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THE PRESENT DEVELOPMENT STATUS OF THE C-100 PLANICOMP

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1. Introduction

The C-100 PLANICOMP Analytical Stereoplotting System was first introduced to the general public at the XIIIth Congress of Photogrammetry in Helsinki in 1976 |1, 2| and has since found a surprising degree of distribution. During the first two years of supplies from mass production, customers from over a dozen countries opted for the PLANICOMP. The remarkably high performance and realibility of a carefully designed product like the PLANICOMP have been able to overcome the skepticism with which analytical instruments were at first considered in photogrammetric practice.

In the meantime, the PLANICOMP system has been further expanded: improved and enlarged programs, a number of new programs and the inclusion of new computer capabilities have kept the software up to date. All users of the system are kept informed about these developments by special information sheets. Recently, working groups have been formed, which deal with the uses of the PLANICOMP, and there are the first beginnings of an exchange of programs even among users. The first reports on experience |4, 5, 6, 7| are presently being supplemented by contributions from large-scale users of the PLANICOMP |8, 9, 10, 11, 12|. As a result, the PLANICOMP may be considered to be fully integrated into photogrammetric practice already today.

In the following, an account will be given of the present-day capabilities of the instrument system, dealing above all with new possibilities and improvements which have resulted since the comprehensive report presented in |3, 4|.

2. Basic unit and tracing table

The basic unit of the PLANICOMP with the operator control panel and the control unit as well as the DZ-6 Digital Tracing Table still correspond to the prototype in all essential aspects and have not changed in their general appearance. Apart from a few refinements designed to increase reliability even further, mention should be made of the use of a new type of lead screw with a roller nut in the photocarriage drives, a change that was made for general production reasons. The resolution and real-time accuracy of the new lead screw is 1 or 2 to 3 µm, as before. Traveling noise has been reduced so that it will no longer be found bothersome.

3. Computer

The tremendous progress made in electronics has also been to the benefit of the HP 21 MX family of Hewlett-Packard computers. The computer system which is now called HP-1000 has been expanded by new and more efficient units in the processor, the periphery and the software.

Special mention should be made of the so-called F-processor which has been available for several months and which by comparison with the previously used E-processor contains an additional floating-point processor and a wired set of scientific instructions which speed up the computation of square roots as well as trigonometric and logarithmic functions 7 to 20 times over previously used software routines. As a result, the computer-time ratio in routine PLANICOMP operation between the new F-processor, the E-processor and the M-processor used in the Helsinki prototype is 1:1.4:3.5 for the LOOP control program and about 1:2:3 for an off-line program such as strip adjustment (Fig. 1).

TASK ON PLANICOMP			Computation time on HP 1000-Systems F-Processor High Performance Memory	E-Processor High Performance Memory	H-Processor Standard-Memory
LOOP OPERATING PROGRAM	SINGLE RUN	NOT MOVING	1 msec	1.1 msec	2.3 msec
		MOVING – PHOTO MODE	2 msec	2.2 msec	5.8 msec
		MOVING – MODEL-MODE – NO DIST. CORR.	2.7 msec	4.2 msec	9.8 msec
		MOVING – MODEL-MODE – DISTORT. CORR. 1)	2.9 msec 1)	6.3 msec 1)	22 msec 1)
	LONG TERM USE PROCESSOR	NONSTOP MOVING MODEL-MODE WITH DIST. CORR.	14 %	20 %	50 %
		AVERAGE WORK	9 %	12 %	30 %
C 105 STRIP ADJUSTMENT	Computation time per model per single iteration		0.5 sec	1 sec	1.7 sec
	Overall computation time per model and 2 iterations ex dialogue, ex listing		2 sec	3.5 sec	6 sec
PATM MODEL BLOCK ADJUSTMENT	Computation time per model per single iteration		6 sec 2)	7 sec 2)	12 sec 2)
	Overall computation time per model and 2 iterations ex dialogue, ex listing		19 sec 2)	22 sec 2)	37 sec 2)
Overall speed ratio			1	1.7	3.2

1) every 25th run only 2) improvement by reduction of disc transfers with RTE IV

Fig. 1 Typical computation times in PLANICOMP work.

The aforementioned comparison also makes allowance for higher speed due to faster storage modules.

All E and F-processors are now equipped with so-called high-performance storage modules with a cycle time of 350 ns as opposed to 600 ns in the standard memory of the M-processor (PLANICOMP prototype). At the same time, HP has increased the capacity of a storage board from 8 Kwords (16 Kbytes) via 16 Kwords to, at present, 64 Kwords. As a result, the cost per memory word went down by some 30 % per year. In spite of this, the computer of a typical PLANICOMP system still contributes about 1/3 to the cost of the system, since the aforementioned reductions in the processor and the memory are offset by the rising costs of peripheral equipment (which contains mechanical components) and higher demands of customers concerning computer capabilities.

Only one fourth of all systems are now equipped with the minimum-configuration 32 Kw memory. Half of all customers decide in favor of 64 Kw, 25 % in favor of 80 to 128 Kwords so that the computer may also be intensively used for parallel work. Two thirds of all PLANICOMPS already use the 15 or 20-Mbyte unit instead of the 5-Mbyte disk storage, which today may likewise be considered a natural precondition if additional off-line work, such as block adjustment, is to be performed.

As far as peripheral equipment is concerned, the trend is still the same. Now as before, only 1/4 of all customers choose a card reader, 50 % a punched-tape reader, 40 % a tape punch, 43 % a magnetic tape deck with a recording density of 800 bpi, and 17 % with one of 1600 bpi. Preference of the lower recording density is probably less due to the costs involved than to the fact that the clinical environmental conditions of a computer center will only rarely be found in a photogrammetric production facility, while on the other hand 800 bpi are more widely used today.

Statistically, every system has a printer (increasingly the microprocessor-controlled matrix printer HP 2631 with 180 lines per second). Every second computer already has an additional terminal. Altogether, the share of printing terminals went down to 20 %, which in practically all cases are no longer used as PLANICOMP dialog units. By contrast, video display terminals have taken over without reservation, which today are available in a particularly low-priced version (HP 2621) and in a graphical version (HP 2647/2648 models - already now 1/3 of all C-100 VDTs).

These figures show that contrary to original opinion, the control computer of an analytical plotter is more and more being used for non-central data preprocessing. The present possibilities in the hardware and software fields clearly show that this trend will gain added momentum in the future.

4. Computer operating systems

The HP operating systems RTE II and RTE III have been continually improved over the past few years. The on-line generation of new operating systems with so-called grandfather disks has eased the situation considerably. The improvement of the Fortran compiler brought, among other things, the introduction of commons in conjunction with BLOCK DATA statements. In addition, the program loader was improved.

The RTE IV operating system succeeds the RTE III and offers considerable advantages for photogrammetric practice if the memory is expanded accordingly. The maximum length of a program or program segment has been increased from 16 to 27 Kwords. In addition, program-internal data fields can be set up outside the program partition by extended-memory addressing (EMA) up to a size limited by memory expansion. This means that the 27 Kwords are available exclusively for the program code. The fact that the memory division and the computer periphery can easily be reorganized are further essential advantages of RTE IV.

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Now as before, all PLANICOMPS are equipped with a few system programs which illustrate the system configuration and memory assignment and aid users in their programming work.

5. Operating and service programs

Over the past few years, PLANICOMP software has been continually improved. Errors were eliminated, programs expanded and new programs written for inclusion in the standard package. The improvements above all refer to uses such as triangulation, DTM recording, graphical output and data administration.

The elimination of errors in the storage of models for triangulation adjustment resulted in a slight improvement in the accuracy given for the PLANICOMP in |6|.

In a comparison of accuracy with precision comparators (ZEISS PK-1, PSK) on the basis of the Oberschwaben test block (photo scale 1:28 000), the differences now remain within 10 %. Even at large photo scales (JÄMIJÄRVI test block 1:4000) in conjunction with a bundle method, the slight differences between instrument accuracies have only a minor effect of 10 - 20 % on total accuracy |8|.

The most important software expansion is a test variant for strip adjustment by models with the STRIM program by Stuttgart Technical University, in which only gross errors are indicated in a heavily shortened printout of results. This makes this variant so handy that it may be used for preliminary checking during strip measurement after every 1 - 2 models.

The additional PATM program for block adjustment by models now also uses the possibilities offered by RTE IV for the use of large data fields. As a result, 900 models per block can be processed with 300 measurements per model of 300 control points. If full use is made of the capabilities of the operating system and if a sufficiently large memory is available, even a multiple of these figures can be attained. Since in PATM the number of disk accesses has an essential effect on computation time, shorter program duration may also be expected. This results in considerable improvement of the efficiency given in |5|.

Other expansions refer, above all, to DTM measurement (possibility of additional individual recording in the incremental mode, profile measurement also with comb-type instead of back-and-forth planimetric motion, possibility of skipping in grid measurements and several extensions for cross-sectioning) and data administration (selective access of partial ranges even in the "model bank", new editing commands for faster searching and variation of the data of general files).

New programs are the following:

GENERAL FILE EDITING (GEFIL)

For the editing of "general files" - generally available data files - even from terminals other than those assigned to the PLANICOMP. This program provides rapid information about the entire general file and allows the transfer of data between files and peripheral units. As a result, an "off-line operator" at a second terminal has far-reaching access to the general files.

SHEET PLOTTING (C088)

Preparation of map sheets by the plotting of map grids and points after the end of the start dialog, a combination of separate programs "grid plotting" and "point plotting".

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RECORD CENTER LINE (B74)

Incremental and individual measurement of route lines or other lines defined by traverses.

TRANSFER ATX DATA, Mode 1 (A57)

Derivation of PLANICOMP orientation data groups from the stored result of PATM block adjustment and transfer to the model bank.

Improvements like the aforementioned ones will be made also in the future to suit specific requirements and will benefit all PLANICOMP systems ordered. Up to this date, such improvements have also been supplied to previous buyers without additional cost. In view of a realistic and fair price policy, however, future additions to the PLANICOMP software will only be supplied on the basis of software maintenance contracts. Such a contract offers PLANICOMP users the advantage that they will receive advice and improvements even after the warranty period has expired.

6. Special configurations

In addition to the generally improved performance, mention should also be made of the special capabilities of the PLANICOMP system which can already be used in photogrammetric practice.

The control of two PLANICOMPs by a single computer is such a special configuration. This is predicated on the availability of a sufficiently fast and efficient computer. One such system is an F-processor with a memory of 128 Kwords, a 20-Mbyte disk memory, magnetic tape deck and RTE IV operating system. In addition to a printing HP-2635 A terminal as a general computer console, every PLANICOMP is assigned a graphical HP-2648 A VDT with a graphical HP-2631 G printer as a subsystem. All special PLANICOMP programs, except for the off-line programs (C-programs) are loaded doubly. The data areas also are separate, but an exchange of data between "Unit A" and "Unit B" is easily possible in the usual manner. In normal operation, there is hardly any noticeable interference between the two units.

In other respects also, the efficiency of the HP computer has lead to an expansion of the standard PLANICOMP configuration. The Hanover Topographic Survey Office, for example, has connected an additional ZEISS PK-1 Monocomparator on-line for interactive measurement with the PK-1-AS program |13| and has also installed a direct connection to a Siemens 4004 computer system |9| (Fig. 2). Due to intensive off-line computation and plotting work, however, bottlenecks are already turning up in the slow M-processor used so that the inclusion of a second minicomputer in the network is presently being considered, also in view of the projected connection of PLANIMAT and PLANICART stereoplotters as well as a PSK Stereocomparator. The Distributed Systems 1000 package by HP makes such a connection between minicomputers fairly simple but still efficient. The example illustrates the potential of dynamic system expansion. The resulting configuration may serve as a model for other large photogrammetric organizations.

In the meantime, other organizations have also implemented data telecommunications systems between PLANICOMP and large computers (IBM 360/370). Since the PLANICOMP computer takes care of processing the data right up to block adjustment, this connection is used more for the occasional transfer of results or control groups than for a continuous flow of data. This is why a magnetic tape deck is frequently given preference as an interface, all the more so as it may serve as an additional and economical mass storage.

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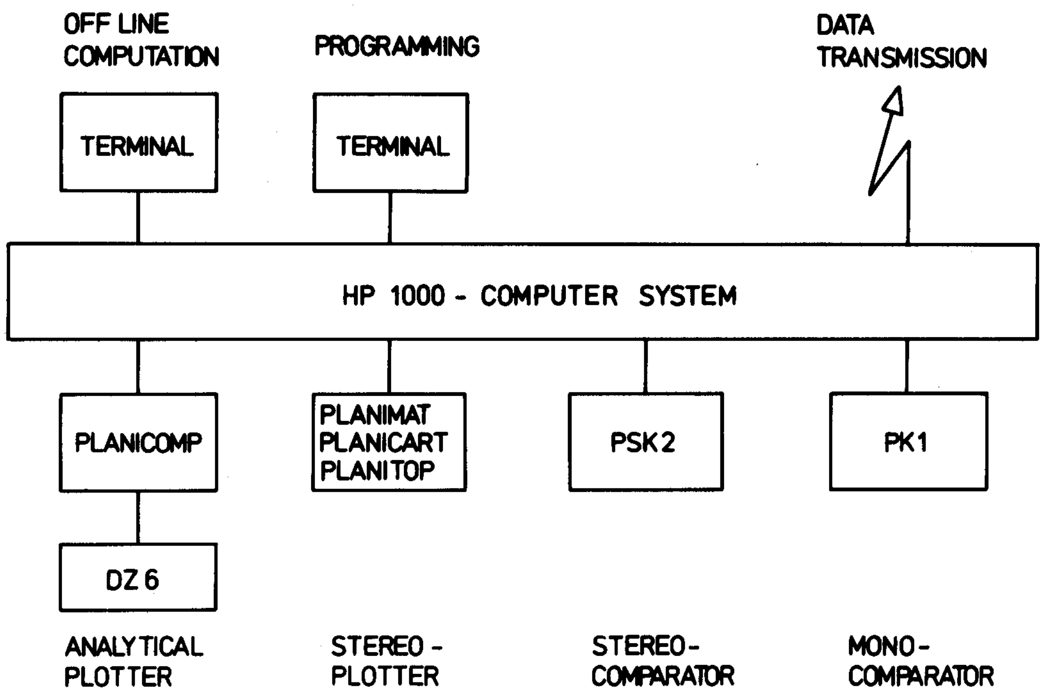

Fig. 2 Use of a minicomputer in photogrammetric production.

A special case is the connection of an SG-1 Storage Unit to a PLANICOMP to produce analog profiles for control of a GZ-1 Orthoprojector. By fairly simple conversion, the storage unit was equipped with yz-servodrives suitable for a DZ-6 Digital Tracing Table. An existing program for DTM profile measurement was adapted for the purpose with only slight modification for control of the SG-1 scribing tool. It is thus possible to combine a PLANICOMP and a GZ-1, the overall process benefiting from a considerable reduction of preparation time (orientation, computation of GZ-1 orientation data, etc.) for profiling.

Further new developments refer to PLANICOMP software. Here, a short program for showing the instantaneous position of the floating mark and the measured orientation points on a VDT, written by Prof. RUANCHIH CHEN, is of particular interest. A graphical terminal (such as an HP 2648 A) is required for the purpose. The screen information is brought up to date at brief intervals.

Other important developments are two bundle programs adapted by Hanover Technical University and Stuttgart University for use in a PLANICOMP computer: the bundle block program written in Hanover, which has become known as the "Müller program" and the PAT-B adjustment program by Stuttgart Technical University [14]. Contrary to PATM, the two programs require use of the RTE IV operating system and a sufficiently large storage capacity and are capable of processing directly stored PLANICOMP measurements in the form of image coordinates. In either case, additional parameters may be taken into account.

7. Special uses

The C-100 PLANICOMP has found general acceptance in all fields of photogrammetry. Half of the systems are used by government agencies, one quarter each in training and research as well as in industrial and private enterprises.

The most frequent application is aerial triangulation: measurement of image and model coordinates and strip and block adjustment by models for control extension, cadastral and civil-engineering surveys. This share of about 45 % is followed by another of approx. 35 % which accounts for all types of DTM work: measurement of parallel profiles, point grids and cross sections. The remaining work involves large-scale plotting (10 %) and miscellaneous (10 %), which is primarily the orientation of special models and other test work. |7| and |12| report about general uses. In the following, only a few special projects will therefore be mentioned.

The PLANICOMP was found particularly useful for analyzing stereo models which could not be oriented in analog machines by conventional means. By variation, control errors were frequently found very quickly even if there was only slight redundancy. Incomplete models (coast lines and lake areas as well as half 9"x18" photography) hardly presented any problems either, just as points near the "critical cylinder". It should be noted, however, that iterative orientation adjustment tends to show ever less favorable convergence towards the edge of indeterminacy. In this case, the results will show the operator after seven iterations whether a useful orientation has been attained or whether another seven iterations should be tried. It goes without saying that a mathematically indetermined case (very small or zero determinant of normal-equation matrix) cannot be directly solved even in a PLANICOMP.

Other special cases are oblique or convergent photography or photography with swung camera axes, which are primarily used in terrestrial photogrammetry. Practically all usual configurations can be traced back to orientation angles

$\omega_1, \omega_2 \approx -20...+120$ gon (rotation about base line),

$\phi_1, \phi_2 \approx -50...+50$ gon (rotation at right angles to base and camera axis)

$\chi_1, \chi_2 \approx -50...+50$ gon (rotation about camera axis)

as well as by, bz base components up to a magnitude of bx. These combinations of parameters were already handled in conjunction with stereoscopic photography. The practical limits to the plotting of such models are the difficulty they present for stereoscopic vision if the camera axes are no longer sufficiently parallel or if photo scales vary too much. The admissible deviations are here much smaller for dynamic measurement than for static measurement.

Terrestrial photography has already been used for a great variety of different purposes: architecture and monument conservation, strip mining and the monitoring of slope movement, accident and building-site photography, measurement of machine parts, radar reflectors and automobiles, of bullet trajetories and underground deposits. Photography taken with practically any type of photogrammetric camera right up to ordinary 35 mm cameras has already been used for this type of work. Practical experience here has shown that the accuracy and "objectivity" of the PLANICOMP is the reason why insufficient knowledge of camera geometry reduces the quality of the result much more frequently than in normal empirical orientation and graphical plotting. The use of an analytical plotter in "industrial photogrammetry" should therefore be combined with test-field calibration of the cameras employed so that full use can be made of the accuracy inherent in the equipment. The additional work is more than compensated by the fact that far less stringent requirements are then made of the photographic configuration. The time saved in an automobile survey, for example, was about 80 %. In this project, block triangulation in the PLANICOMP was for the first time used for terrestrial plotting. The success of this project suggests wide use of the PLANICOMP for terrestrial block triangulation in the future.

Even stereo pairs with a non-rigorous central-perspective photographic geometry have already been plotted in a PLANICOMP, such as picture assemblies taken with ZEISS KRb 6/24 and KRb 8/24 reconnaissance cameras, Landsat photography and two-media photography.

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8. Conclusions

Only three years after its introduction into the market, the C-100 PLANICOMP has its firm place in photogrammetric practice. PLANICOMP users have firmly committed themselves to this system which in the meantime has far outgrown the capabilities of a simple analytical plotter. Its efficiency and the modular design of its hardware as well as the versatility of its software make the PLANICOMP a central piece of equipment in photogrammetric practice. Wide future use of interactive data acquisition even in analog machines, of efficient off-line programs for minicomputers and of the potential of direct data transfer to other computers will further emphasize this trend. It may be expected that this development will considerably heighten the prestige and responsibility of photogrammetric organizations and divisions everywhere.

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Abstract

In the three years since its introduction into the market, the C-100 ZEISS PLANICOMP has won a firm place in photogrammetric practice. Apart from its ingenious design concept, it is above all the continual adaptation to the developments in the computer field and consequent expansion of software that are responsible for the high efficiency of this plotting system.

While the basic PLANICOMP unit has remained practically unchanged, the new F-processor is now generally chosen as an HP computer, which is approximately three times faster than the prototype. Moreover, the larger 20-Mbyte disk memory is now generally used to satisfy present-day requirements of off-line computation. New video display terminals and new printers mark further progress in the development of computer hardware. The suitability of RTE operating systems for multi-user operation has led the great majority of users to prefer memory expansion from 64 K to 128 Kwords over the minimum of 32 Kwords, so that the more efficient RTE IV may be used.

Further additions to PLANICOMP software already make allowance for the experience of the first users and not only incorporate corrections and expansions of existing programs, but also include completely new programs.

The present state of the art is marked by special system configurations and applications:

- Two PLANICOMPs connected to one control computer.
- Interactive data acquisition in analog machines by connection to a type C-100 computer.
- Remote data transmission between PLANICOMP and a central computer as a data bank.
- Connection of an SG-1 Storage Unit to a PLANICOMP.
- Indication of floating-mark position on a graphical terminal.
- Off-line programs for bundle adjustment.
- Plotting of oblique, convergent and swung photography.
- Plotting of incomplete or other models which present problems in analog machines.
- Plotting of terrestrial photography from different areas, including block triangulation.
- Plotting of non-rigorously central-perspective photography.

Gegenwärtiger Leistungsstand des PLANICOMP C-100

Zusammenfassung

Das ZEISS PLANICOMP C-100 hat bereits drei Jahre nach seiner Markteinführung seinen festen Platz in der photogrammetrischen Praxis erlangt. Für die hohe Leistungsfähigkeit des Systems ist neben der erfolgreichen Konzeption vor allem auch die ständige Anpassung an die Rechner-Entwicklung und die konsequente Erweiterung der Software von Bedeutung.

Während sich das PLANICOMP-Grundgerät praktisch nicht verändert hat, wird als HP-Rechner inzwischen überwiegend der neue F-Prozessor gewählt, der gegenüber dem Prototyp etwa dreimal schneller ist, wegen der gestiegenen Ansprüche an off-line-Berechnungen wird auch überwiegend der größere 20 MByte-Plattenspeicher verwendet. Neue Bildschirm-Terminals und neuer Drucker kennzeichnen ebenfalls Fortschritte der Rechner-Entwicklung. Die Eignung der RTE-Betriebssysteme für Multi-User-Betrieb haben dazu geführt, daß bereits die Mehrzahl der Benutzer einen Speicherausbau von 64 K bis 128 KWorten der Minimalausstattung von 32 KW vorzieht und damit das leistungsfähige RTE IV verwenden kann.

Die weitere Abrundung der PLANICOMP-bezogenen Software berücksichtigt bereits die Erfahrungen der ersten Benutzer und führt außer zu Korrekturen und Erweiterungen bestehender Programme auch zu neu entwickelten Programmen.

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Der gegenwärtige Leistungsstand wird deutlich durch besondere Systemkonfigurationen und Anwendungen der Benutzer:

- 2 PLANICOMPs an einem Steuerrechner.
- Interaktive Datenerfassung an Analoggeräten durch Kopplung an den C-100 Rechner.
- Datenfernübertragung zwischen PLANICOMP und zentraler Rechenanlage als Datenbank.
- Anschluß eines Speichergerätes SG 1 an das PLANICOMP.
- Anzeige der Meßmarkenposition an einem graphischen Terminal.
- Off-line-Programme zur Bündelausgleichung.
- Auswertung von Schräg-, Konvergent- und verschwenkten Aufnahmen.
- Auswertung von unvollständigen oder anderen am Analoggerät problematischen Modellen.
- Terrestrische Aufnahmen aus verschiedenen Gebieten einschließlich Blocktriangulation.
- Auswertung nicht streng zentralperspektiver Bilder.

Les performances du PLANICOMP C-100 à l'état actuel

Résumé

Depuis sa sortie sur le marché il y a trois ans, le PLANICOMP C-100 de ZEISS s'est bien implanté dans la pratique photogrammétrique. A l'origine des performances excellentes du système, il y a certes la conception réussie, mais surtout il y a l'adaptation permanente aux développements des calculateurs et l'extension conséquente des programmes.

Alors que l'appareil de base PLANICOMP n'a pratiquement subi aucune modification, le calculateur HP choisi est presque toujours le nouveau processeur F qui est à peu près trois fois plus rapide que le prototype. On utilise aussi de plus en plus le grande modèle de la mémoire à disques de 20 MByte. De nouvelles consoles de visualisation et de nouveaux types d'imprimantes sont les résultats des progrès réalisés dans le développement technologique des calculateurs. Les systèmes de gestion opérant en temps réel (RTE-Operating System) étant parfaitement appropriés pour la multiprogrammation, la plupart des utilisateurs préfèrent déjà une capacité de mémoire de 64 K à 128 Kmots à l'équipement minimum de 32 Kmots, et peuvent ainsi utiliser l'operating system plus puissant RTE IV.

Le remaniement du software destiné au PLANICOMP tient compte des expériences qu'ont faites les premiers utilisateurs; il englobe des corrections et des extensions des programmes existants et le développement des nouveaux programmes.

Les performances actuelles du PLANICOMP C-100 sont mises en évidence par ses applications et par les différentes configurations du système:

- 2 PLANICOMP raccordés à un calculateur pilote.
- Acquisition interactive des données par raccordement des appareils analogiques au calculateur du C-100.
- Transfert des données à distance du PLANICOMP à un ordinateur central ayant le rôle d'une banque de données.
- Branchement d'un appareil de mémorisation SG 1 au PLANICOMP.
- Affichage de la position du repère de mesure sur un terminal de visualisation graphique.
- Programmes off-line pour la compensation par gerbes.
- Restitution de prises de vues inclinées, convergentes, latérales.
- Restitution de modèles incomplets ou d'autres modèles complexes sur l'appareil analogique.

- Prises de vues terrestres pour différents secteurs, y compris triangulation par blocs.
- Restitution de clichés dont la perspective centrale n'est pas rigoureuse.

Rendimiento actual del PLANICOMP C-100

Resumen

Sólo tres años después de su introducción en el mercado, el ZEISS PLANICOMP C-100 ha conquistado un puesto fijo en la práctica fotogramétrica. Además de su concepto ingenioso, su adaptación permanente a la evolución de las computadoras y la consecuente ampliación del software son de importancia decisiva para la alta eficacia del sistema.

Mientras que el equipo básico del PLANICOMP ha quedado prácticamente invariable, se emplea entretanto predominantemente el nuevo procesador F como calculadora HP, el cual es unas tres veces más rápido que el prototipo. Debido a las mayores exigencias planteadas a los cálculos off-line, también se emplea en la mayoría de los casos la memoria de discos de 20 Mbyte, de mayor capacidad. Nuevos terminales de video y una nueva impresora son otros indicios del progreso en el sector de las computadoras. Por ser los sistemas de operación RTE muy adecuados para el servicio de usuarios múltiples, la mayoría de los usuarios prefiere una ampliación de la memoria de 64 K a 128 Kpalabras antes que el equipo mínimo de 32 Kpalabras, de manera que resulta posible emplear el sistema RTE IV más eficaz.

La reciente ampliación del software para el PLANICOMP ya tiene en cuenta las experiencias de los primeros usuarios y ha permitido corregir y ampliar los programas existentes, así como desarrollar nuevos programas.

El estado actual queda caracterizado por especiales configuraciones de sistema y aplicaciones de usuarios:

- Dos equipos PLANICOMP conectados a una computadora de mando.
- Adquisición interactiva de los datos en instrumentos analógicos por acoplamiento a la computadora C-100.
- Teletransmisión de los datos entre PLANICOMP y una computadora central como banco de datos.
- Conexión de un equipo de almacenamiento SG 1 al PLANICOMP.
- Indicación de la posición del índice de medición en un terminal gráfico.
- Programas off-line para la compensación de haces.
- Restitución de fotos oblicuas, convergentes y giradas.
- Restitución de modelos incompletos u otros problemáticos en los equipos analógicos.
- Fotos terrestres de diferentes zonas, inclusive la triangulación de bloques.
- Restitución de fotos de perspectiva central no rigurosa.

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