## *Now a Major Photogrammetric Systems Supplier*

# A Visit to Racurs

*Since the break-up of the Soviet Union and the end of its communist regime, gradually a substantial commercial sector in surveying, mapping and remote sensing has been built up inside Russia serving government agencies and both privately-owned and state-owned industrial and commercial enterprises. Besides this development within the country, some of the companies involved in the mapping sector either as system suppliers or service providers have also entered foreign markets, both within the former communist bloc countries and also further afield. One of the most prominent of these is the Racurs company - which is both a system supplier and a service provider. The opportunity to visit this company's main facility located in the north-eastern part of Central Moscow and to see and hear about its various products and activities was presented to my wife and I during the recent conference on Laser Scanning & Digital Aerial Photography held in Moscow. It proved to be a most interesting and informative visit.*

By Gordon Petrie

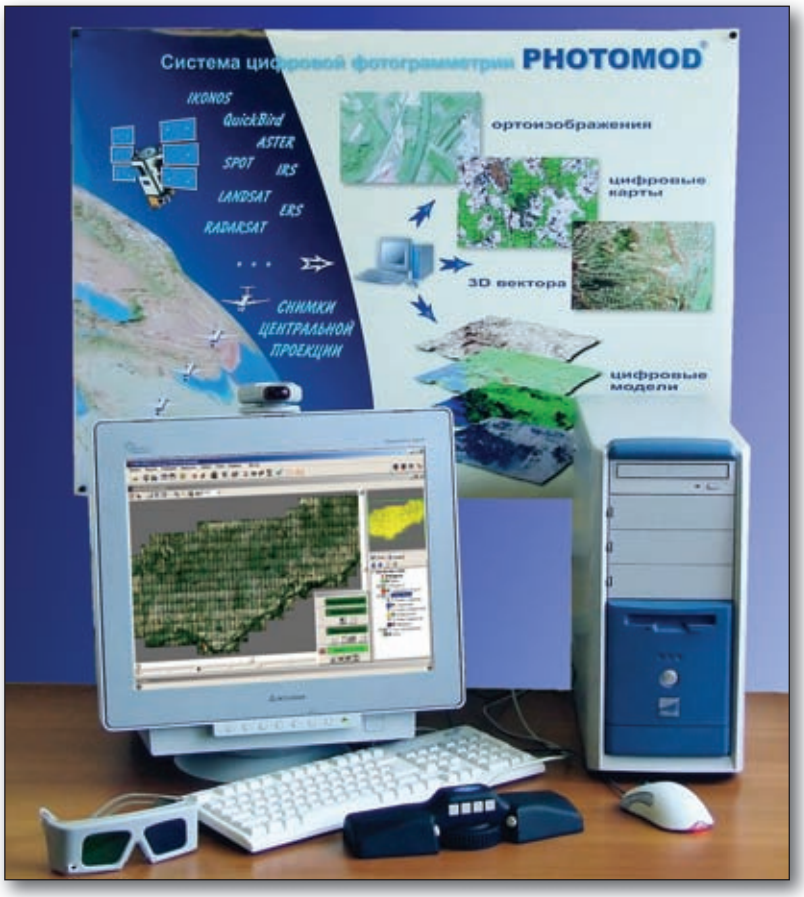


***Fig. 1*** *- A PHOTOMOD system showing the main hardware components - with the wireless glasses, keyboard, 3D mouse and standard mouse in the foreground; and the display monitor and computer in the middle - with a display board acting as the background.*

### Introduction

The Racurs company was formed in 1993 with a group of four employees led by Dr. Victor Adrov, formerly a mathematician employed at the Russian Academy of Sciences. They first developed a set of tools for the digital processing of individual stereo-pairs of aerial photographs. This rapidly evolved into the PHOTOMOD software suite, the first licence of which was sold to a Russian agency in 1995. Since then, the software has been developed in a systematic manner into a full blown digital photogrammetric system (Fig. 1). The software can now handle digital imagery exposed either by frame cameras or by pushbroom line scanners, irrespective of whether the imagery has been acquired from airborne or spaceborne platforms. Besides its main activities as a software developer and supplier of systems to the photogrammetric and remote sensing communities, the Racurs company has also entered other fields related to these communities. In particular, over the last four years, it has offered a photogrammetric production service to both Russian and foreign customers. Furthermore, the company is now offering to its customers, various digital mapping and GIS software products that have been developed by other Russian software companies. Finally, over the last two years, Racurs has started to distribute certain types of spaceborne imagery, e.g. those acquired by the SPOT-2, -4 & -5 satellites.

### PHOTOMOD

The software has, from its beginning, been designed to run solely on PCs under the Windows operating system. The user interface is available in one of two languages - Russian and English. PHOTOMOD is a modular system comprising a core module together with numerous additional modules (Fig. 2). These allow DPWs to be configured individually to satisfy the specific requirements of each customer.

### (a) Core Module

The core module is called ***Montage Desktop*** and carries out the management and organisation of all the operations and projects being carried out on the PHOTOMOD system. This includes the management of the input of the digital image data, whether it comes from a photogrammetric film scanner or from a digital frame camera or pushbroom line scanner. Also feeding into the core is the image data from desktop (DTP) scanners, which first passes

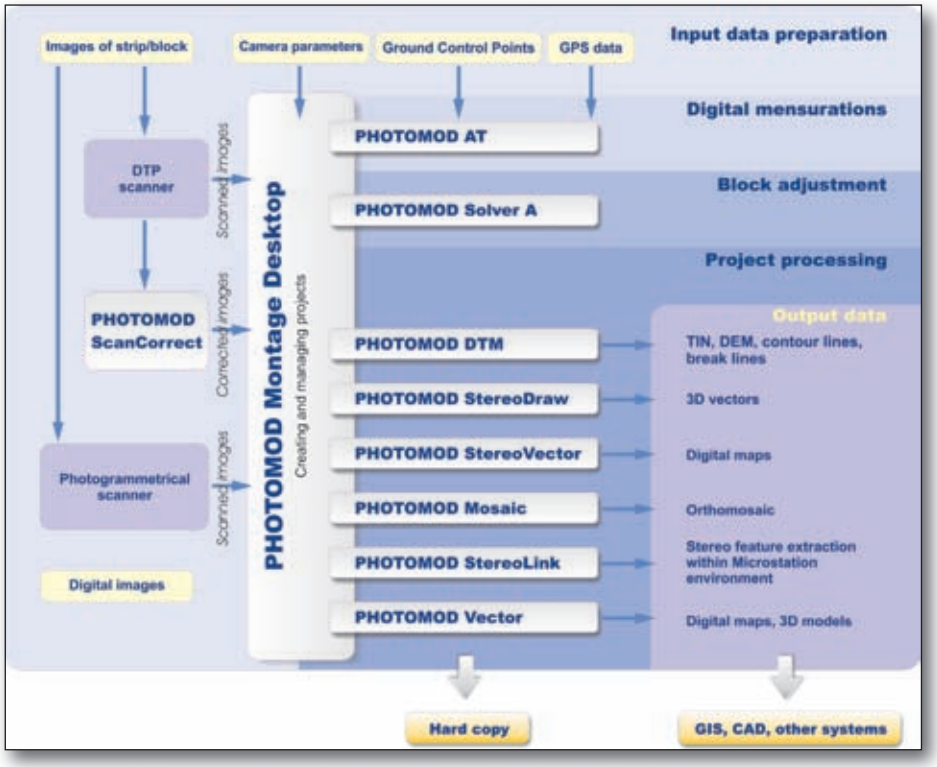


***Fig. 2*** *- A diagram showing the modules and work flow of the PHOTOMOD system, including the input and output data.*

through a ***ScanCorrect*** module. As the title suggests, this module calibrates and corrects the distortions that are inevitably present in the scanned raster image data generated by these low-cost devices. The core module is also used to build up the database associated with each project and displays the DEMs, contour lines, vector line features and other objects generated by the system and does this on a block wide basis.

## (b) Orientation & Triangulation

The next group of modules are concerned (i) with the selection and measurement of the points required for the orientation and triangulation of the images that have been input to the system; and (ii) with the actual execution of the computations needed to generate individual stereo-models and blocks of these stereo-models. The first of these two operations is carried out using the ***PHOTOMOD AT*** module which executes the inner and relative orientation of the images and the linking together of the resulting stereo-models using tie points to form strips and blocks. A fully automatic aerial triangulation option is available as well as all the usual manual tools. This is then followed by the second set of operations which are executed by the so-called Solver modules. There are two alternative modules depending on the type of imagery - frame or linescan - that has to be processed. The ***Solver-A*** module carries out the absolute orientation of individual stereo-pairs and the strip or block adjustment of frame images, in each case fitting them to the available ground control points (GCPs). The alternative is the ***Solver-S*** module which carries out the equivalent operations for the linescan images acquired by airborne or spaceborne pushbroom line scanners.

## (c) Data Generation & Output Modules

The final group of modules that form part of the PHOTOMOD system carry out the various photogrammetric operations needed to generate the various standard products (terrain models, vector line maps, orthoimages) that can be derived from the imagery.

(i) The ***DTM*** module allows the creation of an elevation model either through manual measurement or automatically using image correlation techniques based on various alternative strategies. The module can then carry out the formation of the final DTM using TIN techniques in conjunction with measured break lines and can create contour lines from the elevation data. The editing and correction of the DTM data and the contour lines can also be carried out using the routines contained in this module (Fig. 3).

(ii) The ***StereoDraw*** module allows 3D feature extraction from stereo-pairs. The floating measuring mark can be kept in contact with the ground in the stereo-model automatically through image matching as well as manually by the operator. Again the module includes a full set of editing tools and the capability of adding the appropriate attributes to the features that have been measured.

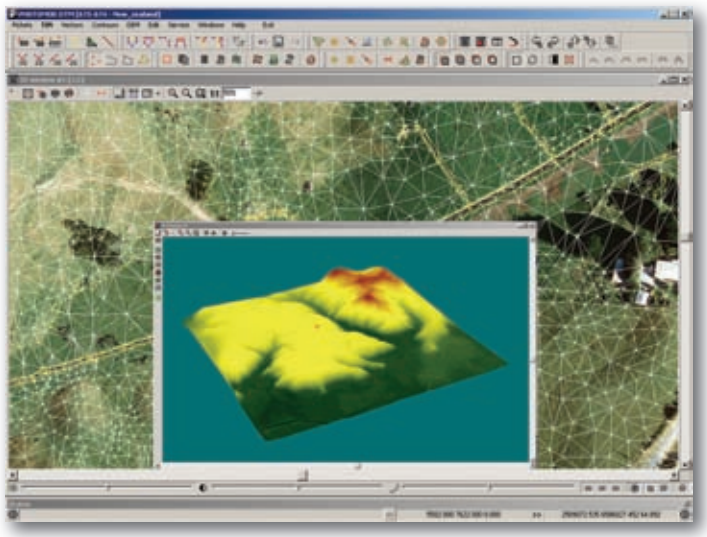

***Fig. 3*** *- A screen shot of the DTM module in use, showing a TIN (Triangular Irregular Network) connecting the measured elevation points superimposed on the image of the corresponding orthophoto. The inset window shows a perspective block diagram of the terrain constructed from the measured DEM.*

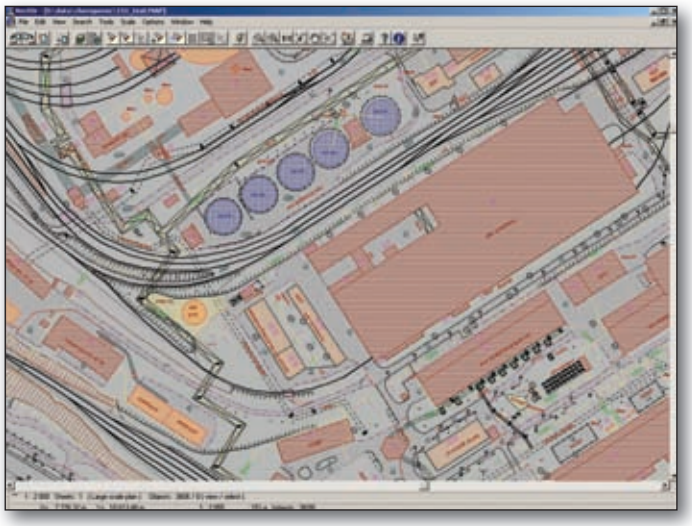

***Fig. 4*** *- The VectOr module is used to edit and annotate the vector features that have been measured using PHOTOMOD and create the final map.*

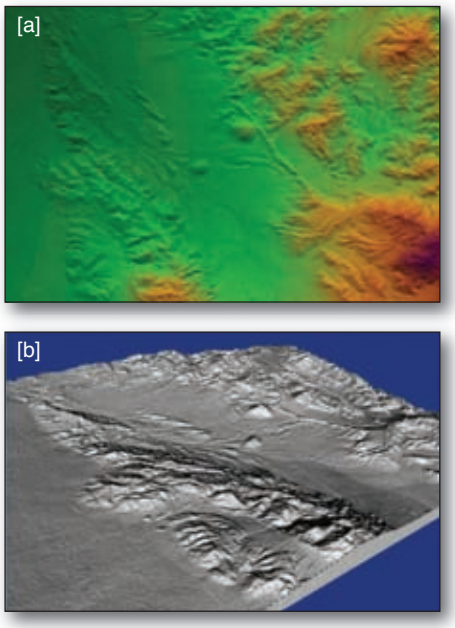


***Fig. 5 (a)*** *- A digital elevation model (DEM) generated using the stand-alone PHOTOMOD Radar software package.*
***(b)*** *- A perspective block image of the terrain formed from the measured DEM.*

(III) Closely associated with the StereoDraw module is the ***VectOr*** module. Essentially this is a desktop cartographic system equipped with a powerful vector editor and the capability of creating map sheets complete with symbols, legends and marginal information (Fig. 4). It can also be used to extract features from orthoimages.

(IV) These last two modules - StereoDraw and VectOr - are also available as a single linked product called ***StereoVectOr***.
(V) A special ***StereoLink*** module is also available to allow the collection and editing of 3D features within the Bentley MicroStation environment - which is a common procedure in photogrammetric production facilities in many Western countries.
(VI) Finally, within this group, the ***Mosaic*** module carries out the ortho-rectification of images on the basis of DTMs, either measured using PHOTOMOD or derived from an external source. It then combines the resulting orthoimages into an orthoimage mosaic.

## (d) Stand-Alone Programs

Racurs also offers two additional stand-alone programs.
(I) The first of these is ***PHOTOMOD GeoMosaic***. This is a program that carries out the georeferencing of raster images followed by their mosaicing and, if required, their division into individual map sheets. Image transformations between map projections are also supported.
(II) The second program is called ***PHOTOMOD Radar***. This accepts spaceborne SAR image data from the Radarsat, ERS, Envisat and Almaz satellites and from the Shuttle SIR-C and SIR-X missions. Using its 'GeoProcessor' tool, it carries out the geometric correction, geo-referencing and mosaicing of these radar images. Interestingly, with suitable image data, it can also generate DEMs (Fig. 5), either using interferometric techniques (with its 'Interferometric Processor' tool) or from overlapping SAR images forming stereo-pairs (using its 'Stereo Processor' tool).

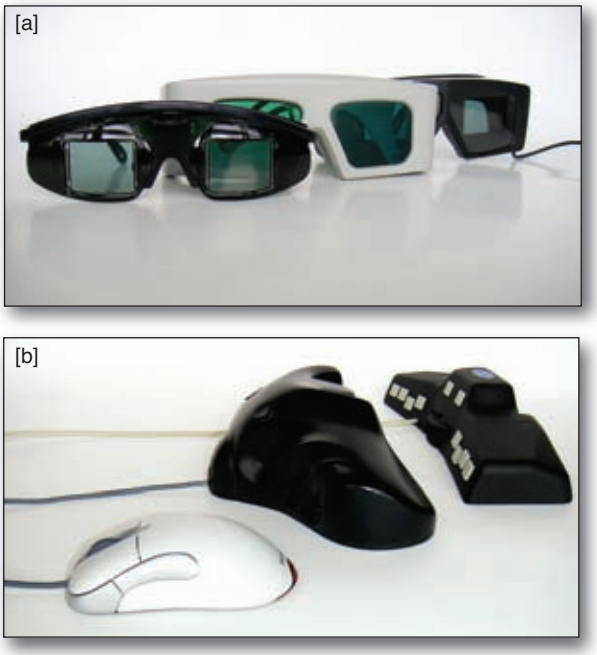


***Fig. 6 (a)*** *- Examples of the "active" 3D stereo-viewing glasses that can be used with PHOTOMOD showing (from front to back) the wireless E-D glasses from eDimensional; the wireless NuVision 60GX glasses from MacNaughton; and the wired 3D glasses from the Russian supplier, IBIK.*
***(b)*** *- Examples of the 3D measuring "mice" that are supported by PHOTOMOD, showing (from left to right) a standard mouse; the Stealth 3D Mouse from ABC Software Developers; and the GeoMouse from the Russian supplier, EOMZ.*

## Hardware Aspects

As one would expect, the PC configuration that is needed to ensure that a PHOTOMOD system or DPW can be used in an efficient and comfortable manner will vary according to the photogrammetric and image processing tasks that it has to perform - which in turn will define the specific modules that will need to be used. However, in general terms, one can say that a fairly powerful machine is required in terms of its processor speed, RAM, storage space and network bandwidth. Besides the overall system requirements, it was interesting during the visit to observe and hear about the other hardware components such as stereo-viewing systems and 3D measuring devices (mice) from Russian sources that are supported for use with PHOTOMOD. Thus, with active shutter glasses, as well as the familiar NuVision wireless glasses from MacNaughton, the similar CrystalEyes glasses from StereoGraphics and the E-D glasses from eDimensional in the USA, the Russian-made IBIK wired shutter glasses can also be supplied (Fig. 6 (a)). There is also a locally manufactured stereo-viewing system from StereoPixel featuring twin LCD monitors and a semi-reflecting mirror that is used in conjunction with passive polarising glasses, rather similar to the Planar systems from the U.S.A. (Fig. 7). As for the specialized 3D measuring mice, a GeoMouse is available from the Moscow Experimental Optical-Mechanical Plant (EOMZ) as well as the more familiar Stealth 3D Mouse from ABC Software Developers and the SoftMouse from the Immersion Corporation in the U.S.A. (Fig. 6 (b)).

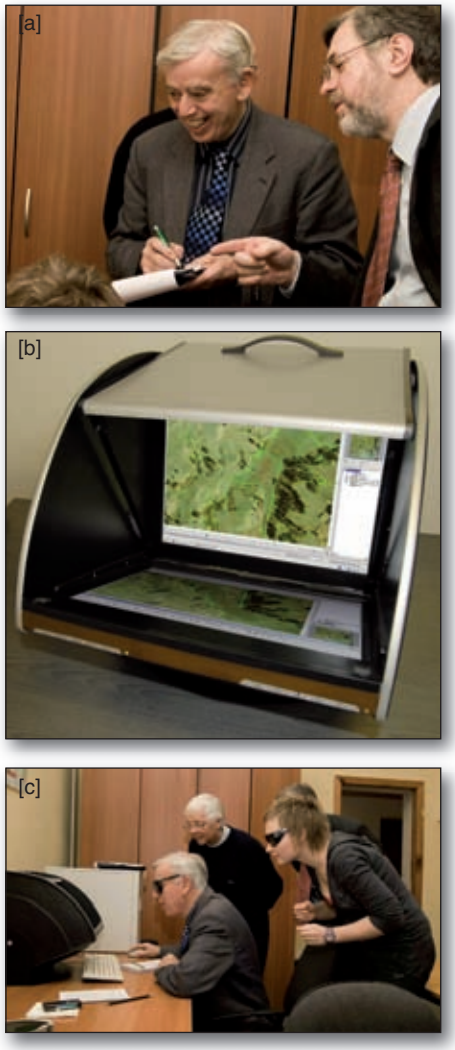


***Fig. 7 (a)*** *- Dr. Adrov, the Managing Director of Racurs, explains the features of the StereoPixel stereo-viewing system to Prof. Petrie.*
***(b)*** *- The StereoPixel 3D stereo-viewing system which features twin LCD monitors, a semi-reflecting mirror and "passive" polarising glasses.*
***(c)*** *- Prof. Petrie tries out the StereoPixel system monitored by his photogrammetrist wife (Kari Dahl Petrie) and the photogrammetric engineer who normally operates the system.*

*Fig. 8 - Diagram of the strips and blocks of aerial photography being used in the cadastral survey and mapping of an electric power network and its infrastructure in Siberia.*

## User Community

With such a comprehensive and powerful set of tools and capabilities, it came as no surprise to learn that Racurs now has more than 300 PHOTOMOD customers with over 3,500 licensed work stations. Half of these customers are in Russia and the former Soviet Union countries; the other half are in other foreign countries. Indeed PHOTOMOD is now in use in over 45 countries. This places the company among the major suppliers of DPWs world-wide - with the advantage of its products being rather less expensive than the other leading high-end digital photogrammetric systems. Within Russia, the majority of PHOTOMOD systems are placed in the large state mapping agencies, especially cadastral mapping organisations such as the Project-Research Institute of Land Cadastre Survey "Goszemkadastrsyomka". Within this particular market, Racurs has had to face strong competition from the DPWs that have been developed by Russian government research organisations. These include the DPS (Digital Photogrammetric Station) developed by the F.N. Krasovsky Central Research Institute of Geodesy, Aerial Survey & Cartography and the Talka system developed by the Institute of Control Sciences of the Russian Academy of Sciences (RAS). In spite of the advantage that these systems have had with certain government agencies, PHOTOMOD has been adopted widely within Russia.

In the countries outside Russia and the former Soviet Union, sales of PHOTOMOD are made through a network of dealers instead of by direct sale to user agencies and companies as happens in Russia. The number of users in these foreign countries will depend to some extent on the strength and initiative of the local dealer. Thus PHOTOMOD is already in widespread use in the Balkans (in Bulgaria, Serbia, Bosnia & Croatia) and in the Baltic States (Latvia & Lithuania). It is also used in Eastern Europe (Poland & the Czech Republic) and in Western Europe (in Austria, Italy, France, Portugal, Spain and the U.K.). Further afield, there are a substantial number of customers in the Middle East (Turkey, Syria, Israel, Saudi Arabia & Iran); in India (with many users); and in the Far East (Taiwan and Vietnam). In Latin America, there are customers in Argentina and Mexico. All of which is reflected in the venues of the annual PHOTOMOD user conferences. The first three were held in 2001, 2002 and 2003 in Russia; the fourth was held in 2004 in Belarus; the fifth (in 2005) in Latvia; and the sixth (in 2006) in Montenegro. The seventh conference is planned to be held in Bulgaria in September 2007.

*Fig. 10 - A group training course on the PHOTOMOD system being undertaken at a customer's site.*

## Map Production

The Racurs company has also undertaken a series of production contracts for a number of customers both at home in Russia and abroad. Two of the largest of these projects may be taken as examples. The first concerns the mapping of extensive power line networks in Siberia carried out in cooperation with the state cadastral offices in Omsk and Irkutsk. The aerial triangulation of long strips of aerial photographs at 1:15,000 scale amounting to 6,000 images has been undertaken (Fig. 8), followed by the extraction of the power lines as vector features from the resulting stereo-models. The data is then used in the preparation of the land ownership documents and their registration in the state cadastre. Another significant contract has been with the French IGN national mapping organisation. This has been to supply 3D vector data for IGN's new topographic database (BD Topo) which has very demanding requirements in terms of its accuracy, content and time-scale (Fig. 9). Racurs has already completed the processing of 25 blocks of aerial photography at 1:25,000 scale amounting to 25,000 sq. km. or 4.5% of France's territory.

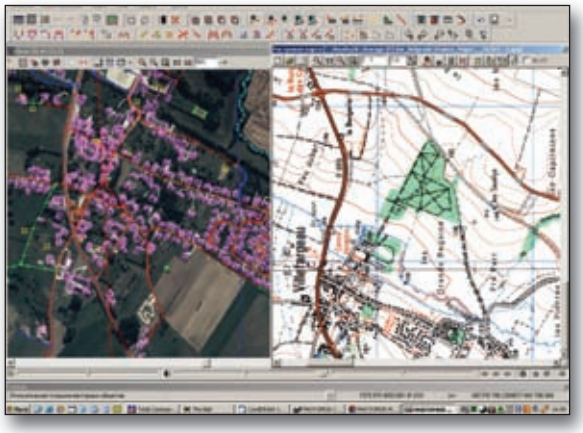

*Fig. 9 - A representative screen shot of the work being undertaken at Racurs for the BD Topo project of IGN France with an annotated othophoto image being displayed alongside an existing map.*

## Support & Training

Turning next to customer support and training, Racurs prides itself on providing strong technical support to its customers. On the training front, short introductory courses in the use of PHOTOMOD are provided in the Racurs office in Moscow. Longer basic and advanced courses are given by the staff of the Photogrammetry Department at Moscow State University of Geodesy & Cartography (MIIGAiK) either at the University or at the customer's site (Fig. 10). A further visit to the University confirmed the extensive facilities available for this type of training, the Photogrammetry Department having adopted PHOTOMOD for much of the practical training of its own students.

## Staff

The Racurs company employs 35 staff at its main facility in Moscow. Many of the software developers are graduates of the Moscow Institute of Physics & Technology (MFTI), while most of the staff of the production department at the main facility are photogrammetry graduates of the MIIGAiK mentioned above. The company has an additional production facility outside Moscow that is equipped with half-a-dozen workstations with 15 additional trained staff who work shifts at busy periods.

## Conclusion

As this report has shown, over the last decade, Racurs has developed rapidly from being a small specialized software house to its present position of being a major photogrammetric systems supplier on an ever expanding scale and a service provider with a substantial production capacity.

*Gordon Petrie is Emeritus Professor in the Dept. of Geographical & Earth Sciences of the University of Glasgow, Scotland, U.K. E-mail - g.petrie@ges.gla.ac.uk.*