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## Create Accurate Orthophotos with Softcopy Photogrammetry

*Softcopy photogrammetry can offer great savings when created in-house*

By Kyle Bohnenstiehl

Photogrammetry was once the domain of engineers, surveyors, and mathematicians but now GIS professionals can utilize this powerful mensuration tool right on their own desktop. Executing photogrammetry projects in support of GIS mapping is a complex process that involves many steps. However, by linking these steps together in a systematic manner, it is possible to create very accurate orthophotos in house at a substantial savings over outsourcing to service bureaus. This article dicusses the softcopy photogrammetric process as it applies to GIS mapping and topographic mapping. The Management Association for Private Photogrammetric Surveyors ([MAPPS](#)) is a good resource for finding companies in your area that perform aerial photography services.

### The Development of Early Photogrammetry

Although modern softcopy photogrammetry employs digital scans of photographs or even digital satellite imagery for measurements, the concepts go back into history. Leonardo da Vinci in 1492 began working with perspective and central projections. Later scientists developed the geometric theorems that eventually led to the 1759 publication by Johan Heinrich Lambert, of the treatise "Perspectiva Liber" (The Free Perspective) This book developed the mathematical principles of a perspective image using space resection to find a point in space from which a picture is made.

In 1837, Jacques Mandé Daguerre obtained the first "practical" photograph using a process called the Daguerreotype. Around 1840, the French geodesist, physicist and astronomer Dominique François Jean Arago began to advocate in front of the French Arts and Science Academy, the use of "photogrammetry", using the daguerreotype as his remote sensor. He demonstrated the use of photographs for surveying elevations and other surface features of land. In 1859, Aime Laussedat, a colonel in the French Army, announced the first successful use of photographs in surveying.

Since the 1850's , photogrammetry has followed four development cycles that are outlined below.

- a. Plane table photogrammetry, 1850 to 1900,
- b. Analog photogrammetry, 1900 to 1960,
- c. Analytical photogrammetry, 1960 to present, and
- d. Softcopy Photogrammetry

The key moments in analog photogrammetry were probably the European development of precise stereo viewing optics and the Wright Brothers airplane .The "father" of American photogrammetry, Earl Church (August 11, 1890 - May 11, 1956) contributed to the theory of analytical photogrammetry. Church, who was a professor at Syracuse University , was one of the founding members of the American Society of Photogrammetry ([ASPRS](#)) .

### What is softcopy photogrammetry?

We will now jump ahead to the late-1980's when the first practical softcopy photogrammetric workstations became available. These are the types of systems that most GIS professionals would consider buying today and will therefore be discussed in detail. In a typical softcopy environment, digital images are transeferred from tape or CD-ROM into a UNIX or NT/2000 machine with large SCSI data storage systems. The scans are then geometrically corrected or made "metric" using the fiducial and camera information. The scans are then oriented to the ground using a set of real world coordinates generated through ground surveys. All of the scans in a block are adjusted using a triangulation algorithm so that they all fit within the constraints of the control information. At the end of the triangulation, individual stereo models have been mathematically defined between adjacent stereo images. It is now possible to "extract" topographic information out of the images using autocorrelation techniques that match patterns between images within a certain search radius. Using the parallax created by different exposure stations, elevation can be automatically measured by pixel matching. Finally, the terrain model is used to create an orthophoto from the original scan that is precisely geocoded and has its own Digital Elevation Model (DEM) associated with it.

### Why use softcopy photogrammetry?

The cost savings in terms of film processing, labor, and instrumentation are substantial and have made photogrammetry accessible to many new users. It is conceivable that any GIS operation with more than a few people would want to invest in this technology to create this data in house. Once trained properly, operators can develop orthophotos on an as needed basis for a fraction of the cost of outsourcing large county wide projects. This allows GIS managers to pinpoint specific areas that require updates and prepare high quality datasets that are up to date. It is also advantageous to contract much of the procedure and to specify for delivery a variety of products: a raw DTM, the results of the final triangulation, and a Digital Stereo Model file to use for stereo editing for example. Often GIS feature collection and mosaicing are the most expensive part of the contract, tasks that can be performed by most GIS shops. The main uses of this technology by the GIS industry are:

- To create orthophotos for use as GIS or CAD basemaps
- To create topography from stereo photography
- To perform volumetric and planimetric mensuration using the stereo model



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