EUROPEAN POINT OF VIEW ON STANDARDIZING THE METHODS OF TESTING PHOTOGRAMMETRIC AERIAL CAMERAS

F. L. Corten, K. L. M., Royal Dutch Airlines, Amsterdam, Holland

IT IS an honor indeed to present to you the point of view of our European colleagues. As Professor Schermerhorn has indicated already, we had a conference in Paris, two weeks ago, with photogrammetrists of seven other countries. Representatives came from Austria, Belgium, Finland, France, Germany, Italy, the Netherlands and from Switzerland, in order to present their point of view to your Annual Meeting.

F. L. CORTEN

As guests of the French Photogrammetric Society, we held our conferences in the surroundings of the first daguerrotypes, stereo-daguerrotypes, color pictures made by Lippmann, and of the first photogrammetric map, compiled by Laussedat about a century ago; in other words, we met at one of the birthplaces of photography and photogrammetry.

Our proposals have been compiled in a report which will be published completely in "Photogrammetria," I will present the main points to you today. But before doing this, just a few words on the approach and the way of thinking from which these conclusions have been drawn.

In the United States the developments in this field have been made, and are still being made to a great extent, by experts in physics, optics, and photogrammetric engineering; furthermore there is a strong tendency to develop aerial survey more or less parallel with military mapping, because your most urgent needs and purposes are interpretation and medium-scale maps of large areas.

In Europe, on the contrary, photogrammetry has been developed to a science mainly by geodesists who started at the fundamental laws and worked towards the practice and the applications. Many of these scientists are also active in our aerial surveys, and representatives of these photogrammetrists met in Paris.

I will now read the main items of the "Proposal for Standardizing the Methods of Testing Photogrammetric Aerial Cameras."

I. INTRODUCTORY REMARKS

1.1 This proposal concerns photogrammetric aerial cameras as a complete unit, i.e. as they are of interest to the photogrammetrists.

1.2 The present proposal deals only with testing methods. It does not concern standardization of focal lengths, sizes of cameras, film, etc.

1.3 It is believed that the proposal of the U. S. Commission I, entitled "Proposal for International Photogrammetric Lens Tests" may cause some confusion as to whether is meant the control of lenses, or the control of the complete camera unit.

1.4 Any special testing of separate elements, for instance separate lenses, will be excluded from this report.

1.5 . . . . . .

1.6 Members of Commission I who met in Paris are of opinion that it is of the utmost importance that laboratory methods of investigation are carried out under the same conditions, as far as possible, as are encountered in actual survey (unless this would lead to insufficient accuracy).

1.7 The essence of this proposal is to provide means of comparing the performance of aerial cameras used in different countries. It should not be forgotten, however, that the photogrammetric camera is only one element in the long chain which leads from the construction of the camera itself to the issue of the map. It may therefore be expected that the different national organizations will go on using apparatus and testing methods more specially adapted to their own plotting instruments and methods.

1.8 The Commission believes however that it is of great importance to standardize certain definitions, types of illuminants and targets, the general character of the methods (visual or photographical) as well as the way of presenting the results.

1.9 The members of Commission I, present in Paris, do not consider this report as final, but simply as providing a basis for discussion leading to the adoption of standards to be proposed to the Washington Congress in 1952.

Coming to the *determination of the resolving power*, we see a difference between the American proposal and the underlying report.

In many respects the European surveyor is using other methods than you do; for instance, we often use cameras with picture size 18×18 cm, and sometimes even 15×15 cm.; their lenses are designed to cover a smaller field than 9×9″, and may consequently have a higher intrinsic resolving power and a larger relative aperture. It is the practice of many of the European surveyors to use an emulsion of a higher intrinsic resolving power than Super XX, and which is, consequently slower. In order to compare the rendering of object detail of cameras designed for different methods, it is felt that the resolution tests should then be made with the emulsion used in normal practice.

II. DETERMINATION OF THE RESOLVING POWER OF PHOTOGRAMMETRIC CAMERAS

2. The method of determining resolving power and resolution should be a photographic method.

2.01 Cameras should be tested with the same filter and emulsion as are used in actual practice (in most cases a yellow or yellow-orange filter and a fast panchromatic emulsion).

2.02 No special filters and emulsions are prescribed, but the report should mention the characteristics of the filter and of the emulsion used.

2.1 . . . . . .

2.11 It is recommended that provision be made for a general level of illumination prevailing in survey photography over the entire field, in order to take into account the influence of scattered light.

2.12 The illuminant should reproduce mean noon sunlight; its radiance should have approximately the same spectral distribution of the energy as is given by a tungsten lamp at a color temperature of 2360°K ± 20°K provided with the normal Davis and Gibson filter; this system is to be completed by a diffuser as perfect as possible.

2.13 Development should be to a gamma of 1.2 ± 0.1.

2.131 The developer should be the same as is used in normal practice.

2.2 The targets should be line targets in the focal plane of a collimator; a line target seems to be the most compatible with respect to the divergent opinions of different investigators. In addition, investigators may of course add other patterns to their targets.

I must make two amendments to this item. Prof. Kasper was ill at the time of the Paris meeting and he sent me a letter afterwards. He studied the annulus type target and compared it with line targets, and it is his opinion that the use of both types of targets is advisable, first because of having an independent control, and secondly because a lens type is better characterised by both annulus and line targets than by one kind of target alone. The second amendment is that we have not yet had the opportunity to use the continuously varying target that the National Bureau of Standards is now developing; therefore we can not yet express our opinion about this type of target.

As to the next item, the contrast, the European members prefer for the low-contrast target a logarithmic difference of 0.2, unless statistically proved that the contrasts in actual survey for altitudes up to about 5,000 m (about 15,000 ft.) are very much lower than 0.2.

2.21 The tests are to be made with two series of targets:

1. high contrast targets

$$\left(\frac{B-b}{B} > 0.9 \text{ or } \log B - \log b > 1\right)$$

2. low contrast targets

$$\left(\frac{B-b}{B} = 0.38 \pm 0.02 \text{ or } \log B - \log b = 0.208 \pm 0.014\right).$$

2.22 The elementary object targets are formed by three bright, equal and parallel lines on a dark background. Period of target and length of lines should be such that the 3 lines form a square. Each set of targets consists of four elementary targets oriented radially, tangentially and in both 45° positions.

2.23 The series of targets consists of a number of sets of elementary targets, the period of which should be varied in a ratio of $\sqrt[4]{2}$.

2.231 . . . . . .

2.232 . . . . . .

We now arrive at the *calibration*. The U. S. Commission I proposes a photographic method instead of a visual one, in order to ensure results which are consistently equivalent with those obtained in actual practice. Up until now, the European laboratory calibration was nearly always done by visual methods. It is not known to us whether investigations have been made, comparing the results which are obtained photographically and visually; nor is it known to us whether the discrepancies between both methods lie within the tolerances required or whether they do not; European investigators have not yet encountered difficulties of this kind.

Nevertheless, in general we agree with a photographic conception; it must, however, be explicitly ensured that the photographic method provides for accuracy and reproducibility, sufficient even for the so-called "distortion-free" lenses.

As to the emulsions to be used for calibration, it is the U. S. proposal to standardize for the near future on Super XX, developed to a gamma of about 1.4. However, an axiom for all measurements in general is that the accuracy inherent in the measurement itself is higher than the tolerances in the phenomenon to be measured. Therefore, in order to avoid the necessity of making a great number of measurements for every calibration, we propose to use an emulsion with the same color sensitivity, but with a higher resolving power than Super XX. This proposal is stressed by the fact already mentioned that there are cameras which are designed for the use of other types of emulsions.

III. CALIBRATION OF PHOTOGRAMMETRIC AERIAL CAMERAS

3.0 A photographic method for comparing internationally the calibration of cameras is recommended.

3.01 The illuminant should be as defined in 2.12.

3.02 The emulsion used for calibration should have the same color sensitivity as the emulsion used in practice. It should be developed to a gamma of 1.2 ± 0.1. It should, however, be as fine as possible, even if less sensitive. It should be coated on thick plane glass, in order to avoid the influence of shrinkage and irregularities of the base. The data of the emulsion should be stated in the report.

3.03 The camera should be examined together with the filter normally used in practice. The data of the filter should be stated in the report.

3.04 The camera should be calibrated at full aperture and at one or more working apertures.

Now we arrive at the *definitions*. There has been a great deal of confusion in this respect and it is high time that we put a stop to this. Two things are necessary:

First, to define clearly all geometrical and all physical points, rays, lengths and angles which are of interest to the photogrammetrist, even when some of these conceptions coincide.

And secondly, never to use an already existing word for a new conception, even when this word would have only a historical meaning.

On the definitions, the report runs:

3.1 The elements concerning camera calibration should be defined as follows:

3.11 *fiducial center:* point of intersection of the fiducial axes.

3.12 *principal object ray of autocollimation:* the object ray which, in the object space, is perpendicular to the image plane.

3.13 *principal image ray of autocollimation:* the image ray which is optically conjugated to the principal object ray of autocollimation.

3.14 *principal point of autocollimation:* The point of intersection of this last ray and the image plane.

3.15 *principal point:* the foot of perpendicular from the center of the exit pupil for the paraxial rays to the image plane.

3.16 *distortion:* distortion is a vector quantity, being the difference between the computed image point and the point actually obtained in the emulsion plane. This vector contains a radial and a tangential component, the radial one being commonly called "distortion," and the tangential one generally being small and called "tangential distortion."

3.16 In a lens of good quality, tangential distortion is generally very small. As the present standard should lead to simple methods, we consider the tangential distortion as being negligible, and we may call "distortion" what is in reality "radial distortion."

3.17 *Calibrated principal distance:*[1] an adjusted value of the principal distance so computed as to distribute the distortion in such a way that it suits best the plotting conditions to be employed.[2] The report will mention the way in which the calibrated principal distance has been computed.

3.2 The photographic calibration requires the recording of:

1. targets for at least 9 different values of the angle of field in every half field examined; the distribution of these values should be such that it gives a sufficient accuracy in the determination of distortion, especially in those parts of the field where the variations of distortion are great.
2. the principal point of autocollimation.
3. targets along the two diagonals of the image plane.

[1] Corresponding to the American expression "calibrated focal length."

[2] In order to avoid a possible confusion, the Commission proposes to use the expression "plotting principal distance" instead of "principal distance" in those cases where other causes of variations interfere and are taken into consideration, such as film shrinkage and other irregularities.

3.3 . . . . . .
3.31 . . . . . .
3.32 . . . . . .
3.33 . . . . . .

Regarding the *specifications* as they are suggested by the U. S. Commission I, it was found that the judging of the results by specifications is advisable for several special purposes, but not for international standardization, because of the fact that different cameras are designed for different purposes and methods, as there are military mapping, cadastral surveys, etc. Therefore, the next item reads:

3.34 The accuracy with which the measurements have been made and the curves have been established should be indicated in the report.

3.4 . . . . . .

The last item concerns the visual methods. The meaning of this item is, that, in case both methods give sufficiently consistent results, a visual method may alternatively be employed.

3.5 A visual method may be used, provided that the procedure and probable accuracy of the results are mentioned in the report.

Signed in Paris, December 29th, 1950.
The Representatives of Austria
Belgium
Finland
France
Germany
Italy
Netherlands
Switzerland.

When we are trying to speak one language, as was said yesterday by Professor Schermerhorn, you may be assured that Europe will do its utmost to reach this purpose, especially as we are aiming at the same goal as you are: the best possible development of photogrammetry.

Chairman Howlett: There are two kinds of talks that one likes on occasions like these—the one that you disagree with completely, so you can then have some fun attacking it; and the other type with which you are in complete agreement, except perhaps in certain minor and rather unimportant details. I think Mr. Corten's talk will certainly find agreement, at least in the minds of a very large proportion of us here. It certainly seems to me a very hopeful sign for agreement at the next International Meeting when we can have presented here, at this time, a summary of the views of Europe which certainly are almost identical to the results of the experiences of many of us on this continent.

As far as any small amount of work that we have been able to do in Canada is concerned, I think the suggestions which Mr. Corten has made appeal to us as entirely realistic, and as a very sound approach to the whole problem. I do not think it should be very difficult to make concessions in this way and that way, on some of the very minor items on which perhaps we have formed other habits and customs, and which are slightly hard to shake, if one realizes in the interests of the over-all picture that one has to climb down from his hobby-horse. The approach, particularly in the field of resolutions tests—a field in which I have had more experience perhaps than in the others—is a happy one. We can maintain the targets and see which one works out the better. Since there is already a large body of information based on those two types of targets, the work of the past is not lost, and in some sense anyway, it is reserved for future occasions.

We now have the privilege of hearing Mr. Odle, who is well known to us on this side because of his frequent visits. We feel he must like this continent since we see him every several months, and this is a great pleasure to his friends on this side.

He has been kind enough to work on our behalf in gathering together a general summary of the views of people interested in this field in the United Kingdom.