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THE STEREOCORD G3

H. Mohl, Stuttgart

Introduction

Presented in 1975 as a simple plotting instrument for quantitative air photo interpretation, the STEREOCORD G2 has been supplied since 1978 with a new software for the HP 9815 desk-top computer of HEWLETT PACKARD |1|.

Several fundamental changes in the basic opto-mechanical unit, the computer equipment, the software as well as in the kind of coordinate acquisition used have given rise to the designation STEREOCORD G3, under which this plotting system will now be presented.

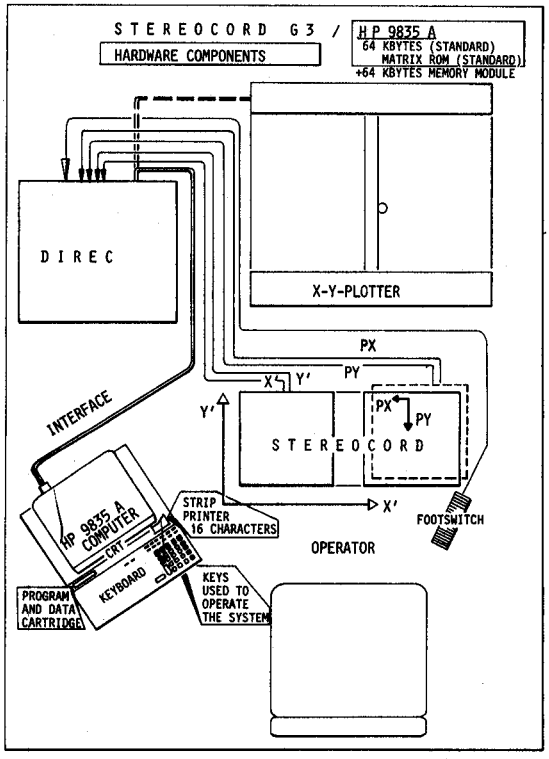


Fig. 1:
STEREOCORD G3 equipment components together with HEWLETT PACKARD desk-top computer HP 9835 A

The hardware components of the 'STEREOCORD G3'

The basic opto-mechanical unit was essentially taken over from the previous model (see Fig. 10): under a mirror stereoscope equipped with a measuring-mark bridge a photocarriage moves in the directions x' and y'. The right photostage can be displaced in respect of the left by the amounts px and py. This basic opto-mechanical instrument can now be extended step by step, starting with a stereo-interpretoscope with photocarriage up to an instrument for coordinate measurements with the four components x', y', px and py (Figs. 1 and 2). The x' and y' movements are digitized by means of new linear encoders with improved reliability, whereas the px and py movements are recorded numerically by rotational encoders. The DIREC data acquisition system counts the pulses of the four components and feeds them via an interface to the connected desk-top computer. The latter transforms the image coordinates into the ground system, calculates distances, angles or areas or controls a connected x/y-plotter.

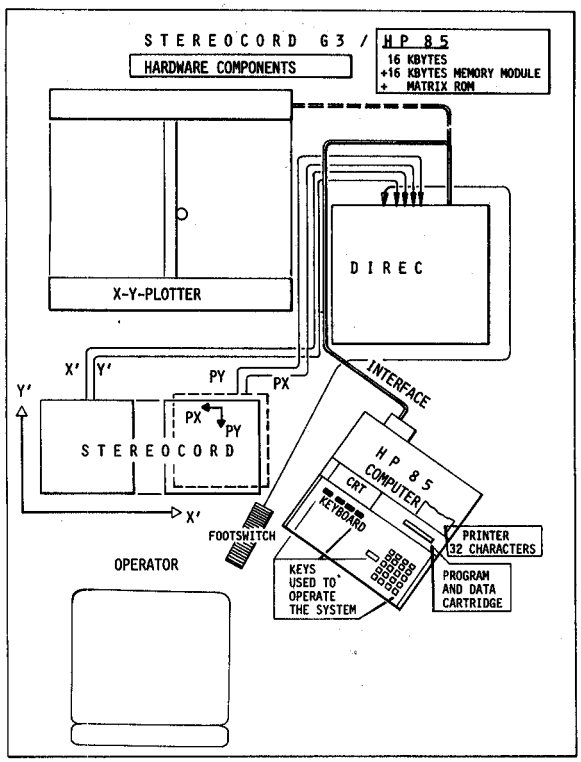


Fig. 2:

STEREOCORD G3 equipment components with HEWLETT PACKARD desk-top computer HP 85

The program system for the 'STEREOCORD G3'

Fig. 3 shows a flowchart of the new program system for the BASIC desk-top computers HP 9835 A and HP 85 of HEWLETT PACKARD. The relations between the various parts of the program are illustrated schematically. In a standard situation the operator orienting a new photopair will start with interior orientation and proceed via relative orientation to absolute orientation; afterwards he will directly select the measurement or plotting programs. If the orientation of the photopair was already carried out the day before, only interior orientation will be repeated after turning on the system, whereafter the operator will directly head for the plotting programs. By means of the so-called parameter orientation a photopair already plotted before can be reoriented in order to complete or to check the previous compilation. In the following the main characteristics of the program element are described.

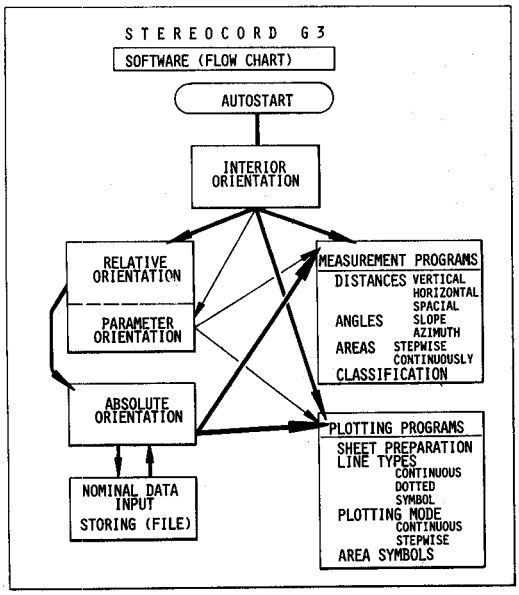


Fig. 3:

Flowchart of the program system for the STEREOCORD G3

Interior orientation

The orientation of a new photopair begins with the setting of the photos in the STEREOCORD. If four-component equipment is used, a rough orientation of the photos according to epipolar lines will suffice. The first part of the program carries out the interior orientation. The operator obtains all information on program control via the CRT display.

Fig. 4 gives a general idea of the possibilities of interior orientation. The program provides the alternative of plotting either air photos with fiducial marks in the middle or in the corner or special imagery without fiducial marks. Having chosen the type of camera he wants to use, the operator is told in every phase which fiducial mark he has to set. The mechanical ranges of the STEREOCORD allow only for three fiducial marks to be measured per photo. If the calibration distance between these fiducial marks is known, allowance is made for film distortion. If one of the standard marks is not visible, the interior orientation data can be determined by measuring three auxiliary marks. The interior orientation of special photographs is obtained by measuring the border of the image by means of two points each time and determining the principal point through the intersection of diagonals.

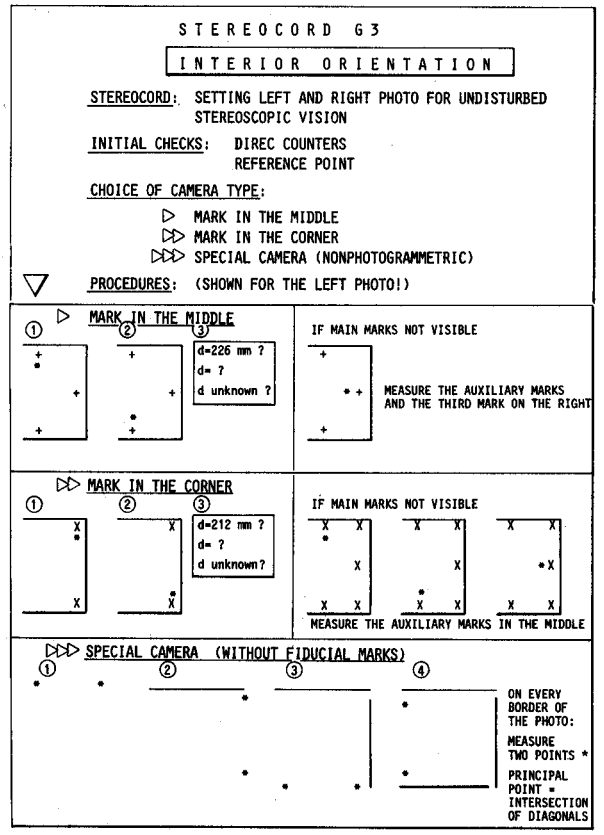


Fig. 4:
Possibilities of the "Interior Orientation" program

Relative orientation

The "Relative Orientation" program includes monocular or stereoscopic y-parallax measurements of up to 25 orientation points, according to whether three or four components are measured. The planimetry of the orientation points is rigorously accounted for. Thus uncommon orientation point distributions like those that occur in architectural photogrammetry (see Fig. 5) can also be plotted. For every y-parallax measured the computer immediately forms the correction equation. The iterative solution leads to the results of a rigorous least-squares adjustment. Besides the angles of orientation their standard errors and the residual parallaxes are also obtained. Individual parallaxes can be eliminated and supplementary measurements are possible. Orientation results are immediately stored on cartridge.

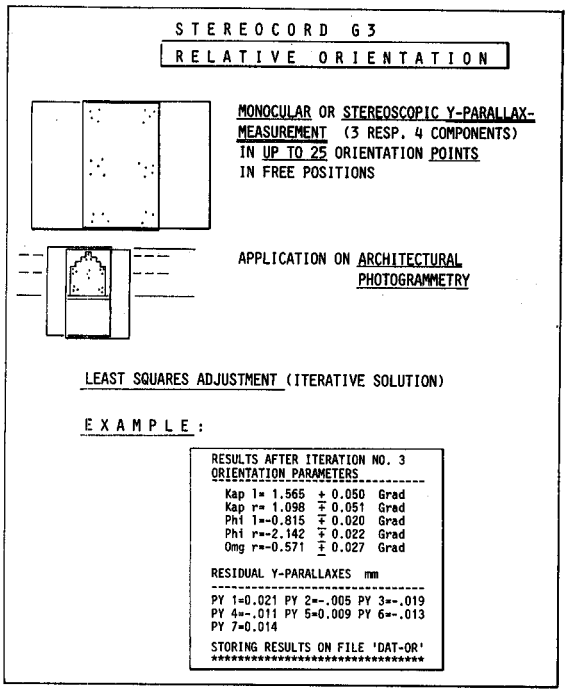


Fig. 5:
The principle of relative orientation

Absolute orientation

The program for absolute orientation contains two basically different possibilities of handling control points. Under A (Fig. 6, left column) point numbers are used. Up to 100 or 200 points respectively can be stored simultaneously on a data file in the computers HP 85 or HP 9835 A, respectively. In that context complete control points, horizontal or height control points can be entered one after another in a free sequence. When measuring control points, the point number has to be keyed in on the computer. The computer checks whether the point data are available in the file read in and requests this point to be set on the STEREOCORD. In this fashion up to 25 control points can be measured. The method of control point handling presented in Fig. 6 under B, right-hand column, presupposes that no point numbers are used. Up to 25 control points can be filed on an up-to-date model file and are available till a new model is oriented. Also in this case the sequence of complete control points, horizontal or height control points is free. When measuring the control points, the same sequence has to be observed as when entering control point data (allocation of nominal and actual data according to sequence).

Absolute orientation is calculated iteratively in respect of planimetry and elevation with the results of the rigorous adjustment corresponding to a spatial similarity transformation with overdetermination. The residuals shown in Fig. 6 below relate to a photopair at a scale of 1/4,500 with signalized control points. The standard errors of unit weight relating to the image are as follows: $\sigma_{oxy} = \pm 24$ µm, $\sigma_{oz} = \pm 0{,}17^{o}/_{oo} \cdot h_g$. These accuracies are obtained regularly when plotting with the new STEREOCORD system.

Once orientation is completed, the parameter list can be recalled (Fig. 7). If the corresponding photopair is to be replotted later on, it is sufficient to key these parameters in again to reestablish the previous orientation state (parameter orientation).

Immediately after absolute orientation the desk-top computer calculates in a real-time loop the three spatial coordinates x, y and z of the ground point set in the STEREOCORD. The calculated coordinates are displayed (xyz or xy or only z alternatively). By pressing the footswitch the point data can be output on the built-in tape printer and/or stored on cartridge. State plane coordinates of any ground points can thus be measured in the stereomodel (see Fig. 8).

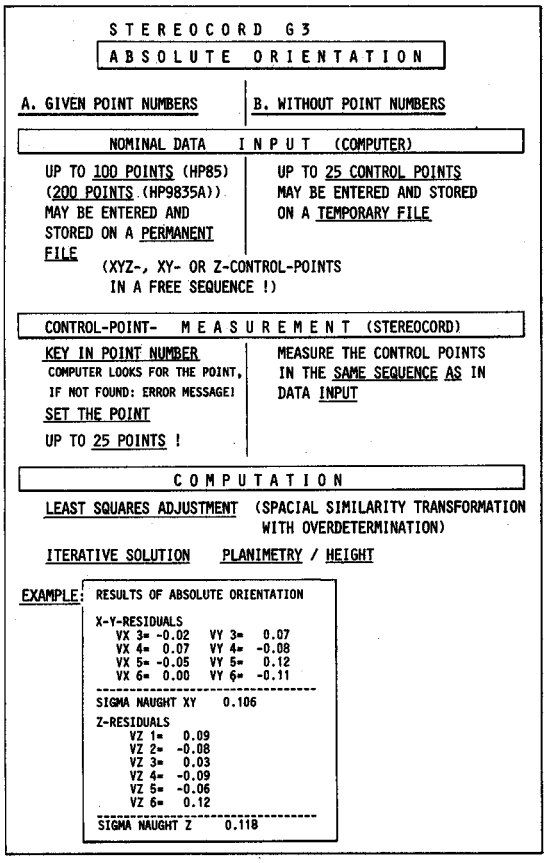
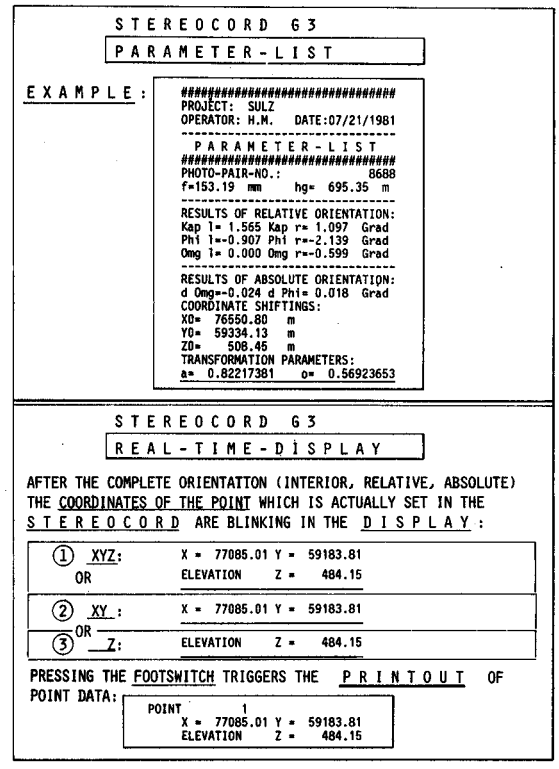


Fig. 6: Absolute orientation in the STEREOCORD G3



Figs. 7/8: Parameter list/Real-time display of coordinates

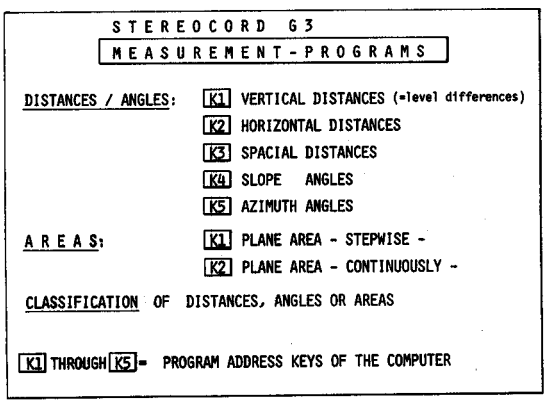


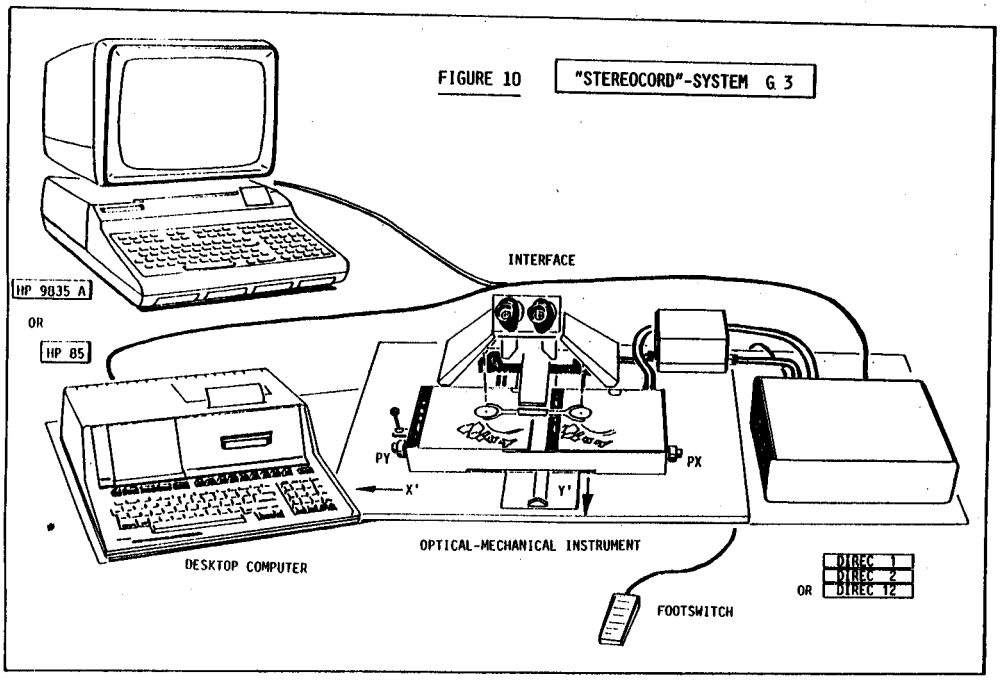
Fig. 9:

Measurement program for determining and classifying distances, angles and areas

Measurement programs of the 'STEREOCORD system'

The measurement programs already available up to now (Fig. 9) have also been converted to the new desk-top computers. The possibility of CRT dialog makes, however, for much easier operation. Selecting the 'DISTANCES/ANGLES' program system, the operator is able to measure vertical distances, horizontal distances, spatial distances, slope angles, and azimuth angles between any two points recorded immediately one after another.

The area programs (AREAS) allow areas to be measured stepwise or continuously. In a classification program system distances, angles or areas can be classified.



Additional program packages

The special programs for geology, forestry, volume determination, and planning available up to now are presently being adapted to the new computers. While the programs mentioned previously furnish purely numerical results, connecting an x/y-plotter gives the possibility of on-line mapping (Fig. 10). The application potential of the STEREOCORD system for rationalizing field research in the geosciences is described by JORDAN and KRESSE (|2| 1981). Among other things results of graphic plotting are presented. A new graphic program system is presently being developed by JORDAN and KRESSE for the HP 85 desk-top computer. Some promising results have already been achieved.

Concluding remarks

With the new STEREOCORD G3 a universal plotting system of medium accuracy is available which appears to be particularly well suited, besides for applications in the field of small-scale photogrammetry, for neighbouring disciplines such as geography, geology, forestry, planning and architectural photogrammetry. Its modularity permitting subsequent expansion takes in particular economic aspects into account.

Bibliography

|1| MOHL, H.: Conception and accuracy of the program system for the STEREOCORD G2, ISP Hamburg 1980, Volume XXII Part B2, Commission II, p. 177-186.

|2| JORDAN, E., KRESSE, W.: Die computer-gestützte quantitative Luftbildauswertung mit dem ZEISS-STEREOCORD und seinen Peripheriegeräten zur Rationalisierung der Feldforschungen in den Geowissenschaften (Computer-aided quantitative air photo interpretation with the ZEISS-STEREOCORD and its peripherals as a means for rationalizing field research in the geosciences). In: Erdkunde, Vol. 35, No. 3, 1981, p. 222-231.

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Abstract

The STEREOCORD G3, a plotting system of medium accuracy, has been derived from the model G2, which was presented in 1975. The basic optical-mechanical instrument can now be extended step by step, starting with a stereo-interpretoscope with photo carriage up to an instrument for coordinate measurements with the four components x', y', px and py. New encoders improve the reliability of the measuring device.

In the field of the software, the main changes have been made. With the adaptation of the program system to the BASIC desktop computers HP 9835 A and HP 85 the capacity and flexibility have been improved considerably.

The following catchwords may describe the new plotting system:
- CRT-conducted orientation and plotting procedures.
- Least squares adjustment of interior, relative and absolute orientation.
- Plotting of photos of any camera type and camera axes.
- Measurement programs for the quantitative photo interpretation (as G2).
- Measurement of independent models for small scale aerotriangulation.
- Graphic programs for lineplotting in topography and architectural photogrammetry (in preparation).

The lecture will give an outline of the new instrument and program system by means of several graphs.

Das Stereocord G3

Zusammenfassung

Das STEREOCORD G3, ein Auswertesystem mittlerer Genauigkeit, ist aus dem 1975 vorgestellten Modell G2 weiterentwickelt worden. Das optisch-mechanische Grundgerät läßt sich jetzt stufenweise vom Stereo-Interpretoskop mit Bildwagen bis zum Koordinatenmeßgerät mit den 4 Komponenten x', y', px und py ausbauen. Neue Impulsgeber erhöhen die Zuverlässigkeit des Meßgeräts.

Die Hauptänderungen liegen jedoch auf dem Gebiet der Software. Mit der Umstellung des Programmsystems auf die BASIC-Tischrechner HP 9835 A und HP 85 wurden Leistung und Flexibilität beträchtlich erhöht.

Folgende Stichworte kennzeichnen das neue Auswertesystem:
- Lückenlose Steuerung der Orientierungs- und Auswertevorgänge durch Bildschirmdialog.
- Strenge Ausgleichungsverfahren für innere, relative und absolute Orientierung.
- Auswertung von Bildern beliebiger Kammertypen und Aufnahmerichtungen.
- Meßprogramme für die quantitative Luftbildinterpretation (wie G2).
- Messung unabhängiger Modelle für die kleinmaßstäbliche räumliche Aerotriangulation.
- Graphikprogramme für die linienweise Kartierung in Topographie und Architekturphotogrammetrie (in Vorbereitung).

Der Vortrag gibt anhand einiger Graphiken einen Überblick über das neue Geräte- und Programmsystem.

Le Stereocord G3

Résumé

Le Stereocord G3 est un appareil de restitution photogrammétrique de précision moyenne, dérivé du modèle G2 présenté en 1975. Appareil fondamental, conçu selon des principes optiques et mécaniques, il peut passer progressivement des fonctions d'un stéréoscope d'interprétation à chariot porte-cliché à celles d'un appareil de mesure de coordonnées à quatre composantes x', y', px et py, dont la fiabilité a été accrue par des nouveaux générateurs d'impulsions.

Les principales modifications touchent le domaine du logiciel. L'adaptation du système de programme aux ordinateurs de table BASIC HP 9835 A et HP 85 en a amélioré sensiblement la puissance et la souplesse.

Le nouveau système de restitution se distingue par les fonctions suivantes:
- Commande en continu des opérations d'orientation et de restitution selon le mode conversationnel.
- Procédés de correction d'erreurs rigoureux, appliqués à l'orientation interne, relative et absolue.
- Possibilité de restitution de photographies, quels que soient le type de chambre et l'axe de prise de vues considérés.
- Programmes de mesure destinés à l'interprétation quantitative de photos aériennes (comme G2).
- Mesure de modèles indépendants pour l'aérotriangulation spatiale à petite échelle.
- Programmes graphiques de cartographie par lignes, employés en topographie et en photogrammétrie architecturale (en cours de préparation).

El Stereocord G3

Resumen

El STEREOCORD G3, un sistema restituidor de exactitud mediana, es un desarrollo ulterior del modelo G2, presentado en 1975. Ahora es posible ampliar el instrumento base óptico-mecánico en etapas desde el estereointerpretoscopio con carro portavistas hasta el aparato medidor de coordenadas con los cuatro componentes x', y', px así como py. Nuevos generadores de impulsos incrementan la fiabilidad del aparato medidor.

Sin embargo, las modificaciones más importantes conciernen el software. La conversión del sistema de programas a calculadoras de sobremesa BASIC HP 9835 A y HP 85 ha aumentado considerablemente la capacidad y la flexibilidad del mismo.

El nuevo sistema restituidor está caracterizado por los siguientes conceptos:
- Mando perfecto de los procesos de orientación y de restitución mediante diálogo en la pantalla.
- Métodos muy exactos de compensación para las orientaciones interior, relativa y absoluta.
- Restitución de fotos tomadas con modelos discrecionales de cámara y desde direcciones cualesquiera.
- Programas de medición para la interpretación cuantitativa de aerofotos (al igual que el G2).
- Medición de modelos independientes para la aerotriangulación espacial a pequeñas escalas.
- Programas gráficos para el trazado línea por línea en topografía y fotogrametría arquitectónica (en preparación).

Prof. Dr.-Ing. Hans Mohl,
Fachhochschule für Technik Stuttgart,
Kanzleistr. 29, D-7000 Stuttgart