AN ANALYTICAL PHOTOGRAMMETRIC SOLUTION TO A CIVIL ENGINEERING PROBLEM

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I. The Problem

A major east coast shopping mall developer had decided to double the size of an existing mall complex. When they went to look for their twenty year old "As-Built" drawings, they found that they were not complete. In addition, over the years various superficial modifications had been made to the complex. Among those were changes such as:

- resurfacing of some of the pavement,
- construction of 50 ft. square concrete planters,
- sign relocations,
- lamp post relocations,
- increase in air conditioning capacity,
- enclosure of some of the original walkways to form a partial mall.

Obviously, these changes were made "piecemeal" by various departments, individuals and firms. To reconstruct and/or merge all of these superficial changes into one "As-Built" drawing set would be a monumental task of doubtful accuracy.

At this point they did not want to actually design the expansions, they simply wanted to determine the feasibility of such a plan. They wanted to expand on the existing architecture. They needed more than a sketch but less than a full blown structural engineering study.

II. The Alternatives

Various conventional survey and/or engineering firms were approached with the problem. Their responses were unsatisfactory. In order to accomplish a "measurement inventory" of the complex, they would have to do nearly the same amount of work as would be necessary to produce full blown final construction plans. In short, survey crew personnel would be "crawling" all over the complex for at least a month with most of the work having to be done when customers were not in the area.

One of the management group, having had some military experience in photogrammetry, thought that it might be a good idea to at least find out if it was feasible to use that method. After a cursory examination of available firms that performed photogrammetric services, he centered on one that used an analytical stereoplotter. This type of instrument would allow for extremely wide latitude in the original photography.

III The Solution

Let us digress for a moment and consider why photogrammetry is not used more often in this application, since it was in terrestrial photogrammetry that the science of photogrammetry got it's start.

Aerial photography has taken over as the major field and has dwarfed the terrestrial aspects. Because of this nearly all associated instrumentation has been designed around the parameters of aerial photography. Therefore, the only analogue instruments that can be conveniently used for compilation from other than rigorously obtained aerial photography are those which are <u>universal</u> in nature. These instruments cost well in excess of $100,000 and require extensive training before even minimal efficiency can be realized. Analytical instruments could be used but their cost (over $200,000) has caused them not to be economically feasible in the commercial photogrammetric engineering field. However, it has come to my attention that a new analytical instrument is now available for about $65,000 and that should change all of this.

Therefore, the factors that have been instrumental in inhibiting the use of terrestrial photogrammetry have been: a general lack of economically feasible equipment, a scarcity of trained personnel, and most importantly, a general lack of knowledge concerning the potentials of analytical stereoplotters applied to terrestrial photogrammetry.

Mapping from other than vertical aerial photography and, in this case, terrestrial or close range photography requires extensive instrument set-up procedures. The operator must first make the determination of the instrument scale and the gearbox settings. For example, with one commonly available universal analogue instrument, he must consult a table of transmission ratio settings and their relationship to the knob settings. The approximate maximum instrument scale must be determined and is derived by dividing the z range of the instrument by the difference between the greatest distance and the least distance to objects to be plotted. The instrument scale is limited by the transmission ratios available at the height counter gearbox. Yet another table must be consulted for the transmission ratios and knob settings at the height counter gearbox for instrument scales corresponding to 1 meter or 1 foot increments. The operator must then make the determination and settings of the photo tilts and base components. He must then begin on the relative orientation, which is quite a bit different in it's procedures from the normal vertical photography procedures for which the instruments are primarily designed. Absolute orientation is, to say the least, unnerving for the average stereoplotter operator especially when it comes to terrestrial photography. For example, after insertion of the photographs, introduction of all orientation data and elimination of Y parallaxes by means of relative orientation and it's arduous procedures, small errors in position and elevation may still remain in the model. The magnitude of the positional errors may be determined after connection of the coordinatograph to the plotting instrument. By setting the floating mark on the given control points in the model and checking to determine how closely the image of the reticle of the microscope placed in the pencil holder coincides with the plotted positions of those control points. Elevation errors are determined by checking model elevations of control points with their surveyed elevations.

With error correction as the final step it is no wonder that photogrammetry is not used in more instances.

Let us turn the entire situation end for end. Put three reasonably competent, reasonably well-rounded men in a van-type truck with a tripod-mounted 35mm camera, a normal 12 foot surveyors rod, a rod level and a 100 foot steel tape. No transits, no levels, no theodolites. However, we are using an analytical stereoplotter.

Controlled photography is acquired by holding the rod stationary in a plumb position using the rod level with at least it's base against the face of the structure while two overlapping stereo photographs are taken by the man on the roof of the van. The rod cannot be moved while the van is being positioned for the second of the two photographs in the stereo pair. This "set-up" is used as many times as is necessary to acquire a sufficient number of stereo pairs to cover the structure. For the shopping mall case, we used 25 of these set-ups. The total number of set-ups could have been reduced by using additional rodmen for two parallel surfaces in the same stereo pair.

The rod, in conjunction with the building face (surface) acted as all of the control necessary for set-up on the analytical stereoplotter.

Back in the office, the photographs are set up on the analytical plotter with exactly the same rapid procedures used for vertical aerial photography. No differences. As with any analytical stereoplotter, there is no "classical" error correction. There is, simply, a computer developed mathematical model produced with no real approximations made due to the instrument.

IV. Conclusion

With the advent of economically feasible analytical stereoplotters, such as the AUTOPLOT from Systemhouse, the rigorous process of controlling, acquiring and setting-up that is now associated with terrestrial photogrammetry, can be relaxed. This relaxation should not be considered sloppiness. It should, however, be viewed as an opportunity to redirect the photogrammetric community's efforts away from exotic camera and operator procedures and towards expanding the everyday applications of photogrammetry as a profitable endeavor.

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