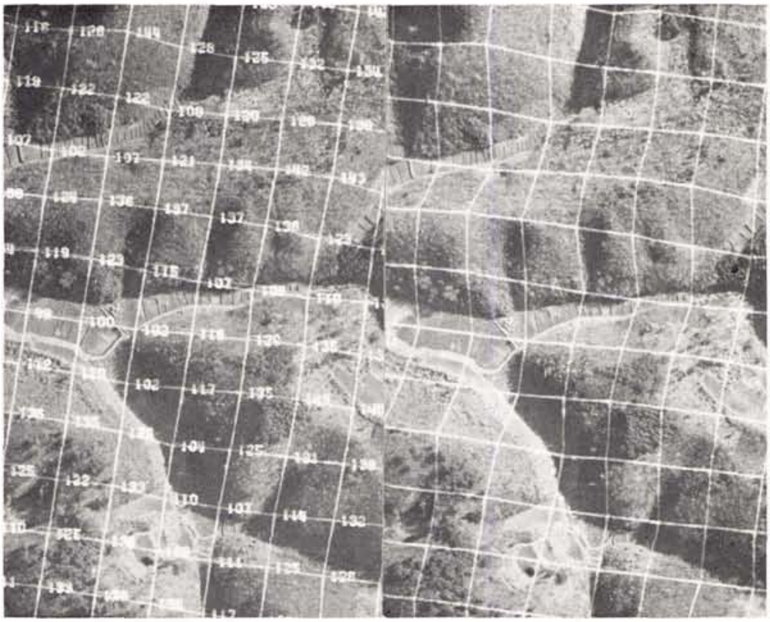

FIG. 1. Example of a Digital Photo Map.

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# The Digital Photo Map

**Its use would eliminate the need for a contour map in engineering design applications.**

*(Abstract on next page)*

## INTRODUCTION

TOPOGRAPHIC CONTOUR MAPS are mainly used by civil engineers for planning and designing purposes. They draw approximate designs on the map free hand or with rulers, and then gather a lot of digital data which, in turn, are processed on a computer to obtain output information to be used in decision making.

Why don't the engineers use the original photograph for designing and do the previously mentioned directly on the photograph itself? It can be said that it is only because the designers cannot put the digital data directly on the photograph.

The Author would like to introduce a new type of photographic map—one which he calls a Digital Photo Map (DPM) shown in Figure 1. The main function of a DPM is to allow designers to use the original photograph in place of a contour map, putting the digital information directly on the photograph itself.

In the stereoscopic observation of Figure 1, you will see not only the stereoscopic model of the terrain itself but also a grid mesh in three dimensions closely following the terrain's surface on which elevations have been measured using conventional methods (photographic or terrestial). Digital figures written at each grid point represent the terrain's elevation in meters.

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The grid interval of this sample DPM has been made about 1 cm; this corresponds to just 40 meters on the ground, but it should be clear that this interval can be selected at any value.

## The Characteristics of a DPM

• All the information on the original photograph is kept intact. As is well-known, a lot of information is discarded during the process of map-making. That is to say, the surveyor deprives the designers of their right to free selection of various information.

ABSTRACT: *The use of a digital photo map is proposed instead of a topographic contour map for civil engineering design. A digital photo map consists of a pair of photographs on which planimetric distances and elevations on the ground are indicated digitally. The terrain data obtained and stored in a computer can be used effectively in the design phase. Civil engineering design can be defined as the repetition of a couple of actions selecting approximate figures on a map and then feeding them to a computer so as to make available an output of objective digital information for a designer's decision making. It can be seen that digital photo maps will provide a short cut between the photograph and the computer in the area of engineering design in the computer age.*

• Distances and heights can be known directly from the photograph just the same as from a contour map. As fractional measurement is a form of interpolation, a nonlinear variation of a portion of the terrain can be clearly observed stereoscopically on the photograph and, if necessary, additional simple interpolational measurements will suffice for the purpose.

• Digital terrain data are already stored or ready to be stored in the computer. If a contour map is used, the digital terrain data must be obtained by elaborate procedures. In the case of a DPM, it has already been obtained and is used for making the DPM itself.

• All the information observed on the photograph can have immediate reference coordinates.

## The Process of Making a DPM

The major operations required in making a DPM are shown in the flow diagram in Figure 2. They are very simple and almost automatic, requiring very little operator skill. If there are errors, easy inspections can be exercised through stereoscopic observation

## Use of DPMs in Engineering Phase

Designers need only draw an approximate design on the photograph free hand under stereoscopical observation.

In an area surrounding the approximate drawing, strictly reasonable digital figures for certain special conditions can be obtained by computer quite easily for individual items by utilizing mathematical and computer techniques.

Output information for decision making can be processed by the computer at once.

## Cost and Time Performance

There may be many possibilities to make the DPM performance less expensive and less time-consuming than map making.

There are numerous advantages in using a DPM (including the design phase) compared with conventional design process which relies on contour maps.

## Final Design

The position of the final design figure can be superimposed on the photograph stereoscopically by using the same technique used on the DPM, and can be utilized for staking.

## Conclusions

This paper is a brief introduction to an attempt at surmounting a barrier—the topographic contour map systems. This system seems to work against the effective use of photogrammetry and the computer in civil engineering design.

As is well-known, we go through many repetitions of analoge-to-digital (AD) and digital-to-analogue (DA) conversions of information before attaining the final decision for a civil engineering design. A typical example of this repetition is the process of topographic map making.

The topographic contour maps are of analogue expression, but they are originally of a digital nature. They are converted into analogue maps losing the original digital information in the course of the DA-conversion, leaving scant means to recover digital figures approximately (by scaling or through the use of the coordinate grid system and contours).

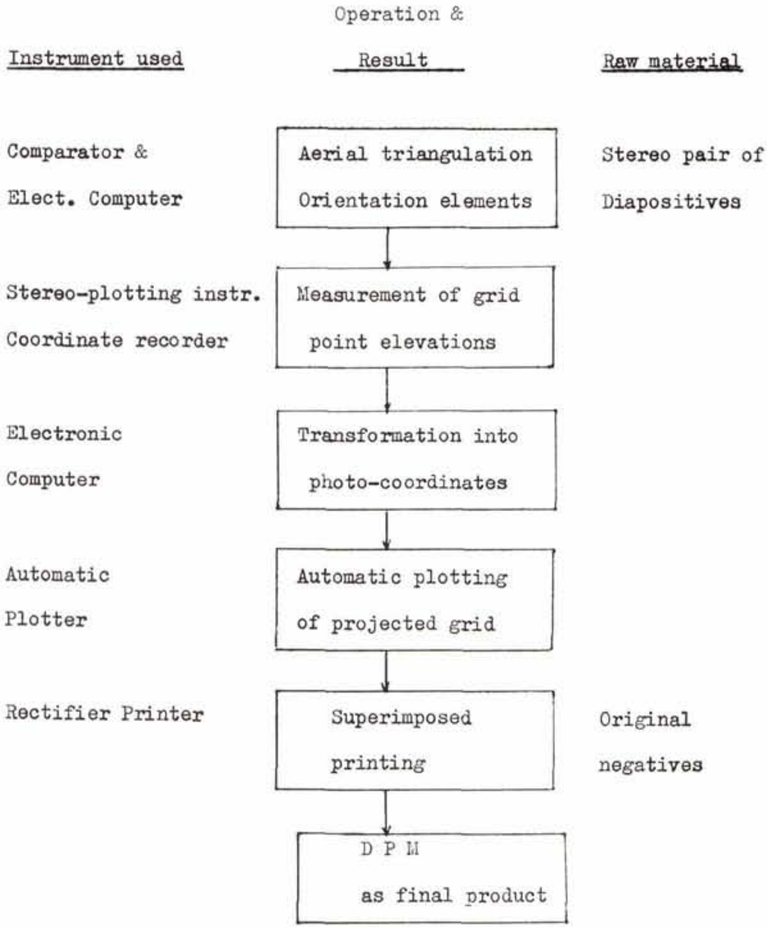


FIG. 2. Principal operations in making a Digital Photo Map.

The original digital information has been obtained by measurements from either photographs of the ground taken from the air or ground or the view by eye while standing on the ground; both operations AD-conversion. (In photogrammetry, the plotting machine is an AD-convertor and the plotting table is a DA-convertor.)

An analogue map is a convenient and useful map on which we draw approximate designs directly, with scaling and contours playing an important part. But the approximate design drawings are useless without sufficiently precise digital figures, which are needed information used in decision making. The needed digital information is often obtained by processing the digital terrain data by computer under given conditions among which optimization is one important conditional concept that has become more fully understood in recent years.

Thus, the digital terrain data must again be picked up from an analogue map, which is also a repetition of AD-conversion. The Author will refer here only briefly to one more example of each DA- and AD-conversion: the drawings of cross sections by digital data just obtained (DA-conversion), and the measurements of cross section areas by a planimeter (AD-conversion).

All of these elaborate repetitions of conversions are procedures resulting from the conventional analogue contour map system which, as one can see, turns out to be an obstacle toward any advancement in the computer age.

Here it must be emphasized, nevertheless, that a computer will never be effective without approximate values. It can find an optimum solution in a certain area of an approximate drawing, only with the skill of a specialist.

From the above considerations, it seems to the author that a clear and practical definition can be given to civil engineering designing in the computer age. It consists of two parts: firstly, designing is "A technique to get approximate figures as correctly as possible under certain given conditions" and, secondly, "to get the most reasonable digital figures through the use of a computer in the neighborhood of the approximate figures obtained in the first step."

In order to obtain approximate figures it is necessary to have in hand an analogue expression of terrain information—a map on which we can have approximate dimensional aspects or a photograph with digital expressions—a DPM. Although the approximations will be much poorer in the latter instance, the computer program will certainly compensate for it and much more effective will be the performance if we consider the laborious task of repeating AD- and DA-conversions as for the conventional topographic contour map system.

Instead of a conclusion, the author wishes to refer to an interesting fact on finishing this paper. It is not difficult to superimpose contour lines on a DPM. But it will become immediately apparent upon steroscopic examination that the contour lines are not attached closely to the terrain in some places. But what about contour maps? Is there any one who can superpose a contour map on real terrain and then check the accuracy of the contour lines of the map?

# BOOK REVIEW

*Optical Fundamentals of Underwater Photography*, Second Edition, by Gomer T. McNeil. Edwards Brothers, Inc., Ann Arbor, Mich. 48104; 119 pages, 6 by $9\frac{1}{4}$ inches, hard cover, \$7.50, 1972.

Few authors, if any, have dealt, as Mr. McNeil has, with the design and manufacture of a lens and camera specifically for submerged photography of underwater objects. The text documents, in terms of simple mathematics, some very important principles for these applications, including the thick lens in water and the dome window.

One of the reasons for the importance of the book is the extreme difficulty of obtaining satisfactory photographs underwater. Water seriously absorbs and scatters illumination to the extent that good photographs of objects farther away than 30 feet are nearly impossible. In addition, the different refractive index of water must be combined with the indexes for glass and air to complicate the normal optical problems of image sharpness and fidelity. It is therefore reasonable to expend considerable effort in the research and design of a lens and camera in order to maximize the efficiency of such a system.

A good sample of the text is contained in the article (that is incorporated in the book), "Underwater Photography" by the same author in PHOTOGRAMMETRIC ENGINEERING, 35:11, 1135–1152, Nov. 1969.