Photogrammetrische Woche 1985
Institut für Photogrammetrie
Schriftenreihe, Heft 11, 1986

PROGRESS IN DIGITAL MAPPING INSTRUMENTS DESIGN

D. Hobbie, Oberkochen

1. Introduction

PLANIMAP, a digital mapping system for photogrammetric stereoplotters, was introduced by Zeiss during the 39th Photogrammetric Week in 1983 /1/. This software package for mapping mostly at medium and large scales has since been distributed all over the world. In the last two years considerable efforts have been made to enhance the performance of PLANIMAP.Major improvements were presented already at the ISPRS convention in Rio de Janeiro in June 1984 /2/. This paper presents the current development status at the time of the 40th Photogrammetric Week 1985. However, the PLANIMAP fundamentals shall be presented first.

2. PLANIMAP Fundamentals

The PLANIMAP software system puts graphical plotting on a digital basis. This means that the objects measured by the operator in the stereo model are no longer plotted directly on a precision tracing table to produce a map manuscript, but are stored in the form of codes and coordinates in a data file on the magnetic disk of a workstation computer. The graphical data can be put out either simultaneously (in real time) or at a random later time (playback) on any graphical output device supported by the workstation computer. Real-time output with one of the Zeiss precision tracing tables largely retains the direct plotting method familiar to the operator.

Compared to direct plotting, this "digital mapping" methods opens up a variety of new functions which can be classified in three major groups:

- Editing of the collected graphical or, more precisely, geometrical data in order to eliminate errors and improve the quality (collection-oriented editing);
- Preparing the stored and edited data for output, e. g. for display on a CRT screen or for plotting, with a view to improving the appearance or selective editing for specific tasks (output-oriented editing);
- Transfer of the raw, corrected or edited geometrical data in machine-readable form to other workstations or organizations for direct representation or for integration in the data bases of information retrieval systems(compatible data formats).

Zeiss is pursuing the development of PLANIMAP with the aim of continuously improving these and other practice-oriented features.

When the performance of mapping software available on the market is being assessed, the number and flexibility of the editing functions is often used as a decision-making criterion. This is due to the fact that considerable editing work is still required in order to eliminate measurement imprecisions such as bad line junctions, non-parallel lines, omissions etc. The importance of effective measurement functions which help to reduce this editing effort is often underestimated. A single measurement error can often necessitate several editing operations. Under favorable conditions, the data acquisition steps performed by the operator can reach 90% or more of the total activity in medium to large scale mapping tasks. This clearly illustrates the significance of data collection optimization. This is why Zeiss has developed the PLANIMAP mapping software with the intent to produce, as far as possible, a complete and correct data base in the collection phase already.

3. Data Acquisition with PLANIMAP

3.1 Acquisition Instruments

The PLANIMAP photogrammetric mapping system supports graphical measurement with analog instruments and with Planicomp family stereoplotters. Being a "truly" three-dimensional geometrical data acquisition system, it satisfies all photogrammetric requirements and the requirements of future land information systems, and stores all object data in planimetric and elevation object space coordinates. Depending on this task, either a world system (e. g. Gauß-Krüger) or a local system can be used.

When switching from direct to digital mapping, the problem of integrating existing maps becomes rather urgent. This is why Zeiss has expanded the PLANIMAP system for two-dimensional (plane) digitization. The DIGI-AS program implements the PLANIMAP functions in the same way as the Zeiss PLANI-AS program for analog instruments. DIGI-AS and PLANI-AS are nearly identical in design, scope of functions and handling.

The map is placed on a digitizing table and oriented by affine transformation using up to 24 control points. Points,lines, areas and their symbols can then be digitized and stored in the PLANIMAP format. As with stereoplotters, object codes or similar "comment" codes can be entered, and parallel lines, slope symbols and buildings can be measured. Elevations, which cannot be gained directly during plane digitization, may be set to mean values by the operator either locally or in general. It will soon be possible to complement plane measurements with elevations by interpolating them from a HIFI grid.

The DIGI-AS program currently supports the Aristogrid Series 100 precision digitizing tables made by Aristo, Hamburg. They connect to the RS 232 C interface and feature a geometrical resolution of 0.025 mm and an accuracy of less than 0.1 mm (Fig. 1). A 5-button-cursor is used for point measurement and line following. The measurement area of 900 mm x 1200 mm of the GRT 108 model is generally sufficient.

Just as with photogrammetrically collected PLANIMAP data, all editing and output functions can also be applied to data collected with DIGI-AS. Even background programs can be run on a DIGI-AS workstation computer.

3.2 Program Control

Another improvement of the PLANIMAP concept relates to command entry. It will now be possible to use a programmable function panel at the stereoplotter or the digitizing table (Fig. 2). The PLANIMAP panel, which can be placed in any convenient location, consists of a flat keyboard with 53 sensor keys, interchangeable key assignment overlays and service routines for the HP 1000 workstation computer. It connects to the computer through an RS 232 C interface.

Since only one sensor key has to be touched to initiate a function, the PLANIMAP panel facilities operator control compared to conventional command code entry at the Planicomp panel or the computer terminal. Even macros (command sequences) can be entered by touching only one key. The PLANIMAP commands and macros assigned to the keys are stored in ASCII files and are indicated symbolically or by appropriate texts on the interchangeable key assignment overlays. Several key assignments are supplied with each PLANIMAP panel. The user can easily make further assignments or alter existing ones.

The PLANIMAP panel considerably reduces the number of manual entries and thus considerably increases the speed and accuracy of data collection and editing. The panel can also be used in alternation with conventional command code entry. Compared to the voice entry system also implemented within the PLANIMAP system, the PLANIMAP panel is currently the better solution because single word identification by the voice recognition modules requires further improvement.

Another program handling improvement has been achieved by continuously displaying relevant information at the CRT terminal. The selected mode of operation, major control and symbol parameters and, with PLANI-AS and DIGI-AS, the ground coordinates of the floating mark location are now displayed and updated continuously in the upper "locked" screen area, while the operator guidance information continues to appear in the lower area and in the display memory.

3.3 Functional Enhancements

The PLANIMAP function enhancement made since the last reports /1, 2/can be subdivided in geometry-related improvements and symbol-related improvements.

The major geometry-related improvement is that all geometrical data will now be stored in the PLANIMAP file. This means that the "4th corner" of a rectangular building or the partner lines of a parallel, which up to now were stored only by codes, will be stored with all their coordinates so that they can be subjected to geometrical operations. A program for converting "old" records into new records is available.

The tracing function for measuring lines by incremental point measurement was converted from vector connections to spline connections, and the measurement increment was changed from a permanently programmed small tube width to a modifiable and generally greater width. This considerably reduces the number of points that have to be stored for curves such as contour lines. Measuring spline curves by recording individual points is still possible.

Further advances in geometrical data acquisition comprise multiple parallels measurement, measurement of a reference axis for parallels that is not to be shown, and several detail improvements in building measurement (computation of invisible building corners by line intersection, adjustment of polygonal buildings for rectangularity and parallelity, parallelization with a defined base line, and avoidance of multiple lines in the case of adjoining buildings by selecting a "non-plotting" pen).

Symbol-related improvements comprise, for example, easy creation of symbol groups from single symbols (e. g. coniferous wood symbol from the coniferous tree symbol) and the management of "run-time" symbols which can be created from basic symbols by means of parameters in the preparation phase. 999 run-time symbols each for point, line, text and area mapping can be stored, listed, represented graphically, and assessed directly for use. Vectorial symbol lines can be complemented by additional symbols at the break points (e. g. pole symbol added to overhead line symbol).

3.4 Test Plotting

In direct photogrammetric plotting, the map manuscript produced by the connected precision tracing table serves as a test plot for checking the data acquisition accuracy and completeness. With digital mapping, real-time graphical output is theoretically not required, but graphical logging is generally considered opportune compared to "blind" digitization, regardless of whether a precision tracing table or a cheap plotter, e. g. the successful HP drum plotter, is used.

However, graphical superimposition of the data collected with the stereoplotter onto the air photo by means of the Zeiss VIDEOMAP system has established itself astonishingly fast as the ideal solution to real-time logging. Without having to remove his eyes from the eyepiece, the operator can check his work for geometrical precision, correct coding and completeness. Probably the most valuable advantage is that neat line junctions are ensured and symbol placement can be finalized so that much conventional editing work can be avoided. In particular the model edge matching problem, which often exceeds the capabilities also of powerful competing mapping systems, can be averted with VIDEOMAP.

VIDEOMAP was first presented at the Rio convention in June 1984 and has since been improved regarding the memory size and the display update rate when the memory is rather full (e. g. by means of a dynamic display window). Apart from test plotting, further VIDEOMAP applications will be emphasized in the future, for example superimposition of information not visible in the air photo (property boundaries /3/, underground utility networks) both for comparison and for harmonic integration in the PLANIMAP file; superimposition of the current map condition (as digitized with DIGI-AS, for example) for map revision; and superimposition of planning data for comparison with the "real world" of an up-to-date stereomodel.

4. Data Editing with PLANIMAP

No error recovery or data editing function can be as effective as direct error-free data collection (see section 2). This is why the functions ensuring clean data collection will be emphasized here:
- "Complete" for precise line junctions at the start point without having to set it again;
- "Snap Point" for searching the measured point nearest to the floating mark or cursor, e. g. for connecting another line or deleting the point (combined in the Planicomp with automatic moving to the point);
- "Snap Line" for searching the measured line element nearest to the floating mark or cursor, e. g. for connecting another line or deleting an element (combined in the Planicomp with automatic moving to the cursor to the plumb line base point of the cursor position on the line).

The major editing functions are:
- "Delete last point" for deleting the point measured last for direct correction e. g. if a point measurement error occured;
- "Delete last element" for deleting the element measured last for direct correction, e. g. if a wrong graphic code was used.

Further functions for collection-oriented and output-oriented editing are under development.

5. Data Output

The PLANIMAP system allows graphical data output for test plotting in the data acquisition phase (see section 3.4) or at a later time after editing. Plotting programs are available for independent plotting, e. g. in the background of a workstation or mainframe computer, not only for map sheet preparation (map frame, point plotting) but also for map content plotting.

Since the graphical data is stored with three-dimensional object coordinates, it can be plotted not only in plan but, for special applications, also in elevation in the basic directions. The map sheet preparation program has already been modified by several users to suit their particular requirements.

Real-time test plotting and later plotting are done with the GRAPH F1 software, a library of graphical subroutines which supports the Zeiss DZ 7 precision tracing table, various HP plotters (including the HP 7580 and 7585 drum plotters) and HP graphics terminals.

The GRAPH F1 subroutine library, which can be accessed also by user programs, has now been enhanced by optional output to a plot file. Setting a control code in the calling program causes elementary plotting commands to be stored in an ASCII file. The set of commands includes commands such as Plot Absolute, Pen Up, Pen Down, Select Pen, Select Speed, Set Line Type, Set Text Size, Set Text Slant, Set Text Rotation, Text String, Set Window, which are understood by many plotters. The plot commands consist of a two-letter code and integer XY coordinates in 0.01 mm units. The plot file may therefore be plotted also with HP plotters connected to other computers without a control program being required. A conversion routine which any programmer can write in next to now time is gnerally required for output on other plotter models.

Another major innovation in the mapping field is the inclusion of additional precision tracing tables in the Zeiss product line. The PLANITAB T 110 and T 102 tracing tables are identical in concept, technology and accessories and feature high precision, speed and acceleration. Compared to the low-cost PLANITAB T 110 (Fig. 3), the 102 offers a larger size, higher acceleration and higher operator convenience. The two models differ essentially in:

	PLANITAB T 110	PLANITAB T 102
Tracing area (dual head)	1.000 mm x 1.192 mm	1.200 mm x 1.200 mm
Speed	250 mm/s	300 mm/s
Acceleration	2 m/s²	4 m/s²

The PLANITAB tables consist of a base and a stable tiltable frame, a bilateral-drive primary carriage and a secondary carriage with the tracing head. The control and drive electronics are housed in the base. The drive and measuring system consists of precision racks, no-play pinions, dc motors and encoders. The closed-loop servo systems guarantee utmost static and dynamic precision. A dual and a quadruple tracing head are available for the tracing tools. The controls are located on a bar in the frame and on mobile panels.

The travelling behaviour of the tables is optimized by microprocessor control for three aspects:
- Speed and acceleration selection from 37 or 2 increments, respectively.
- Maximum speed and acceleration for travelling.
- Speed matching to the line curvature.

The tracing head features programmable lowering with damping and sensitive pen pressure setting. The tracing table and the tracing head are prepared for dual or quadruple tangential control. Tangential control causes the tool to be turned by a servo system in accordance with the line curvature. The tracing surface can be illuminated and equipped with a vacuum system for optimum paper flattening. It is tiltable and, in the T 102, height-adjustable. To orient map sheets and digitize individual points, a setting microscope and a TV option comprising a camera and a monitor are available.

The processor which controls these tracing tables can be assessed over an RS 232 C interface by means of a comprehensive set of commands in ASCII format. A complement to the Zeiss PLANIMAP system is the GRAPH F2 subroutine library. It has the same scope of functions as the GRAPH F1 subroutine library mentioned above but supports the T 110 and the T 102 instead of the DZ 7.

The PLANIMAP mapping programs and the GRAPH F2 subroutine library together form the PLTAB-AS software package. It enables graphical output on independent T 110/T 102 tables connected to HP 1000 computers in the same way as DZ 7-AS for the DZ 7.

6. Data Transfer

The transfer of graphical data becomes ever more important in photogrammetry. Code conversion is generally required when the data is to be transferred to higher-level data-bases.

The above-mentioned option to enter the data in a plot file can be used for a simple form of data transfer. The standardized plot commands are useful in particular where the graphical aspect of the data is relevant for further processing. The approach currently used by the Landesvermessungsamt Nordrhein-Westfalen can serve as an example. Plot files are there used to transfer PLANIMAP data to the graphical interactive workstation (GIAP) developed by this agency. However, if the semantic aspect of the graphical or geometrical data is also important, as for example in the object code catalog (OSKA) established by the Arbeitsgemeinschaft Deutscher Vermessungsverwaltungen, a separate data interface has to be created for every relevant data base format."Only" the geometrical object information has to be transferred in this case because the symbolic representation will be recreated by means of the particular symbol tables implemented in the data base. The PLANIMAP format, of which a detailed description is available to all users, is well suited to such format conversions.

Intermediate solutions are the existing interfaces to today's interactive graphical systems (IGS, e. g. Intergraph), which use the specific graphical features of PLANIMAP such as slope signatures but also require object relationship information.

Setting a trend for such data interfaces, Zeiss with Intergraph support has implemented the conversion of PLANIMAP files to the "Intergraph Standard Interchange Format (ISIF)" which has also been adopted by several other IGS-vendors. The new GENSIF routine converts PLANIMAP data files to SIF ASCII files. The SIF file can be transferred directly or on magnetic tape to the Intergraph system and converted to a SIF Binary Command File by the ASI (ASCII In) routine. This file is then converted to the IGDS Design File Format by TRI (Translator In) routine.

We anticipate that further PLANIMAP data interfaces to other interactive graphical systems and data bases will be created soon.

7. Outlook

Zeiss PLANIMAP, a system for geometrical graphical data acquisition, has been tailored specifically to the requirements of everyday photogrammetric work. The PLANIMAP/VIDEOMAP concept can today already be considered trendsetting and leading in concept and implementation despite considerable competition.

An innovative team of experts and the fruitful cooperation with numerous users have contributed to this success. Representative for all our thanks go to the Landesvermessungsamt Nordrhein-Westfalen for closely following the PLANIMAP pilot project for several years.

Only by tailoring IGS systems to the particular requirements of photogrammetry will these systems be successful in the photogrammetry market also in the future. Zeiss has accepted this challenge and will stand up to it by intense efforts. Data processing and management, "objects" invisible from air such as property or utility network information, statistics as well as cartographical and other information, merit special attention.
Will this lead to a land information system?

References

/1/ Hobbie, D.: Weiterentwickelte Graphik zum Planicomp, Bildmessung und Luftbildwesen, Vol. 1, 1984

/2/ Saile, J.: Graphical Plotting with the Zeiss Planicomp System Bildmessung und Luftbildwesen, Vol. 3a, 1984

/3/ Pape, E.: Erfahrungen mit der Herstellung der deutschen Grundkarte in digitaler Form, 40th Photogrammetric Week, Stuttgart, September 1985

Abstract

The Zeiss PLANIMAP system for photogrammetric mapping has been the subject of continuous development ever since its introduction during the last Photogrammetric Week. Together with dynamic superimposition of the graphical work onto the photo by means of VIDEOMAP it constitutes a powerful instrument system for collecting geometrical graphical data.

Apart from many detail improvements of the software functions such as continuous mode display, multiple parallels, extended building measurement and more flexible symbol handling, the following major innovations may be mentioned:

- The PLANIMAP panel, a programmable function keyboard with several key assignments with which even macro functions can be called;
- DIGI-AS, a program for digitizing existing maps similar in design and handling to PLANI-AS, for two-dimensional geometrical data collection with an Aristogrid Series 100 digitizing table;
- The PLANITAB T 110 and T 102 high-speed precision tracing tables with a tracing surface of 1.000 mm x 1.192 mm or 1.200 mm x 1.200 mm, respectively, and the associated GRAPH F2 subroutine library;
- Conversion of PLANIMAP data files of SIF format (ASCII) with the GENSIF routine, e. g. for direct data transfer to an interactive Intergraph system.

PLANIMAP will meet growing demands also in the future.

Zusammenfassung

FORTSCHRITTE IM INSTRUMENTENBAU FÜR DIGITALE KARTIERUNG

Das Zeiss PLANIMAP System zur photogrammetrischen Kartierung ist seit seiner Vorstellung bei der letzten Photogrammetrischen Woche ständig weiterentwickelt worden. Zusammen mit der dynamischen Überlagerung der Graphik mit dem Luftbild mittels VIDEOMAP ist damit ein leistungsfähiges Instrumentarium zur Erfassung geometrisch-graphischer Daten verfügbar.

Die wesentlichen Neuerungen neben zahlreichen Einzelverbesserungen der Software-Funktionen, wie z. B. ständige Betriebsartenanzeige, Mehrfach-Parallelen, erweiterte Gebäudemessung, Flexiblere Symbol-Handhabung sind vor allem:

- PLANIMAP Panel, ein programmierbares Funktionstastenfeld mit umschaltbarer Mehrfachbelegung und für Aufruf von Makrobefehlen,
- DIGI-AS, ein Programm zur Digitalisierung vorhandender Karten mit einer, dem PLANI-AS ähnlichen Struktur und Handhabung für die zweidimensionale geometrische Datenerfassung an einem Aristogrid Digitalisiertisch der Serie 100,
- PLANITAB T 110 und T 102, weitere Präzisionszeichentische hoher Präzision und Geschwindigkeit mit einem Zeichenformat von 1.000 mm x 1.192 mm bzw. 1.200 x 1.200 mm und der zugeordneten Bibliothek von Subroutinen GRAPH F2,
- Datenweitergabe der PLANIMAP Datenfiles als Plotfile im ASCII-Format durch GRAPH F1 bzw. GRAPH F2, alternativ zur unmittelbaren Darstellung auf einem angeschlossenen Plotter,
- Datenweitergabe der PLANIMAP Datenfiles im SIF-Format (ASCII) durch das Programm GENSIF, z. B. für die unmittelbare Übertragung zu einem interaktiven System von Intergraph.

PLANIMAP wird auch zukünftig ständig den steigenden Anforderungen angepaßt werden.

Dr.-Ing. Dierk Hobbie
Firma Carl Zeiss
Geschäftsbereich Vermessung
Postfach 1369/1380
7082 Oberkochen

Photogrammetrische Woche 1985
Institut für Photogrammetrie
Schriftenreihe, Heft 11, 1986

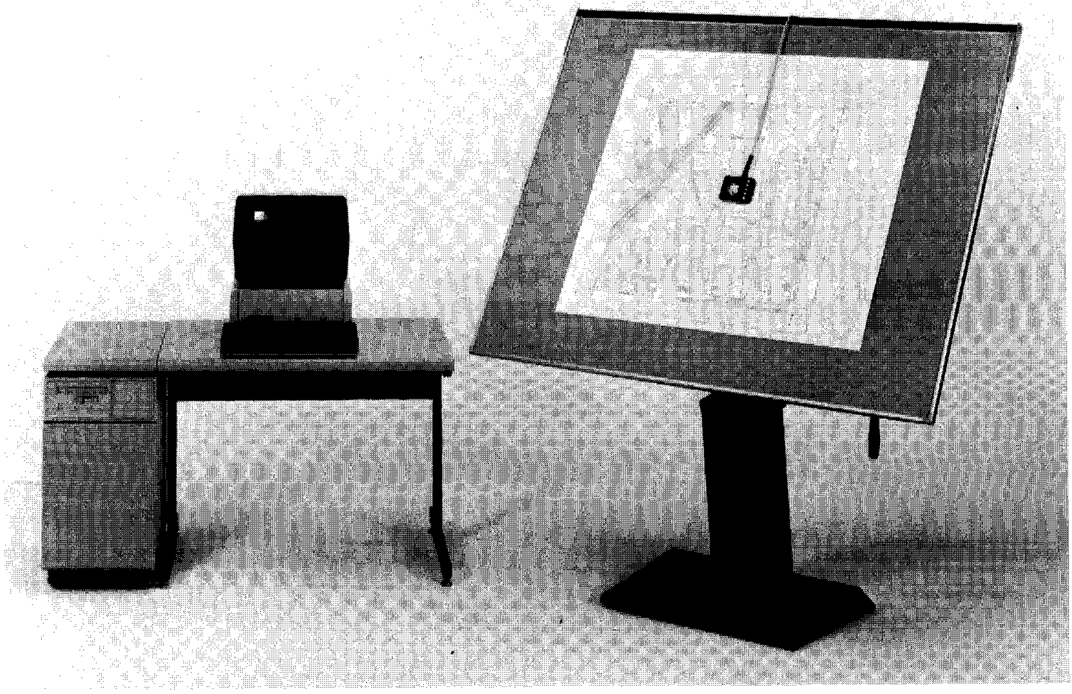

Fig. 1. The Aristogrid Series 100 digitizing table as a PLANIMAP workstation for digitizing existing maps with Zeiss DIGI-AS

Fig. 2. The programmable PLANIMAP panel for entering commands and macros

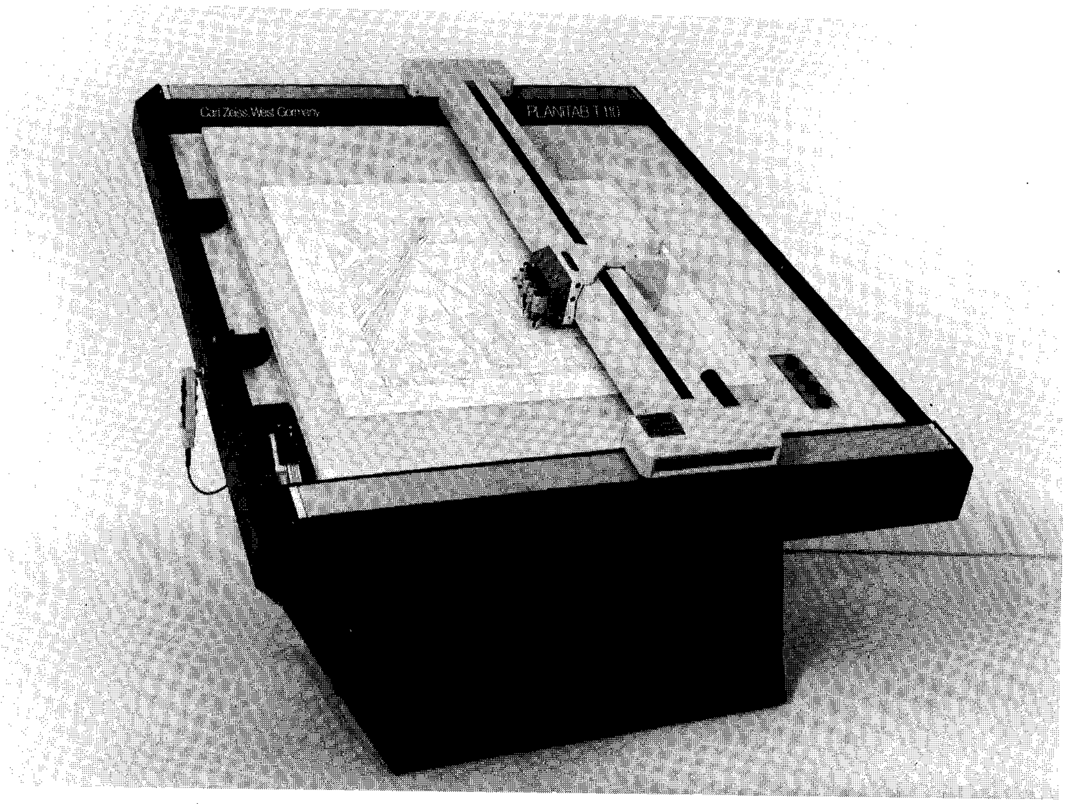

Fig. 3. The PLANITAB T 110 precision tracing table