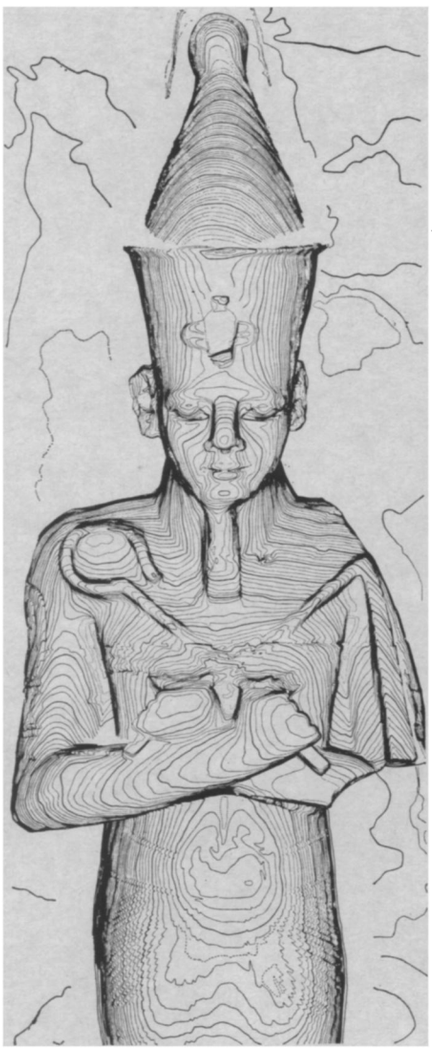

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Archaeology: A photogrammetric pharoah and a view of the original.

Cover: B. S. Savara

Mapmaking Goes Far Afield

Photographic techniques of the cartographers are coming to the aid of surgeons, archaeologists, dentists.

by Carl Behrens

Aerial photography has been used for years to make precise maps of the earth's surface. Now the mapping and measuring technique—photogrammetry—is being brought down to earth to solve a major medical problem; the mapping of a living man's anatomy.

Photogrammetry uses stereo photographs to measure variations in surfaces. By using X-ray stereographs, this technique can be used to go below the surface of the human body and locate points of interest to within a few thousandths of an inch.

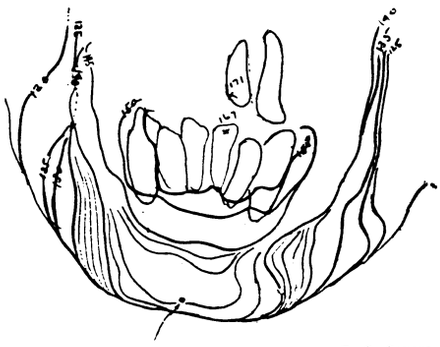
Research in medical applications of photogrammetry has been carried out principally in Sweden, where the Royal Institute of Technology's Photogrammetric Division has been working with three different medical schools to develop techniques in this area. In the last few years, 12 doctoral candidates in medicine have written theses on photogrammetric applications to medicine, doing research at the institute on such subjects as the functions of various joints of the body and changes in the liver connected with temperature variations.

Other uses for earth-bound photogrammetry, where the surface has barely been scratched, include studies of the morphology of the face and applications to dentistry, archaeology and engineering models, according to Dr. Bertil Hallert, director of the Swedish photogrammetric center. But Dr. Hallert, who is winding up a lecture tour of American universities, sponsored by the American Society of Photogrammetry, put particular emphasis on the medical possibilities of the mapping technique.

The great advantage to X-ray mapping of the human anatomy, said Dr. Hallert, is that it affords a view of the body of living individuals, both those who are healthy and those who have defects which must be cured. Anatomy at present is studied by cutting sections of dead people, he said.

. . . Medical mapmaking

In this country, study of the possibilities of X-ray photogrammetry is just beginning. This despite the fact that stereo X-rays and equipment for viewing them are a common feature of such large research institutions as the National Institutes of Health.



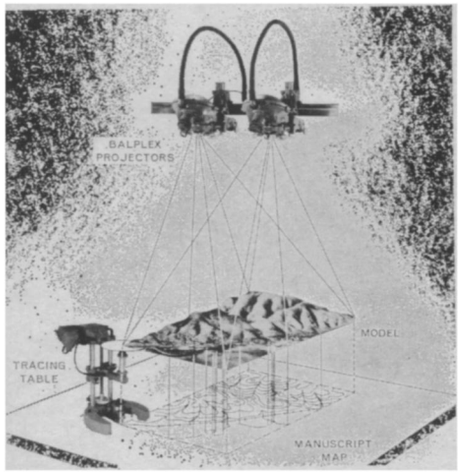
B. S. Savara

X-ray contour map of jawbone.

What photogrammetric techniques add to this sophisticated equipment is the ability to measure, in three dimensions, the location and form of the interior of the human body. These measurements can be represented on paper with the use of carefully plotted contour lines, such as are used in maps of the earth's surface.

In surgery, such a map would tell a surgeon precisely how far he had to cut to reach a desired spot. The third dimension now is a blind one, by and large, until after the organs are exposed. In general, contour maps of human anatomy would be valuable in research and teaching as well.

Preliminary experiments in obtaining accurate Xray stereograms were reported in the November issue of Photogrammetric Engineering by Gomer T. McNeil of Photogrammetry, Inc. McNeil, who worked with NIH technicians to develop the X-ray procedures, said the medical personnel were startled to learn how easily the measurement capability could be added to their stereo equipment.



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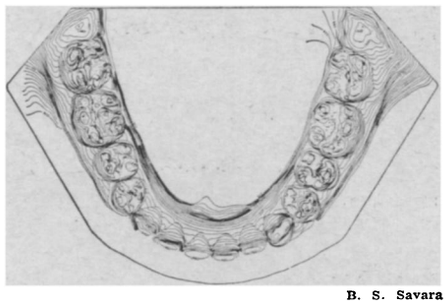
Map is drawn from stereo image.

The techniques developed by McNeil include two basic steps. First, X-rays are taken of the same object from two different points, about 18 inches apart, to give a view of the object from different angles. The two

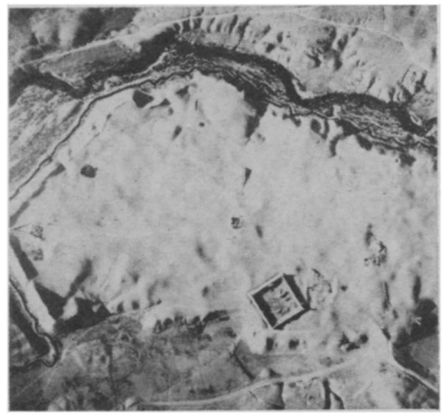


B. S. Savara

Teeth: contours replace plaster.

X-rays are then placed in a dual projector which forms a three-dimensional image in space of the object. By means of a stereo viewer and a tracing table, the contours of the three-dimensional image can be transferred onto paper.

McNeil simplified the process by using a single X-ray source and tilting the object table in order to photograph it from two angles. This eliminated the need for two X-ray cameras. Distances were measured to thousandths of an inch in order to be sure of reproducing the object accurately in tracing out the image.



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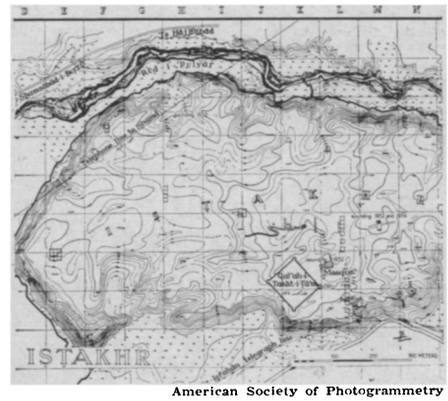
Istakhr, Iran: Aerial map and . . .



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. . . contour. Archaeology uses both.

Dentistry is another area of human photogrammetry where research has been carried out. Using visible light photos, Dr. B. S. Savara of the University of Oregon produced contour-lined diagrams of teeth and jaws that can substitute for the laboriously-obtained plaster casts which dentists are now forced to use. Dr. Savara also made X-ray stereographs of jawbone joint which were accurate to within 1/25 inch, which, while coarse by some standards, is better than with existing techniques and can be refined.

Photogrammetric studies of faces have applications beyond the field of medicine, according to Dr. Savara. Geneticists could use the technique to trace inheritance of genetic aberrations, while psychologists could study the effects of emotions on facial expressions.

Photogrammetrists tend to become ecstatic when discussing the many possibilities of their technique when applied to terrestrial objects. One reason for their enthusiasm is that the problem of accuracy, while not eliminated, is greatly eased when the objects to be photographed are man-size rather than mountain-size. With aerial cameras, where the object being photographed is reduced by a factor of 20,000 to 1 or more, a slight distortion on the film will result in a serious error in the final map. Where the photographic image is approximately the same size as the object, such variations are nowhere near as misleading.

The major obstacle to a wider use of photogrammetry at present seems to be lack of communications between photogrammetrists and their prospective customers. On the one hand, many researchers are unaware of the possibilities of photogrammetric studies in their specialized fields. On the other, photogrammetrists are handicapped in developing practical and inexpensive techniques because they do not know the degree of accuracy needed by particular applications of their techniques.

Despite these difficulties, it is likely that photogrammetry will soon develop into a major tool in the study of man. The application of its techniques, laboriously developed in the highly demanding field of aerial mapping, to relatively less demanding fields, should bring it within the reach of many researchers who are now unaware of its possibilities.