little knowledge.

It is apparent that nearly everything around us is in a transitory state of destruction and that there may come a time when the rate of this destruction will be very rapid. Photogrammetry represents a most powerful tool, not to prevent destruction, but to permit an accurate, nearly ageless reconstruction. To my knowledge, the use of such a powerful tool for this and many other important purposes is not yet in sufficient widespread common use.

In many sciences there is a growing need for improved measuring methods. Often the opinion is expressed that at least in natural sciences the measuring techniques become more and more important and that there are several sciences in which measuring has become nearly a part of the science itself. Here too, photogrammetry has much to offer.

The need for mapping in the world is so great that most photogrammetrists have to deal with aerial photogrammetry. Instruments for non-topographic photogrammetry are not yet available to meet the need. The knowledge of photogrammetry is still too limited among people other than the photogrammetrists. Also among photogrammetrists themselves there is sometimes too little knowledge about or interest in the methods and possibilities of non-topographic photogrammetry.

We will have to work hard to improve these conditions. The manufacturers of photogrammetric instruments must be stimulated and guided to make new types of cameras and other facilities. There must be closer cooperation between photogrammetrists and other scientists who may profit by the use of photogrammetry. Finally, photogrammetric training must be expanded to non-topographic methods.

Some of those points of view were given at the sessions of Commission V at the International Congress for Photogrammetry in Washington D. C. 1952 and were also accepted in the resolution of the commission.

The initiative of the Committee responsible for this journal to organize a symposium, covering parts of the non-topographic photogrammetry, deserves great recognition. I hope that the methods and applications that are later described will awaken interest and that the development of this important branch of photogrammetry will be greatly accelerated all over the world.

PHOTOGRAMMETRY AND MEDICAL RESEARCH

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MODERN technical resources are being applied more and more widely in medical research for the objectivization and measurement of physiological and pathological phenomena. To mention two examples, neurophysiologists are availing themselves of electrical technology, and both theoreticians and clinical workers are using isotope research. The progress of medicine has also been greatly assisted by increased facilities for the objective study of vital phenomena in both the healthy and the diseased organism.

Photogrammetry is an area in the technology of measurement which as yet has not had much attention from medical research workers. Its rapid development in recent years was brought out at the International Congress of 1952 in Washington, where new views on the medical applications of photogrammetry were demonstrated (1). It therefore seems appropriate to suggest some areas in which this specialized type of photogrammetry may be of use.

Edema, the swelling which plays an integrating role in inflammation—the body's answer to trauma, in the broadest sense of the term—is harmful as well as useful. It may cripple, as when with an injury to a hand it may undergo a transformation to connective scar-tissue. It may even kill, as after burns or a brain operation.

The cause of edema, and its treatment when it becomes harmful, are thus important problems, with many questions remaining to be answered.

For measuring edema and the effect upon it of drugs or other therapy, plethysmography or methods based on the displacement principle have been employed. These methods have the disadvantage, however, that a deformation can occur at the point of application of the apparatus, or the circulation may be affected. With photogrammetry, on the other hand, it is possible to study, with a very high degree of accuracy, the volume changes of a finger or the like without deforming the surface or affecting the circulation. Volume changes in fingers have been studied hitherto by determining the variation in diameter (2), but it has also been possible, by the drawing of contour lines, to make direct measurements of the postoperative swelling of a cheek after a tooth extraction (3), which has allowed insight into the pathogenesis and course of edema and the mechanism for a common treatment, sympathetic blocking.

With special measuring cameras—constructed with funds provided by the Swedish Medical Research Council—it now seems possible to make direct measurements of the volume of round or cylindrical bodies such as the extremities. This opens up the possibility of using a "no-touch" method for measuring the effect upon the volume of a part of an extremity as a result of treatment with drugs under physiological and pathological conditions, with physical therapy of various sorts, and the like.

It is also theoretically possible to make an early diagnosis of deep thrombosis by photogrammetric demonstration of the existence of local swelling.

This technique of measurement should also be valuable in studying the growth of tissue cultures and of skin grafts and their circulatory conditions.

As photogrammetry has proven suitable for determining the speed and direction of an object in motion (1), as well as currents in liquids, medical rheology should also benefit by photogrammetric studies. I am thinking in particular of further investigation of the blood-sludging problem; the tendency of blood corpuscles to clump or sludge, a very common pathological phenomenon, is considered by many as an important factor in circulatory pathology. "The rheology of pathologic blood has not yet been worked out with the mathematical precision which has been achieved in the study of viscous or Newtonian fluids," says Knisely (4).

Studies of the magnitude and direction of movements are also suitable for photogrammetric measurements and records which can be used in investigations of the physiology of work (5) and of anatomical physiology.

The excursions of the chest and abdomen in breathing can also be measured (6); this enables a study being made of the effects of drugs, breathing exercises, respirators, and other therapeutic measures.

The rather high cost of the apparatus —such as special cameras and stereocomparators—and the lengthy computation of the results, prevent more general use of the method. However, rapid technical progress is being made; we may soon be able to use motion-picture cameras to record the progress of changes, and mechanical processing of the data is technically possible.

X-ray photogrammetry has also received considerable attention of late. It is now being applied in odontology for the objective measurement and recording of such as healing processes (7). A new adaptation of old photogrammetric principles (8) now makes it possible to study volumetric changes in the organs of living animals without resorting to the unphysiological enclosing of the organ in a plethysmograph. This "no-touch" method is the subject of a detailed description in this issue* by P. Hjelmström. Metal indicators are introduced into the organ operatively; they enclose a geometrically definable body; the position of the indicators can be determined exactly in a coordinate system by means of stereoroentgenographic photogrammetry. The volume can then be computed with great exactness; for instance, a volume of 38 cc. can be measured with an error of less than 1 per cent. Since the measuring instrument required—an orthogonal coordinatograph—is simple and not especially expensive, this method should find widespread application.

The method is now being used in Sweden to study volumetric changes in the liver in hypothermia and shock, a central problem in medical research. A growing number of observations tend to show that the liver, which is "a blood reservoir of considerable and variable capacity" (Wiggers, (9)), plays an important role here. Circulation in the liver is also an important factor in other pathological conditions, such as infection; at the latest Josiah Macy conference on liver injury, in 1951, Mae-

* See page 663.

graith (10) suggested that hepatic venous constriction may be intimately concerned in the control of the blood flow through the organ and in the pathogenesis of lesions which appear in various disease states.

It would appear possible to use a similar procedure with laboratory animals to measure the variations in the width of the large blood vessels, thus eliminating the variations caused by the contrast agents in use at present.

It thus seems clear that problems of both theoretical and practical importance can be investigated with photogrammetric methods; intimate cooperation between medicine and technology in this field should be of benefit to both.

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STEREOPHOTOGRAMMETRY AND STUDIES OF MOVEMENTS*

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FOR years the manual movements in certain working processes have been taken cinematographically or by the so-called light point's process. By both methods we obtain a clear picture of the movements executed; they do not, however, permit obtaining a sufficiently accurate determination of their form and especially of their strewing. For the study of the economy of working processes, need exists for an exact knowledge of the spatial curves of the single movements and their strewing, and consequently the possibility of a comparison with other working dispositions. Only this possibility of comparison permits ascertaining the most favorable working conditions with regard to length of way and form. For the study of the movements, the operator who was examined was provided with incandescent lamps on both hands, and also on the head and shoulders. For the task in question the "Wild" Stereo-Camera of a basic length of 40 cm. was used by which a plotting accuracy of about 1 mm. on the scale of 1:2 was obtained for taking distances up to about 4 mm.

In studies of movements another light signature has to be chosen for every working course. This is obtained by using an automatic interrupter with variable intervals. This is necessary, since the courses of the lamps belonging together must be established beyond a doubt, within a range where different movements are continually crossing.

Furthermore the first experiments have shown that from a series of about 24 working courses on one pair of photographs it is advisable to take out only 3 to 4 repetitions in certain intervals. Thereby we obtain also a better mean value of the movements and a more reliable picture of the strewing. The photographs were taken in a feebly darkened room, the shutter of the stereo-camera remaining open while taking

* Summary of the treatise in the Congress Number VIII, 1951/52, 4 of "Photogrammetry."