Portland, Oregon, and the work was done with a K-17 six-inch focal length camera at a shutter speed of 1/300, an aperture of F-8, with a plane speed of 135 mph. The original fears of distortion due to inability of stopping motion at this scale were unfounded and very clear photography with an extremely minute detail of ground shapes was obtained. It was found after setting up models on this job that stereoscopic perception on the river bottom to a depth of about 15 feet was possible and that soundings could have been made by correcting for the light refraction of the water.

Some difficulty was found in establishing ground elevations by multiplex along the dikes above the tide flats due to the prevalence of heavy grasses. To reduce this source of error to a minimum, notes were kept in the course of ground control work regarding the exact height of grasses in various portions of the area. As a result, the precision of the work was well within the limits as indicated for the job.

Obviously the procedure used is applicable only where the ground is not overly obstructed by heavy vegetation or timber and where the topography of the surrounding country permits safe flying at elevations of 1,500 feet above the terrain. The cost involved for this type of work approximates $\frac{1}{3}$ of the costs of doing the work with differential levels and plane table, and also permits mapping of areas such as mud flats and tide lands where it is impossible to carry out ground instrumental work. The technique should have wide usage wherever good leveling is required in open or cleared land where differences in elevation are not excessive.

A FUNCTIONAL COMPARISON OF STEREOSCOPIC PLOTTING INSTRUMENTS

R. J. Sparling and J. V. Sharp, Bausch & Lomb Optical Co.

ON SEVERAL occasions, various organizations and individuals have contacted representatives of the Bausch & Lomb Optical Co. to discuss the possibilities of our developing for manufacture, various photogrammetric and particularly stereoscopic plotting instruments for aerial surveying. It has seemed strange to some that we did not immediately embark upon development for manufacture of each new photogrammetric instrument, its optics or other components when presented for development. The reason may be simply found in the fact that the number of problems and personnel required to develop an instrument, even from an operating prototype to a manufactured instrument, are as multitudinous as those in developing the prototype. To develop such instruments for manufacture also requires that each instrument of a given type when manufactured must meet the same manufacturing specifications as to quality and function. Then only is the user of the equipment assured of consistent performance for each instrument he secures. Only then, also, can he safely base economic commitments for funds to secure equipment and personnel to operate a successful mapping organization. This latter continuity specification is a major cost—often overlooked—in the manufacture of such instruments by small instrument shops, besides the usual costs of material, of labor, of factory operations, of engineering, of administration, of distribution, and of operating capital. There has been, likewise, a need expressed by several members of the Photogrammetric Society for a readily available and compact summary of the functions of stereoscopic instruments, such information often being remote and

MAJOR FUNCTIONAL PROPERTIES OF STEREOSC

From Volume XIV Number 3 Photogrammetric Engineering

Functional Analysis of Stereoscopic Plotting Instruments by R. G. Sparling and J. V. Sharp of Bausch and Lomb Optical Co.

Notes on Functions by Number in Article

Symbols defined in Upper right corner

Symbol — Based on the Following Major Published Sources

A = B.B. Talley, Engineering Applications of Terrestrial and Aerial Photogrammetry. Pitman Publishing Co., New York, N. Y.

B = Manual of Photogrammetry, 1944, Pitman Publishing Co., New York, N. Y.

C = V. Gruber, Collected Lectures and Essays, Chapman & Hall, London

D = Photogrammetric Engineering, The American Society of Photogrammetry

Aerial Photography

Instrument (In use or of interest)	As manufactured by	Function No.	Type of Photography: Vertical (1)	Oblique (1)	Convergent (1)	Multilens (1)	Normal Angle (1)	Wide Angle (1)	Camera Lens: Focal Lengths Limits (2)	Printers Used: Contact (3)	Reduction (3)	Enlarging (3)	Rectifying (3)	Transforming (3)	Printed Medium: Film Negatives (3)	Glass Positives (3)	Paper Prints (3)	Maximum Size (4)
Holst-Cahill Stereometer	Brock & Weymouth Philadelphia, Pa.	1	√	—	—	—	√	√	3" to 8¼"	—	×	√	√	—	×	√	—	14"×17"
Reading Stereoplotter	U. S. Coast & Geodetic Survey	2	√	—	—	√	√	×	8¼"	—	×	—	√	√	0	0	√	35"×35"
Bauersfeld Stereoplanigraph	Carl Zeiss Jena, Germany	3	√	√	√	√	√	√	100 to 210 mm	√	×	—	×	×	√	√	—	18×18 cm
Hugershoff Aero-Cartograph	G. Heyde Dresden, Germany	4	√	√	√	—	√	—	125 to 210 mm	√	×	—	×	×	√	√	—	18×18 cm
Wild Autograph A-5	H. Wild Heerbrugg, Switzerland	5	√	√	√	—	√	√	100 to 215 mm	√	×	—	×	—	√	√	—	18×18 cm
Multiplex Projectors	Bausch & Lomb Optical Co. Rochester, New York	6	√	√ [4]	√ [4]	—	—	√	3" to 12"	—	√	—	×	×	—	√	—	60 mm diameter
Kelsh Plotter	Instrument Corporation Baltimore, Maryland	7	√	—	—	—	√	√	8¼"	√	×	—	×	×	×	√	—	9"×9"
Ferber Scintillating Plotter	Gallus Paris, France	8	√	√	√	—	√	—	?	√	×	—	×	—	√	?	—	?
Nistri Photocartograph	O.M.I. S.A. Rome, Italy	9	√	—	—	—	√	—	18 cms	0	×	—	×	×	√	0	—	13×18 cm
Santoni Stereo-Simplex	Gallileo Florence, Italy	10	√	√	—	—	√	—	65 to 85 cms	√	×	—	×	—	?	√	—	10×10 cm
Poivillier Stereotopograph	S.O.M. Paris, France	11	√	√	√	—	√	—	125 to 300 mm	√	×	—	×	—	√	?	—	18×18 cm
Santoni Stereo-Cartograph III	Gallileo Florence, Italy	12	√	√	√	√	√	—	100 to 200 mm	√	×	—	×	—	—	√	—	18×20 cm
Wild Stereoplotter A-6	H. Wild Heerbrugg, Switzerland	13	√	—	—	—	√	√	98 to 270 mm	√	×	—	×	×	√	√	√	9"×9"
Fourcade Plotter	Air-Survey-Committee London, England	14	√	√	√	—	√	?	?	√	×	—	×	—	?	√	—	?
K.E.K. Plotter	P. B. Kail Denver, Colorado	15	√	—	—	—	√	√	none	√	×	×	0	—	—	—	√	9"×9"
Mahan-Wernstedt Plotter	H. C. Ryker Berkeley, California	16	√	—	—	—	√	√	none	√	×	—	0	—	—	—	√	9"×9"
Cooks Plotter Multiscope Plotter	Harvard University Cambridge, Massachusetts	17	√	—	—	—	√	√	none	√	×	—	0	—	—	—	√	?
Talley Stereocomparagraph	Fairchild Jamaica, New York	18	√	—	—	—	√	√	none	√	×	—	0	—	—	—	√	10"×10"
Abrams Contour Finder	Abrams Instrument Corp. Lansing, Michigan	19	√	—	—	—	√	√	none	√	×	—	0	—	—	—	√	8½"×8½"

Design Functions Used; Relative Orientation; Model Scaling

Instrument	Projection: Interior Orientation (5)	Perspective Center (6)	Parallel Axes (6)	Mechanical Control (7)	Optical Control (7)	Total Image (8)	Partial Image (8)	Distortion Elimination: Poro Principle (9)	Correction Plate (9)	Printer Lens (9)	Mechanical Linkage (9)	y-Parallax Removal: Approximate (10)	Exact (10)	Mechanical Motions: Angular (11)	Linear (11)	Method: Base Components (12)	Measuring marks (12)	Horiz.-Vert. Scale ratio: Constant (13)	Variable (13)
Holst-Cahill Stereometer	√	—	√	—	√	×	√	0	0	0	0	—	√	1	1	—	—	—	√
Reading Stereoplotter	√	—	√	—	√	×	√	—	×	×	√	—	√	1	1	—	—	—	√
Bauersfeld Stereoplanigraph	√	√	—	—	√	×	√	√	×	×	×	—	√	3	3	3	—	√	—
Hugershoff Aero-Cartograph	√	√	—	√	√	×	√	√	×	×	×	—	√	3	3	3	—	√	—
Wild Autograph A-5	√	√	—	√	—	×	√	—	√	—	—	—	√	3	3	3	—	√	—
Multiplex Projectors	√	√	—	—	√	√	—	—	—	√	—	—	√	3	3	3	—	√	—
Kelsh Plotter	√	√	—	—	√	0	√	√	×	—	—	—	√	3	3	3	—	√	—
Ferber Scintillating Plotter	√	√	—	—	√	×	√	√	×	×	×	—	√	3	3	3	—	√	—
Nistri Photocartograph	√	√	—	—	√	√	—	√	×	×	×	—	√	3	3	3	—	√	—
Santoni Stereo-Simplex	√	√	—	√	√	√	—	√	×	×	×	—	√	2	3	1	—	√	—
Poivillier Stereotopograph	√	√	—	√	√	×	√	√	×	×	×	—	√	3	3	3	—	√	—
Santoni Stereo-Cartograph III	√	—	√	√	—	×	√	×	×	×	√	—	√	3	3	3	—	√	—
Wild Stereoplotter A-6	√	√	—	√	—	×	√	—	√	—	—	—	√	3	1	1	—	√	—
Fourcade Plotter	√	√	—	√	√	×	√	√	×	×	×	—	√	3	1	1	—	√	—
K.E.K. Plotter	—	√	—	—	√	√	—	—	—	—	0	√	—	3	—	1	√	—	√
Mahan-Wernstedt Plotter	—	√	—	—	√	√	—	—	—	—	0	√	—	3	—	1	√	—	√
Cooks Plotter Multiscope Plotter	—	√	—	—	√	√	—	—	—	—	0	√	—	3	3	1	—	—	√
Talley Stereocomparagraph	—	—	√	—	√	√	—	—	—	—	0	√	—	1	1	—	—	—	√
Abrams Contour Finder	—	—	√	—	√	—	√	—	—	—	0	√	—	1	1	—	—	—	√

Exterior Orientation; Floating Mark and Related Design; Plotting S

Instrument	Common Motions Provided: Number (14)	On Table (14)	On Instruments (14)	Type: Number (15)	Luminous (15)	Opaque (15)	Floating Dot Moves Vertically By Motion of: Model (16)	Marks (16)	Screen (16)	Mapping Surface (16)	Plotting Base (16)	Optical Elements (16)	Individual Image (16)	Elevation Linkage: None (17)	Separate (17)	Fixed (17)	Drive: Tracks (18)	Gear Drives (18)	Free Hand (18)	Plotting Device: Pencil Arm (19)	Coordinatograph (19)	Pantograph (19)	Built in (19)	Separate (19)	Scale Range with respect to model scale (20)
Holst-Cahill Stereometer	×	×	×	2	—	√	—	—	—	—	—	—	√	—	—	√	√	√	0	√ [2]	—	—	—	—	1 to 1
Reading Stereoplotter	×	×	×	2	—	√	—	—	—	—	—	—	√	—	—	√	—	—	√	—	—	√	√	—	1 to 1
Bauersfeld Stereoplanigraph	2	×	√	2	√	√	√	—	—	—	—	√	—	—	—	√	√	√	0	—	√	—	—	√	0.1 to 8
Hugershoff Aero-Cartograph	0	0	0	2	—	√	—	—	—	—	√	√	—	—	—	√	√	√	0	—	√	—	—	√	0.2 to 5
Wild Autograph A-5	3	×	√	2	√	—	—	—	—	—	√	√	—	√	—	√	√	√	0	—	√	—	—	√	0.33 to 8
Multiplex Projectors	2	×	√	1	√	0	—	√	√	—	—	—	—	√	—	—	—	—	√	√	—	—	√	—	1 to 1
Kelsh Plotter	2	×	√	1	√	0	—	√	√	—	—	—	—	√	—	—	—	—	√	√	—	—	√	—	1 to 1
Ferber Scintillating Plotter	0	0	0	1	—	√	√	—	—	—	—	—	—	—	√	—	√	—	√	√	—	—	√	—	?
Nistri Photocartograph	0	0	0	1	—	√	—	√	√	—	—	—	—	√	—	—	√	√	—	—	√	—	—	√	?
Santoni Stereo-Simplex	2	×	√	2	√	—	—	√ [5]	—	—	—	√	—	—	√	—	√	—	√	√	—	—	√	—	?
Poivillier Stereotopograph	0	0	0	2	—	√	—	—	—	—	√	√	—	—	√	—	√	√	—	—	√	—	—	√	0.2 to 5
Santoni Stereo-Cartograph III	2	×	√	2	—	√	—	—	—	—	√	√	—	—	—	√	√	√	√	—	—	√	√	—	?
Wild Stereoplotter A-6	1	0	√	2	—	√	—	—	—	√	—	√	—	—	√	—	—	—	√	—	—	√	√	→	0.15 to 1.0
Fourcade Plotter	2	√	×	2	—	√	—	—	—	—	√	√	—	—	√	—	√	—	√	√	—	—	√	—	1 to 1
K.E.K. Plotter	0	0	0	2	—	√	√	—	—	—	—	—	—	—	—	√	—	—	√	—	—	√	√	—	0.5 to 2.5
Mahan-Wernstedt Plotter	0	0	0	2	—	√	√	—	—	—	—	—	—	—	—	√	—	—	√	—	—	√	√	—	0.2 to 2.0
Cooks Plotter Multiscope Plotter	0	0	0	1	√	—	—	—	√	—	—	—	—	√	—	—	—	—	√	√	—	—	√	—	1.25 to 1.5
Talley Stereocomparagraph	0	0	0	2	—	√	—	√	—	—	—	—	—	—	—	√	—	—	√	√	—	—	√	—	1 to 1
Abrams Contour Finder	0	0	0	2	—	√	—	√	—	—	—	—	—	—	—	√	—	—	√	√	—	—	√	—	1 to 1

…OPIC PLOTTING INSTRUMENTS

…stem: Continuous Plotting	…stem: Exact Contours	…stem: Approx. Contours	…stem: Form Lines	…stem: Orthographic	…stem: Conic	Observation Measurement System: Direct	Observation Measurement System: Mirror Stereoscope	Observation Measurement System: Magnifier	Observation Measurement System: Binocular Telescope	Observation Measurement System: Porro-Principle	Observation Measurement System: Perspective Center: Fixed	Observation Measurement System: Perspective Center: Variable	Observation Measurement System: Orthogonal	Observation Measurement System: Stereo-image	Observation Measurement System: Flicker image	Observation System Details: Images: Interchangeable	Images: Erect	Images: Reverted	Magnification: Fixed: Telescopic	Magnification: Fixed: Projective	Magnification: Varies: Telescopic	Magnification: Varies: Projective	Image Scale Balance: None	Image Scale Balance: By Projection	Image Scale Balance: Telescopically	Image Scale Balance: Extra Instrument	Eye Motions: Pupil Location	Eye Motions: Pupillary Distance	Eye Motions: Finite Accommodation	Planes of Image and Floating Dot: Common	Planes of Image and Floating Dot: Different	Rays to Eyes Require Eye Axes To Be: Parallel	Rays to Eyes Require Eye Axes To Be: Convergent	Rays to Eyes Require Eye Axes To Be: Variable	At Critical Focus: Floating Mark	At Critical Focus: Photo Image	Illumination System: Light: White: Constant	Illumination System: Light: White: Flickering	Illumination System: Light: Bichromatic	Illumination System: Filter Spectacles	Illumination System: Condenser System	Illumination System: Reflector System	Illumination System: Diffuse System	Extension of Control: Mechanical Means Provided	Extension of Control: Resetting Orientation Data Required	Extension of Control: Optical Reversions Required	Extension of Control: Mechanical Reversions Required	Plotting Operations: Simultaneous Observers: One	Plotting Operations: Simultaneous Observers: Several	Plotting Operations: Simultaneous Operators: One	Plotting Operations: Simultaneous Operators: Several	Service and Maintenance: Portable	Service and Maintenance: Stationary	Service and Maintenance: Periodic Service Adjustment	Service and Maintenance: Recalibration when moved	Service and Maintenance: Light Sources: Arc	Service and Maintenance: Light Sources: Filament	Auxiliary Equipment: Reduction Printer	Auxiliary Equipment: Transforming Printer	Auxiliary Equipment: Rectifier	Auxiliary Equipment: Enlarging Projector	Auxiliary Equipment: Transforming Projector	Remarks	Source: Volume & Page	
21	22			23		24				25	26		27	28		29	30		31		32		33				34	35	36	37		38			39		40			41	42			43	44	45		46		47		48		49		50		51					Remarks	Source: Volume & Page	
0	√	–	–	–	√	–	–	–	√	–	–	–	√	√	–	0	√	–	√	–	0	–	×	–	–	√	–	√	–	√	–	√	–	–	√	√	√	–	–	–	–	–	√	0	–	–	–	√	–	√	–	0	√	√	√	–	√	×	×	√	√	√	1) Pencil Hand Operated	A-542 B-522 C-162, 236	1
√	√	–	–	√[2]	–	–	√	–	√	–	–	–	√	√	–	0	√	–	√	–	0	–	×	–	–	√	–	–	–	√	–	√	–	–	√	√	√	–	–	–	–	–	√	0	–	–	–	√	–	√	–	0	√	√	√	–	√	×	√	√	×	×	2) Transformation from conic projection by spiral reduction gear	D-XIII, 2-257	2
√	√	–	–	√	–	–	–	–	√	√	√	–	–	√	–	√	√	–	√	–	0	√	×	√	–	–	–	–	–	√	–	√	–	–	√	√	√	–	–	–	–	√	–	√	×	×	×	√	–	√	–	0	√	√	√	–	√	×	×	×	×	×		A-489 C-345	3
√	√	–	–	√	–	–	–	–	√	√	√	–	–	√	–	√	√	–	–	√	√	–	–	–	√	–	–	–	–	√	–	√	–	–	√	√	√	–	–	–	–	√	–	√	×	×	×	√	–	√	–	0	√	√	√	–	√	×	×	×	×	×		A-489 C-345	4
√	√	–	–	√	–	–	–	–	√	–	–	–	√	√	–	0	–	√	√	–	√[3]	–	√	–	0	–	–	–	–	√	–	√	–	–	√	√	√	–	–	–	–	√	–	√	×	√	√	√	–	√	–	0	√	√	√	–	√	×	×	×	×	×	3) 2 Steps—2x and 6x	A-502 D-XIII, 1-59	5
√	√	–	–	√	–	√	–	0	–	√	–	–	–	√	–	√	√	–	–	–	–	√	×	√	–	–	–	–	√	√	–	–	√	–	√	–	–	–	√	√	√	–	–	√	×	×	×	–	√	–	√	√	–	–	–	–	√	√	×	×	×	×	4) Projectors require special mounts	A-224 C-500	6
√	√	–	–	√	–	√	–	0	–	√	–	–	–	√	–	√	√	–	–	–	–	√	×	√	–	–	–	–	√	√	–	–	√	–	√	–	√	–	√	√	–	√	–	0	–	–	–	–	√	–	√	√	–	–	–	√	–	×	×	×	×	×		D-XIII, 1-121 D-XIV, 1-11	7
√	√	–	–	√	–	√	–	0	–	√	√	–	√	–	√	–	√	–	–	–	–	√	×	√	–	–	–	–	√	√	–	–	√	–	√	√	–	√	–	–	√	–	–	–	–	–	–	–	√	√	–	0	√	–	√	–	√	×	×	×	×	×		A-516	8
√	√	–	–	√	–	√	–	–	–	√	–	–	√	–	√	0	√	–	–	–	–	√	×	√	–	–	–	–	√	√	–	–	√	–	√	–	–	√	–	–	–	√	–	0	–	–	–	–	√	√	–	0	√	√	√	√	–	×	×	×	×	×		A-522 C-219	9
√	√	–	–	√	–	–	–	–	√	√	√	–	–	√	–	–	–	√	√	√	–	–	√	–	–	–	√	√	–	√	–	–	–	√	√	√	√	–	–	–	–	–	√	–	–	–	–	√	–	√	–	√	–	√	√	–	√	×	×	×	×	×	5) Point of Intersection of space rods	Santoni-Galileo Pamphlet—1938	10
√	√	–	–	√	–	–	–	–	√	√	√	–	–	√	–	0	?	?	√	√	0	–	√	–	0	–	–	–	–	√	–	√	–	–	√	√	√	–	–	–	–	√	–	√	×	√	√	√	–	√	–	0	√	√	√	–	√	×	×	×	×	×		A-513 C-223	11
√	√	–	–	√	–	–	–	–	√	–	–	–	√	√	–	0	?	?	√	√	0	–	√	–	0	–	–	–	–	√	–	√	–	–	√	√	√	–	–	–	–	√	–	√	×	√	√	√	–	√	–	0	√	√	√	–	√	×	×	×	×	×		A-522	12
√	√	–	–	√	–	–	–	–	√	–	–	–	√	√	–	0	√	–	√	–	0	–	√	–	0	–	–	–	–	√	–	√	–	–	√	√	√	–	–	–	–	√	–	0	–	–	–	√	–	√	–	0	√	√	√	–	√	×	×	×	×	×		D-XIII, 1-59	13
√	√	–	–	√	–	–	–	–	√	√	√	–	–	√	–	0	?	?	√	√	–	–	√	–	–	–	–	–	–	√	–	√	–	–	√	√	√	–	–	–	–	√	–	0	–	–	–	√	–	√	–	0	√	√	√	–	√	×	×	×	×	×		A-536 C-231	14
√	–	√	–	√[6]	–	–	√	–	–	–	–	√	–	√	–	–	√	–	√	√	–	–	√	–	–	–	√	√	√	–	√	–	–	√	0	0	√	–	–	–	–	–	√	–	–	–	–	√	–	√	–	√	×	×	√	–	√	×	×	×	×	×		D-XII, 4-459	15
√	–	√	–	√[6]	–	–	√	–	–	–	–	√	–	√	–	–	√	–	√	√	–	–	√	–	–	–	√	√	√	–	√	–	–	√	0	0	√	–	–	–	–	–	√	–	–	–	–	√	–	√	–	√	×	×	√	–	√	×	×	×	×	×	6) Approximately	D-XI, 4-336 D-XII, 4-459	16
√	–	√	–	√[6]	–	–	√	–	–	–	–	√	–	√	–	–	√	–	√	√	–	–	√	–	–	–	√	√	√	–	√	–	–	√	0	0	√	–	–	–	–	–	√	–	–	–	–	√	–	√	–	√	×	×	√	–	√	×	×	×	×	×		D-XI, 3-171 D-XII, 3-315 D-XII, 4-459	17
√	–	–	√	–	√	–	√	–	–	–	–	–	√	√	–	–	√	–	√	√	0	–	√	–	0	–	–	–	–	√	–	–	√	–	√	√	√	–	–	–	–	–	√	–	–	–	–	√	–	√	–	√	×	×	×	–	√	×	×	×	×	×		B-464	18
√	–	–	√	–	√	–	–	√	–	–	–	–	√	√	–	–	√	–	√	√	0	–	√	–	0	–	–	–	–	√	–	–	√	–	√	√	√	–	–	–	–	–	√	–	–	–	–	√	–	√	–	√	×	×	×	–	√	×	×	×	×	×		B-312, 752	19

Symbols Used

Function

(√) = applies
(–) = not applicable
(x) = not required
(0) = not provided for
(?) = information not available

difficult to locate in photogrammetric literature. Such a summary should be compact enough to be of use for wall or desk-top reference.

As a result of both these needs, it was felt advisable to analyze the available published literature together with published comments on this literature in order to secure at least a functional basis of comparison of stereoscopic plotting instruments of current interest. This comparison, begun in July 1948, is limited to those instruments which are concerned primarily with aerial surveying. We have also limited the list to instruments reported to be now in use, or of sufficient interest, because of basic type, to include in this analysis. No attempt has been made to compare the accuracy or range of usefulness, as this is an exceedingly difficult task. It was successfully attempted, however, by Mr. W. T. Pryor, of the U. S. Public Roads Administration, in the December 1946 issue of Photogrammetric Engineering. We do not agree with the limits he placed on Multiplex System of instruments as now manufactured by Bausch & Lomb, but we do agree that, in his article, he made a splendid and accurate effort to muster the then published available data and the opinion then existing. We, consequently, have encouraged articles to be written and the intensification of efforts of Multiplex mapping organizations, to change this point of view; this applies particularly to mapping organizations engaged in producing complete highway maps in many states and countries, Such an article by K. B. Wood and S. B. Gross is published in this issue and describes 2 foot contour work with the Multiplex Projector.

In a similar manner, related to this paper, if any group or individual feels that its favorite instrument has in any way been misrepresented in the following analysis, an article is invited. Such an article, we have been assured, would be published in subsequent issues of Photogrammetric Engineering.

Operational tests have been reported, from time to time, on prototypes of new instruments as indicating excellent operating accuracy; unfortunately these tests have been over areas of low relief. It is our belief that tests of such instruments are open to considerable question, unless tested in rugged terrain from pictures taken at a variety of flying heights from 1,500 to 40,000 ft., the now published range of practical flying. This will aid in indicating the full operational scope of the instrument. The use of accurate grids is also considered an excellent indication of the performance of an individual stereoscopic plotting instrument of a system, if properly interpreted. A statement of the residual radial distortion of the system is also an important consideration, as no system, in spite of claims, is completely free of small residual distortions. The distortion portion introduced by lens systems can be measured to within an accuracy of a few microns, and its effects on mapping accuracy are reasonably well established. These factors all aid in judging the potentialities of any new prototype instrument.

Factors of operating convenience and operational fatigue for operators and supervisors, whose time is a major item in mapping labor costs, are important particularly in the competitive situation which exists in mapping today. Ease of training new operators is also of particular importance.

In judging any instrument, it seems important for any purpose that it be clearly shown whether or not the major functions are performed by the prototype instrument. With this object in mind, analysis of the literature available in this country has been reduced to a concise tabulation enclosed in this issue. Functional properties have been described in as few words as possible for the purpose of compactness. Wherever possible, words have been used which are defined in the Appendix of the MANUAL OF PHOTOGRAMMETRY (1944 preliminary edition). Statements explaining the meaning of various functions are referred to by function numbers in this tabulation and are listed as follows:

Major Functional Properties
of
Stereoscopic Plotting Instruments

No.	*Function*
1.	Type of photographs the instrument accommodates (vertical, oblique, convergent, multilens, normal angle, wide angle).
2.	The camera lens focal lengths limits used or applicable.
3.	The material the instrument uses (film negatives, glass diapositives, paper prints) and printed by contact, reduction, enlarging, rectifying or transforming printers.
4.	The size of photographs used.
5.	The interior orientation of exposure camera restored or taken into account in the photogrammetric process.
6.	The principle of the design, based on central or parallel projection.
7.	The projection produced by optical or mechanical means.
8.	Total or partial projection of the image used in the plotting procedure.
9.	Means by which the distortion of the camera lens is minimized.
10.	The relative orientation of photographs permit correct coincidence setting within the entire model area.
11.	Number of linear and angular movements which are provided for relative orientation.
12.	Means by which the scale of the optical model can be changed adequately.
13.	The ratio between horizontal and vertical model scale is constant or variable during operation.
14.	Common motions provided to rotate the optical model or the plotting table for exterior orientation purposes.
15.	Measuring marks, opaque or luminous, are employed.
16.	Elevations measurements are made by displacements of the floating mark, screen, the model surface, the plotting base, the plotting surface, individual image, or by the mechanical movement of optical elements.
17.	The measuring marks or individual photographs are jointly moved during the process of measurement or they are individually connected by a separate linkage.
18.	Tracks and gear drives of a rectangular coordinates system are provided for the real or apparent movement of the floating mark, or this movement of the floating mark is hand controlled.
19.	The plotting device consists of a simple pencil arm, a coordinatograph, or a pantograph linkage, which is built in, or separate part of the instrument.
20.	The range between model scale and mapping scale.
21.	The delineation of contours or profiles can be followed in continuance.
22.	The vertical measurements recorded on the map are contours or form lines.
23.	The plotting is drawn in orthographic or conic projection.
24.	The viewing system consists of looking at the model directly, through a mirror stereoscope, a set of magnifiers, or a binocular telescope.
25.	The Porro-principle of measurement is applied.
26.	The centers of perspective of observation of image detail are fixed or variable.
27.	The photographic images are viewed orthogonally.
28.	The stereoscopic or the flicker principle is applied.

29. Two image views are interchangeable at the observer's eyes.
30. The pictures as observed through the viewing system are erect and directionally unreverted, or reverted.
31. The magnification of the viewing system is produced by telescopic or projective means, but is fixed.
32. The magnification of the viewing system is produced by telescopic or projective means, but is variable.
33. Scale differences of conjugate images are or are not balanced in observation systems, in the projective system, or in using another instrument.
34. Results of measurements vary with the location of the pupils of the eyes.
35. Results of measurements change with the variation of inter-pupillary separation.
36. The observation method (or system) requires accommodation of the eyes to finite distance.
37. Photographs or their images and floating marks or their images are invariably viewed in common planes.
38. The orientation of rays emerging from the exit pupils of the observation system or the direct observation of images require parallel, convergent, or variable position of the eye axis.
39. The photographic detail and the floating mark are observed at critical focus.
40. Artificial lighting required is white or dichromatic, and if white, constant or flickering.
41. Filter spectacles are needed for image separation.
42. Illumination of image by optical or reflective means or by direct diffusion.
43. Mechanical means are provided to extend instrumental control.
44. Resetting of orientation data is required in extending control.
45. Optical and mechanical reversions of movements are required in extending control in alternate models.
46. Several persons can observe the floating mark simultaneously.
47 Several operators can do plotting work simultaneously.
48. The instrument is portable or stationary.
49. Service adjustments are necessary with each reassembling.
50. The light source used is an arc or filament type.
51. Specially designed auxiliary equipment needed in the system of mapping in addition to standard contact printers.
52. Remarks.
53. Source of information in literature. (See symbols on left corner of chart.)

Other factors in considering stereoscopic plotting instruments are the collective effects of approximate solutions of true design. Often we read that this or that instrument will perform satisfactorily with one or more of the following "If's":

If the plane altitude is nearly constant.
If the photographs are nearly vertical.
If the terrain is nearly flat.
If an existing map of the terrain is nearly as good as the one to be made.
If the lens is nearly free of distortion.
If the eyes are held nearly fixed.
If the interpupillary distance of all observers was nearly constant.
If the point of projection is nearly at the principal point.
If the photographic image supporting surface is nearly flat.
If the instrument orientation is nearly exact.

If the machine is mechanically maintained nearly precise.
If the photographic prints are nearly stable.

These are a few of the dangerous "if's" to be considered in designing and using stereoscopic plotting instruments. We agree that any one "if" may be proven to have "negligible" effect in mapping. But, failure to consider the collective effects of all the "if's" and the setting of operating tolerances on the "nearly's" can result only in an assurance of operating difficulties in map production. We would not do justice to our present and future users by developing a photogrammetric instrument for their use, which does not consider all of these factors collectively.

Another important item not to be overlooked in comparing mapping instruments, is information on whether an instrument which has been purchased, has been put in operation, and then set aside to be displayed in operation only when visitors are shown through, on a tour of a mapping organization. Information as to the extent to which an instrument is being used, is often difficult to secure, but is worth seeking in comparing stereoscopic instruments.

Finally, in conclusion, when using such a tabulation as a basis for judging the value of any instrument for use, or for development, or for manufacture, each function needs to be considered and clearly understood in regard to its effects on mapping accuracy, operating convenience and maintenance, and the collective effect of all these factors on the ultimate factor—the final cost of the specified map to the purchaser and user of that map.

REPORT OF NOMENCLATURE COMMITTEE

A. O. Quinn, Chairman

The American Society of Photogrammetry is in the process of revising the "MANUAL OF PHOTOGRAMMETRY." This important book contains a complete list of symbols and nomenclature used in the science of photogrammetry. Since the original compilation of these data, a number of new terms have come into common usage and several of the terms probably need revisions and clarification.

In order to further the science of photogrammetry, the Society feels that it is absolutely essential to standardize our nomenclature. All groups using aerial and terrestrial photographs should use common expressions in the exchange of ideas and practices in photogrammetry.

The Nomenclature Committee of the Society has been charged with the responsibility of reviewing, revising and completing the symbols and nomenclature used in this country, Canada and South America. To accomplish this most important task, the Committee is contacting the various commercial and government organizations using photographs, to enlist their aid in the standardization of photogrammetric terms. In addition, the Committee requests the assistance of every member of the Society. This job, once completed, will be a great contribution to all agencies and will do much in furthering the exchange of ideas and the training of new personnel.

The Committee would greatly appreciate the cooperation of each member of the Society in reviewing the present list of nomenclature as found in the "MANUAL OF PHOTOGRAMMETRY." A note or letter should be sent to the Nomenclature Committee at the Society's address in Washington.

MANUAL REVISION COMMITTEE

Letters have been forwarded to individuals or organizations requesting monitoring of the various chapters of the new MANUAL OF PHOTOGRAMMETRY. Acceptance has already been recieved from 75%. Those contacted have been very cooperative. Manuscript deadline has been tentatively set as April 15, 1949.