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The Pitfalls and Temptations of Aerial Mapping

The basic phases of map production—ground control, aerial photography, analytical photogrammetry, and production speed—are considered.

PHOTOGRAMMETRY, specifically the area of making topographic maps from aerial photographs, can be a very difficult business. The client wants a job to cost as little as possible and the mapping contractor wants to make as much profit as possible. The client expects a map that is absolutely perfect in every detail; the mapping contractor is satisfied if the map meets the required specifications. Often there is no middle ground, no room for compromise. If the job is awarded on a competitive bid basis, sometimes the lowest price is awarded the job regardless of the qualifications of the contractor. Some clients don't ask for proof of the qualifications. In spite of the proven competence and professionalism of most aerial mapping firms, negotiated contracts are few and far between. Many aerial mapping firms feel this is a direct affront to their professionalism. To date we know of no existing legislation to correct the situation of bidding for professional services.

ABSTRACT: *Pressures placed on the aerial mapping contractor by delivery schedules and profit motive may force him to consider cutting corners. The temptations are encountered in some of the basic phases of map production: ground control, aerial photography, analytical photogrammetry, and production speed. This paper is an analysis of some of these pitfalls, treated from a practical standpoint and analyzed with regard to their effect on the end product.*

Every mapping project is different. No two pieces of land are exactly alike. Nearly every mapping project has different purposes and different uses for the finished product. It is impossible to lump aerial mapping into clear-cut, definitive categories. From the standpoint of the aerial mapping contractor, certain pitfalls can, and should, be avoided. The production of an accurate map, delivered within the required deadline, is, after all, the goal of every aerial mapping firm.

Experienced photogrammetric mapping firms will agree that qualified, experienced aerial mapping survey crews can set up ground control networks quicker and more efficiently than survey crews with no experience in aerial mapping work. Some clients still insist that they do their own survey work because of the expected savings in money. Often they say that they pay their surveyors, for instance, $15 per hour. The aerial mapping contractor may have quoted a cost of, perhaps, $30 an hour for his surveyors. The client relates his cost only to direct wages. He neglects to realize that the contractor's quote includes all wages, overhead, equipment, and profit. It isn't until the client's survey is found lacking in either accuracy or completeness that he realizes the costs were not that much different to begin with, and that the added experience of the contractor would have accomplished better results with less overall costs. The contractor would be doing his client a favor to point out these facts in advance, and have the survey work included in the contract.

The most common surveying errors often are the result of obvious cost-cutting techniques: unclosed level and traverse loops, pro-rating of closure errors without a field check, side shots, etc.

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Surveyors have at times admitted that errors exist in the work but that these won't matter "because the job isn't designed to be that accurate, anyhow." This situation is not a common one, but it does occur. It would be a disservice to the client for a contractor to use this sort of ground control knowing that it will adversely affect the topographic maps, and eventually their accuracy for whatever use they are intended.

Let us consider the use of ground panels in aerial photography. Because it takes time and material to panel control points, a survey crew will sometimes reduce the size of panels to the point where they are not visible and therefore worthless on the subsequent aerial photographs. This saves money for the surveyor, but will add time and cost to the job for the contractor. An insistence on panels of sufficient size to do the job properly will upgrade the accuracy of a map, and in the end result mean a saving to both the client and the contractor. Some aerial mapping firms use a rule of thumb of having panel legs (in length) one tenth (1/10th) of the map compilation scale. For a mapping scale of 1 in. = 100 ft, this means panels with 10 ft legs. If the client is to set his own ground control, panel size must be agreed to at the proper time in the negotiations.

In setting ground control panels, several other factors are worthy of consideration. The placement (location) of the panels is critical to adequate coverage in the aerial photography. The configuration (shape and size) of the panels as well as the color and type of panelling material can also affect their visibility. All of these factors must be outlined by the aerial mapping contractor to the client so that his expertise can be properly utilized by the survey crews.

In the analytical photogrammetry stage of a project, errors in ground control are often discovered. It is essential to have these errors checked and corrected before map compilation starts. In the normal analysis of computer solutions during analytical photogrammetry, it is possible to (1) misinterpret errors, (2) deduce errors that do not exist, or (3) assign the error to the wrong point(s). It requires intelligent interpretation by the personnel in charge of this phase of the mapping project to insure that the analytical solution is done correctly. The temptation to ignore the ground control errors, accept the best of the several analytical solutions, and get the maps turned out as quickly as possible, can be overwhelming when cost is made a primary consideration. The suggestion here is obvious. Whenever a ground control error is discovered, the surveyor should be informed and asked to check and correct it. This should be done before the analytical solution is accepted and before map compilation is begun. It should be done even if the client has done the control work, or has contracted it out.

Clients will sometimes ask for a finished product that is beyond the capabilities of the aerial photography and the stereo plotting instruments available to the contractor. For instance, the request for a topographic map at a scale of 1 in. = 200 ft with 1 foot contours may be requested because the client feels that the smaller scale will cost less. Using photography at a scale of 1 in = 1000 ft to draw 1 foot contours will exceed the C factor of most commonly used stereo plotters. It is also possible to draw only 5 or 10 foot contours from this photography and have the additional 1 foot contours added by a draftsman. A topographic map produced in this manner will probably cost less than a map done by conventional, accepted methods, and in all probability it will not meet the accuracy requirements of the project. Rather than yield to the temptations, it behooves the aerial mapping contractor to discuss this with his client, including the possibility of insufficient contour accuracy, so that the end product meets engineering requirements.

Another practice that can seriously compromise the accuracy of a mapping project is to compile the map from high altitude aerial photography, enlarge the manuscript to delivery scale, sketch in the missing contours, draft it, and deliver it as if it had been drawn from larger scale photography. This method is not within the ethics of professional practicing photogrammetrists. Sooner or later the true accuracy of the maps will be discovered, and the consequences can be very serious.

If spot elevations are recorded on a map, they should be recorded to the level of accuracy of the instrumentation. If the instrument is capable of reading only to the nearest foot, trying to record to the nearest tenth of a foot can be misleading. An interpretation to the nearest half foot would be more in keeping with good practice. Recording an elevation of 345 on a map as 345.0 also leads to a misinterpretation of the capabilities of the instrumentation, or to the intended accuracies of the map itself.

In aerial photography there usually are areas where the ground is totally obscured by vegetation. Since the accuracy *must* be sacrificed to some extent in such areas, the contours should be produced as dashed lines. This tells the client as he studies the map that the ground was not visible and the contours not reliable. There have been instances where a map was requested with *all* contour lines drafted as dashed lines and *no* vegetation shown on the maps. Special cases such as this should be covered in the pre-job negotations to insure that the accuracy specifications are well understood by both client and contractor. It would seem advisable always to draw contours with the proper symbol, rather than suffer the consequences at a later date of a law suit, or having to do the job over again. Use of field cross sections in

obscured areas can also be of value in situations where vegetation obscures the ground. These can be readily used by the instrument operator while compiling the map manuscript, and a reference note on the final map noting a special condition such as this is also advisable.

There have been instances when a topographic map was contracted for as a study map for preliminary drainage and site possibilities. Eventually this same map was used for design purposes, including earth work and grading quantities. The contractor has very little control over this. It is mandatory that the map use be specified before the project is begun. This can aid greatly in designing the project in its initial stages, and a special note should be added to the finished maps indicating their intended purpose.

A considerable percentage of the cost of a topographic map is attributed to the ground control. A savings in production costs can be realized if the job is done by analytical methods utilizing high altitude photography for control, and the points transferred onto lower altitude photos for compilation. This does require less primary ground control, less photographs in the analytical phase, and reduces cost. If the scale difference of the two sets of aerial photographs is not too drastic, it is possible to make the point transfer with a minimum of introduced error by utilizing a judicious choice of point marking sizes. Care must be taken to adjust for the apparent image position of the points due to this scale difference, however. Without a careful pre-project analysis, the sacrifice in accuracy may not be worth the risk of using the two-photo scale process.

The client should be required to test the finished maps for accuracy. A few field cross sections across the mapping area will serve not only to provide a test of the map, but can often be of great help to the contractor. If a map is thoroughly checked, and the contractor is willing to stand behind his product by making the necessary revisions and changes, the client can usually be counted on to return at some later date with another project. The contractor that has done a competent job will find revisions are usually minor. They may require the resetting of a few stereo models, some drafting corrections, perhaps some number transposition corrections. Regardless of the scope of the corrections, however, the client appreciates the attention to detail and accuracy, and respects the contractor for his professionalism.

Anyone who has operated a stereo plotter is familiar with the need for speed to "meet the deadline." Employees who can combine speed with accuracy are the backbone of any successful business. If an emphasis is placed on speed alone, it can result in a sacrifice of both accuracy and completeness. If the contractor is not satisfied with both of these aspects of his product, the client won't be, either. Some aerial mapping firms will turn down a contract where they realize that the delivery schedule, or the profit margin, can be met only by an overemphasis on speed or a relaxing of accepted standards of production.

Often a contractor is asked to quote the accuracy specifications under which a map is done. The tendency is to say "Why, we always work to National Map Accuracy Standards." *Period.* There is no subsequent explanation, no quotation from such standards, and no further references to actual guarantees. Often a client thinks he knows exactly what National Map Accuracy Standards are. The contractor also thinks he knows. In reality, neither one has a copy of *any* standards, and both have differing ideas on the subject. Map accuracy must be discussed so that both client and contractor understand the end result. It is suggested that the client be supplied with a written copy of the accuracy standards to be incorporated into the project, regardless of the source or type of those specifications. At least the client and contractor have agreed to the end result.

The aerial mapping industry as a whole enjoys a good reputation primarily because most contractors are honest, dedicated professionals. The pitfalls and temptations outlined in this paper are a danger to all aerial mapping contractors. A contractor must not allow profit margin to become his primary concern in a project because of the danger of producing a substandard product. There has been a great deal of emphasis in the recent past on law suits resulting from "bad maps." It is hoped that attention to detail, an insistence on the standards of good practice, and a certain pride in map production can eliminate the occurrence of such law suits in the future.

We must recognize that there are many clients of aerial mapping contractors who are aware of the advantages, requirements, and limitations of the photogrammetric process of aerial mapping. Their cooperation with, and utilization of, the aerial mapping industry has helped greatly in building the industry to its present level of professionalism.

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