

geometrically-correct fashion much of the quantitative data that goes into the making of reliable measurements.

The non-topographic photogrammetrists—they are really photogrammetrists who apply topographic concepts to their own work—might chart their way into the future with the words of Lord Kelvin, the English physicist who said:

“When you can measure what you are talking about and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind. It may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.”

This symposium has been brought together because of a growing interest in photographic measuring instruments that can be applied in many fields of science, in addition to surveying and mapping. Some of these instruments, you will recognize, are adaptations of instruments that have been developed for topographic mapping; other instruments that you will hear about have been developed, or are in process of development, for distinctly different uses—for example, for geologic mapping. These developments will be followed with interest by many of us; they unmistakably indicate a wider application of photogrammetry to geology, engineering, hydromechanics, architecture, archaeology, meteorology, medicine, photosculpture, to mention only a few fields. Photogrammetry has even found a place in atomic physics, in the tracking of alpha-particles and other forms of radiation, by stereophotogrammetric means.

This Semi-Annual meeting marks the first time the American Society of Photogrammetry is conducting an entire meeting on non-topographic concepts of photogrammetry. Our Society is deeply indebted to our participants for giving so freely of their time and skills in bringing to you some of the latest instrument developments in these special applications of photogrammetry.

## INDUSTRIAL PHOTOGRAMMETRY\*

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AS ONE who works with Photogrammetry—not at it—there are times that I find it hard to believe that the science of Photogrammetry was introduced at about the same time that the first practical photographs were being made. It has not enjoyed application to the same broad front that photography has. Since its inception Photogrammetry has been developed as a topographic mapping science and has dealt almost exclusively with terrestrial and aerial photography. Application to other fields has been limited to the efforts of only a few workers and organizations. Applications to industrial problems, if Spectrography and Radiography are excluded, have been practically nonexistent. A discussion of the reasons for this confinement would be a digression; let us consider the result.

We must first appreciate that the current state of technics in our science is high; and the increasing strong desire to broaden our scope is not untimely. The major deterrent to the application of Photogrammetry to new fields has been our self-containment. Too few of our members are in a position where they may be confronted with nontopographic problems, and certainly they have rare occasion to express an opinion or reaction to this subject to other than a fellow Photo-

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grammetrist. It is clearly the objective of this panel to stimulate interest in, and to promote non-topographic applications of Photogrammetry. Let's make it the objective of each one of us to "spread the word"—let fellow sciences in on our secret.

One of the most useful implements available to my own research and development organization is known to us as "Transport of Concept." In operation this consists of subjecting the problem in its simplest terms to the reasoning of our entire staff. This action sometimes results in the treatment of the problem by a branch of science normally considered foreign to the field involved. We know from experience that the Photogrammetrist welcomes the opportunity to

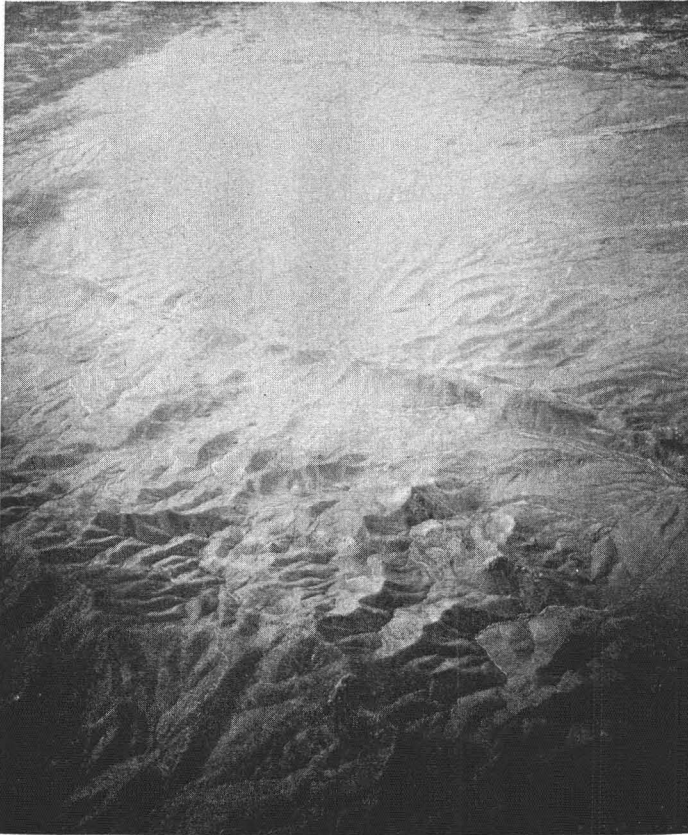


FIG. 1.—Undodged contact print.

consider nontopographic applications, and in our own group he has made significant contributions to many problems that have confronted us.

A recent development which can be credited to this method is a new principle involving the application of electronics to photographic reproduction. It promises to provide at last a means for obtaining uniformly exposed prints from all portions of all negatives. Translated, this means completely automatic dodging and exposure control, which results in a quality such as that obtained by "unsharp mask" techniques, but with the speed and simplicity of operation comparable to ordinary printing. Figure 1 shows an undodged print and Figure 2 a dodged print of the same negative made automatically with this new principle.

The principle appears to be applicable to contact and projection printing on virtually any photosensitive medium. A development program involving prototype equipment is presently under way, and a paper describing it in detail is being prepared for publication in the near future.

As research and development contractors to private industry, we are aware of two conditions which contribute of Photogrammetry's failure to do a job, or cause it to be arbitrarily eliminated as a possible solution. One is caused by a failure to exercise the proper control during the actual filming, and the other is

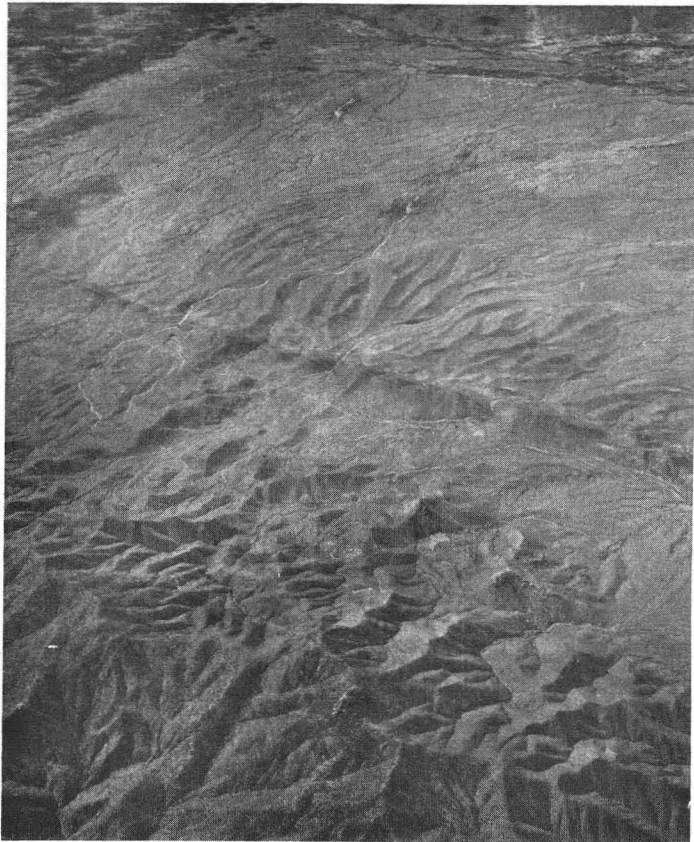


FIG. 2.—Automatically dodged print from same negative.

caused by the erroneous notion that a precisely calibrated, aerial or goniometric type camera is required for taking the photograph so that accurate measurements may later be made. We are aware of the existence of many frames of photography taken inadvisedly which could have been invaluable for metric determinations if the taker had exercised even the most basic camera control. The second is an excellent example of the danger of too little knowledge. So that I don't impart the notion that a Photogrammetrist can work with the product of a box Brownie, I hasten to add that with reasonable care in the selection of the taking camera, and conditions, a very acceptable accuracy of measurement can be achieved.

There is another aspect of photography which is fraught with possibility for

industrial application. This is the Orthograph, which maintains the familiar pictorial effects of photography, while offering the geometrical characteristics of a mechanical drawing. The taking device is the Orthocamera,\* an invention of the late Professor Cooke of Princeton University, and for which further development has been undertaken by our laboratory. Its principle of operation is quite simple; it utilizes a telecentric lens interposed between the taking lens of the camera and the object. The telecentric lens in effect transmits to the camera lens only rays leaving the object in directions parallel to the axis of the lens system. The result is a photograph or orthograph completely free of the effects of paral-

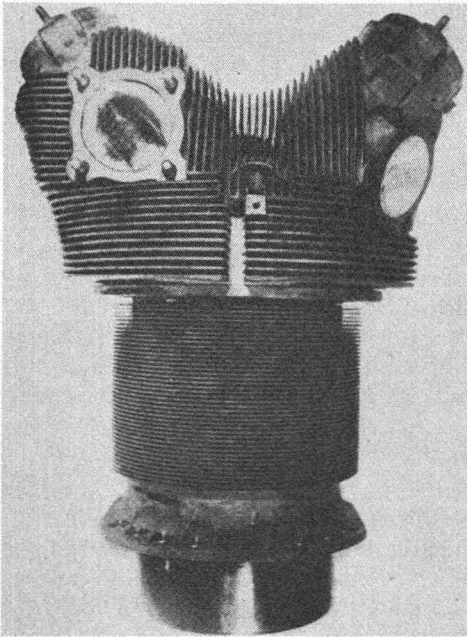


FIG. 3.—Conventional photograph of aircraft cylinder.

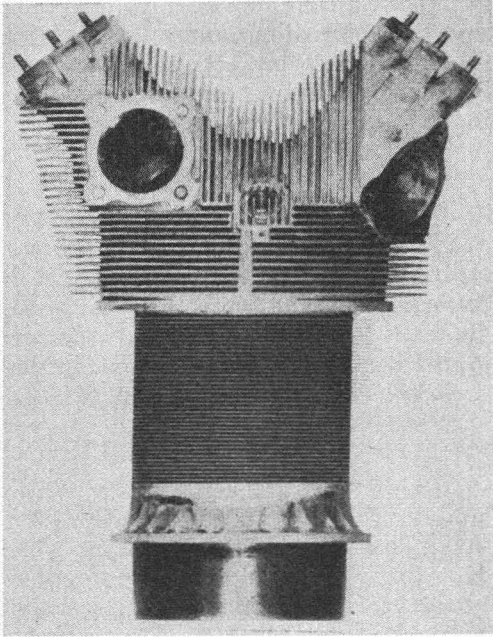


FIG. 4.—Orthograph of the same cylinder.

lax or perspective. A conventional photograph (Figure 3) of an aircraft cylinder is compared with an Orthograph (Figure 4). Some obvious uses for orthographs are as guides for mechanics and technicians in assembly work, as an easily produced replacement for mechanical drawings, and for obtaining form lines of curved surfaces of models such as are produced by many industries today.

But then these devices are really by-products of Photogrammetry, and while they are all very interesting and sometimes quite novel, it is the science itself which is the most impressive. The ability of Photogrammetry to actually measure and plot three-dimensional flow in fluids, the position of moving objects in space, the true geometry of transient phenomena and many, many other subjects which you all deal with from day to day has been proven, can be proven, or has actually been reduced to practice. I invite, or better still, I implore those in industry who are seeking better, faster, and possibly cheaper methods of measurement, to consult the Photogrammetrist. His opinion may well be a revelation, and a pleasant surprise.

\* Prickett & Morris, "The Orthocamera: Orthogonal Photographic Scanning Camera," *PHOTOGRAMMETRIC ENGINEERING*, Vol XVI, No. 5, December 1950, pp. 823-830.