QUANTITATIVE BASIS FOR COMPARISON OF SYSTEMS OF MAPPING*

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THE briefest way to present this subject is to read a prepared tabulation (Fig. 1) based on what, at Bausch & Lomb, are regarded as the major quantitative factors available for such a comparison. Each factor has its place in such a comparison even though interrelated, and to consider one or more without all the other factors tends toward promotional, rather than an engineering comparison.

This tabulation makes evident that in planning to use a mapping system of instruments, the "C Factor," rather than the counter-interval specified, is a prime factor controlling map accuracy and economy. This factor can only be accurately established by wide usage of a particular system under a variety of terrain and map production and organizational conditions. It is particularly noted in the tabulation that for a wide angle system to be approximately comparable, a "C" factor of 1/1,000 in a wide angle system requires a normal angle "C" factor of about 1/1,600 as borne out by the analysis of comparison number "III."

Also to be noted is that a quantitative comparison between systems of adequacy of resolved detail in the stereoscopic plotting model of each particular system, is best made at the plotting scale for each system established by accuracy considerations; and until such a model comparison is made with instruments of most recent manufacture, theoretical statements as to resolution have little meaning as to adequacy of resolved detail for a particular system. The purpose of this paper is not to make comparisons among any particular systems but to invite those who do make such comparisons to do so on a similar basis using figures obtained from wide operational experience.

In comparing systems of instruments in photogrammetry, a statement is often made that each system has its place for a particular type of mapping project; this is a comforting thought to those who develop new instruments, but to the man who must purchase equipment and make a mapping organization produce maps of all types economically, it is not so comforting, as he must select the best over-all system which provides the widest use, economies, and flexibility.

I should like to report two other matters of interest in regard to increased accuracies of mapping systems, based on photogrammetric development and research at Bausch & Lomb. First, results of measurement of the Topogon V (V meaning manufactured on an experimental basis), and design computations of this lens reveal that the nominal radial distortion of this lens is of the same order of magnitude as the nominal residual radial distortion of the Multiplex system as now manufactured. We feel that hopes of considerable improvement in mapping accuracy is therefore open to question, with this lens. Second, as a result of investigation and reporting of "tangential" distortion by J. T. Pennington in PHOTOGRAMMETRIC ENGINEERING, March 1947, an intensive investigation of this subject over the last 18 months has been conducted by Bausch & Lomb Optical Co. Based on this research we now can recommend for Multiplex mapping that the following factors be added to aerial mapping specifications at the earliest practicable time: (a) The maximum tangential displacement on a

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FIG. 1. TABULAR BASIS OF

	Contour Map Specification		Lens System			
	Plotting Scale	Contour Interval	Focal Length	Angle of Coverage	Film to plotting scale ratio	Flying Height
Factors to consider	(1) 1" = 100 ft. usual minimum spec. (2) larger scales need longer plotting time	(1) 2′ Contours usual minimum spec. in most practical mapping (2) horizontal accuracy 4× vertical	(1) Mfg. specification of focal length, & distortion & resolved detail in entire system		(1) Enlarging plotting scale enlarges distortions in systems	(1) Haze at higher altitudes (2) days with high overcast & smooth air make low flying practical
I Compare at same map specification with "C" factor for organizations not controlling all instruments of the system						
*	1" = 100′	2′	5⅛"	90°	2.9×	1500 ft.
F	1" = 100′	2′	8¼"	68°	4×	3300 ft.
II Compare with "C" factor at expected performance for systems with minimum ground control per model for organizations not controlling all instruments of system						
*	1" = 100′	2′	5⅛"	90°	2.9×	1500 ft.
F	1" = 75′	2′	8¼"	68°	4×	2400 ft.
F	1" = 150′	2′	8¼"	68°	2×	2400 ft.
III Compare with "C" factor at expected performance for systems with plentiful ground control per model for one organization controlling performance of all instruments of the system						
*	1" = 130′	2′	5⅛"	90°	2.9×	2000 tf.
F	1" = 90′	2′	8¼"	68°	4×	3000 ft.
F	1" = 180′	2′	8¼"	68°	2×	3000 ft.

5.2 or 6 inch aerial camera 9″×9″ photographs be not greater than fifteen microns. (b) That prior to accepting photography for Multiplex work there be made an extension of at least 7 models using diapositives copied from the film of the camera being used, exposed over a specified flat terrain. The curvature of the flight line and reduction of scale in the seven model extension shall be in amounts less than that caused by "tangential" distortion of 25 microns at any one point on the 9×9 inch camera film. This will assure that the lens elements have not been disturbed in any way, and the resolution of the lens will be maintained. These factors should be tempered naturally with present day flying and photographic skills.

The tests, it is believed, will assure that the lens has not been disturbed in camera maintenance or operation. It is believed that the present "C factor" in a Multiplex system has been primarily limited by the above factors and, if these specifications are adopted, considerable improvement in the accuracy of not only the Multiplex system but others as well will result particularly when used by organizations who do not control the operation of the camera.

COMPARISON OF MAPPING SYSTEMS

Planning and Performance					
Ratio of contour interval to flying height ("C" factor)	Base to height ratio	Average parallax angle	Scale of negative (9"×9")	Area per model	Models with extended control
(1) Includes effects of distortions in camera, film or glass plates; processing, printing & plotting with instruments for *all types* of terrain	(1) Controls time between camera stations	(1) Strength at ray intersection in model, increase at larger angles	(1) Considering 60% −25% overlaps (2) 6.75"×3.6" per model (3) more resolved detail at larger scales		(1) Cost of ground control a major factor in cost of most mapping contacts
I Compare at same map specification with "C" factor for organizations not controlling all instruments of the system					
1/750	0.70	34°	1/3500	47 acres	9–18
†1/1650	0.44	24°	1/4800	90 acres	1
II Compare with "C" factor at expected performance for systems with minimum ground control per model for organizations not controlling all instruments of system					
1/750	0.70	35°	1/3500	47 acres	9–18
1/1200	0.44	24°	1/3500	47 acres	1
1/1200	0.44	24°	1/3500	47 acres	1
III Compare with "C" factor at expected performance for systems with plentiful ground control per model for one organization controlling performance of all instruments of the system					
1/1000	0.70	35°	1/4650	85 acres	9–18
1/1500	0.44	24°	1/4350	72 acres	1
1/1500	0.44	24°	1/4350	72 acres	1

* Multiplex Wide Angle System.
† This C-factor not considered obtainable under Comparison I.
F Typical Normal Angle Systems.

NEWS NOTE

WALLACE & TIERNAN ALTIMETER

The following is contained in the Company's News Release of June 8

The new W&T Precision Altimeter is a low-range surveying altimeter which will determine elevations accurately in about one-tenth the time required by vertical angle or spirit levelling. The altimeter has a range of 2,000 ft. and may be read easily to the nearest foot. The operating mechanism is mounted within a light-weight metal case. It is a durable instrument designed to withstand rough handling in the field, yet it is one of the most sensitive aneroid instruments ever constructed. The excellent performance of the Precision Altimeter is utilized to best advantage in the Two-Base Method of Precise Altimetry. For this procedure the altimeters are supplied in matched sets to obtain maximum accuracy. For a complete description of the W&T Precision Altimeter and information on surveying procedures please write Wallace & Tiernan Products, Inc., 1 Main Street, Belleville 9, N. J.