stop—*Optics*: The physical element (such as a stop, diaphragm or a lens periphery) of an optical system which limits the size of the pencil of rays traversing the system. The adjustment of the size of the aperture stop of a given system regulates the brightness of the image without having any necessary effect upon the size of the area covered. **Field Stop**—The physical element (such as a stop, diaphragm, or lens periphery) of an optical system which limits the field of view covered by the system. **Entrance Pupil**—The image of the aperture stop formed by all the lens elements on the object side of the aperture stop. **Exit Pupil**—The image of the aperture stop formed by all the lens elements on the image side of the aperture stop. **Entrance Window**—The image of the field stop formed by all the lens elements on the object side of the field stop. **Exit Window**—The image of the field stop formed by all the lens elements on the image side of the field stop. **Field of View**—1. *Optics*: The angular coverage of a lens system. It is equal to the angle subtended by the diameter of the entrance window at the center of the entrance pupil. 2. *Photogrammetry*: The angular coverage of a photograph is equal to twice the angle whose tangent is one-half the length of the diagonal (or diameter) of the photograph divided by the calibrated focal length of the camera.

Aplanatic Lens—A lens which has been corrected for spherical and chromatic aberrations.

Apochromatic Lens—A lens which has been corrected for chromatic aberration for three colors.

Apparent Horizon—See HORIZON.

Astigmatism—See under ABERRATION.

Astronomic Station—A point on the earth at which observations are made on heavenly bodies to determine latitude, longitude, or azimuth.

Asymmetrical Lens—A lens which is not symmetrical. See SYMMETRICAL LENS.

Axis—See OPTICAL AXIS.

Axis of Tilt—See under PRINCIPAL PLANE—*Photogrammetry*.

Background—*Photography*: That part of the landscape imaged in a horizontal or oblique photograph which is more distant from the camera station.

Barometer—An instrument for measuring the pressure of the atmosphere. **Aneroid**

Barometer—A hollow corrugated metal box from which the air has been partially exhausted and the walls of which are so thin that it will change its form when the air pressure changes. Most aneroids have two scales; one graduated to correspond to height of a mercury column and the other to feet of altitude. **Mercury Barometer**—Basically a vertical glass tube containing mercury; the upper end of the tube is closed so as to form a vacuum above the mercury and the lower end rests in a suitable cup, the column of mercury being sustained by the pressure of air against the mercury in the cup. A suitable scale measures the height of the mercury column.

Barometric Elevation—An elevation which has been determined with a barometer. See also ELEVATION.

Basal Coplane—See under COPLANAR.

Basal Orientation—The establishment of the position of both ends of an air base with respect to a ground system of coordinates. In all, six elements are required. These are essentially the three dimensional coordinates of each end of the base. In practice, however, it is also convenient to express these elements in one of two alternative ways. (1) The ground rectangular coordinates of one end of the base and the difference between the ground rectangular coordinates of the ends of the base. (2) The ground rectangular coordinates of one end of the base, the length of the base and two elements of direction such as Base Direction and Base Tilt. **Base Direction**—The direction of the vertical plane containing the air base which might be expressed as a bearing or azimuth. **Base Tilt**—The inclination of the air base to the horizontal.

Basal Plane—See under EPIPOLES.

Base Direction—See under BASAL ORIENTATION.

Base Map—See under MAP.

Base Tilt—See under BASAL ORIENTATION.

Beam of Light—See under RAY OF LIGHT.

Between the Lens Shutter—See under SHUTTER.

Binocular Vision—See under STEREOSCOPY.

Bridging—*Photogrammetry*: The extension and adjustment of photogrammetric surveys between bands of ground control.

Cadastral Map— See under MAP.

Cadastral Survey*—A survey relating to land boundaries and subdivisions, made to create units suitable for transfer or to define the limitations of title. Derived from "cadastre," meaning register of the real property of a political subdivision with details of area, ownership, and value. The term cadastral survey is now used to designate the surveys of the public lands of the United States, including retracement surveys for the identification, and resurveys for the restoration of property lines; the term may also be applied properly to corresponding surveys outside the public lands, although such surveys are usually termed land surveys through preference.

Calibrated Focal Length—See under EQUIVALENT FOCAL LENGTH.

Calibration—The act or process of determining certain specific measurements in a camera or other instrument or device for comparison with a standard. **Camera Calibration—Photogrammetry:** The determination of the calibrated focal length, the location of the principal point with respect to the fiducial marks, and the lens distortion effective in a focal plane located at the particular calibrated focal length. In a multiple lens camera, the calibration also includes the determination of the angles between the component perspective units. The setting of the fiducial marks and the positioning of the lens are ordinarily considered as "adjustments" although they are sometimes performed during the calibration process. Unless a camera is specifically referred to, distortion and other optical characteristics of a lens are determined in a focal plane located at the equivalent focal length (i.e., the point of best focus on the lens axis) and the process is termed "lens calibration." See also ANGULAR CALIBRATION CONSTANTS and COLLIMATE.

Calibration Constants—Photogrammetry: Results obtained by calibration which give the relation of the principal point to the fiducial marks of a camera and the calibrated focal length of the lens-camera unit.

Calibration Data—A record of the measurements obtained by calibration. See CALIBRATION.

Calibration Plate—See CALIBRATION NEGATIVE which is preferred.

Calibration Templet—Photogrammetry: A templet of glass, celluloid, or metal made in accordance with the calibration constants to show the relation of the principal point of a camera to the fiducial marks. Used for the rapid and accurate marking of principal points on a series of photographs. Also in the case of a multiple lens camera a templet prepared from the calibration data and used in assembling the individual photographs into one composite photograph.

Camera—A chamber or box in which the images of exterior objects are projected upon a sensitized surface. **Aerial Camera**—A camera specially designed for use in aircraft. The prefix aerial is not essential where the context clearly indicates the use of an aerial camera rather than a ground camera. **Ground Camera**—A camera designed for use on the ground. See also PHOTOTHEODOLITE. **Surveying Camera**—A camera specially designed for the production of photographs to be used in surveying. The prefix surveying indicates that the camera is equipped with mechanism to maintain and to indicate the interior orientation of the photographs with sufficient accuracy for surveying purposes. A surveying camera may be an aerial surveying camera or ground surveying camera. **Mapping Camera**—The term Surveying Camera is preferred. **Photogrammetric Camera**—A general term applicable to any camera used in any of the several branches of photogrammetry. **Precision Camera**—A relative term used to designate any camera capable of giving results of a definite high order of accuracy. **Single Lens Camera**—A camera having only one lens. **Multiple Lens Camera**—A camera with two or more lenses, the axes of the lenses being systematically arranged at a fixed angle in order to cover a wide field by simultaneous exposures in all chambers. In most such cameras the oblique lenses are arranged symmetrically around a central lens. In some multiple lens cameras the axes of the lenses are all vertical and images are projected onto a single film, the obliquity of the side photographs being obtained by mirrors or prisms in front of the side lenses. Several types of multiple lens cameras are the three, four, five, seven, and nine lens aerial cameras. Prints are made from the oblique negatives of a multiple lens camera by projection in a transforming printer which projects the oblique images into a common plane. The transforming printer is usually designed specially for the particular multiple lens camera. The transformed photographs are assembled to form one composite photograph equivalent to a photograph taken with a single wide angle lens. In

some cases the transformation and assembly of the separate photographs are both performed by the transforming printer. **Horizon Camera**—*Aerial Photography*: A camera used in conjunction with an aerial surveying camera in vertical photography to photograph the horizon simultaneously with the vertical photographs. The horizon photographs indicate the tilts of the vertical photographs.

Camera Axis—In a single lens camera, the photograph perpendicular. In a multiple lens camera the photograph perpendicular of the central perspective unit or the photograph perpendicular of the transformed photograph.

Camera Calibration—See under CALIBRATION.

Camera Station—*Photogrammetry*: The point in space, in the air or on the ground, occupied by the camera lens at the moment of exposure. Also called the **Exposure Station**. In aerial photogrammetry the camera station is called the **Air Station**.

Cant and Torque—*Photogrammetry*: Elements of tilt in the mechanical relative orientation of a pair of photographs which are the declination and polar bearing respectively of the photograph perpendicular of one photograph in a system of spherical coordinates in which the polar axis is the air base. The reference basal or meridional plane can be arbitrarily chosen but is usually vertical. In a measuring stereoscope based on the Fourcade principle of orientation the **Principal Torque**, sometimes called the **Lateral Level Element**, is the torque of the photograph perpendicular of the left hand photograph and the **Differential Torque** is the difference of torque between the left and right photographs. See Fig. 2 and also BASAL ORIENTATION.

Cantilever Strip—A term used principally in Great Britain and Canada for a strip of vertical air photographs with the usual forward lap extending over a known area into an area of no control, the plot of the portion of the strip taken over the known area serving to fix the scale and azimuth of the plot of the cantilever portion, or the portion over the area of no control.

Cardan Link—A universal joint. An optical cardan link is a device for universal scanning about a point.

Cartographer—One who practices the science or the art of cartography.

Cartographic—(Not cartographical). Of or pertaining to cartography.

Cartography—The science and art of expressing graphically, by means of maps and charts, the known physical features of the earth's surface, and often including the works of man and his varied activities; specifically, cartography is the art of map construction and the science upon which it rests. It combines the achievements of the astronomer and mathematician with those of the explorer and the surveyor in presenting a picture of the physical characteristics of the earth's surface. It invariably includes assembly, evaluation, selection and rejection of data.

Celluloid Templet—See under TEMPLET.

Chart—See NAUTICAL CHART and AERONAUTICAL CHART.

Chromatic Aberration—See LATERAL and LONGITUDINAL CHROMATIC ABERRATION under ABERRATION.

Circle of Confusion—*Optics*: The circular image of a distant point object as formed in a focal plane by a lens. A distant point object (e.g., a star) is imaged in a focal plane of a lens as a circle of finite size which may be caused by (1) the focal plane not being placed at the point of sharpest focus, (2) the effect of certain aberrations, (3) diffraction at the lens, (4) the grain of a photographic emulsion, or (5) poor workmanship in the manufacture of the lens, etc.

Clinometer—A simple instrument used for measuring the degree or per cent of slope.

Coated Lens—A lens whose air-glass surfaces have been coated with a thin transparent

film of such index of refraction as to minimize the light loss by reflection. This reflection loss of uncoated lenses amounts to about 4 per cent per air-glass surface.

Collimate—*Physics and Astronomy*: To render parallel to a certain line or direction; to render parallel, as rays of light; to adjust the line of sight of an optical instrument so that it is in its proper position relative to the other parts of the instrument. See also COLLIMATOR. **Collimate**—*Photogrammetry*: To adjust the fiducial marks of a camera so that they define the principal point. See also CALIBRATION.

Collimating Axis—Not approved for FIDUCIAL AXIS which see.

Collimating Line—Not approved for FIDUCIAL AXIS which see.

Collimating Marks—Not approved for FIDUCIAL MARKS.

Collimator—An optical device for artificially creating a target at infinite distance (a beam of parallel rays of light) used in testing and adjusting certain optical instruments. It usually consists of a converging lens and a target (a system or arrangement of cross hairs) placed at the principal focus of the lens.

Coma—See under ABERRATION.

Common Scale Strip—A term used in Great Britain and Canada in graphical methods of plotting aerial photography to define the plot of a strip of vertical aerial photographs whose scale is adopted as standard for compilation purposes. Plots of adjacent parallel strips are then brought to this standard scale by means of the extreme lateral control points in the common overlap.

Comparator—An optical instrument, usually precise, for measuring rectangular coordinates of points on any plane surface, such as a photographic plate.

Complementary Colors—*Optics*: Two colors are said to be complementary if when added together, such as by projection, they produce white light.

Composite Photograph—*Aerial Photography*: A photograph made by assembling the separate photographs made by each lens of a multiple-lens camera during the same simultaneous exposure into the equivalent of a photograph taken with a single wide angle lens. See also MULTIPLE LENS CAMERA under CAMERA.

Condenser—*Optics*: A lens or lens system so designed as to concentrate the illumination from a light source upon a limited area.

Conjugate Distance—For every position that an object may occupy with respect to a lens, there is a corresponding position for the image. The distances of object and image from the lens are called conjugate distances. A convenient formula for computing the conjugate distances "O" and "I" for use in photographic enlarging is:

$$O = F + \frac{F}{M}; I = F + FM$$

in which

$$F = \text{focal length of lens}$$

$$M = \text{enlarging ratio}$$

Note: the total distance from object to image equals the sum of the two conjugate distances plus or minus (depending on lens design) a small distance called the nodal point separation.

Conjugate Focal Point—Not approved for the ISOCENTER, which see.

Conjugate Image Point—The images on two (or more) overlapping photographs of a single object point.

Conjugate Image Rays—Rays connecting each of a set of conjugate image points with its particular perspective center.

Constant Tilt—*Aerial Photography*: In vertical aerial photography, the condition where the photographs in a flight strip or section of a flight strip are tilted in nearly the same direction.

Contact Glass—See FOCAL PLANE PLATE under FOCAL PLANE.

Contact Plate—See under FOCAL PLANE.

Contact Print—See under PRINT.

Contour (line)—An imaginary line connecting the points on a land surface that have the same elevation; also the line representing this on a map or chart. **Depression Contour**—A closed contour inside which the ground is at a lower elevation than outside.

Contour Map—See under MAP.

Control—A system of relatively accurate measurements to determine the distances and directions or differences in elevation between points on the earth, as triangulation, traverse, or levels, and upon which depends a system of lesser accuracy. The accuracy of the control is usually described as first-order, second-order, third-order, or fourth-order. **Horizontal Control**—Control which determines horizontal positions only, as with respect to parallels and meridians, or to other lines of reference. **Vertical Control**—Control which determines positions with respect to elevations only, specifically leveling. **Geodetic Control**—Control which takes into account the size and shape of the earth. Geodetic control implies a reference spheroid representing the geoid and horizontal and vertical control datums. **Ground Control**—In photogrammetry, control obtained by ground surveys as distinguished from control obtained by photogrammetric methods. As for example, first, second, or third-order triangulation or traverse are used to control the photogrammetric plot which in turn establishes more intensive but less accurate control for the map detailing. **Photogrammetric Control**—Control established by photogrammetric methods as distinguished from control established by ground methods. Also called *Minor Control*.

Control Point—*Photogrammetry*: Any station in a horizontal and/or vertical control system that is identified on a photograph and used for correlating the data shown on that photograph.

Control Strip—*Aerial Photography*: A strip of aerial photographs taken to aid in planning and accomplishing later aerial photography, or to serve as control in assembling other strips.

Controlled Mosaic—See under MOSAIC.

Convergence—See ANGLE OF CONVERGENCE under PARALLAX.

Converging Lens—See POSITIVE LENS.

Convertible Lens—Usually refers to a photographic lens containing two or more elements which can be used individually or in combination.

Coordinates—*Surveying and Mapping*: Linear or angular quantities which designate the position which a point occupies in a given reference frame or system. Also used as a general term to designate the particular kind of reference frame or system, as Plane Rectangular Coordinates, Spherical Coordinates, etc. **Plane-Rectangular Coordinates** (also called simply **Plane Coordinates**)—A system of coordinates in a horizontal plane, used to describe the positions of points with respect to an arbitrary origin by means of two distances perpendicular to each other. The two reference lines at right angles to each other passing through the origin are called the coordinate axes. The distances parallel with the true, or arbitrarily assigned, North-South axis are called the ordinates, the *y* coordinates, or the total latitudes. The distances parallel with the true, or arbitrarily assigned, East-West axis are called

the abscissas, the x coordinates, or the total departures. A plane-rectangular coordinate system is used in mapping areas of such limited extent that the errors introduced by substituting a plane for the curved surface of the earth will be within the required order of accuracy. In mapping, the North and East directions are positive and the South and West directions are negative. In practice, therefore, in order to avoid the use of negative coordinates the origin of the system is usually chosen to be a point to the southwest of the area being mapped, or its coordinates instead of being zero are assigned large positive numbers. The great merit of a rectangular-coordinate system is that computations involving positions of points thereon may be performed by the use of plane trigonometry. Plane-rectangular coordinates may or may not be adjusted to a map projection. **Grid Coordinates**—A plane rectangular coordinate system based on and mathematically adjusted to a map projection in order that geographic positions (latitudes and longitudes) may be readily transformed into plane coordinates and the computations relating to them made by the ordinary methods of plane surveying. **State Plane Coordinate Systems**—A series of Grid Coordinate Systems prepared by the U. S. Coast and Geodetic Survey to cover the entire United States, there being a separate system for each State. Each State system consists of one or more zones. The Grid Coordinates for each zone are based on and mathematically adjusted to a map projection. The Lambert Conformal Conic Projection with Two Standard Parallels is used for zones of limited North-South extent and predominant East-West extent. The Transverse Mercator Projection is used for zones of predominant North-South extent and of limited East-West extent. **Polar Coordinates**—A system of coordinates used to describe the position of a point in space with respect to an arbitrarily chosen origin by means of two directions and one distance, i.e., the vectorial angles and radius vector. Any plane containing the polar axis may be called a meridional plane, and the plane perpendicular to the polar axis containing the origin is called the equatorial plane or equator. As any point must lie on a meridional plane, one coordinate of a point in this system is the angle formed by the intersection of its meridional plane with the reference meridional plane. This is called the polar angle or polar bearing. The second coordinate of a point is the angle in its meridional plane subtended at the origin between the line to the point and the polar axis. This angle is called the polar distance and its complement, the angle between the line to the point and the equator, is the declination. The third coordinate is the distance between the origin and the point. (See Fig. 4.) **Plane Polar Coordinates**—A system of polar coordinates in which the points all lie in one plane. In the phraseology of analytical geometry the distance from the origin to the point is the radius vector and the polar distance is the vectorial angle. **Spherical Coordinates**—A system of polar coordinates in which the origin is the center of a sphere and the points all lie on the surface of the sphere. The polar axis of such a system cuts the sphere at its two poles. In Photogrammetry, spherical coordinates are useful in defining the relative orientation of perspective rays or axes and make possible the stating and solving in simple forms of many of the problems connected therewith. For example, as used in the determination of the exterior orientation of a single photograph, the origin is the air station and the polar axis is the vertical. The polar bearing is the horizontal bearing (azimuth) of the principal plane and the polar distance is the tilt. (See Fig. 1.) In the determination of the relative orientation between pairs of photographs by the method originated by Fourcade, the polar axis of the coordinate system is the air base and the origin is one of the air stations. A meridional plane in this case is called a basal or epipolar plane and the reference meridional plane may be arbitrarily chosen but is usually the vertical. (See also definitions under Tilt and Fig. 2.) **Geographic Coordinates**—A system of spherical coordinates for describing the positions of points on the Earth. The decli-

nations and polar bearings in this system are the latitudes and longitudes, respectively. **Photograph Coordinates**—*Photogrammetry*: A system of coordinates either rectangular or polar to describe the position of a point on a photograph. If a two dimensional system is used the origin is usually the principal point but it may be the nadir point, isocenter, one of the fiducial marks, or in high oblique photography the intersection of the horizon and principal line. The coordinate axes are usually either the fiducial axes, or the principal line and a photograph parallel. If a three dimensional system is used the origin is either the principal point or the perspective center. **Space Coordinates**—*Photogrammetry*: A three dimensional system of rectangular coordinates in which the x and y coordinates lie in a reference plane tangent to the earth at a selected point and the z coordinate is perpendicular to that plane. Used in the extension of horizontal and vertical control through a series of overlapping vertical photographs from an initial point which is the point of tangency of the reference plane. When these coordinates are corrected to allow for the curvature of the earth they cease theoretically to be true space coordinates because the x and y coordinates become distances along great circles at right angles to each other and the z coordinates are distances perpendicular to the vertical control datum. The use of the term space coordinates therefore should be strictly limited to a three dimensional rectangular coordinate system which has not been adjusted to the vertical and horizontal control datums. **Air Coordinates**—*Photogrammetry*: The space coordinates of any point imaged on an overlapping pair of photographs which define its position with reference to the air base. They correspond in respect to the position of origin and direction of axes to a system of spherical coordinates in which an air base is the polar axis. (See Fig. 2.) Consequently one such system as suggested by Fourcade can be defined as follows:

Origin: The left-hand air station.

X-axis: The line of the air base to the right.

Z-axis: The line perpendicular to the X-axis, in the basal plane containing the principal point of the left-hand photograph. The ground is considered as being in the negative direction.

Y-axis: The line perpendicular to the X and Z axes. The positive direction is towards the top side of the strip when viewed as running from left to right.

Strip Air Coordinates—The air coordinates of any point in a strip, whether on the ground or actually an air station, referred to the origin and axes of the air coordinate system of the first overlap.

Coplanar—Lying in the same plane. **Basal Coplane**—*Photogrammetry*: The condition of exposure of a pair of photographs whereby the two photographs lie in a common plane parallel to the air base. If the airbase is horizontal the photographs are said to be exposed in HORIZONTAL COPLANE.

Correspondence—*Stereoscopy*: The condition when corresponding images on a pair of photographs lie in the same epipolar plane.

Course—*Air Navigation*: The direction in which a pilot attempts to fly an aircraft; the line drawn on a chart or map as the intended track. Its direction is measured in degrees from the true meridian and the true course is always meant unless it is otherwise qualified, as a magnetic or compass course. See also TRACK.

Crab—1. *Air Navigation*: Any turning of an airplane which causes its longitudinal axis to vary from the track of the plane. 2. *Aerial Photography*: The condition caused by failure to orient the camera with respect to the track of the airplane as indicated in vertical photography by the sides of the photographs not being parallel to the principal point base lines. See DRIFT for a special condition of crab.

Crabbed Photograph—*Aerial Photography*: See CRAB.

Culture—Mapping: Those features of the terrain that have been constructed by man such as roads, trails, buildings, and canals; also, boundary lines; and all names and legends.

Curvature of Field—See under ABERRATION.

Cylindrical Lens—A lens in which the surfaces are segments of cylinders.

Datum—See under GEOID.

Datum Level—See under GEOID.

Datum Plane—See under GEOID.

Declination—Geometry: In a system of polar or spherical coordinates the angle at the origin between a line to a point and the equator, measured in a plane perpendicular to the equator. Also the arc between the point and the equator measured on a great circle perpendicular to the equator. See also MAGNETIC DECLINATION and Fig. 4.

Delineation—Surveying and Mapping: The accurate representation on a map of physical and cultural features of the earth, or a section thereof, by means of lines and symbols.

Depression Contour—See CONTOUR.

Details—Mapping: The small items, or particulars of information shown on the map by lines, symbols, and lettering which when considered together, as a whole, furnish the comprehensive representation of the physical and cultural features. The greater the omission of details the more generalized is the map.

Diapositive—Photogrammetry: A positive photographic print on a transparent medium, usually on glass. In photogrammetry the term is generally used to refer to a transparent positive on a glass plate used in a plotting instrument, or a projector.

Differential Shrinkage—Mapping: The difference in unit contraction along the grain structure of the material as compared to the unit contraction across the grain structure; frequently applied to photographic film and papers and to mapping papers in general.

Differential Torque—Photogrammetry: See under CANT.

Diffraction—Optics: The bending of light-waves around the edges of opaque objects. Due to diffraction a point of light seen or projected through a circular aperture will always be imaged as a bright center surrounded by light rings of gradually diminishing intensity. Such a pattern is called a diffraction disk.

Diopter—A unit of measurement of power of lenses, especially spectacle lenses. The power in diopters equals the reciprocal of the focal length in meters, thus a lens whose focal length is 20 cm. has a power of 5 diopters.

Direction of Flight—See COURSE and also TRACK.

Direction of Tilt—The direction (azimuth) of the principal plane of a photograph. Also the direction of the principal line on a photograph.

Direct Radial Triangulation—See under RADIAL TRIANGULATION.

Direct Radial Plot—See under RADIAL TRIANGULATION.

Dispersion—Optics: A characteristic of optical glass which enables it to form a spectral band. Also used in place of "dispersive power," to mean a specific characteristic of optical glass having to do with the relative width of the spectral band formed.

Distant Line—The trace of the apparent, or visible, horizon on an oblique photograph used as an approximation to the terrestrial horizon trace when the latter is not identifiable. See also HORIZON.

Distortion—Optics: See under ABERRATION.

Diverging Lens—See NEGATIVE LENS.

Dove Prism—A prism which performs a reversion of the image but does not deviate nor displace the beam. A given angular rotation of the prism about its longitudinal axis causes the image to rotate through twice the angle. Also called a **Rotating Prism**.

Drift—1. *Air Navigation*: The horizontal displacement of an aircraft under the action of the wind from the track it would have followed in still air. 2. *Aerial Photography*: Sometimes used to indicate a special condition of crab wherein the photographer has continued to make exposures oriented to the predetermined line of flight while the airplane has drifted with the wind; in such instances the edges of the successive photographs are parallel but sidestepped.

Elevation—Vertical distance above the datum, usually mean sea level, to a point or object on the earth's surface. Do not confuse with altitude which refers to points or objects above the earth's surface.

Emergent Nodal Point—See under PRINCIPAL POINT—*Optics*.

Entrance Pupil—See under APERTURE STOP.

Entrance Window—See under APERTURE STOP.

Epipolar Plane—See under EPIPOLES.

Epipolar Ray—See under EPIPOLES.

Epipoles—In the perspective set up of two photographs (two perspective projections), the points on the planes of the photographs where they are cut by the air base (extended line joining the two perspective centers). In the case of a pair of truly vertical photographs the epipoles are infinitely distant from the principal points.

Epipolar Plane—Any plane which contains the epipoles; therefore, any plane containing the air base. Also called **Basal Plane**. **Epipolar Ray**—The line on the plane of a photograph joining the epipole and the image of an object. Also expressed as the trace of an epipolar plane on a photograph.

Equator—*Geometry*: In a system of polar or spherical coordinates, the great circle of a sphere cut by a plane which passes through the center of the sphere and is perpendicular to the polar axis.

Equator Trace—The trace on a photograph of an equatorial plane passing through the former's perspective center.

Equivalent Focal Length—The equivalent focal length is defined as the distance from the rear node of a lens to the point of best axial focus, the object being at infinity.

Calibrated Focal Length—The perpendicular distance from the rear node of the lens to the plane of the film emulsion. The calibrated and equivalent focal lengths usually differ inasmuch as the former is selected to give the best average definition and/or the least distortion over the entire negative while the latter is based on best axial imagery only. **Principal Distance**—The perpendicular distance from the internal perspective center to the plane of a particular finished negative or print. This distance is equal to the calibrated focal length corrected for both the enlargement or reduction ratio and the film or paper shrinkage or expansion and maintains the same perspective angles at the internal perspective center to points on the finished negative or print, as existed in the taking camera at the moment of exposure. This is a geometrical property of each particular finished negative or print.

Equivalent Principal Distance—Not approved. See under EQUIVALENT FOCAL LENGTH.

Exit Pupil—See APERTURE STOP.

Exit Window—See APERTURE STOP.

Exposure Station—See under CAMERA STATION.

Exterior Orientation—*Photogrammetry*: A set of quantities which fixes the position of

the camera station and the angular orientation of the photograph. Such a set consists of three elements of position and two elements of angular orientation. The position is usually expressed in terms of three rectangular coordinate distances— x , y , and z . The elements of angular orientation are essentially the tilt of the photograph perpendicular and the azimuth of the principal plane. **Relative Orientation**—The reconstruction of the same perspective conditions between a pair of photographs which existed when the photographs were taken. In a stereoscopic pair this is achieved when each pair of conjugate image rays lie in an epipolar plane. **Absolute Orientation**—Following relative orientation which establishes the model, absolute orientation fixes the scale, position, and orientation of the model with reference to the ground coordinates.

Exterior Perspective Center—See PERSPECTIVE CENTER.

Eye Base—The distance between the centers of rotation of the eyeballs of an observer.

Eyepiece—In a telescope or microscope, the lens group nearest the eye, with which the image formed by preceding lenses is viewed.

Fiducial Axes—*Photogrammetry*: The lines joining opposite fiducial marks on a photograph.

Fiducial Lines—Not approved. See FIDUCIAL AXES.

Fiducial Marks—*Photogrammetry*: Index marks rigidly connected with the camera lens through the camera body and forming images on the negative which define the principal point of the photograph.

Field Inspection—*Photogrammetry*: The process of comparing aerial photographs with conditions as they exist on the ground and of obtaining information to supplement or clarify that not readily discernible on the photographs themselves.

Field of View—See under APERTURE STOP.

Field Stop—See under APERTURE STOP.

Film Pressure Plate—See PRESSURE PLATE.

Filter—Any transparent material which absorbs a certain portion of the spectrum, such as for use in the optical path of a camera lens to prevent certain portions of the spectrum from reaching the sensitized negative.

Five Lens Camera—See under CAMERA.

Flat—See OPTICALLY FLAT.

Flight Altitude—The vertical distance above a given datum of an aircraft in flight or during a specified portion of a flight.

Flight Line—A line drawn on a map or chart to represent the track over which an aircraft has been flown or is to be flown.

Flight Ceiling—See SERVICE CEILING.

Flight Map—The map on which are indicated the desired lines of flight and/or the positions of exposure previous to the taking of air photographs, or the map on which are plotted, after photography, selected air stations and the tracks between them.

Floating Mark—*Photogrammetry*: A mark seen as occupying a position in the three dimensional space formed by the stereoscopic fusion of a pair of photographs and used as a reference mark in examining or measuring the stereoscopic model. The mark may be formed (1) by one real mark lying in the projected object space as in the case of projection instruments such as the Multiplex; (2) by two real marks lying in the projected or virtually projected object spaces of the two photographs as in the case of certain other types of stereoscopic plotting instruments; (3) by two real marks lying in the planes of the photographs themselves as is usually the case in simple mirror stereoscopes; (4) by two virtual marks lying in the image planes of the

binocular viewing apparatus as is the case in certain other types of stereoscopic plotting instruments. **Index Mark**—*Photogrammetry*: A real mark such as a cross or a dot lying in the plane or the object space of a photograph and used singly as a reference mark in certain types of monocular instruments or singly or as one of a pair to form a floating mark as in certain types of stereoscopes. **Reticle**—*Photogrammetry*: A mark such as a cross or system of lines lying in the image plane of a viewing apparatus and used singly as a reference mark in certain types of monocular instruments or as one of a pair to form a floating mark as in certain types of stereoscopes. See also PARALLACTIC GRIDS.

Focal Length—See EQUIVALENT FOCAL LENGTH.

Focal Plane—*Aerial Photography*: The plane (perpendicular to the axis of the lens) in which images of points in the object field of the lens are focused. **Focal Plane Plate**—A glass plate set in the camera so that the surface away from the lens coincides with the focal plane, for the purpose of locating the emulsion of the film in the focal plane when the film is pressed into contact with the glass plate mechanically. Also known as **Contact Glass** or **Contact Plate**.

Focal Plane Plate—See under FOCAL PLANE.

Focal Plane Shutter—See under SHUTTER.

Focus—The point toward which rays of light converge to form an image after passing through a converging lens.

Fore and Aft Overlap—Not approved. See FORWARD LAP under OVERLAP.

Fore and Aft Tilt—Not preferred. See Y-TILT under TILT.

Foreground—*Photography*: That part of the landscape imaged in a horizontal or oblique photograph which is nearest the camera station.

Form Lines—Lines having the same appearance as contour lines but which have been sketched from visual observation to show the shape of the terrain rather than the elevation. These lines are based upon as many determined elevations as may be secured but too few to prescribe limits of accuracy for the resulting work.

Forward Lap—See under OVERLAP.

Forward Overlap—Not approved. See FORWARD LAP under OVERLAP.

Four Lens Camera—See under CAMERA.

Front Nodal Point—See under PRINCIPAL POINT—*Optics*.

Fusion—See STEREOSCOPIC FUSION under STEREOSCOPY.

Gap—*Aerial Photography*: Any space where aerial photographs fail to meet minimum coverage requirements. This might be a space not covered by any photograph or a space where the minimum specified overlap was not obtained.

Geodesy—The science which treats of the determination of the size and figure of the earth (geoid) by direct measurements as triangulation, leveling, gravimetric observations. The applied science of geodesy is called **Geodetic Surveying**, i.e., surveying which takes account of the figure and size of the earth.

Geodetic Control—See under CONTROL.

Geodetic Surveying—See under GEODESY.

Geographic Coordinates—See under COORDINATES.

Geoid—A theoretical surface of the earth as defined by the surface of the sea at mean elevation over the oceans and conceived as extending continuously through all the continents. **Reference Spheroid**—A spheroid determined by revolving an ellipse about its shorter (polar) axis and used as a base for geodetic surveys of a large section of the earth, as the Clarke's Spheroid of 1866 used for geodetic surveys in the

United States. The spheroid of reference is a theoretical figure, the dimensions of which approach closely the dimensions of the geoid, the exact dimensions being determined by various considerations of the section of the earth's surface concerned.

Level Surface—A surface which is at every point perpendicular to the direction of gravity; the geoid, or, in general, any surface parallel thereto. The surface of the sea, if changes in elevation due to tides, winds, etc., are neglected, is a level surface. A level surface is not a plane surface but is sometimes so regarded in surveys of limited areas. See also VERTICAL CONTROL DATUM. **Horizontal Control Datum**—The position on the spheroid of reference assigned to the horizontal control (triangulation and traverse) of an area and defined by (1) the position (latitude and longitude) of one selected station in the area, and (2) the azimuth from the selected station to an adjoining station. The horizontal control datum may be for a continent or a small area. A datum for a small area is usually called a **Local Datum** and is also given a proper name. The horizontal control datum for the North American continent is known as the **North American Datum of 1927**, the selected station for which is "Meades Ranch," Kansas with the azimuth to the adjoining station "Waldo." All geodetic positions on the North American Datum of 1927 depend on the position of "Meades Ranch" and the azimuth "Meades Ranch" to "Waldo." **Vertical Control Datum**—Any level surface, as for example mean sea level, taken as a surface of reference from which to reckon elevations. Also called the **Datum Level**. Although a level surface is not a plane, the vertical control datum is frequently referred to as the **Datum Plane**. See LEVEL SURFACE. **Horizontal Plane**—A plane perpendicular to the direction of gravity; any plane tangent to the geoid or parallel to such a plane. **Ground Plane**—*Photogrammetry*: The horizontal plane passing through the ground nadir of a camera station. **Map Plane**—Any horizontal plane to which the planimetry and relief of an area are plotted or referenced. **Hill Plane**—*Photogrammetry*: The plane containing the positions of three ground marks constituting control points. This may be, but rarely is, a horizontal plane.

Geometric Axis—Not approved when used in place of FIDUCIAL AXIS, which see.

Goniometer—An instrument for measuring angles. **Photogoniometer**—An instrument for measuring angles to any point on a photograph from the true perspective center.

Graphic Ray Plot—Not approved. See RADIAL PLOT under RADIAL TRIANGULATION.

Grid—See MAP GRID.

Grid Coordinates—See under COORDINATES.

Grid Method—*Photogrammetry*: A method of plotting detail from oblique photographs by superimposing a perspective of a map grid on a photograph and transferring the detail by eye, the latter being guided by the corresponding lines of the map grid and its perspective. See also PERSPECTIVE GRID.

Ground Camera—See under CAMERA.

Ground Control—See under CONTROL.

Ground Control Point—See under CONTROL POINT.

Ground Line—Not preferred. See GROUND PARALLEL under PRINCIPAL PLANE—*Photogrammetry*.

Ground Nadir—See under NADIR.

Ground Parallel—See under PRINCIPAL PLANE.—*Photogrammetry*.

Ground Photogrammetry—See under PHOTOGRAMMETRY.

Ground Photograph—Any photograph taken on the ground.

Ground Plane—See under GEOID.

Ground Plumb Point—GROUND NADIR is preferred. See under NADIR.

Ground Speed—*Air Navigation*: The velocity of an aircraft along its track with relation to the ground; the resultant of the heading and air speed of an aircraft and the direction and velocity of the wind. See also AIR SPEED.

Ground Survey—See under SURVEY.

Ground Trace—Not preferred. See GROUND PARALLEL under PRINCIPAL PLANE—*Photogrammetry*.

Gyroscopic Stabilization—Equilibrium obtained in a ship or airplane by the use of gyroscopes. The maintenance, by the use of gyroscopes, of an airplane on constant course in a horizontal position; the maintenance, by the use of gyroscopes, of a camera in a desired position within an aircraft.

Hand Templet—See under TEMPLET.

Hand Templet Method—See TEMPLET and RADIAL TRIANGULATION.

Hand Templet Plot—See under RADIAL TRIANGULATION.

Hand Templet Triangulation—See under TEMPLET and also under RADIAL TRIANGULATION.

Haze—The presence of foreign matter in the atmosphere to an extent sufficient to reduce even slightly its transparency. Not aerial haze.

Heading—*Air Navigation*: The angular direction of the longitudinal axis of the aircraft with respect to the true meridian. In other words it is the course with drift correction applied. It is the true heading unless otherwise designated.

High Oblique Photograph—An oblique photograph taken with the camera axis more nearly horizontal than vertical. Also called **High Oblique**.

Hill Plane—See under GEOID.

Homologue—A point or line in one system of points or lines corresponding to a point or line in another similar system; for example, homologous image points are the images on two or more photographs of the same object point.

Horizon—In general, the apparent or visible junction of earth and sky, as seen from any specific position. Also called the **Apparent, Visible, or Local Horizon**. **Terrestrial Horizon**—A mathematical concept which is defined as the locus on the surface of the reference spheroid of the earth of the points of tangency of tangent rays from any given point of vision or perspective center. The APPARENT or VISIBLE HORIZON often approximates the TERRESTRIAL HORIZON. **True Horizon**—A horizontal plane passing through a point of vision or perspective center. The APPARENT or VISIBLE HORIZON approximates the TRUE HORIZON only when the point of vision is very close to sea level.

Horizon Camera—See under CAMERA.

Horizon Photograph—*Aerial Photography*: A photograph of the horizon taken simultaneously with a vertical photograph for the sole purpose of obtaining an indication of the tilt of the vertical camera at the instant of exposure.

Horizontal Control—See under CONTROL.

Horizontal Control Datum—See under GEOID.

Horizontal Coplane—See under COPLANAR.

Horizontal Parallax—See under PARALLAX.

Horizontal Photograph—A photograph taken with the camera axis horizontal.

Horizontal Plane—See under GEOID.

Horizon Trace—See under PRINCIPAL PLANE—*Photogrammetry*.

Humidity—Degree of wetness, especially of the atmosphere. **Relative Humidity**—Ratio of

- aqueous vapor present in a space at a given temperature, as compared with the greatest amount it could possibly contain, at that temperature. **Absolute Humidity**—The weight of water vapor contained in a given volume of air, as grains per cubic foot. **Specific Humidity**—The weight of water vapor per unit weight of the moist air.
- Hydrographic Map**—See under MAP.
- Hypsograph**—An instrument of the slide rule type used to compute elevations from vertical angles and horizontal distances.
- Hypsometry**—In general, the determination of elevations above sea level. In particular, the determination of such elevations by observing the boiling point of water.
- Incident Nodal Point**—See under PRINCIPAL POINT—*Optics*.
- Index Mark**—See under FLOATING MARK.
- Interior Orientation**—The establishment of the principal distance, and the position of the principal point of a photograph with respect to the fiducial marks of the camera.
- Interior Perspective Center**—See under PERSPECTIVE CENTER.
- Interocular Distance**—Synonymous with EYE BASE, which see.
- Interpolation**—Determination of an intermediate value between fixed values from some known or assumed rate or system of change.
- Interpupillary Distance**—Synonymous with EYE BASE, which see.
- Intervalometer**—A timing device for automatically operating the shutter of a camera at any predetermined interval.
- Iris Diaphragm**—A continuously variable aperture in a lens which makes it possible to control the amount of light passing through the lens. Also called **Stop**.
- Isocenter**—(1) The unique point common to the plane of a photograph, its principal plane, and the plane of an assumed truly vertical photograph taken from the same camera station and having an equal principal distance. (2) The point of intersection on a photograph of the principal line and the isometric parallel. (3) The point on a photograph intersected by the bisector of the angle between the plumb line and the photograph perpendicular. The isocenter is significant because it is the center of radiation for displacements of images due to tilt.
- Isocenter Plot**—See under RADIAL TRIANGULATION.
- Isocenter Triangulation**—See under RADIAL TRIANGULATION.
- Isometric Parallel**—See under PRINCIPAL PLANE.
- Isoradial**—See under RADIAL.
- Lateral Chromatic Aberration**—See under ABERRATION.
- Lateral Level Element**—*Photogrammetry*: See under CANT AND TORQUE.
- Lateral Magnification**—See under MAGNIFICATION.
- Lateral Oblique Photograph**—An oblique aerial photograph taken with the camera axis as nearly as possible normal to the flight line. Also called **Lateral Oblique**.
- Lateral Overlap**—Not approved. See SIDE LAP under OVERLAP.
- Lateral Tilt**—Not preferred. See X-TILT under TILT.
- Legend**—A description, explanation, table of symbols and other information, which is printed on a map or chart, for a better understanding and interpretation of it. The title of a map or chart was formerly considered as part of the legend but this usage is obsolescent. The title should be considered as separate and not a part of the legend. Not legend reference.
- Lens Component**—See LENS ELEMENT.
- Lens Distortion**—See under ABERRATION.

- Lens Element**—One lens of a complex lens system. In a photographic lens, the terms front and rear elements are often used.
- Lens Speed**—See RELATIVE APERTURE.
- Level Surface**—See under GEOID.
- Light Ray**—See RAY OF LIGHT.
- Light Slides**—A thin plate, usually metal or fiber, rigid or flexible, which after insertion in a camera magazine renders it light tight. The employment of light slides makes it possible to interchange camera magazines in daylight.
- Linear Magnification**—See under MAGNIFICATION.
- Linear Parallax**—See under PARALLAX.
- Line of Equal Scale**—See ISOMETRIC PARALLEL under PRINCIPAL PLANE—*Photogrammetry*.
- List**—Not preferred. See X-TILT under TILT.
- Local Horizon**—See HORIZON.
- Locating Back**—*Aerial Photography*: A plane surface in an aerial camera (parallel to the plane of the lens) which is out of the focal plane by an amount equal to the thickness of the film used and against which the film is sucked by vacuum, or pressed by air pressure, in order to maintain the emulsion surface of the film in the focal plane at the instant of exposure. Locating backs are usually of metal and in both above cases are perforated or slotted to allow for the building up of a differential pressure or for the removal of air in the formation of a vacuum. A locating back which utilizes vacuum is known as a **Vacuum Back**, and one which utilizes pressure is known as a **Pressure Back**.
- Longitudinal Chromatic Aberration**—See under ABERRATION.
- Longitudinal Magnification**—See under MAGNIFICATION.
- Longitudinal Overlap**—Not approved. See FORWARD LAP under OVERLAP.
- Longitudinal Tilt**—Not preferred. See Y-TILT under TILT.
- Louver Shutter**—See under SHUTTER.
- Loxodromic Curve**—Synonymous with RHUMB LINE, which see.
- Low Oblique Photograph**—An oblique photograph taken with the camera axis more nearly vertical than horizontal. Also called LOW OBLIQUE.
- Magnetic Declination**—The angle between the true (geographical) north and magnetic north (direction of the compass needle). The magnetic declination is different for different places and changes continuously with respect to time.
- Magnification**—*Optics*: A quantity which states the ratio of the size of an image to the size of the object. **Linear Magnification**—The ratio of a linear quantity in the image to a corresponding linear quantity in the object. It may be Lateral Magnification or Longitudinal Magnification. **Lateral Magnification**—The ratio of a length in the image, perpendicular to the lens axis, to a corresponding length in the object. **Longitudinal Magnification**—The ratio of a length in the image, along the axis, to a corresponding length in the object. **Angular Magnification**—The ratio of the angle subtended at the eye by the image formed by an optical device, to the angle subtended at the eye by the object itself without the optical device. This is convenient to use in cases where a distance in the object cannot be measured for expressing a Linear Magnification, as in the use of a telescope.
- Manuscript Map**—See under MAP.
- Map***—A representation on a plane surface, at an established scale, of the physical features (natural, artificial, or both) of a part or the whole of the earth's surface, by

means of signs and symbols, and with the means of orientation indicated. Also a similar representation of the heavenly bodies. A map may emphasize, generalize, or omit the representation of certain features to satisfy specific requirements. The type of information which a map is designed primarily to convey is frequently used, in adjective form, to distinguish it from maps of other types. **Topographic Map***—A map which presents the horizontal and vertical positions of the features represented; distinguished from a planimetric map by the addition of relief in measurable form. A topographic map usually shows the same features as a planimetric map, but uses contours or comparable symbols to show mountains, valleys, and plains; and in the case of hydrographic charts, symbols and numbers to show depths in bodies of water. **Contour Map****—A topographic map which portrays relief by means of contour lines. The term "contoured" is disapproved. **Planimetric Map***—A map which presents the horizontal positions only for the features represented; distinguished from a topographic map by the omission of relief in measurable form. The natural features usually shown on a planimetric map include rivers, lakes, and seas; mountains, valleys, and plains; forests, prairies, marshes, and deserts. The cultural features include cities, farms, transportation routes, and public utility facilities; political and private boundary lines. A planimetric map intended for special use may present only those features which are essential to the purpose to be served. **Base Map**—1. A map showing certain fundamental information, copies of which are used to compile additional data of specialized nature. Often used to define a large scale planimetric map compiled from aerial photographs, copies of which are used for the addition of contours and other data by means of the planimeter and/or photogrammetric methods. 2. A map showing all of the information from which maps showing specialized information can be prepared; a master map. **Cadastral Map***—A map showing the boundaries of subdivisions of land, usually with the bearings and lengths thereof and the areas of individual tracts, for purposes of describing and recording ownership. A cadastral map may also show culture, drainage, and other features relating to the value and use of land. **Hydrographic Map**—A map showing a portion of the waters of the earth, including shore lines, the topography along the shores and of the submerged portions, and as much of the topography of the surrounding country as is necessary for the purpose intended. See also Nautical Chart. **Manuscript Map***—The original drawing of a map as compiled or constructed from various data as ground surveys, photographs, etc. **Special Purpose Map****—Any map designed primarily to meet specific requirements. Usually the map information portrayed on a special-purpose map is emphasized by omitting or subordinating other information of a general character which is not essential or is of less importance to the purpose to be served. The special purposes for which maps are designed and used are numerous and are increasing with the trend toward the graphic portrayal of factual information in relation to the areas of origin or application. The map, in most cases, serves as a base on which special information is correlated. A word or phrase is usually employed to describe the type of information which the map is designed to present, as Route Maps, Tax Maps, Index Maps, etc.

Map Data—Collectively, the basic information which the surveyor obtains and the cartographer uses in the construction and compilation of a map.

Map Drawing—Not to be used for MANUSCRIPT MAP, which see under MAP.

Map Grid—Two sets of parallel lines at right angles drawn on a plane surface and used as a rectangular coordinate system (a reference system) for plotting positions and scaling distances and directions in surveying and mapping. A map grid may or may not be based on a map projection. For various classes of coordinate systems see under COORDINATES. See also MAP PROJECTION.

Map Parallel—See under PRINCIPAL PLANE—*Photogrammetry*.

Map Plane—See under GEOID.

Map Projector—A specially designed optical instrument by means of which the image of a photograph or a drawing is projected onto a table where it can be traced or compared with another drawing. The instrument is usually equipped with a mirror to erect the projected image and always is arranged so that the scale of the projected image can be varied. The instrument does not provide for rectification of the photograph.

Map Projection—A systematic drawing of lines on a plane surface to represent the parallels of latitude and the meridians of longitude of the earth or a section of the earth. A map projection may be established by analytical computation or may be constructed geometrically by perspective projection. A map projection is frequently referred to as **Projection** but the complete term should be used unless the context clearly indicates the meaning.

Mapping Camera—Not preferred. See SURVEYING CAMERA under CAMERA.

Master Glass Negative—*Photogrammetry*: A glass negative exposed with the emulsion side in the same position as will be the emulsion on the film at the moment of exposure. Such a negative is a record of the distance between the fiducial marks and is used for measuring film shrinkage.

Mechanical Templet—See under TEMPLET.

Mechanical Templet Plot—See under RADIAL TRIANGULATION.

Mechanical Templet Triangulation—See under RADIAL TRIANGULATION.

Meniscus Lens—A lens in which the centers of curvature of the two surfaces lie on the same side of the lens.

Mercury Barometer—See under BAROMETER.

Meridional Plane—See under POLAR BEARING.

Metapole—Not approved for isocenter, which see.

Micron—One-thousandth part of a millimeter.

Millimicron—One-millionth part of a millimeter.

Minor Control—See under CONTROL.

Minor Control Plot—See RADIAL TRIANGULATION.

Mosaic—*Photogrammetry*: An assemblage of aerial photographs whose edges have been torn, or cut, and matched to form a continuous photographic representation of a portion of the earth's surface. Also called Aerial Mosaic though the adjective is unnecessary where the context clearly indicates the meaning. **Controlled Mosaic**—A mosaic laid on ground control to improve the accuracy of representation as regards distances and directions.

Multiple Lens Camera—See under CAMERA.

Multiple Lens Photograph—A photograph made with a multiple lens camera. See also MULTIPLE LENS CAMERA under CAMERA.

Nadir—That point on the celestial sphere directly beneath the observer, and directly opposite to the zenith. **Photograph Nadir**—*Photogrammetry*: That point at which a vertical line through the perspective center of the camera lens pierces the plane of the photograph. Also referred to as the **Nadir Point**. **Ground Nadir**—The point on the ground vertically beneath the perspective center of the camera lens.

Nadir Point—See under NADIR.

Nadir Point Plot—See under RADIAL TRIANGULATION.

Nadir Point Slotted Templet Plot—See under RADIAL TRIANGULATION.

Nadir Point Triangulation—See under RADIAL TRIANGULATION.

Nadir Radial—See under RADIAL.

Nautical Chart—A hydrographic or marine map. A map of a portion of the earth's surface which includes navigable waters and the adjacent or included land, if any, and on which are indicated depths of the water, marine obstructions, aids to navigation, and other information to aid the mariner in navigating.

Negative—*Photography*: A sensitized plate or film which has been exposed in a camera and which has the lights and shades in inverse order to those of the original subject. The plate or film does not become a negative until it is exposed, after which it may be an undeveloped or a developed negative.

Negative Lens—A lens which will diverge a beam of parallel light rays, no real focus being obtained. Also called **Diverging Lens**.

Nine Lens Camera—See under CAMERA.

Nodal Plane—See under PRINCIPAL POINT—*Optics*.

Nodal Point—See under PRINCIPAL POINT—*Optics*.

Node—See under PRINCIPAL POINT—*Optics*.

North American Datum of 1927—See under GEOID.

Objective—The lens in a microscope or telescope which is nearest the object. Also the lens used in a camera.

Oblique Photograph—A photograph taken with the camera axis directed intentionally between the horizontal and the vertical. The word oblique should be followed by the word photograph unless preceded or followed by some other clarifying noun or adjective. Example: Oblique Photograph, High Oblique, Low Oblique, etc.

Oblique Plotting Instrument—An instrument (usually monocular) for plotting from oblique photographs.

Occupy—*Surveying*: To set a surveying instrument over for the purpose of making observations, said of a station e.g. "occupy Greylock station" or "occupy Station B 16."

Optical Axis—The optical axis of a lens element is a straight line which passes through the centers of curvature of the lens surfaces. In a compound lens if the centers of curvature of all the components were to lie in one straight line, this line would be the optical axis of such a lens. This exact condition is rarely obtained in practice.

Optical Flat—A piece of optical glass (usually a disk with parallel surfaces) the surfaces of which have been ground and polished plane to within a fraction of a wave-length of light. Such a flat is used for testing the planeness of prism faces, mirrors, etc. Also called **Optical Plane**.

Optical Plane—See OPTICAL FLAT.

Optically Flat—A surface is said to be optically flat when it has been ground and polished plane to within a fraction of a wave-length of light.

Origin—*Surveying*: The reference position from which angles or distances are reckoned. See also under COORDINATES.

Orthogonal—At right angles; rectangularly; meeting, crossing, or lying at right angles.

Overlap—*Photography*: Amount by which one photograph overlaps the area covered by another, customarily expressed as a percentage. The overlap between aerial photographs in the same flight is distinguished as the **Forward Lap**, and the overlap between photographs in adjacent parallel flights is called the **Side Lap**.

Overlapping Pair—*Photogrammetry*: Two photographs taken at different exposure stations in such a manner that a portion of one photograph shows the same terrain as

shown on a portion of the other photograph. This term covers the general case and does not imply that the photographs were taken for stereoscopic examination. See also STEREOSCOPIC PAIR under STEREOSCOPY.

Overlay—Mapping: A record on a transparent medium to be superimposed on another record; Example—maps showing original land grants (or patents) prepared as tracing cloth overlays in order that they may be correlated with the maps showing present ownership, also the name overlay for a manuscript map.

Parallactic Angle—See under PARALLAX.

Parallactic Grids—Photogrammetry: A uniform pattern of rectangular lines drawn or engraved on some transparent material, usually glass, and placed either over the photographs of a stereoscopic pair, or in the optical system of a stereoscope, to provide a continuous floating mark system.

Parallax—The apparent displacement of the position of a body with respect to a reference point or system caused by a shift in the point of observation. **Absolute Stereoscopic Parallax—Photogrammetry:** Considering a pair of truly vertical photographs, of equal principal distances, taken from equal flight heights, or a pair of rectified photographs—the absolute stereoscopic parallax of a point is the algebraic difference, parallel to the air base, of the distances of the two images from their respective principal points. In photogrammetry the term **Parallax** is generally used to denote absolute stereoscopic parallax and also to denote similar measurements when the above theoretical conditions are not strictly attained, as for example when measuring parallaxes on unrectified aerial photographs. **Linear Parallax, X-Parallax and Horizontal Parallax** are synonymous with absolute stereoscopic parallax but are not preferred. **Parallax Difference**—The difference in the absolute stereoscopic parallaxes of two points imaged on a pair of photographs. Customarily used in the determination of the difference in elevations of the objects. **Y-Parallax—Photogrammetry:** The y-parallax of a point is the difference of the perpendicular distances of its two images from the vertical plane containing the air base. The existence of y-parallax is an indication of tilt in either or both photographs and/or a difference in flying height and is confusing to stereoscopic examination of the pair. Also called **Vertical Parallax** though the latter is not preferred. **Angular Parallax**—The angle subtended by the eye base of the observer at the object viewed. Also called **Parallactic Angle or Angle of Convergence**.

Parallax Difference—See under PARALLAX.

Pass Point—A point whose horizontal and/or vertical position is determined from photographs by photogrammetrical methods, and which is intended for use after the manner of a ground control point in the orientation of other photographs.

Pencil of Light—See under RAY OF LIGHT.

Perspective Axis—Not approved for MAP PARALLEL, which see under PRINCIPAL PLANE—*Photogrammetry*.

Perspective Center—The point of origin or termination of bundles of perspective rays. The two such points usually associated with a survey photograph are the **Interior Perspective Center** and the **Exterior Perspective Center**. In a perfect lens-camera system, perspective rays from the interior perspective center to the photographic images enclose the same angle as do the corresponding rays from the exterior perspective center to the objects photographed. In a lens having distortion the above is true only for a particular zone of the photograph. In a perfectly adjusted lens-camera system the exterior and interior perspective centers correspond respectively to the front and rear nodal points of the camera lens.

Perspective Grid—Photogrammetry: A network of lines drawn or superimposed on a

photograph which represents the perspective of a systematic network of lines on the ground or datum plane. See also GRID METHOD.

Perspective Plane—Any plane containing the perspective center. Since the intersection of two planes is a straight line, it follows that the intersection of a perspective plane and the ground will always appear as a straight line on the photograph. It also follows that any straight line in the object space will appear as a straight line on the photograph.

Perspective Ray—A line joining a perspective center and a point object.

Photogoniometer—See under GONIOMETER.

Photogrammetric Camera—See under CAMERA.

Photogrammetric Control—See under CONTROL.

Photogrammetric Survey—See under SURVEY.

Photogrammetry—The science or art of obtaining reliable measurements by means of photography. **Aerial Photogrammetry**—Photogrammetry with the aid of aerial photographs. **Ground Photogrammetry**—Photogrammetry with the aid of ground photographs. Also called **Terrestrial Photogrammetry** though this term is not preferred. **Stereophotogrammetry**—Photogrammetry with the aid of stereoscopic equipment and methods.

Photograph—A general term for a positive or negative picture made by a camera on plate, film, or other medium. Sometimes incorrectly called picture or view. For specific types of photographs, see under the proper name as: AERIAL PHOTOGRAPH, MULTIPLE LENS PHOTOGRAPH, etc.

Photograph Axis—See FIDUCIAL AXIS which is preferred.

Photograph Center—The center of a photograph as indicated by the images of the fiducial mark or marks of the camera. In a perfectly adjusted camera the photograph center and the principal point are identical.

Photograph Coordinates—See under COORDINATES.

Photograph Meridian—See under PRINCIPAL PLANE—*Photogrammetry*.

Photograph Nadir—See under NADIR.

Photograph Parallel—See under PRINCIPAL PLANE—*Photogrammetry*.

Photograph Perpendicular—The perpendicular from the INTERIOR PERSPECTIVE CENTER to the plane of the photograph.

Photograph Plumb Point—PHOTOGRAPH NADIR is preferred. See under NADIR.

Photograph Pyramid—A pyramid whose base is a triangle formed by three point images on a photograph and whose apex is the interior perspective center of the photograph.

Phototheodolite—A ground surveying instrument combining a theodolite and a surveying camera in which the relationship between the camera axis and the line of collimation of the theodolite can be measured.

Plane Control—See CONTROL.

Plane Coordinates—See under COORDINATES.

Plane Polar Coordinates—See under COORDINATES.

Plane Rectangular Coordinates—See under COORDINATES.

Planetable—An instrument by means of which points are located in the field directly on a map by graphical methods, the map being fastened to a table top supported by a tripod, from which the instrument derives its name.

Planimetric Map—See under MAP.

Plat—A diagram drawn to scale showing land boundaries and subdivisions, together with

all data essential to the description of the several units. A plat differs from a map in that it does not show additional cultural, drainage and relief features. See also MAP.

Plate Axis—Not approved. See FIDUCIAL AXIS.

Plate Center—See PHOTOGRAPH CENTER which is preferred.

Plate Meridian—Not preferred. See PHOTOGRAPH MERIDIAN under PRINCIPAL PLANE—*Photogrammetry*.

Plate Parallel—Not preferred. See PHOTOGRAPH PARALLEL under PRINCIPAL PLANE—*Photogrammetry*.

Plate Perpendicular—See PHOTOGRAPH PERPENDICULAR which is preferred.

Plate Plumb Point—Not preferred. See PHOTOGRAPH NADIR under NADIR.

Plumb Point—Synonymous with NADIR POINT which is preferred. See under NADIR.

Plumb Point Triangulation—Not preferred. See NADIR POINT TRIANGULATION under RADIAL TRIANGULATION.

Polar Axis—In a system of polar or spherical coordinates, the primary axis of direction.

Polar Bearing—In a system of polar or spherical coordinates, the angle formed by the intersection of the reference meridional plane and the meridional plane containing the point. A *Meridional Plane* is defined as any plane containing the polar axis. See Fig. 1.

Polar Coordinates—See under COORDINATES.

Polar Distance—In a system of polar or spherical coordinates the angle at the origin between a line to a point and the pole. Also the arc of the great circle between the point and the pole.

Porro Prism—This prism deviates the axis 180 degrees and inverts the image in the plane in which the reflection takes place. It may be considered to be two right angle prisms cemented together.

Positive Lens—A lens which will converge a beam of parallel light rays to a point focus. Also called *Converging Lens*.

Positive—*Photography*: A photograph having approximately the same rendition of light and shade as the original subject.

Power of a Lens—See DIOPTRER and also MAGNIFICATION.

Precision**—Degree of refinement in the performance of an operation or in the statement of a result. Precision relates to the quality of execution, and is distinguished from accuracy which relates to the quality of the result. The term precision not only applies to the fidelity with which required operations are performed, but by custom has been applied to methods and instruments employed in obtaining results of a high order of accuracy. Precision is exemplified by the number of decimal places to which a computation is carried and a result stated. In a general way, the accuracy of a result should determine the precision of its expression. Precision is of no significance unless accuracy is also obtained.

Precision Camera—See under CAMERA.

Pressure Back—See LOCATING BACK.

Pressure Plate—*Photography*: A flat plate, usually of metal but frequently of glass or other substance, which by means of mechanical force, presses the film into contact with the focal plane plate of the camera.

Principal Distance—See under EQUIVALENT FOCAL LENGTH.

Principal Line—See under PRINCIPAL PLANE—*Photogrammetry*.

Principal Meridian—See under PRINCIPAL PLANE—*Photogrammetry*.

Principal Parallel—See under PRINCIPAL PLANE—*Photogrammetry*.

Principal Plane—*Optics*: See under PRINCIPAL POINT—*Optics*.

Principal Plane—*Photogrammetry*: The vertical plane through the internal perspective center containing the plate perpendicular of an oblique photograph, i.e., any photograph which is not a truly vertical photograph. In Figure 3 the plane of the paper. In the case of a truly vertical photograph the principal plane and the other planes and lines discussed below have no meaning. **Principal Line**—The trace of the principal plane upon the photograph. **Horizon Trace**—An imaginary line on the plane of the photograph which represents the image of the true horizon. It corresponds to the intersection of the plane of the photograph and the horizontal plane containing the internal perspective center or rear nodal point of the lens. In Figure 3, the line through the point "t" perpendicular to the plane of the paper. **Vanishing Point**—The image on the plane of the photograph of the point towards which a system of parallel lines in the object space converge. Since any system of parallel lines in the object space will meet at infinity, the image of the meeting point will be formed by the ray through the perspective center, *O* in Figure 3, parallel to the system. The vanishing points of all systems of parallel lines parallel to one plane will lie on a straight line on the photograph called a **Vanishing Line**. The vanishing line for all systems of horizontal parallel lines in the object space is the horizon trace. **Photograph Meridian**—The image on the photograph of any horizontal line in the object space which is parallel to the principal plane. Since all such lines meet at infinity, the image of the meeting point is at the intersection of the principal line and the horizon trace, the point "t" in Figure 3, and all photograph meridians pass through that point. The principal line sometimes called the **Principal Meridian** is the only photograph meridian which is perpendicular to the photograph parallels. **Photograph Parallel**—Any horizontal line on the photograph. All photograph parallels are perpendicular to the principal line. The photograph parallel passing through the principal point is the **Principal parallel**, and that passing through the isocenter is the **Isometric Parallel**. Thus the isometric parallel is the intersecting line between the plane of the photograph and a horizontal plane having an equal perpendicular distance from the same perspective center. Also called **Line of Equal Scale**. **Axis of Tilt**—A line through the perspective center perpendicular to the principal plane. The term is arbitrarily restricted to this definition to avoid confusion in usage. Theoretically the axis of tilt could be any one of several lines in space, as for example the Isometric Parallel or the Ground Line. **Map Parallel**—The intersection of the plane of the photograph with the plane of the map. **Ground Parallel**—The intersection of the plane of the photograph with the plane of reference of the ground.

Principal Point Assumption—See under RADIAL TRIANGULATION.

Principal Point Method—Not recommended. See RADIAL TRIANGULATION.

Principal Point—*Optics*: One of two points on the optical axis of a lens (or a system of lenses) such that when all object distances are measured from one point and all image distances are measured from the other, they satisfy the simple lens relation $1/O + 1/I = 1/F$ (conjugate foci formula). **Nodal Point**—*Optics*: One of two points on the optical axis of a lens (or system of lenses) such that a ray emergent from the second point is parallel to the ray incident at the first. When the initial and final media have equal indices of refraction (such as the aerial camera lens), the nodal points coincide with the principal points and consequently satisfy the simple lens relation $1/O + 1/I = 1/F$. The first nodal point is also referred to as the **Front Nodal Point**, or **Incident Nodal Point**, and the second point as the **Rear Nodal Point**,

or *Emergent Nodal Point*. Also called simply *Node*, as front node. *Principal Plane—Optics*: A plane perpendicular to the optical axis at a principal point. *Nodal Plane*—A plane perpendicular to the optical axis at a nodal point.

Principal Point—Photogrammetry: The foot of the perpendicular from the interior perspective center to the plane of the photograph i.e., the foot of the photograph perpendicular.

Principal Point Radial—See RADIAL.

Principal Point Triangulation—See RADIAL TRIANGULATION.

Principal Torque—Photogrammetry: See under CANT AND TORQUE.

Print—Photography: A photographic copy made by projection or contact printing from a photographic negative or from a transparent drawing as in blue printing. *Contact Print*—A print made with the negative or transparent drawing in contact with the sensitized surface. *Ratio Print*—A print, the scale of which has been changed from that of the negative by photographic enlargement or reduction.

Projection—In geometry, the extension of lines or planes to intersect a given surface; the transfer of a point from one surface to a corresponding position on another surface by graphical or analytical methods. *Perspective Projection*—The projection of points by straight lines drawn through them from some given point to an intersection with the plane of projection. Unless otherwise indicated the point of projection is understood to be within a finite distance of the plane of projection. For example, a photograph is formed by a perspective projection of light rays from the rear node of the lens (the point of projection) to the negative (the plane of projection). The term PERSPECTIVE PROJECTION is preferable to the term CONIC PROJECTION as applied to the geometry of a photograph. *Orthographic Projection*—A perspective projection of points by straight lines from a point of projection at an infinite distance from the plane of the drawing. It is regularly used in mechanical drawing and when so used, the two vertical planes are revolved about their respective lines of intersection with the horizontal plane so as to show all three views on the plane of the paper. See also MAP PROJECTION.

Radial—Photogrammetry: A line or direction from the radial center to any point on a photograph. The radial center is assumed to be the principal point unless otherwise designated as for example *Nadir Radial*—a radial from the nadir point or *Iso radial*—a radial from the isocenter.

Radial Center—The selected point on a photograph from which radials (directions) to various image points are drawn or measured, i.e., the origin of radials. The radial center is either the principal point, the nadir point, the isocenter, or a substitute center.

Radial Direction—Not preferred. See RADIAL.

Radial Line—Not preferred. See RADIAL.

Radial Line Method—See RADIAL TRIANGULATION.

Radial Line Plot—Not preferred. See RADIAL PLOT under RADIAL TRIANGULATION.

Radial Plot—See RADIAL TRIANGULATION.

Radial Triangulation—Photogrammetry: A method of triangulation either analytic or graphic, utilizing overlapping vertical, nearly vertical, or oblique aerial photographs for the location of points, imaged on the photographs, in their correct relative position to one another. The center of each vertical photograph (radial center), or the approximate nadir point of each oblique, serves as a station from which directions to points imaged on the photograph are traced, or measured, and used to extend the triangulation by intersection and by resection. A radial triangulation is also cor-

rectly called a *Radial Plot* or a *Minor Control Plot*. If made by analytic methods it is an *Analytic Radial Triangulation*. A radial triangulation is assumed to be graphic unless prefixed by the word analytic. A graphic radial triangulation is usually laid out directly onto ground control plotted on a map, map projection, or map grid, but may be first laid out independently of such control and later adjusted to it as a unit. In the latter case the scale and azimuth of the radial triangulation unit are not known until it is adjusted to the ground control. The radial center for near vertical photographs may be the principal point, the nadir point, or the isocenter. A radial triangulation is assumed to be made with the principal points as radial centers unless the definitive term designates otherwise, as for example, *Nadir Point Triangulation* or *Nadir Point Plot* and *Isocenter Triangulation* or *Isocenter Plot*. The adjective "radial" is not necessary in the preceding four terms. The adjective "analytic" is required to designate that the triangulation is by analytic and not graphic methods as *Analytic Nadir Point Triangulation*. A graphic radial triangulation may be made by several methods as follows: *Slotted Templet Triangulation* or *Slotted Templet Plot*—A graphic radial triangulation using slotted templates. *Spider Templet Triangulation* or *Spider Templet Plot*—A graphic radial triangulation using spider templates. *Mechanical Templet Triangulation* or *Mechanical Templet Plot*—A graphic radial triangulation using either slotted or spider templates or any form of mechanical templet. *Hand Templet Triangulation* or *Hand Templet Plot*—A graphic radial triangulation using any form of hand templates. In the preceding eight terms it is assumed that the radial center is the principal point unless the term includes the words "Nadir Point" or "Isocenter" as *Nadir Point Slotted Templet Plot* or unless the context states that a radial center other than the principal point was used. For definitions of various templates see under TEMPLET. *Direct Radial Triangulation* or *Direct Radial Plot*—A graphic radial triangulation made by tracing the directions from successive radial centers directly onto a transparent plotting sheet rather than laying the triangulation by the templet method. *Strip Radial Triangulation* or *Strip Radial Plot*—A Direct Radial Triangulation in which the photographs are plotted in flight strips without reference to ground control and the strips later adjusted together and adjusted to the ground control. *Principal Point Assumption*—The assumption with respect to near vertical photographs that radial directions are correct if measured from the Principal Point.

Random Acceleration—*Air Navigation*: Unintentional acceleration, or deceleration, usually of short duration, of an aircraft in flight caused by uncontrollable changes in speed or direction while attempting to maintain constant horizontal flight.

Rate of Climb—The rate of ascent from the earth's surface, the vertical component of the velocity of the center of gravity of an aircraft, usually expressed in feet per minute.

Ratio Print—See under PRINT.

Ray—Not approved for RADIAL, which see.

Ray Center—Not approved. See RADIAL CENTER.

Ray Direction—Not approved for RADIAL, which see.

Ray of Light—The geometrical conception of a single element of light propagated in a straight line and of infinitesimal cross section used in tracing analytically the path of light through an optical system. **Pencil of Light**—A bundle of rays originating at, or directed to, a single point. **Beam of Light**—A group of pencils of light, as those originating at the many points of an illuminated surface. A beam of parallel light rays is a special case in which each pencil is of such a small cross section that it may be regarded as a ray.

Rear Nodal Point—See under PRINCIPAL POINT—*Optics*.

Reconnaissance—A general examination or survey of a region with reference to its main features, usually as a preliminary to a more detailed survey.

Recording Statoscope—See under STATOSCOPE.

Rectification—*Photogrammetry*: The process of projecting a tilted or oblique photograph onto a horizontal reference plane, the angular relation between the photograph and the plane being determined by ground measurements. The special process of rectifying the oblique images from a multiple lens camera to equivalent vertical images by projection into a plane perpendicular to the camera axis is called **Transformation**. In this case the projection is into a plane determined by the angular relations of the camera axes and not necessarily into a horizontal plane. **Transforming Printer**—A specially designed projection printer for use with a particular multiple lens camera for transformation of the oblique (wing) negatives taken by that camera.

Reference Spheroid—See under GEOID.

Reflecting Prism—A prism in which deviation of a light beam is produced by reflection within the prism. Practically all prisms used in optical instruments are of this type.

Refracting Prism—A prism which deviates a beam of light by refraction. The angular deviation caused by this type of prism is a function of the wave-length of light, therefore, if the beam being deviated is composed of white light, the prism will spread the beam into a spectrum. Refracting prisms are satisfactory only for small deviations. See WEDGE.

Refraction—The bending of light rays when light passes from one transparent medium into another. The **Angle of Refraction** is the angle the refracted ray makes with the normal to the surface separating the two media. See also SNELL'S LAW.

Relative Aperture—The relative aperture of a photographic or telescopic lens is defined as the ratio of the equivalent focal length to the diameter of the entrance pupil. Expressed as $f:4.5$ etc. Also called **f-Number** or **Speed**.

Relative Humidity—See under HUMIDITY.

Relative Orientation—See under EXTERIOR ORIENTATION.

Relative Tilt—In near vertical photography, the tilt of a photograph with reference to an arbitrary plane, not necessarily a horizontal plane, such as the preceding or subsequent photograph in a strip. Also defined as the tilt of a photograph with respect to a polar axis parallel to the plate perpendicular of another photograph such as the preceding or subsequent photograph in a strip.

Reproduction—*Mapping*: 1. The summation of all of the processes involved in printing copies from an original drawing. The principal processes are photography, lithography or engraving, and printing. 2. A printed copy of an original drawing made by the processes of reproduction.

Reticle—See under FLOATING MARK.

Revert—*Optics*: To interchange the right and left sides of an image without altering the relative positions of the top and bottom as accomplished by certain prisms and mirrors. **Reversion**—*Optics*: The act of reverting.

Rhomboidal Prism—A prism which only displaces the axis of the beam of light laterally.

Rhumb Line—A line (curved) on the surface of the earth, crossing all meridians at a constant angle. Also called a **Loxodromic Curve**. On a Mercator projection the rhumb line is represented by a straight line.

Right Angle Prism—A prism which deviates the axis of the beam 90 degrees and reverts the image.

Roof Prism—Any type of prism in which reflection is produced at two internal surfaces inclined at 90 degrees to each other so as to form a little "roof." The term is often used to refer particularly to AMICI PRISM, which see.

Rotating Prism—See DOVE PRISM.

Service Ceiling—*Air Navigation*: The height in the standard atmosphere above which the maximum rate of climb of an aircraft is less than a given value. The highest altitude at which an airplane will perform, with working load, without excessive loss in efficiency. Not FLIGHT CEILING.

Seven Lens Camera—See under CAMERA.

Shutter—*Photography*: The mechanism of a camera which, when set in motion, permits light to reach the sensitized surface of the film or plate for a predetermined length of time. **Focal Plane Shutter**—A shutter located near the focal plane and consisting of a curtain with a slot which is pulled across the focal plane to make the exposure. **Between the Lens Shutter**—A shutter located between the lens elements of a camera and usually consisting of thin metal leaves which open and close or revolve to make the exposure. **Louver Shutter**—A shutter consisting of a number of thin metal strips of louvers which operate like a Venetian blind to make the exposure. Usually located just in front of or just behind the lens.

Side Lap—See under OVERLAP.

Side Overlap—Not approved. See SIDE LAP under OVERLAP.

Single Lens Camera—See under CAMERA.

Skewed Photograph—*Aerial Photography*: Not recommended. See CRAB.

Slotted Templet Plot—See under RADIAL TRIANGULATION.

Slotted Templet—See under TEMPLET.

Spider Templet—See under TEMPLET.

Slotted Templet Method—See TEMPLET and RADIAL TRIANGULATION.

Slotted Templet Triangulation—See under RADIAL TRIANGULATION.

Snell's Law of Refraction—This law states that the sine of the angle of incidence divided by the sine of the angle of refraction equals a constant called the index of refraction when one of the media is air. The index of refraction can also be explained as the ratio of the velocity of light in one medium to that in another. For air-glass this ratio is approximately 1.4 to 1.6. Also see REFRACTION.

Space Coordinates—See under COORDINATES.

Special Purpose Map. See under MAP.

Specific Humidity—See under HUMIDITY.

Speed of a Lens—See RELATIVE APERTURE.

Spherical Aberration—See under ABERRATION.

Spherical Coordinates—See under COORDINATES.

Spherical Lens—A lens in which the surfaces are segments of spheres. Practically all photographic lenses belong in this class.

Spheroid of Reference—See under GEOID.

Spider Templet Plot—See under RADIAL TRIANGULATION.

Spider Templet Triangulation—See under RADIAL TRIANGULATION.

Standard**—An exact value, or concept thereof established by authority, custom, or common consent, to serve as a model or rule in the measurement of quantity, or in the establishment of a practice or procedure.

State Plane Coordinate Systems—See under COORDINATES.

Station—*Surveying*: 1. A point whose position has been or is to be determined. A Station may be a marked station, i.e., a point more or less permanently marked for recovery, or an unmarked station, one which is not recoverable. 2. A length of 100 feet, measure along a given line, which may be straight, broken, or curved. 3. Any point on a straight, broken, or curved line, whose position is indicated by its total distance from a starting point, or zero point; as station 4 +47.2 meaning 447.2 feet from zero. See also CAMERA STATION.

Statoscope—A sensitive form of barometer used in aerial photography for measuring small differences in altitude between successive air stations. **Recording Statoscope**—A statoscope equipped with a recording camera whose shutter is synchronized with that of the aerial camera.

Sterocomparator—*Photogrammetry*: A stereoscopic instrument for measuring parallax and sometimes including a means of measuring photograph coordinates of image points.

Stereogram—See under STEREOSCOPY.

Stereophotogrammetry—See under PHOTOGRAMMETRY.

Stereoscope—See under STEREOSCOPY.

Stereoscopic Correspondence—See CORRESPONDENCE.

Stereoscopic Fusion—See under STEREOSCOPY.

Stereoscopic Image—See under STEREOSCOPY.

Stereoscopic Pair—See under STEREOSCOPY.

Stereoscopic Vision—See under STEREOSCOPY.

Stereoscopy—The science and art which deal with stereoscopic effects and the methods by which they are produced. **Stereoscope**—An optical instrument for assisting the observer to view two properly prepared photographs, or pictures, to obtain the mental impression of a three dimensional model. **Binocular Vision**—Simultaneous vision with both eyes. **Stereoscopic Vision**—That particular application of binocular vision which enables the observer to view an object or two different perspectives of an object (as two photographs taken from different camera stations) to obtain therefrom the mental impression of a three dimensional model. **Stereoscopic Fusion**—That mental process which combines the two perspective images on the retinas of eyes in such a manner as to give a mental impression of a three dimensional model. **Stereoscopic Image**—That mental impression of a three dimensional model which results from stereoscopic fusion. **Stereoscopic Pair**—*Photogrammetry*: Two photographs of the same area taken from different camera stations in such a manner as to afford stereoscopic vision. Also called a **Stereogram**.

Stop—See IRIS DIAPHRAGM and also APERTURE STOP.

Striae—*Optics*: Threadlike filaments within a piece of glass caused by improper mixing of the molten glass during manufacture. Actually these filaments are composed of glass of slightly different index of refraction than the surrounding glass. The extreme fineness of striae often makes their detection difficult.

Strip Air Coordinates—See under COORDINATES.

Strip Radial Triangulation—See under RADIAL TRIANGULATION.

Substitute Center—A point which because of its ease of identification on overlapping photographs is used as a radial center in lieu of the principal point.

Survey—The act or operation of making measurements for determining the relative positions of points on or beneath the earth's surface; also the results of such operations; also an organization for making surveys. **Photogrammetric Survey**—A survey

utilizing either ground photographs or aerial photographs. **Aerial Survey**—A survey utilizing aerial photographs as part of the surveying operations; also the taking of aerial photographs for surveying purposes; also the photographs taken of an area for surveying purposes. **Ground Survey**—A survey made by ground methods as distinguished from an Aerial Survey. A ground survey may, or may not, include the use of ground photographs but does not include the use of aerial photographs.

Surveying Camera—See under CAMERA.

Surveyor—One who surveys. See SURVEY.

Swing—*Photogrammetry*: The rotation of a photograph in its own plane around the photograph perpendicular. Also the angle on a photograph as measured at the principal point between one of the fiducial axes and any other radial, as for example the principal line.

Symbol—A diagram, design, letter or abbreviation, placed on maps and charts, which by convention, usage, or reference to a legend, is understood to stand for or represent a specific characteristic or object. (Not conventional sign.) Standard symbols (for the United States) have been adopted by the Federal Board of Surveys and Maps, 1938.

Symmetrical Lens—A lens whose front group of elements and rear group of elements correspond in every detail, i.e., radii of curvature, thickness, spacings, diameters, indices of refraction, dispersive powers, focal lengths, and respective positions on opposite sides of a point on the lens axis.

Target—*Optics*: See TEST CHART.

Templet—*Photogrammetry*: A templet used in radial triangulation to represent the aerial photograph; the templet is a record of the directions or radials taken from the photograph. **Hand Templet**—A templet made by tracing the radials from the photograph onto a transparent medium, as on celluloid; hand templates are laid out and adjusted by hand to form the radial triangulation. **Celluloid Templet**—A hand templet made on celluloid. **Mechanical Templet**—Any templet which is manipulated and adjusted mechanically in laying out the radial triangulation. **Slotted Templet**—A mechanical templet on which the radials are represented by slots cut in a sheet of cardboard, metal or other material. **Spider Templet**—A mechanical templet which is formed by attaching slotted steel arms representing radials to a center core. The spider templet is characterized by the fact that it can be disassembled and the parts used again.

Templet Method—See general description under RADIAL TRIANGULATION, and also TEMPLET.

Terrain—An area of ground considered as to its extent and topography.

Terrestrial Camera—See GROUND CAMERA under CAMERA, which is preferred.

Terrestrial Horizon—See under HORIZON.

Terrestrial Photogrammetry—Not preferred. See GROUND PHOTOGRAMMETRY under PHOTOGRAMMETRY.

Terrestrial Photograph—Not preferred. See GROUND PHOTOGRAPH.

Test Chart—A chart for testing the performance of photographic lenses. The design usually consists of ruled lines or squares of various sizes so arranged that by examining the image of such a chart the quality of the lens for various parts of the field may be determined. Also called a **Target**.

Thick Lens—A term used in geometrical optics to indicate that the thickness of a lens is considered, all distances being measured from the nodal points instead of the lens center.

Thin Lens—A term used in geometrical optics to indicate that the thickness of a lens is ignored, all distances being measured from the lens center. Used for approximate computations.

Three Lens Camera—See under CAMERA.

Tilt—*Photogrammetry*: 1. The angle between the plate perpendicular and a vertical through the air station. 2. Also expressed as the dihedral angle between the plane of the photograph and a horizontal plane normal to the plumb line. 3. Also expressed in terms of spherical coordinates as the polar distance of the plate perpendicular where the polar axis is a vertical through the air station. See Fig. 1. **X-Tilt and Y-Tilt**—Tilt expressed as resultant rotations about each of two stationary rectangular axes lying in a horizontal plane—the X-Tilt being the resultant rotation about the X-axis and Y-Tilt the resultant rotation about the Y-axis.

Tilt Line—Not approved. See PRINCIPAL LINE under PRINCIPAL PLANE—*Photogrammetry*.

Tip—Not preferred. See Y-TILT under TILT.

Tolerance—The allowable variation from a standard or from specified conditions.

Topographic Feature—See under TOPOGRAPHY.

Topographic Map—See under MAP.

Topography—The features of the actual surface of the earth considered collectively as to form. A single feature as a mountain or valley is called a **Topographic Feature**.

Torque—*Photogrammetry*: See under CANT AND TORQUE.

Track—*Air Navigation*: The actual path of an aircraft over the surface of the earth. The angle contained between a meridian and a line representing the actual path of an aircraft relative to the earth. It is referred to the true meridian unless otherwise stated.

Transformation—See under RECTIFICATION.

Transformed Print—A photographic print made by projection in a transforming printer. Not transformation. See also MULTIPLE LENS CAMERA under CAMERA and TRANSFORMING PRINTER under RECTIFICATION.

Transformer—Not approved for TRANSFORMING PRINTER, which see under RECTIFICATION.

Transforming Printer—*Photogrammetry*: See under RECTIFICATION.

Traverse—A method of surveying whereby the lengths and directions of lines connecting a series of stations are measured. A traverse may be closed or open according to whether it does or does not return to the starting point or end on a known position. Traverses may be of many kinds as stadia, compass, transit, etc.

Trimming and Mounting Diagram—*Photography*: A sketch which indicates how the prints of a transformed multiple lens photograph should be connected in order to obtain, in effect, a photograph made by a single lens. The information is given in the form of distances referred to the fiducial marks on the photograph, and is the result of the calibration test for the particular camera used.

True horizon—See under HORIZON.

Vacuum Back—See under LOCATING BACK.

Vanishing Line—See under PRINCIPAL PLANE—*Photogrammetry*.

Vanishing Point—See under PRINCIPAL PLANE—*Photogrammetry*.

Venturi Tube—A short tube with flaring ends connected by a constricted section, into which is a side tube connection. It is installed in the air stream of an airplane and

when air flows through it, there is a reduction of pressure in the constricted neck which partial vacuum may be utilized to operate small instruments.

Vertical Control—See under CONTROL.

Vertical Control Datum—See under GEOID.

Vertical Parallax—Not preferred. See Y-PARALLAX under PARALLAX.

Vertical Photograph—*Aerial Photography*: An aerial photograph made with the camera axis vertical or as nearly vertical as practicable in an aircraft.

Visibility—*Air Navigation*: The greatest distance toward the horizon that prominent objects, such as mountains, buildings, towers, etc. can be seen and identified by the unaided eye.

Visible Horizon—See under HORIZON.

Wandering Mark—Not preferred. See FLOATING MARK.

Wedge—*Optics*: 1. A prism of very small deviation, such as those used in the eyepieces of some stereoscopes. 2. A plate of glass whose transparency diminishes from one edge to the other. Such a wedge is often used as a "comparison wedge" in determining the density of negatives.

Wide Angle Lens—A photographic lens is said to be a wide angle lens if its angular field is unusually large. There is no definite division point between an ordinary and a wide angle lens, but in general it can be said that a wide angle lens has an angular field of greater than 80 degrees.

Wing Photograph—A photograph taken by one of the side or wing lenses of a multiple lens camera. See MULTIPLE LENS CAMERA under CAMERA.

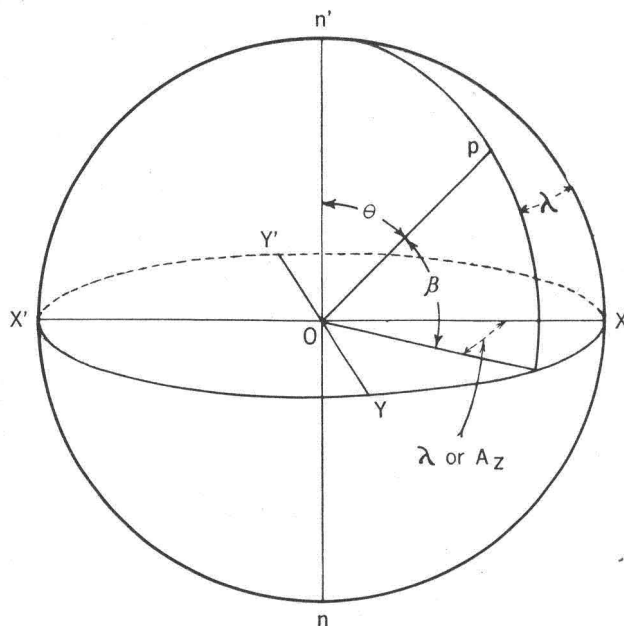
X-Parallax—See under PARALLAX.

X-Tilt—See under TILT.

Y-Parallax—See under PARALLAX.

Y-Tilt—See under TILT.

Figure 1



ORIENTATION OF A SINGLE PHOTOGRAPH
EXPRESSED IN TERMS OF SPHERICAL COORDINATES

- O = Perspective center of the photograph.
- p = Principal point.
- Op = Photograph perpendicular.
- XYX'Y' = Equator (horizontal).
- n n' = Polar axis (vertical).
- θ = Polar distance = tilt.
- β = Declination.
- λ = Polar bearing, azimuth of principal plane with reference to meridional plane (A-).
- XnX'n' = Reference meridional plane.
- Opn' = Principal plane.

Figure 2a

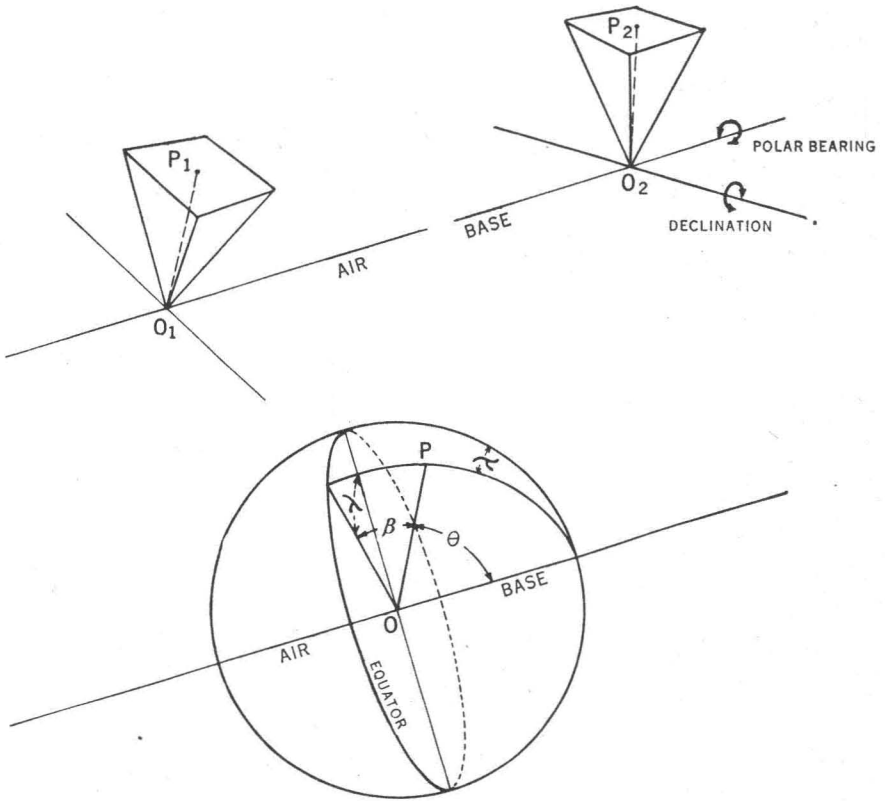


Figure 2b

ORIENTATION OF A PAIR OF PHOTOGRAPHS
EXPRESSED IN TERMS OF SPHERICAL COORDINATES

O = Perspective center of photograph.

P = Principal point.

θ = Polar distance.

β = Declination.

λ = Polar bearing.

The plane of the paper in Fig. 2b corresponds to the reference meridional or epipolar plane.

The subscripts 1 and 2 refer to the first and second photographs, respectively, of a pair.

GEOMETRY OF THE TILTED PHOTOGRAPH
IN THE PRINCIPAL PLANE

- n = Nadir point.
 - i = Isocenter.
 - p = Principal point.
 - t = Point of intersection of the principal line and the horizon trace.
 - O = Perspective center.
- The plane of the paper corresponds to the principal plane.

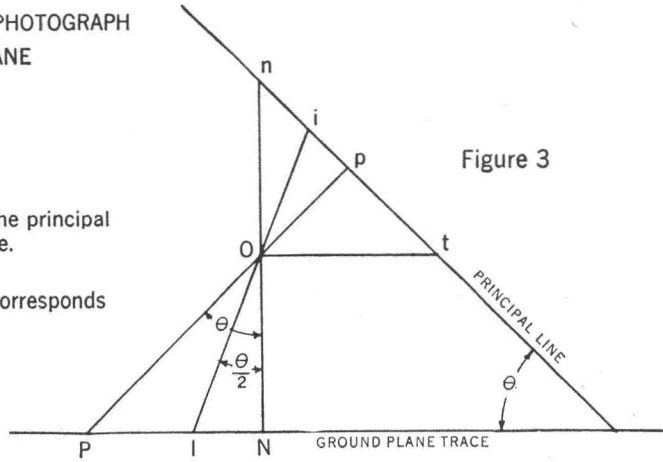


Figure 3

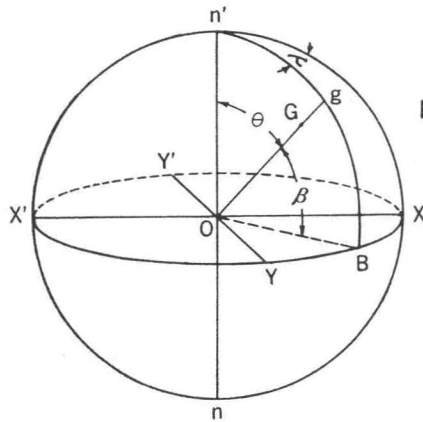


Figure 4

POLAR AND SPHERICAL COORDINATES

$XYX'Y'$ = Equator.

$n'n'$ = Polar axis.

$n'X nX'$ = Reference meridional plane. (plane of the paper).

The polar coordinates of point G are the distance OG, the polar bearing λ and the polar distance θ

The spherical coordinates of point g on the surface of a sphere of radius Og are the polar bearing λ and declination β