'Photogrammetric Week '97' D. Fritsch & D. Hobbie, Eds., Wichmann Verlag, Heidelberg, 1997.

Using Image Data in Geoengineering

JAN WILLEM VAN ECK, Exton

1. WHAT IS GEOENGINEERING ?

Geoengineering is the field created by the convergence of the work traditionally done independently by planners and engineers. Before the convergence of these two disciplines, the planners used geographic information system (GIS) software and the engineers used computer-aided design software. These two types of software performed the tasks needed by their users, but did not allow data to be easily exchanged or to be shared. GIS software allowed spatial analysis, but lacked the accuracy demanded by engineers designing roads, buildings, utility structures and other assets. The computer-aided design software was extremely accurate for engineering purposes, but lacked the spatial analysis features of GIS software. The GIS software used proprietary file formats that effectively prevented the sharing of data by engineers and planners. GIS software could not import engineering data from computer-aided design software, so planners had to enter the spatial data provided by engineers.

Geoengineering software provided by companies such as Bentley Systems, Inc., uses open file formats and lets planners and engineers work together and share information easily. Most users of geoengineering software are concerned with geographically distributed assets - in ways that span planning, engineering, building, operation and maintenance.

2. HOW ENGINEERS' NEEDS DIFFER FROM THOSE OF PHOTOGRAMMETRISTS

The needs of geoengineers differ from those of photogrammetrists and cartographers. For the reasons explained in this paper, geoengineers need practical solutions geared to inexpensive hardware, ease-of-use and quick throughput by thousands of users.

2.1 Pinpoint accuracy is not always essential

In some areas of geoengineering, such as the design phase, great precision is necessary. To date, most of this precision is provided by the vector data overlaid on the raster data.

In other applications, accuracy is less important. Geoengineering professionals often use raster images as backdrops for engineering designs. For example, a cadastral design can be displayed over aerial photographs of the property in the cadaster. Or a civil engineer can display the path and design of a proposed road over an aerial view of the land that it traverses. For this use of image data, the precision demanded by cartographers is not necessary.

However, as more accurate raster images become available and as geoengineering software provides simple tools for engineers to manipulate this more accurate data, geoengineers are taking advantage of the more accurate standards prized in photogrammetry. For further discussion of this point, see the last section of this paper, "Are the needs of these two groups converging?"

2.2 Ease of use

Photogrammetry is a highly specialized discipline practiced by a limited number of professionals. Large-scale engineering projects often involve hundreds or thousands of engineers with little training

'Photogrammetric Week '97' D. Fritsch & D. Hobbie, Eds., Wichmann Verlag, Heidelberg, 1997.

in the fine points of photogrammetry. They devote their time primarily to work with vector graphics in solving engineering problems, and need easy-to-use tools to manipulate spatial images.

2.3 Speed on standard PCs

Images, especially at high resolutions, comprise huge amounts of data that must be stored in immense binary files. Photogrammetrists usually have specially equipped, very powerful - and therefore expensive - workstations at their disposal. These workstations are designed to store and manipulate huge raster files. Since few are required, the expense of these workstations can be mitigated.
On the other hand, when a project requires scores of engineers, it is not cost-effective to provide them all with high-end workstations. So when they use raster images, they must use them on more ordinary PCs. The software must make up for the lackluster performance of the hardware.

2.4 Customization for vertical application

Photogrammetrists have special needs that their software is designed to meet. However, what distinguishes geoengineering use of graphics data is the diversity of specialties, and therefore the diversity of requirements, of engineering users of spatial data. These include planning and designing of roads, utility networks, municipal facilities, and the geoengineering of other assets, including monitoring and protection of environment and natural resources. The software used by engineers must be easily customizable and serve as the software platform for vertical applications that facilitate the use of spatial data in each specialty. This is especially true when the engineers involved in these specialties do not have time to learn the intricacies of graphics tools.

2.5 Real-world decision support

Cartographers and photogrammetrists have standard ways to communicate information that make the information generally applicable by adhering to universal map-making standards. On the other hand, engineers have the luxury of knowing exactly to whom they need to convey information each time they present it. For example, engineers must present the results of feasibility studies, demonstrate preliminary design concepts and make presentations to management. Therefore, flexibility in presentation techniques can be more important to geoengineers.
Engineers are frequently required to communicate engineering information to the public. Since the public generally has little appreciation or comprehension of many technical aspects of an engineering project, there is an increasing importance on the quality of the presentation, as opposed to the strict accuracy of the image. Members of the public may be vitally concerned with whether building a new road will require demolition of their houses, but care little about the method of projecting raster data behind the road design.

2.6 Tools of little interest to photogrammetrists

Engineers expect their geoengineering software to perform a number of utility functions that are infrequently used by photogrammetrists. For example, engineers often need to convert raster maps and drawings to vector format in order to use them in their engineering software.
Corridor mapping for utilities is a good example. Conversion of raster information to vector is less expensive than surveying, but it does require a certain degree of accuracy.

2.7 Case study: Irish Department of Agriculture

Driven by the desire for accurate data on crop growth (which in turn determines farm subsidies), the European Union decided to create a digital map of Ireland. The two sources of data were maps, some as old as 100 years, and aerial photography.

Using the data from these two sources, MicroStation Descartes is now being used to create a seamless map of the entire country. Students on their summer breaks are rotated in three eight-hour shifts on some 120 PCs. They georeference the scanned maps and aerial photographs, then digitize the boundaries of fields and farms. Confirmation of farm boundaries and clarification of ambiguous data is achieved by mailing letters and plots to each farmer; the letters and plots are synchronized with a bar-coding system that links each letter the corresponding plot.

The PCs used are standard configurations set up to run Bentley's MicroStation software. None of them is equipped with more than 32 MB of RAM. The aerial photos being used are about 40 MB per 500 m square, and 5 to 10 of these photos are open on each PC during digitizing. The total open file size, therefore, is several hundred MB, yet the software used (MicroStation and MicroStation Descartes) is able to handle the load efficiently.

The accuracy of the aerial photographs is on the order of plus or minus 5 m. This is sufficient for the accuracy of the digitizing being performed by the students.

The interface of the software was customized for use by the students in this project. None of the students were given over a half hour of training. When the shapes of the fields are created and georeferenced, the simple interface automatically assigns the shapes the proper symbology.

3. ARE ENGINEERS BECOMING PHOTOGRAMMETRISTS ?

The short answer to this question is, "No." However, there are ways in which geoengineering is beginning to take advantage of not only the precision of vector graphics, but also of raster images.

Traditionally, the accuracy has not come from the imagery; it has been derived from the vectors. The originating data for the vectors has come from surveying methods or from photogrammetric data extraction, but the photogrammetry has been a mapping process that is mostly distinct from the engineering.

Now, however, orthophotos (with accuracy tolerances of less than one foot) are useful to engineers in design phases of engineering in some applications where that accuracy is sufficient. A good example is corridor-mapping by utilities, although that is not enough accuracy for highway design. Orthophotos are tending to have more accuracy as the systems can now handle the larger files produced by such systems.

The communication value of the data is accelerating its popularity among engineers - everyone understands a picture. Therefore, mapping tasks are being increasingly integrated into the engineering process and are being done by engineers, not mappers or photogrammetrists.

The threshold of accuracy is now being pushed higher. Engineers can handle mapping projects of increasing accuracy without having to defer to specialists such as the photogrammetric experts. Even people who are not engineers are starting to use imagery and make simple maps, although they tend to think of them as "decision-support documents" and not maps. For an example, a real estate developer might create a site plan that has an orthophoto backdrop.

This trend is likely to continue. The same demand is encouraging satellite image vendors to more into high-resolution imagery, illustrating the trend and the increasing demand. Although even 1/2 meter imagery is not very useful in design engineering, it is useful in planning and other phases of engineering.

'Photogrammetric Week '97' D. Fritsch & D. Hobbie, Eds., Wichmann Verlag, Heidelberg, 1997.

As a result of increased demand and appreciation of all types of graphic imagery, engineers are not only using more graphics themselves, but they are not becoming photogrammetrists. As their needs become more sophisticated, they are increasingly working closer and more often with the photogrammetrists.