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Stereocompilation Equipment Trends in America

When initially exotic requirements are channeled through the competition of suppliers of mapping equipment, they produce a healthy stability.

IN THE SUMMER OF 1966, the Semi-Annual Meeting of the American Society of Photogrammetry, held at Los Angeles, chose for its theme: *Time of Appraisal.* It was felt at the time that an inventory was due in the store of published suggestions and proposals of new, highly sophisticated equipment, processes and products. Claims had been made persistently that when the new schemes were put in operation in the near future, existing instrumental systems and procedures would be uprooted radically, and traditions and conventions both in the military and the civilian field of mapping would be swept away.

At this convention the question is again asked, "Where do we stand and where do we go in the future?" If we essentially limit our investigation of the subject matter to our activities and needs of peacetime mapping—governed by adherence to sound specifications and the economic principles of good housekeeping—the first part of the theme question is answerable in reasonable and encouraging terms. There has not been and there is unlikely to occur a wholesale declaration of obsolescence of our conventional acquisition of new and improved components in our existing systems. The answer to the second half of the theme question is anybody's guess, but it seems to build its strength on more realism and prudence than had been in evidence in the vanishing spell of extravagance.

IN THE AREA OF acquisition equipment, we find that aerial cameras with a field angle of 90 degrees or less have sufficient flexibility within the considerably widened spectral range of photography demanded by monochrome, color, and other emulsions of special spectral sensitization. This has been made possible by recent breakthroughs in lens design as a result of complete computational control by programming of compound-lens systems.

As a result we obtain a higher information content in the aerial negative without an essential improvement of the system resolution, that is, the combined lens-film resolution. Higher information content, of course, has benefited all stereoplotter systems in all work phases of image interpretation, point identification and extension of control. The color photo, in particular, has made the stereo operator's life still more enjoyable than it has been in the past 45 years.

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STEREOCOMPILATION EQUIPMENT has undergone adaptive changes in many details as a result of selective choosing from the abundant crop of mechanical, electrical and electronic innovations, and from new materials and accessories. Essentially all analog plotters of foreign and domestic make, both of the mechanical-restitution and the direct-projection category, used in large numbers in our mapping institutions, are now compatible with all input materials (black-and-white or color) obtained from plate or film aerial frame cameras in contact or reduced-copy form.

It is a unique phenomenon that the American photogrammetrist has preferred in the past and still tends to favor the compilation instruments which permit unconstrained movements of the stereo measuring or scanning device. This may be the reason for the longevity and popularity of the direct-projection-type plotters. A more valid reason may be in the surprising optical perfection and the lucidity of the design concept. Once upon a time it was a real midget, named Multiplex. Its basic design has grown through the years to entail physical dimensions and weight that approach and occasionally exceed those of the *heavy plotters*. Now the original Hypergon projection lens is gradually yielding to more complex systems of higher resolution and refined compensation of radial distortion and related anomalies.

The different types of projectors of 90-degree and 120-degree photography range in projection distance from 400 millimeters (B&L Super-Wide Angle Balplex) to 1675 mm. (the latest super plotter of the Kelsh version). The slow but continuing improvement of light sources of higher color temperature used as projector illuminators has raised the model brightness over the mapping surface sufficiently to remove the plotting instrument from the *isolation booth* into rooms with environmental light levels well above that of the cherished coziness of a dance hall. The achieved standard of individual projector calibration in government institutions which accounts for model fidelity (model flatness) has led the Army Map Service to give their M-2 projection plotter a *first-order* rating. In fact, its performance matches closely that of their top-ranking direct-projection plotters, the Bauersfeld Stereoplanigraphs.

Last year, another product of refined design by the Dell Foster Company has joined the Balplex, Kelsh, Belfort, K&E and OGM family of direct-projection plotters and has, thereby, added a further symptom of sustained vitality to this category of stereocompilation instrumentation.

ABSTRACT: *Although new and sophisticated stereocompilation instruments are being developed, existing systems are by no means obsolete. Stereocompilation equipment has undergone many changes by selection from an abundant crop of mechanical and electronic innovations. Essentially all of the principal plotters can be used with a variety of input materials: black-and-white or color photography, plate or film negative, wide-angle or superwide-angle coverage. American photogrammetrists prefer instruments which permit unconstrained movements of the measuring device. Digitizing of stereoplotters represents a return to principles in use 40 years ago, but the numerical procedures are now carried out efficiently by electronic computers.*

MOST RECENTLY, however, this category has lost its identification characteristics as *anaglyphic instruments*. Therewith, another 30-year *vicious circle* in photogrammetric evolution has been closed, specifically by the reappearance of a shutter system which intermittently interrupts the flux of light from one projector while it turns on the other. Vastly improved operating components of our electronic age promise reliability of operation over long periods that was not obtainable heretofore. Another interesting observation may be permitted here. The initial basic design of the tracing table has never changed essentially through almost four decades since its inception, despite several imitations of the original. Now, however, it may lose its dynamic friction by being given an air bearing under its horseshoe base while providing the option to the operator to retain its static coherence with the mapping table.

More significant than these instrumental details are the methodical changes of operation which have resulted from joint mathematical and electronic developments. Here again we encounter another vicious photogrammetric circle, this one of a 40-year perimeter. The disclosure many years ago of an

automatic plotter, an *autograph* (which has recently been unmasked as an *analog plotter*), was hailed as the great liberation from the drudgery of fighting digits and decimal points. Now, however, our mathematicians have proven to us that, doing it the old hard way by modern electronic means, is the way of keeping up with the times, present and future. So, *digitizing* has become the password and *analytical assault* the lucrative fashion. It has made the sophisticated instrumentation more expensive, the simple plotter more sophisticated, and the once lucid schemes of operation more involved but much more efficient.

The stable base plotters began this development after being equipped with printing readouts on their three-dimensional coordinate systems. Then, shaft encoders and interface devices were added to permit readouts to punch cards, tapes and electrical typewriters. With an abundance of three-axial readout systems now on the market, such as Faul/Coradi/Wang, AutoTrol, Dell Foster, and B&L DIG, other stereocompilation types have become adaptable to digital readout. The direct-projection types use shaft or linear encoders with several alternatives of visual display, card or tape readouts. Unfortunately, in all present solutions the tracing table has to be attached to an auxiliary *x-y*-guidance system of mechanical tracks, a setback from the ideal unrestrained freedom of movement over the mapping table. The chances are that such confinement will be overcome soon.

ALONG THE MANY highways of photogrammetric practice we find numerous roadsigns hailing the arrival of automation. This announcement need not scare today's plotter operator as much as the word *photogrammetry* used to scare the land surveyor of the olden days. There are many good prospects that automation in the map-compilation field will be just as rewarding to the photogrammetrist as photogrammetry in its role as an advanced surveying tool has been to the land surveyor. As exemplified by the Raytheon Stereomat, the highly refined solution of image correlation by electronic means furnishes to the human operator a welcome *visual power assist* in the preparatory steps of relative and absolute orientation of the stereo model. It also makes him the indispensable supervisor in the subsequent map-compilation process. As we witness steady progress in the simplification of electronic circuitry, higher reliability of its components and gradual reduction of production cost, further markets may become ready for selective acceptance of electronic assistance in the construction of the map. It is highly deplorable, however, that Mother Nature is so rarely and so little yielding to the preferences of the automats!

A valuable by-product of several types of electronically assisted compilation systems is the orthophotomap. It constitutes a most helpful and economical substitute or supplement to the conventional topographic map. It is surprising that the availability of orthophotomaps for public use is still limited, although the Orthophotoscope, the pioneer instrument, has been in operation over more than a decade. And it is strange that our domestic builders of direct-projection plotters have paid so little attention to this area of product design. The present state of the art shows that a system based on direct optical transformation of the aerial negative to the orthoprint is capable of superior reproduction quality of monochrome and multicolor imagery.

THE INCREASED reliability and the broadened storage and retrieval capacity of the electronic computer has made it possible for government mapping agencies and a few larger private enterprises to rationalize its employment on a time-sharing basis. Several plotting instruments are linked by special circuitry to the computer for recording and processing coordinate-read-out data, for automatic plotting of control points on map sheets, and also for a variety of computations of a photogrammetric or geodetic nature.

A new service industry is in the making which is entirely based on electronic-computer programming. Computing centers are beginning operation which can be addressed over conventional lines of communications from any geographical location to furnish on short order the mathematical solution of a routine problem. Such installations will soon enable the small mapping organizations to maintain a smooth flow of their production without burdening themselves with computing facilities.

By far the greatest impact of automation is felt in the many processes which convert the map manuscript into the multicolored printed mapsheet. The many necessary steps, such as line and scale transfers, classifications, adding of names, numbers, symbols, grid systems and marginal legends, all of which are costly and time consuming, have been greatly aided and speeded by highly developed means of auto-

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adjustment of strips and blocks. Several organizations are using digital means of solving independent models on topographic plotters for subsequent aerotriangulation, thus increasing the versatility of these plotters for small-scale mapping. Most organizations have developed analytic or semi-analytic methods to perform block aerotriangulation.

Computer utilization has also accelerated the quality control studies for photogrammetric systems that have always been emphasized in many European educational institutions. Computerized statistical studies will aid in the development of standards for the performance of cameras, materials, plotters and operators. Compensations for contributory errors so determined will improve the accuracy of precise survey applications.

Orthophotography has received wide acceptance in Europe and is being used extensively for cadastral surveys for land use and urban planning. Orthophoto maps with overdrawn contours are replacing standard topographic map coverage in some areas. Automatic contouring by drop-line method is available on some equipment to be used in combination with orthophotos. Orthoprinting devices have been added to both classic and analytic plotters and it is expected that this equipment will come into wider use in the future.

Terrestrial photogrammetry is increasing in Europe. Equipment is being modified or manufactured and techniques developed to apply photogrammetry to archaeology, architecture, medicine, crime studies, traffic accident reporting and animal husbandry. Photogrammetry is also used to provide camera calibration constants for X-ray instruments and television cameras. These trends are also expected to accelerate.

IN CONCLUSION, photogrammetric plotting instrument trends in Europe are toward simplification of the optical and mechanical systems while, at the same time, their versatility is increased by analytic orientation and adjustment. New instrument design is strongly influenced by ergonomic considerations to increase the efficiency of the operator. European plotters and American electronics are being combined in many instances in an effort to automate the mapping process. The field of photogrammetry in Europe is broadening to encompass many new applications as its accuracy and efficiency can be demonstrated.

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mation. These functions, however, are distinctly separated from stereocompilation and can, therefore, not be presented here in more detail.

IN SUMMARIZING we make a refreshing observation. Many initially exotic requirements, primarily spawned by desire or necessities above and beyond our economy-bound national operations, are producing advances in science and technology. When these are channeled through the selective process of competitive suppliers and buyers of mapping equipment, they produce a healthy stability on the photogrammetric shareholder's stock exchange.