

certain items to these proposals especially for the application of the visual methods.

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*Chairman Howlett:* As the last item on the agenda, we will allow the "highly paid" manufacturers to say something on their behalf through their representative. I have great pleasure in calling on Mr. Revere G. Sanders, Assistant Vice-President, Fairchild Camera and Instrument Corporation.

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## A CAMERA MANUFACTURER'S COMMENT ON CAMERA CALIBRATION

*Revere G. Sanders, Ass't Vice-President, Fairchild Camera  
and Instrument Corporation*

I SHOULD like to start by defining calibration. My associate did, but I have a definition which I think is a lot better. It is "a lot of hard work involving an expense for the manufacturer, which he can hardly expect to recover, couched in terms few people can understand or agree upon."

There are two very good reasons why a manufacturer should not get involved in this calibration. First, I refer to expense. For getting the equipment and preparing for building our calibration outfit I believe we have spent about \$40,000. And that is only the beginning.

You not only have to put in the equipment but you have to operate it. You cannot take any liberties with accuracy. Also you cannot compromise on techniques. So you must get fully qualified people, and that results in high running expense.

You should realize that of all the cameras made in this world, only one tiny fraction is used to make maps, and those are the ones for which you use this elaborate calibration equipment.

I like to use simply the expression of furnishing a topographic mapping certificate instead of the word "calibrate," and give the data which support that certificate. As regards the term "calibration" we note that many of the specifications of the government services, which specify that certain calibration shall be done, provide for a report by the Bureau of Standards and that this report is simply headed "A Report of the Bureau of Standards on Lens No. So-and-So." I do not think they call it calibration. The people who are using the cameras, writing the specifications or talking about calibration, are the ones who are supposed to provide the calibration and they are a little careful in discussing it. If we call it a topographic-mapping camera certificate, you have what you are talking about.

Of course, if it is such a terrible thing for a manufacturer to shoulder the burden of expense on a limited number of cameras, why does he get into it? There are some very good reasons. That is what caused us to take the deep



REVERE G. SANDERS

breath and the big jump. In the first place, we created a very heavy burden on the Bureau of Standards with the loads of cameras we were shipping to it. We had to give some relief.

In the second place, the building of our own laboratory, more or less parallel to that of the Bureau of Standards provides, in this country at least, two places for camera calibration in the event that any large load should come upon the two of us during serious international conditions.

Also of much importance is the fact that the installation enables the manufacturer to improve his delivery of equipment and to reduce somewhat the overall cost, by virtue of being able to schedule the steps of calibration or inspection at the place where it is most economical in production; it makes possible a scheduling of deliveries more precisely because you have control over it.

Lastly and not least is the fact that we have a research tool by which means we hope to improve the product that is involved; namely, the mapping camera.

We have received nothing but cooperation from the Bureau of Standards. Without it we would have been lost in this undertaking. You will remember that the Bureau of Standards, as *Dr. Macdonald* said this morning, is a research organization whose purpose is to determine and set up primary standards of techniques or measurement. Perhaps I am not using the right words. In accordance with this policy, *Dr. Gardner* a long time ago determined what standards we should have in cameras in order that those cameras would produce the kind of pictures the photogrammetrist wanted. It wasn't much use having standards if nobody made the right measurements to see if the standards were followed. So *Dr. Gardner* provided the equipment with which to make the measurements. That was in 1938, or a little earlier. That was the time that the concept of precision mapping cameras in this country was beginning to be grasped.

Only a few of the aerial photographic contractors had cameras of that description. Their sending a camera to the Bureau of Standards provided a fine opportunity to test new equipment at the Bureau and helped to establish techniques. Then, at the end of the Second World War, the concept of photogrammetric cameras had taken hold and was written into specifications so generally that we felt justified in starting the cartographic series of cameras. This culminated in the new military type camera, now in the Air Forces exhibit.

The total number of cameras we shipped to *Dr. Gardner* for test was not very great but they created much congestion and confusion and interfered greatly with his work. It is easy to see that the functions of research and the establishment of standards and techniques were not aided by that condition. When I suggested to *Dr. Gardner* that we might possibly be willing to go into this business, I was met with enthusiastic cooperation.

The equipment is all installed at present, and it is operating to the extent of making resolutions tests. We have not yet started on the distortion angle, but we hope to within three or four or five weeks. We are proceeding very cautiously and are pretty careful of our first steps until we really know what we are doing.

The design of that equipment was largely based upon the Bureau of Standards equipment. We were fortunate in the Bureau officials giving us in full their experience in using their equipment; this enabled us to go a step beyond here and there.

In order to get the whole thing started we called upon a group of men who were most interested and qualified. *Dr. Gardner* has been in close contact at all times. Many others helped, particularly *Dr. Washer* from the Standards Bureau, *Dr. Howlett* from Canada, *Eldon Sewell* from the West, *Paul Pryor* from the Optical Laboratory of Wright Field and my good associate, *Dr. Pestrecov*, from Bausch and Lomb.

Dr. Howlett agreed to accept the responsibility of consultant. David Mann took on the job of building the equipment and is not yet finished with a second calibration unit.

We intend to calibrate the first group of cameras and then send them to the Bureau of Standards for a check on our calibration before we release them. After we gain confidence in ourselves and Dr. Gardner has confidence in our methods, we hope that the various governmental agencies that specify a need for topographic mapping camera certificates will follow the custom in England, which Mr. Odle has mentioned, wherein the manufacturer's certificate is accepted as adequate certification. Actually, there wouldn't be much sense in our having this equipment if the various departments of the government continue to specify that only the Bureau of Standards can give the certificate. Even in that case our equipment would help because we could eliminate one step. But, except for periodic checking between the Bureau and ourselves, I hope to see our certificate accepted fully by the departments.

The camera calibration laboratory will first be used to calibrate our own cameras as they come through production. This T-11 camera production has put quite an onus on us in that respect. Then, of course, we will recalibrate and recheck our own cameras as may be necessary and as called for by the various governmental specifications with regard to mapping projects. Thirdly and ultimately, we expect to be able to calibrate cameras which have the constructional features which will permit them to be used on our equipment, whether made by us or by anybody else.

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## DISCUSSION

*Mr. A. H. Katz* [Chief, Photo Physics Branch, Photographic Laboratory, Wright Field, Dayton, Ohio]: I assume that when Dr. Howlett invited me to sit up here he wanted disagreement. So I found some points to disagree on.

I want to define my own position for the group. We are exactly half way between the lens designers, manufacturers and research people, and the ultimate consumer. Since the gap is so great between the lens designer and the ultimate consumer, this half-way point is a considerable distance from each end.

My experience with distortion is very limited; so I will not say much about it.

Dr. Howlett and everybody else who has proposed a resolution test have found that in the past we have disregarded them all uniformly, without prejudice. I must say that this is based on some very good and sound experience, which I should like to describe. First, our function has been what Dr. Gardner has described, one of not telling a manufacturer what particular aberration to correct or to decide if this lens is better than that lens. It is not as simple as that because we have in this decision the matter of significant differences to establish. It is not enough to establish if lens *A* resolves 50 lines per millimeter, while lens *B* is resolving 1,000 lines per millimeter. We will pick lens *B*, when out in service we get 30 lines, but most frequently 15 or 12 and lower.

While the important function in the resolution test is to grade lenses serially, it is perhaps not important to establish numbers. But it is important to establish significant differences which may be qualitative.

We have file cabinets of data on the high-contrast, parallel-line target that we have been using. I am willing to commit myself to a statement that we have not yet made a poor decision based on that data. That is the really important point; the rest is academic, but not uninteresting. It is relevant, but academic. If our function is to pick good lenses, we have done it. When we tested a lens and it gave us a high number on our test, that lens has made good pictures. The material Dr. Macdonald presented this morning might lead you to infer that it is a coincidence. If so, it has been a coincidence without exception to date, and I am perfectly happy to have that condition continue.

I am in agreement with Dr. Gardner on that point but I find myself strangely in disagreement on the matter of what emulsion to use. If we pick lenses for the consumer, then the differences between lenses have to be significant. If the consumer uses a certain