Boeing Autometric

"Changing the Way You View the World"

Boeing Autometric is a systems supplier that offers both a wide range of individual software products and a number of end-to-end solutions in the three closely related areas of (i) photogrammetric data production; (ii) geospatial data management; and (iii) the visualization, modelling and analysis of very large sets of spatial data. Although it is a major supplier of systems and software in the USA - especially to American government agencies - it is perhaps rather less well known in Europe, though certainly it does have quite a number of European customers. This article aims to give the background to the company and outline the main products and solutions that it supplies at the present time.

by Prof. Gordon Petrie & Claire Kiedrowski

Company Background

Boeing Autometric has an interesting history. Originally Autometric was incorporated in 1957 as a wholly owned subsidiary of the Paramount Pictures Corporation offering research and development capabilities in the then new field of remote sensing. Much of its early work was in classified military projects concerned with airborne and spaceborne imaging sensors and reconnaissance data handling. In 1962, Autometric was bought by Raytheon and continued to work in these fields. One of its developments during the late 1970s was a very early GIS system called AUTOGIS that was supplied to the U.S. Fish & Wildlife Service and various other government agencies and to commercial companies such as oil exploration firms. At the same time (in 1977), the Autometric operation was purchased from Raytheon by IDEAS (Information Development & Applications), a small independent company that had been involved in the construction and development of analytical photogrammetric instruments. These two main products - analytical plotters and the derivatives of AUTOGIS - together with military work carried out for the Defense Mapping Agency (DMA), the National Photographic Interpretation Center (NPIC), etc. formed the mainstay of the company's activities during the 1980s. In 1984, it became an employee owned company. During the 1990s, a subsidiary of Autometric called Vision International was formed to concentrate on the development, supply and support of digital photogrammetric systems. Finally, in June 2000, the Boeing Company acquired Autometric from its private owners, placing it within its Space & Communications Group, which is based in Seal Beach, California.

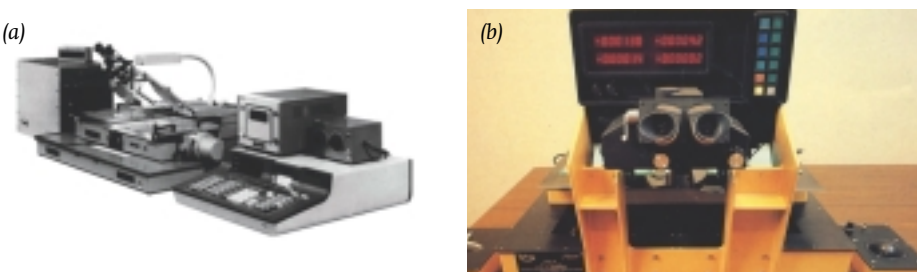

Figure 1: (a) The APPS-I analytical photogrammetric instrument from the 1970s. The photogrammetric solution was provided on a point-by-point basis using software running on a Hewlett-Packard desktop calculator. (b) The APPS-IV analytical plotter from the 1980s.

Photogrammetric Heritage

Autometric's activities in photogrammetry really began in 1973 with the development of the Analytical Photogrammetric Processing System (APPS) for the U.S. Army. The APPS-I was an analytical instrument handling hard-copy aerial images that could be used for targeting purposes by units deploying artillery and surface-to-surface missiles. It was built on the mechanical base, parallel guidance and stereo-viewing optics of the Zeiss Oberkochen Stereotope. Essentially it was an image space plotter that utilized a Hewlett-Packard 9800 desktop calculator for the implementation of its photogrammetric solution. This provided the instrument with an exact solution in terms of the final X, Y and Z coordinates of each measured point, but did not do so via a continually oriented stereo-model. Instead the operator measured the required targets on a point-by-point basis, clearing out the parallaxes as he went. The APPS-I instrument was quite successful: more than 150 were supplied to the U.S. Army, Air Force and Navy during the 1970s. It was then followed by the APPS-III/IV instrument which was a full-blown analytical plotter with a continuously oriented stereo-model, based on an image coordinates primary solution. The software was written in FORTRAN for ease of portability to different mini-computers. The viewing optics were adapted from the Bausch & Lomb Stereo Zoom Transfer Scope (ZTS). Thirty of the APPS-IV analytical plotters were built during the 1980s using the then popular mini-computers from DEC, Data General and Hewlett Packard.

Digital Photogrammetry Development

Towards the end of the 1980s, Autometric saw both the need and the opportunity to move into digital photogrammetry. In 1988, it developed its prototype Pegasus digital photogrammetric workstation (DPW). This was based on an SGI IRIS 4D graphics work station, supplemented by a dedicated Pixar image processing computer and employing the StereoGraphics ZScreen stereo-viewing system. It was relatively easy to modify the FORTRAN code from the APPS-IV to provide the basic photogrammetric solution. However a lot of additional work was still needed to make it into an operational DPW. During the 1990s, under the Vision International banner, the system was developed further into the SoftPlotter and OrthoMAX products, still based on

Figure 2: A SoftPlotter digital photogrammetric workstation (DPW) running in a twin-screen configuration with the SoftMouse used for 3D measurement in the stereo-model in the foreground.

Unix-based workstations. Besides these in-house developments, Vision also acquired Kork Systems, based in Bangor, Maine. This gave it ownership of the Kork Digital Mapping System (KDMS) which is still used widely for vector-based photogrammetric data collection and editing on analogue, analytical and digital stereo-plotters from a number of different suppliers besides Autometric. This acquisition of Kork also gave it possession of the OrthoKork software used to generate digital orthophotos.

Product Overview

As noted in the introduction above, currently Autometric offers a range of products, solutions and systems under the following three main headings:-

I - Photogrammetric Production & Processing: These products comprise SoftPlotter; the KDMS data collection software; and the Kork Digital Stereo Plotter (KDSP), which is a new DPW that combines features from the existing SoftPlotter and KDMS products.

II - Geospatial Data Management: This second group of products is concerned with the management and dissemination of geospatial data. In the case of the DataMaster package, the software allows the retrieval and viewing of airborne and spaceborne imagery from archives measured in petabytes for use by image analysts. The Spatial Query Server (SQS) allows the rapid search and querying of very large spatial databases using an SQL-based system.

III - Visualization & Analysis: The EDGE family of products allow the visualization and analysis of spatial data. The basic EDGE software comprises a large suite of components that can be configured to carry out these operations. Most users select only those components from the available range that are needed to satisfy their specific requirements. A toolkit is also available to further customize EDGE to suit these requirements. Besides which, a number of specially tailored applications packages - ImageScape, TerrainScape, BattleScape, WeatherScape, etc. - have been developed for use by different well-defined user communities having specific needs for the visualization of geospatial data.

I - Photogrammetry

• SoftPlotter

Autometric's flagship DPW is SoftPlotter. Its basic set of photogrammetric functions and geometric models allow it to handle stereo-pairs of frame aerial photographs and overlapping strips of space scanner imagery, e.g. those that have been generated from SPOT, IKONOS, etc. SoftPlotter carries out its basic operations through so-called "tools", comprising its Block Tool (for orientation and triangulation) and Stereo Tool (for stereo-viewing). Additional modules or "tools" are then used to implement specific applications. Thus the KDMS and DGN Tools are added for vector-based map compilation; the DEM and Surface Tools are utilized for DTM collection; and the Ortho and Mosaic Tools are employed for orthophoto and orthoimage production. In this way, the photogrammetric processing can be customized to suit the specific tasks that need to be executed. Originally SoftPlotter was only available for use on SGI graphics workstations. It was then extended to run on Compaq Alpha, Sun Ultra and Windows NT/2000 machines. However with SoftPlotter 4.0, which is due to be released later this year (2002), the supported platforms are SGI IRIX and Windows NT/2000. Either SoftMouse, StealthMouse or a handwheel/footdisk combination are available as options for 3D measurement within the stereo-model. The most recent development is the incorporation of the Pliable Display Technology from the Canadian supplier Idelix. This allows the high-resolution viewing of part of a stereo-model on the SoftPlotter screen within the frame of a lower-resolution background providing a partial overview display of the model - while still maintaining its geospatial context.

• KDMS

The KDMS package is one of the leading packages in the mapping field that is used

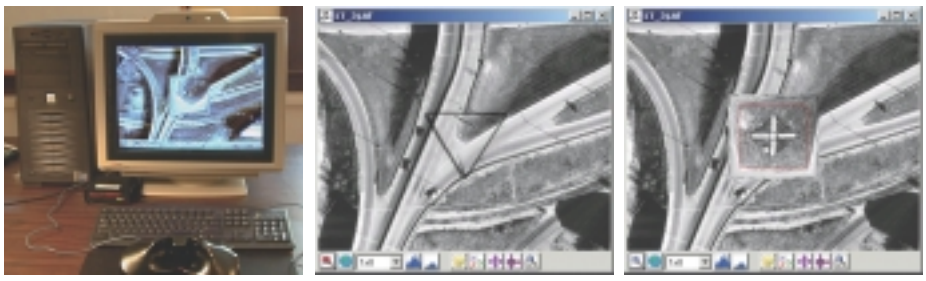

Figure 3:
(a) The new Kork Digital Stereo Plotter (KDSP) designed for digital vector map production with the Idelix lensing tool located in the centre of the display.
(b) The KDSP display screen before the Idelix "lens" has been switched on.
(c) The KDSP display screen with the Idelix "zoom lens" switched on.

Figure 4: A perspective view of the Americas generated by the BattleScape application package based on the EDGE visualization technology.

widely to carry out the vector-based photogrammetric compilation of topographic (3D) and planimetric (2D) map data from stereo-pairs of aerial photographs. Introduced originally in 1982, it has been continuously developed and extended since then. The current version is number 13.2. While it is available as a tightly and seamlessly integrated "tool" within SoftPlotter, its use as a separate stand-alone package is widespread throughout the mapping industry. In this context, it has interfaces to over 40 different analogue, analytical and digital stereo-plotters (for 3D work) and over 15 digitizing tablets (for 2D work). The KDMS package is supplied with extensive editing facilities. These allow both interactive and batch editing operations to be carried out. It also offers a macro language that allows users to write macros to streamline production tasks. The finally compiled and edited vector data can then be viewed superimposed against an image background. Furthermore the feature attributes of the data compiled under KDMS can rather readily be translated into a GIS. In this respect, a range of translators are available for use with various file formats (e.g. MicroStation, AutoCAD and ARC/INFO) that are commonly used within the industry. Specific Terramodel commands are also integrated into KDMS to generate DTMs and contours from measured 3D data.

• KDSP

This is a new DPW for Windows-based PCs that is optimised for digital vector map compilation. Thus it does not provide the facilities for DTM production and orthophoto generation that are offered by SoftPlotter. It is therefore correspondingly less expensive. Instead of the analytical space resection/intersection solution that is used in SoftPlotter - in which the measurements of the ground control points (GCPs) are carried out monocularly - KDSP uses the classical inner, relative and absolute orientation procedure with stereo-measurement of the GCPs to set up the stereo-model. This capability is provided by the AP32 software written by SoftMap. However the high-resolution viewing of the stereo-model is provided by the same stereo-imaging engine that is used in SoftPlotter. Furthermore the lensing display software from Idelix has also been incorporated into the KDSP. The final vector data collection is, once again, carried out using KDMS. While KDSP is a new product, obviously it makes extensive use of various well proven components.

II - Geospatial Data Management

• DataMaster

The DataMaster package is data management software that allows the management, retrieval and distribution of aerial and space imagery in digital form. Using DataMaster, the stored image data can be accessed, displayed and extracted from tape, disk or mass storage, either locally or remotely over a wide area network (WAN). Images can be located rapidly using a special "geolocate" facility and, if required, displayed quickly at a reduced resolution with simultaneous multiple viewing of the images in adjacent windows. Simple methods of image manipulation and processing are also provided, including planar rectification. Needless to say, DataMaster can handle numerous different image file formats. The software has been used extensively on image archives held within U.S. government agencies, mainly running under one of the various flavours of the Unix OS - e.g. IRIX (SGI), Solaris (Sun) and Linux. Most recently, DataMaster has been ported to run under Windows NT and 2000.

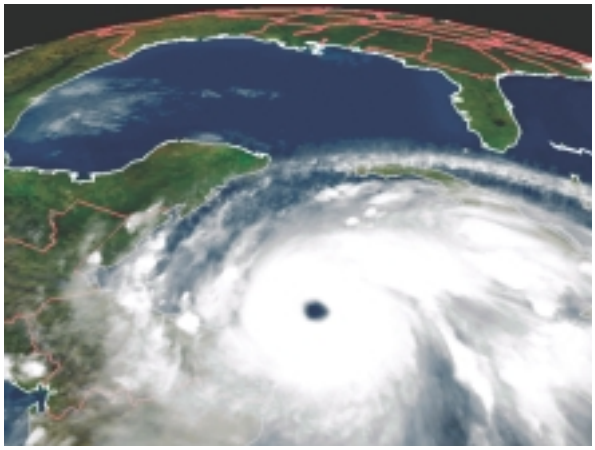

Figure 5: The WeatherScape application package has been used to generate this perspective view of Hurricane Mitch as it nears the coast of Yucatan and Belize in the Caribbean.

• SQS

SQS is a spatial data management system that allows the location of vector-based data to be found quickly and easily and can establish how this data is distributed across a geographic area of interest. It does this using a powerful spatial query engine. The geographic data and datatypes are defined and held in tables and several geographic operators are provided which can be used to build queries to retrieve the specific data that is required for analysis. Essentially SQS provides geographic extensions to the standard ANSI Structured Query Language (SQL). This allows users to transform a simple relational database into a spatial database. In particular, it allows users to access and analyse spatial data held in a Sybase Relational Database Management System (RDBMS). The SQS software has been available for some time running under various flavours of Unix and is now available on Windows NT platforms.

III - Visualization & Analysis

• EDGE

EDGE provides advanced computing facilities to carry out the modelling, simulation, visualization and analysis of large geospatial data sets. The EDGE suite comprises a set of compatible components that allow realistic virtual environments to be created, within which the simulation and analysis can take place. Depending on the coverage of the geospatial data sets that are available, the views that can be created may be global, regional or local. Users can add to the EDGE foundation package those components that are needed to satisfy their particular requirements. Moreover EDGE also has an object class library toolkit - the EDGE Developer Option (EDO) - that provides visualization, simulation and analysis libraries. These help users to create 2D, 3D and 4D views that will meet their specific requirements.

• EDGE Products

(i) Turning next to individual products, the **EDGE Viewer** is designed specifically to generate displays and visualizations from multiple geospatial sources. Thus it will accommodate imagery; vector and raster map data; vector overlays; grid and graticule overlays; and annotated overlays. The EDGE Viewer has been

selected by the U.S. government, which has bought an enterprise licence that allows the distribution of several tens of thousands of copies throughout the U.S. Armed Forces. Thus it is able to accommodate NIMA vector map products (e.g. Digital Chart of the World, Vector Smart Map, Digital Nautical Chart, etc.) and raster map products (ARC Digitized Raster Graphics). It can also handle those commercial data sets that are available in commonly used file formats such as ERDAS Imagine, ARCView Shape, GeoTIFF, USGS DEM, etc. for use in displays and visualizations.

(ii) EDGE Nomad allows the display and visualization of maps and images on handheld (palmtop) computers for use in the field and can display and track information generated from a GPS set that has been connected to the computer. Currently supported palmtop devices include the Compaq iPAQ, HP Jomada and Casio Cassiopeia

(iii) EDGE Vista is an interactive visual display system that is designed specifically for education, training and simulation purposes. Again it can display a large range of maps, charts, imagery and elevation data. Moreover it can also accommodate textual (non-graphic) data such as information on political issues and conflicting news information - as required for example in wargaming in military colleges and training establishments.

• EDGE Applications

As noted above, a large range of specially tailored applications and solutions - BattleScape, WeatherScape, TerrainScape, etc. - have been developed, based on the EDGE suite of components and tools. One of these applications that may be of particular interest to readers of GeoInformatics is the Environmental Work Bench (EWB). Along with basic topographic data, this can also accept specialised thematic data sets on environmental topics from the National Weather Service (NWS), Environmental Protection Agency (EPA), U.S. Dept. of Agriculture (USDA) and other environmental agencies. EWB can then be used to carry out analyses of these data sets producing geolocated displays and perspective views of the results.

Photogrammetric Users

Autometric has a solid base of customers with licences in use worldwide. Just over one-third of the SoftPlotter clients are located outside the U.S.A. With KDMS, there are an equal number of clients inside and outside the U.S.A. Besides the large U.S. government mapping agencies, several of the major American commercial air survey companies such as Surdex, 3Di LLC and Aero-Metric are users of Autometric DPWs on a substantial scale, besides their use in many smaller companies. Outside the U.S.A., Autometric uses a network of distributors to market and sell its products and to support customers. This is the situation in Europe where most of GeoInformatics' readers are located. Thus, for example, in Greece, the distributor, Infomap, has over 30 active installations of SoftPlotter and KDMS. Greek government users include the Hellenic Military Geographical Service, the Hellenic National Cadastral Organisation and the Technical University of Athens. In addition, several private mapping firms in Greece are using SoftPlotter and KDMS for base map production for the National Cadastre. In neighbouring Turkey, Informatik is the distributor and has the General Command of Mapping (GCM) as a major user of SoftPlotter and KDMS for vector map compilation for topographic and planimetric mapping. On the commercial side, the MNG company based in Ankara uses its SoftPlotters both for aerial triangulation using the Block Tool, as well as for stereocompilation purposes.

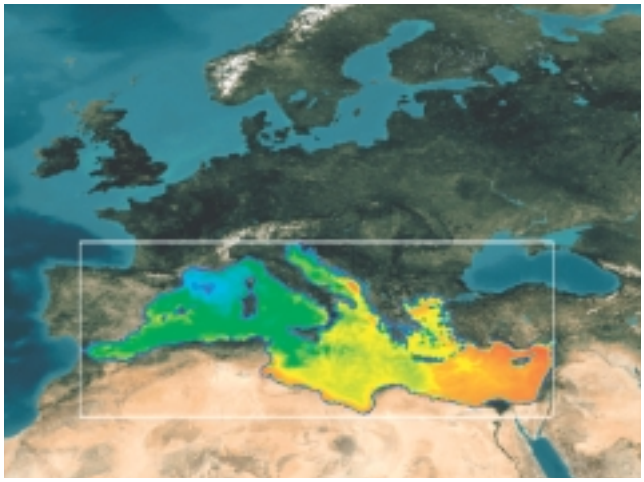

Figure 6: The Environment Work Bench (EWB) has been used to analyze and display data on sea surface temperatures for the Mediterranean Sea.

Turning next to Western Europe, MAPS GeoSystems uses SoftPlotter both in its offices in Munich, Germany and in Lisbon, Portugal and, further afield, in its Middle Eastern offices, in Sharjah in the U.A.E. and in Beirut, Lebanon. In the U.K., ERDAS (UK) Ltd has acted as the distributor. Several of the installed base of customers in British universities and research institutes use OrthoMAX, which is the specially configured version of SoftPlotter that sits within the ERDAS Imagine image processing suite and is optimised to carry out automated DEM and orthoimage production. This includes the ability to handle SPOT stereopairs, as well as aerial photography. Among commercial users, InfoTerra (formerly NRSC) utilize their examples of SoftPlotter for DEM and orthoimage production. BKS Surveys - which is located in Northern Ireland and works internationally - is another commercial mapping user, mainly utilizing KDMS for vector data collection on its battery of analytical plotters. However it has also used SoftPlotter and OrthoKork for orthophoto production work.

Future Directions

Looking to the future, Autometric is paying particular attention to accommodating the different sensor models needed to handle spaceborne remote sensing imagery and lidar data. It is also working towards an industry standard for interfaces so that a "plug and play" approach may be implemented to keep pace with the growing list of available remote sensing platforms. Other R&D efforts are focused on eliminating redundant steps in the mapping workflow by means of automation, especially in the area of DEM and orthoimage generation. Finally Autometric is putting a lot of effort into improving the quality of the digital imagery that can be handled by its various software packages.

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