A Brief History of Color Imposition Devices and Review of Current Offerings

Jim Cucurull

With the advent of fully digital stereoplotting, often referred to as "softcopy" mapping, many owners of existing photogrammetric instruments have been left with some serious questions. One of the most important is whether to commit to a new technology or optimize existing equipment before making a smooth transition into the next era. In this article, we will examine a way in which existing analog and analytical stereoplotters can be equipped with a hardware and software retrofit that significantly increases their performance, at a fraction of the cost of new systems.

Superimposition systems for stereoplotting instruments are tools that have been available in various forms for a number of years. Primarily due to the extremely high cost of the systems and their inability to run on low cost computers, superimposition never really caught on as a viable solution.

Because of advances in several technologies, superimposition (SI), systems have become an affordable option for the owners of almost all analog and analytical stereoplotters. These labor-saving retrofits not only increase productivity and profitability, they improve the quality of the map files being created.

For the first time, SI systems are PC-based. Aided by the increasing speed of graphics processors, the cost of the sytems has dropped dramatically in the last few years. This article will look at the development of these systems and their effect on the firms and individuals who use them today.

Map-making — the process and problems

Most of the work of a photogrammetrist takes place at a stereoplotter, a large mechanical and electronic device. Analog and analytical stereoplotters vary greatly in size and structure. Regardless of size or complexity, all stereoplotters have a surface containing two plates to hold a pair of aerial photographs and an eyepiece similar to a pair of binoculars.

Mounted beside the device is an applications computer with a monitor. This computer contains the mapping system software. These mapping systems are often CAD based or custom designed programs that allow 3D data acquisition. The software also contains programs that control the orientation of the photos, which are called stereo models, and support the stereoplotter and map data compilation system.

Into this computer, the map maker also inputs ground control information concerning the photos. This information, usually obtained through ground surveys, allows for the precise calibration of the two photos and is used to initiate the map making process.

To begin making a map, the photogrammetrist places two aerial photos, a left and right perspective image of the same ground point, on the plates. The operator then aligns the models by matching selected common ground points within them. The stereoplotter's optics then allow him to see terrain in three dimensions, or stereoscopically. Almost all stereoplotters use these basic techniques. While the invention of the stereoplotter cut down immensely on mapping time its deficiencies have continued to nag photogrammetrists.

Foremost among the instrument's shortcomings is the necessity for the map maker to continually pull his head back from the eyepiece, turning each time, to look at a computer monitor and check the accuracy of his drawing. Each time, he must re-adjust his eyes from peering through the binocular-like eyepiece to view the display monitor a few feet away. Each time, he must make certain that the line he's looking at is the same line that he was drawing when he turned

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away. Obviously, this procedure eats up time, fatigues the map maker and can eventually detract from the accuracy of his work. Often, in the transition from eyepiece to monitor, entire objects are emitted from the drawing file.

Many of the other problems inherent in this method of work add time to the task of editing the drawing file to create a finished product. For instance, when drawing the perimeter of an encircled feature such as a lake, it is difficult to precisely match the end of a line with its beginning. Either the mapper must look back and forth and continue to redraw his line if it's not accurate, or an editor must take the time to clean up the final drawing.

Contour lines indicating steep terrain run very close to each other, and again, the mapper must constantly refer back and forth from the model to the screen to see that his drawn lines don't overlap. If he doesn't continually check his drawing, the mapper is almost sure to end up with crossed lines that must be corrected by a map editor. Thus, shortcuts taken by mappers using conventional stereoplotters will eventually be paid for by the map editors who have to fix the resulting errors.

Superimposition - how it works

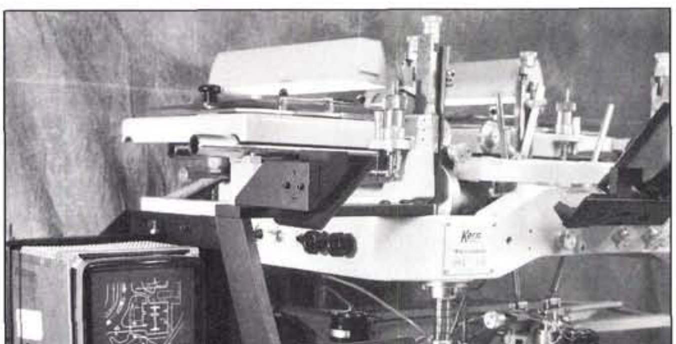
Put simply, SI is a projection of the digital map file back into the eyepiece of the stereoplotter's optical path. As the map file is compiled, the photogrammetrist is able to view the map as an overlay on the stereo model.

The SI system uses two high resolution monitors. One is the applications computer monitor discussed earlier. The second monitor is used for the generation of the superimposition image. The image from this superimposition monitor is entered into the optical path of the stereoplotter through a series of lenses.

First-generation SI systems appeared about a decade ago in response to a need for more efficiency in mapping. Considered slow, inaccurate and expensive, the first systems didn't catch on. Many of their problems centered around the inability of less efficient computers to handle the large amounts of data contained in a stereo model.

Early SI systems only mapped in two dimensions and did not account for elevation distortion, so digitized images became skewed as adjustments to the photographic model were made on the stereoplotter. The systems also relied on slower processors, less memory and primitive graphics cards in their computers. The combination of these ills led to panning delays, partial images and other sources of aggravation.

Early systems only provided crude, thick, dim, monochromatic lines.



The SI covers have been removed from this Kern PG2 to show the simplicity and functionality of the system.

Problems were also compounded by the fact that early SI products were not upgradeable and sometimes entire systems were abandoned by their manufacturers. Because of these shortcomings many photogrammetrists — and their managers — unfortunately were left with bitter feelings toward the idea of superimposition.

Second generation SI systems use advances in computer hardware and computer aided design (CAD) software, creating an entirely different scenario. Today's systems are feature-driven and offer real-time panning, three-dimensional mapping, Z-axis display and control over which map level is being viewed. The superimposed image is very bright, sharp and in full color, enabling operators to instantly verify map accuracy.

Increased computing speeds and advances in video memory have allowed newer SI systems to offer notable features such as the ability to handle map files of unlimited size. The systems are able to display and pan around images with a screen "refresh" that provides a smooth, coordinated motion of the graphics image and stereoplotter stages. The SI image can be turned on and off conveniently and upon initialization, there is no waiting for the image to be redrawn. Regardless of the map file size, the image is instantly displayed. While compiling map data the operator can turn specific CAD layers (or levels) off and leave others on.

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Users talk about the benefits of superimposition

"What you see is what you got!" Is how Dave Kelstrom of Shasta Aerial Mapping of Redding, California described the biggest benefit of SI. His brief but accurate comment illustrates the instantaneous process. As each digitized entity is superimposed over the entity in the photo, it becomes very obvious what has been missed.

Other SI owners recently interviewed for this story cited this ability to see each digitized entity over the photographic model, but came to different conclusions as to what area of their work was most affected.

Mapping without worrying about feature omissions allows the operator to be more productive, said Dave Norby of Aero-Map, U.S. in Ormond Beach, Florida. " There are always one or two items in a map file that make you wonder, did that slip by," he pointed out. Norby said this also puts the responsibility for quality back on the shoulders of the opera-

The addition of SI to this P3 is barely perceivable. What is noticeable is the increased performance and production.

tor, which in turn lightens the load of the editing department "We have relieved them of the burden of checking the quality of the operators work."

With SI, editors are once again responsible for assuring that the user receives the highest quality product. Chuck Adner's photogrammetric section at the Illinois Department of Transportation annually produces in excess of 200 miles of 1" = 50' mapping, often done in 1 foot contours. "It (superimposition) actually helps the quality of the product," Adner stated, "Especially 1' contours, with a lot of topography it's awfully easy to miss something, without SI the operators just tend to run over it." Adner also noted that his department retains traditional editing practices, editors still spot check with stereoviewing to double check the output of the photogrammetrists.

Another area greatly affected by S/I is the generation of digital terrain models (DTMs). DTMs account for a growing percentage of the photogrammetrist's production. DTMs are used for a number of tasks including the creation of orthophotos and contours as well as providing source material for volumetric studies and profiles.

Put simply, a DTM is the accurate definition of an area's ground surface generated through random collection of points, called "mass points", combined with the 3D measurement of points along a "break line". Break line information is collected on lines where the terrain changes suddenly, such as along a ridge or at a valley's lowest point.

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DTM generation requires the precise measurement, in three dimensions, of these mass points and break lines. DTM data collection usually includes the mapping of difficult terrain. The operator must interpret the terrain features correctly. If a tree or shrub is mistaken for a point on the surface of the ground, the resulting contours will be erroneous. "DTM (collection), that's what I bought it for," said Dave Kelstrom, summing up the feelings of many SI owners and operators.

Gerrie DeGrosse of DeGrosse Aerial Mapping in Bothell, Washington, thinks DTM collection will account for a larger and larger amount of the photogrammetrist's work load. "It's a part of photogrammetry that can be easily integrated with information collected in the field to come up with a nice finished product," he said. DeGrosse also noted that although there is relatively little demand for 3D DTM collection now, there will be much more in the future, especially for road design work.

DTMs are becoming the bulk of the Illinois DOT's work, said Chuck Adner. "SI makes the collection of break lines and mass points easier, and using the DTM process is much faster than doing contour data collection."

One emerging impression gained from talking to mapping professionals is that with or without SI they are confident of their abilities. As DeGrosse explained, "After 28 years (of mapping) you pretty much have it down." One also gathers that these skilled technicians are quick to understand and appreciate new technology. "With SI you find yourself shaping the file as you go. The operator can see patterns easier and produce a better overall product," DeGrosse explained. "I can see that in five years it (SI) will be more and more important. It's going to be a life saver on updates."

The updating of map files is another growing area of photogrammetry. Accurate base maps are the foundation of Geographic Information System (GIS) databases. In a GIS application, geographical information is merged with other types of information to form a third, or hybrid, database. Often GIS databases cover dense urban areas. Base map files are frequently revised to include new construction and landscape changes.

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With superimposition, the missing elements on a map file are instantly obvious. By placing the existing map file over new photography the operator quickly makes the new additions and changes.

"I feel that it is best used when you have a heavy model, when there is a lot of information." Norby said of superimposition. "I feel it's best used for planimetric detail." Again, the number and types of benefits provided by SI emerge. Some of them are purely emotional "Mapping without SI is a chore, said Norby. "It's not good, but it can be done. It's like not having cruise control on your car, you can still drive -- but you need more rest stops."

The S/I shrouding helps maintain the intensity of the internal monitor. The hardware and covers are adapted to each application.

The observations and responses to SI may vary, but the bottom line remains constant. Of all the people who contributed to this article, not one said that the system had any drawbacks. More important, all indicated in real numbers the dramatic increases they had seen in productivity.

"Our production increase has been easily 25%. Depending on the job, much more," noted Dave Norby. "Our shop has gained 40% in productivity," Chuck Adner said. Gerrie DeGrosse estimated a 15-20% increase in production and Dave Kelstrom said his shop's output has been 25-35% more productive using SI.

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About the Author

Jim Cucurull is a Marketing Specialist with DAT/EM Systems International, an Anchorage, Alaska based producer of digital photogrammetric hardware and software. Noted for its development of superimposition systems, DAT/EM provides digital mapping products to government agencies and private firms in 38 countries around the world.