THE G3/PC STEREOCORD - A SIMPLE ANALYTICAL PLOTTING INSTRUMENT ON A PC BASIS

Dr. Reiner Schwebel, Oberkochen, Prof. Hans Mohl, Stuttgart and Hans-Wolfgang Faust, Oberkochen

ABSTRACT

The Stereocord is a simple analytical plotting instrument for quantitative stereo interpretation, close-range photogrammetry and special photogrammetric applications. It comprises a measuring unit for stereoscopic viewing and digital measurement of image coordinates, an IBM-compatible PC with MS-DOS, a software package in BASIC and an optional plotter. The basic software includes programs for orientation, measurement and the derivation of geometric quantities. The G3 graphics package permits the digital acquisition, storage and output of graphic information. Special application programs enable the use of Stereocord in forestry, geo sciences, planning, environmental monitoring and close-range photogrammetry. The hardware and software are designed for the use with any IBM-compatible PC.

1. INTRODUCTION

The Stereocord is a simple analytical plotting instrument for quantitative photo interpretation and photogrammetric applications. The version G3 Stereocord was introduced by Carl Zeiss in 1982 on the basis of a software package developed by H. Mohl and W. Kresse for the HP85 and HP86 desk computers /1,2/. The G3 GRAPHIC package permits computer-controlled on-line mapping.

The wide use of IBM-compatible personal computers (PCs) and their favourable price/performance ratio have induced us to convert the G3 software to PC operation and to incorporate major improvements and extensions. The new version called G3/PC permits digital mapping with storage of the graphical information and offers a significantly increased performance and speed at a reduced price.

2. HARDWARE

As illustrated in Fig. 1, the hardware of the G3/PC Stereocord comprises:

- the opto-mechanical basic instrument for viewing and measurement of a stereo pair,

- a counter and interface board

- an IBM-compatible PC with MS-DOS operating system and

- optional graphical periphery.

The basic instrument with 4 components for measuring the photo coordinates x and y and the px and py parallaxes is connected to the new counter and interface board using a modified electric unit. This board is inserted into a free slot of the PC, a simple service procedure which basically can also be performed by the user.

The PC with the MS-DOS 3.2 operating system can either be operated with one or two floppy disk drives (5 1/4") or with a Winchester disk and floppy disk drive, and with a monochrome or colour display terminal. The following PCs can be used, for example:

IBM - XT, IBM - AT
IBM Personal System/2 Model 30
Commodore AT-40

each with a 20 MB Winchester disk and printer.

As an optional plotter, the HP 7550 from Hewlett Packard or any compatible plotter can be employed.

Earlier Stereocord versions (G2, G3) can be upgraded into the G3/PC version by hardware and software updates.

Connections to other computers for data transmission can be implemented on the basis of Kermit.

3. SOFTWARE

The software of the G3/PC is written in BASIC (version A 3.31 or GW BASIC 3.2) and, as shown in Fig. 2, comprises:

- the basic software and

- optional software packages for digital mapping, close-range photogrammetry and applications in the earth sciences.

3.1 Basic software

The basic software includes programs for interior, relative and absolute orientation, for parameter orientation and for measuring points, distances, areas and volumes. A detailed description of the basic software is given in /1,2/. The control points used for absolute orientation can be digitized from existing maps using the new basic software.

A common feature of the G3 programs is the interactive operator guidance via the menu. Menus, recommendations for the menu choice, explanations, instructions, results and correction possibilities are displayed on the CRT terminal. This way the extensive capabilities of the Stereocord become easily accessible to users who are not familiar with photogrammetry. Examples for displays on the CRT terminal are given in Fig. 3.

3.2 G3 GRAPHIC

The graphical representation of interpretation results in the form of
a map is of great value for a wide range of applications, particularly
in the earth sciences. So far, the G3 GRAPHIC program package has
implemented computer-supported direct mapping with graphical output but
without storage of the information. The new GRAPHIC package based on a
PC enables the storage of the graphical information on the PC data media
and the output in an identical or different form, as compared with data
acquisition.

The scope and performance of G3 GRAPHIC are described in /2/, the soft-
ware modules are shown in Fig. 4.

For the user's own programming, the standard program BOSS is available,
permitting access of the user program to transformed ground coordinates,
storage of the results in data files and calling of the program in the
menu.

The graphic information is collected object by object with the programs
LINE, AREA and TEXT and is written into a mapping file in records with
identifiers and ground coordinates. Objects may include: points, point
elevations, lines, areas and texts. The identifier (symbol number,
comment) can be used for a kind of object coding, preparing the data for
transmission to a system for further processing (e.g. Zeiss PHOCUS).
In data acquisition, the current element and the last point measured of
a current object can be deleted and reactivated. Due to the storage in
records and the display of the consecutive record numbers, there is the
possibility of subsequent numerical editing of the stored information.
The new program OFF-LINE DRAWING enables mapping of a digitally stored
map on a plotter at different scales, with different symbols and with a
freely definable cut-out area. The map contents can be fitted by affine
transformation into an existing map frame traced with MAP, and can then
be plotted.

As a result, the G3 GRAPHIC package permits

• the storage of graphical information in elements,

• on-line plotting during storage

• automatic off-line mapping of the stored data

This means that the valuable information is permanently available in
the form of a digital map.

3.3 G3 TERRESTRIAL

The program G3 TERRESTIAL is an enhanced version of the basic software making allowance for the special requirements of close-range photogrammetry. The relevant requirements are:

- plotting of metric and semi-metric photos

- the possibility of placing several photos on one photoholder

- introduction of additional conditions into the orientation

- high flexiblitiy in numerical and graphical plotting

The G3 TERRESTRIAL software meets these requirements as follows:

Interior orientation:

Measurement of 4 or 6 fiducials or réseau crosses or points of the frame edges; input of distances or calibrated coordinates; allowance for distortion corrections; camera file for 4 cameras with 4 focussing positions.

Relative orientation:

Measurement of a maximum of 25 Y parallaxes; input of known relative orientation data and automatic weighting.

Absolute orientation:

Introduction of known exterior orientation data (base, coordinates of the camera position etc.) and of additional controlelements (distances, directions, planes, vertical lines) with weighting. Input of the approximate taking direction with respect to the object coordinate system and selection of the reference plane.

Plotting:

Selection of the plotting plane from xy/z, zx/y and yz/x for numerical and graphical plotting; circle measuring program; direct succession of measurements in different models (max. 9) on the same photoholder.

A plotting example with the programs G3 TERRESTRIAL and G3 GRAPHIC is shown in Fig. 5.

4. MAJOR FIELDS OF APPLCATION

The version G3/PC features a wide range of applications, a process which already started in the G2 Stereocord and was continued in the G3. The most important among them are:

- quantitative photo interpretation in the earth sciences, in planning and environmental monitoring,

- close-range photogrammetry in architecture, archeology, accident surveys and industrial surveys,

- photogrammetry with numerical and graphical plotting, measurement of digital elevation models,

- plotting for war material elimination

- training in numercial and analytical photogrammetry and for digital mapping.

The Stereocord is a simple, independent analytical plotting instrument. Due to the easy linkage of PCs to other computers, the G3/PC will be gaining increasing importance as a photogrammetric data acquisition station for further processing in land information systems.

REFERENCES

/1/ Mohl, H.:   Das Stereocord G3
                    Bildmessung und Luftbildwesen (BuL) 50 (1982), pp. 7-15

/2/ Schwebel, R.: The extended performance range of the G3 Stereocord
                    Proceedings of the 39th Photogrammetric Week,
                    Stuttgart 1984

Fig. 1:   Hardware of the G3/PC <u>Stereocord</u>
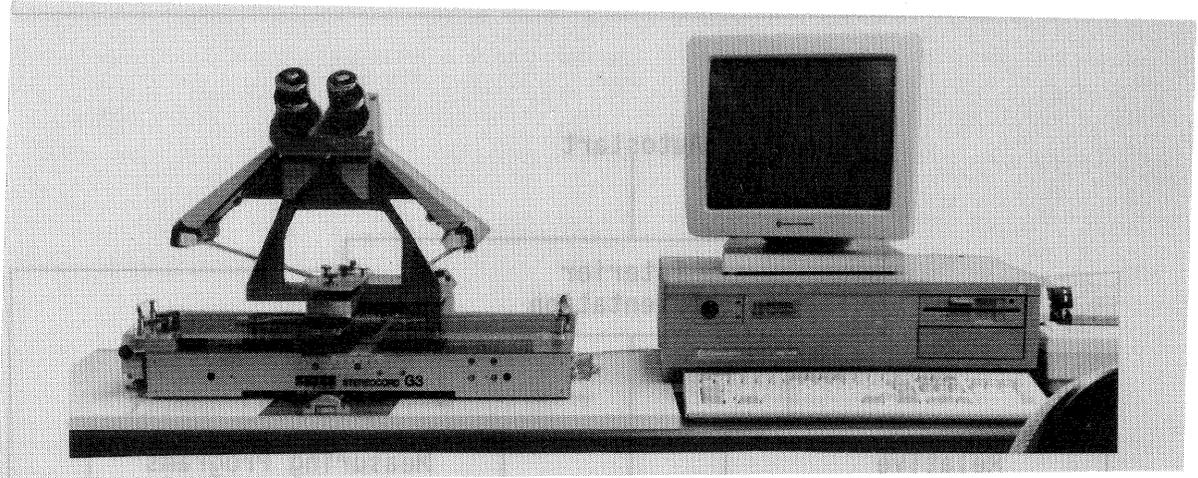
Fig. 2:   Program system of the G3/PC Stereocord

```
┌─────────────────────────────────────────────────────────────────┐
│                      Stereocord G3/PC                             │
│                      Program System                               │
└─────────────────────────────────────────────────────────────────┘

                           Autostart
                               │
                               │
              ┌────────────────┴────────────────┐
              │           Interior              │────────────────┐
              │         Orientation             │                │
              └─────────┬───────────────┬───────┘                │
                        │               │                        │
                        │               ▽                        │
   ┌────────────────────┴──┐   ┌────────────────────────────┐    │
   │      Relative         │   │     Measuring Programs      │    │
   │    Orientation        │   ├────────────────────────────┤    │
   ├───────────────────────┤   │ Distances  vertical        │    │
   │    Parameter          │◄──│            horizontal       │    │
   │    Orientation        │   │            spatial          │    │
   └───────────────────────┘   │ Angles     slope            │    │
                               │            azimuth          │    │
                               │ Areas      incremental      │    │
   ┌───────────────────────┐   │            continuous       │    │
   │      Absolute         │   │ Volume                      │    │
   │    Orientation        │   │ Measurement                 │    │
   └───────┬───────────────┘   └────────────────────────────┘    │
           │       △                                              │
           ▽       │            ┌────────────────────────────┐    │
   ┌───────────────┴───────┐    │     Optional Programs       │    │
   │ Control Point Data    │    ├────────────────────────────┤    │
   │     Storage           │    │   G3 - GRAPHIC             │    │
   │     (FILE)            │     │   G3 - TERRESTRIAL        │────┘
   └───────────────────────┘    └────────────────────────────┘
```
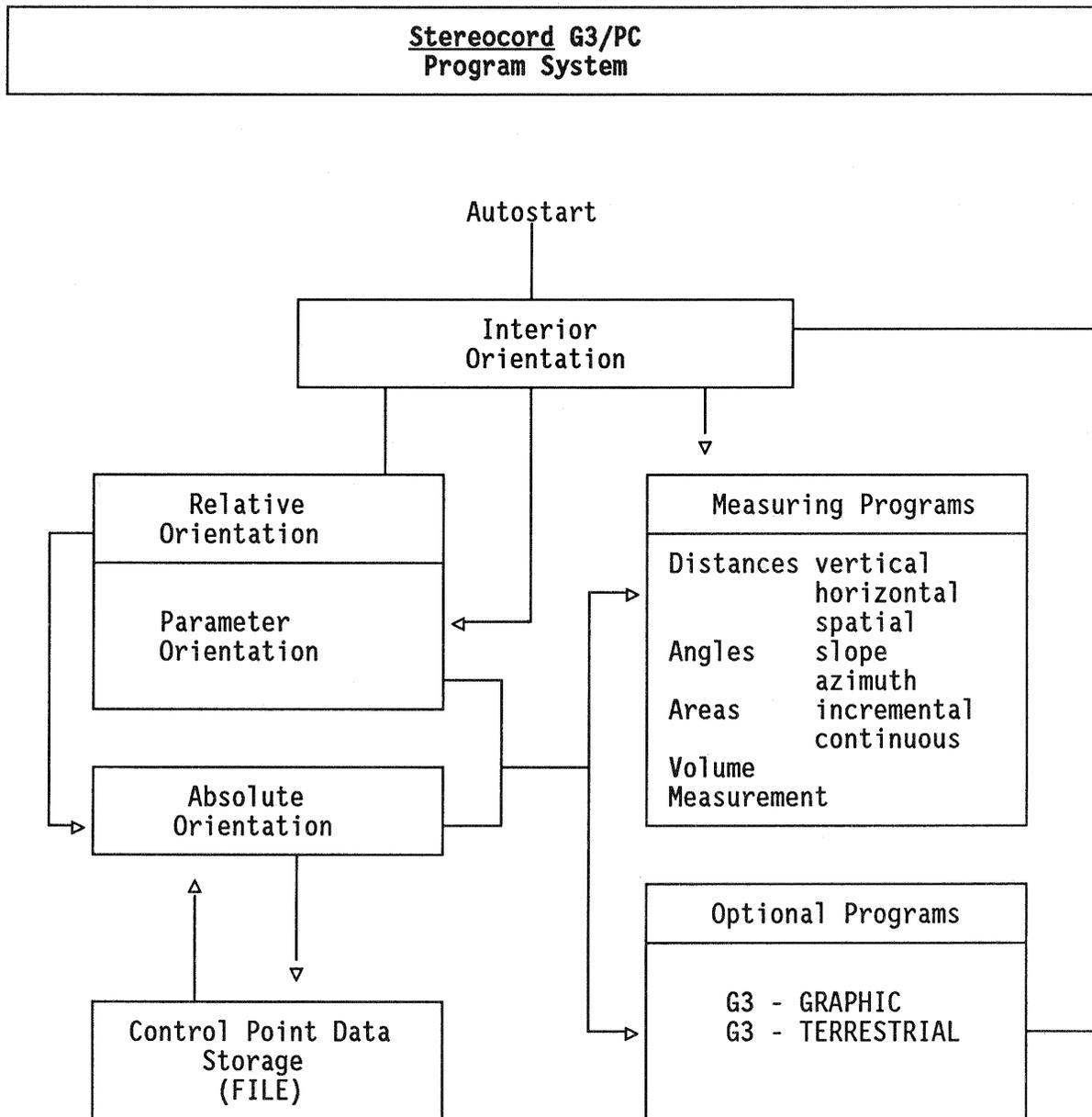
Fig. 3: Display examples

```
┌─────────────────────────────────────────────────────────────┐
│ STEREOCORD G3                      TERRESTRIAL PROGRAMS       │
├─────────────────────────────────────────────────────────────┤
│ INTERIOR ORIENTATION                                         │
├─────────────────────────────────────────────────────────────┤
│   1  AERIAL  CAMERA  /  MARKS  ON  THE   MARGINS    <         │
│   2  AERIAL  CAMERA  /  MAKRS  IN  THE   CORNERS             │
│ * 3  MEASURE MARKS —▷ L E F T         PHOTOGRAPH            │
│   4  MEASURE MARKS —▷ R I G H T       PHOTOGRAPH            │
│   5  SPECIAL CAMERA  /  WITHOUT FIDUCIAL  MARKS             │
│   6  TERRESTRIAL                                             │
│   7  RESEAU  CAMERA  /  FORMAT  24X36  OR  6ØX6Ø            │
│   Ø  RESETTING COUNTERS    -    REFERENCE   TEST            │
│   +  PROGRAM  SELECTRION                                     │
├─────────────────────────────────────────────────────────────┤
│ TO FOLLOW THE STANDARD SEQUENCE —▷        [FOOTSWITCH]       │
└─────────────────────────────────────────────────────────────┘
```

```
┌─────────────────────────────────────────────────────────────┐
│ STEREOCORD  G3                     TERRESTRIAL PROGRAMS       │
├─────────────────────────────────────────────────────────────┤
│ RELATIVE ORIENTATION                                         │
├─────────────────────────────────────────────────────────────┤
│ COMPUTATION              COMPUTING  dKap l ... dOmg r        │
│                                                              │
│ IT   dKap l      dKap r      dPhi l      dPhi r     dOmg r   │
├─────────────────────────────────────────────────────────────┤
│  1    9.821Ø      4.3Ø4Ø      1.3Ø46      1.4494   -Ø.5652   │
│  2    Ø.1647      Ø.1666     -1.1591     -1.25Ø5    Ø.1ØØ7   │
│  3   -Ø.ØØØ9     -Ø.ØØ88      Ø.ØØ12     -Ø.Ø114   -Ø.ØØØØ   │
│  4   -Ø.ØØØØ      Ø.ØØØ1     -Ø.ØØØØ      Ø.ØØØØ    Ø.ØØØØ   │
└─────────────────────────────────────────────────────────────┘
```

```
┌─────────────────────────────────────────────────────────────┐
│ STEREOCORD  G3                     TERRESTRAIL PROGRAMS       │
├─────────────────────────────────────────────────────────────┤
│ ABSOLUTE ORIENTATION                                         │
├─────────────────────────────────────────────────────────────┤
│   1  REFERENCE  SELECTION                    OK              │
│   2  CONTROL  POINT  DATA                    29              │
│   3  OTHER      ORIENTATION ELEMENTS         Ø               │
│   4  KNOWN      ORIENTATION DATA             Ø               │
│   5  CONTROL  POINT  MEASUREMENT             14              │
│   6  C O M P U T A T I O N                   OK              │
│   7  ADDITIONAL MEASUREMENTS                                 │
│   8  CONTROL   POINT   LIST                                  │
│   9  PARAMETER LIST                                          │
│ * Ø  REAL TIME DISPLAY                                       │
│   +  PROGRAM SELECTION                                       │
├─────────────────────────────────────────────────────────────┤
│ REFERENCE PLANE   XY           CAMERA AXES  —▷    -Z         │
└─────────────────────────────────────────────────────────────┘
```

Fig. 4: G3 Graphik - Overview

```
                        ┌─────────────────────────┐
                        │          DRAW           │
                        │     Control Program     │
                        └─────────────────────────┘
                                     │
          ┌──────────────────────────┼──────────────────────────┐
┌───────────────────┐    ┌───────────────────┐    ┌───────────────────┐
│       SYMBOL      │    │        MAP        │    │       TEXT        │
│ Symbol Generation │    │ Map Sheet Prepa-  │    │ Annotations, Gene-│
│        and        │    │    ration and     │    │ ration of Legends │
│    Management     │    │   Readjustment    │    │                   │
└───────────────────┘    └───────────────────┘    └───────────────────┘

          ┌──────────────────────────┼──────────────────────────┐
┌───────────────────┐    ┌───────────────────┐    ┌───────────────────┐
│      PROFILE      │    │       LINE        │    │       AREA        │
│   Conteur Line    │    │ Acquisition and   │    │ Acquisition and   │
│   Measurement     │    │ Mapping of Point  │    │ Mapping of Area   │
│   and Plotting    │    │ and Line Objects  │    │ Objects           │
└───────────────────┘    └───────────────────┘    └───────────────────┘
                                     │
                        ┌─────────────────────────┐
                        │    OFF-LINE DRAWING     │
                        │   Off-line Mapping      │
                        │   of the Stored         │
                        │   Digital Map           │
                        └─────────────────────────┘
```
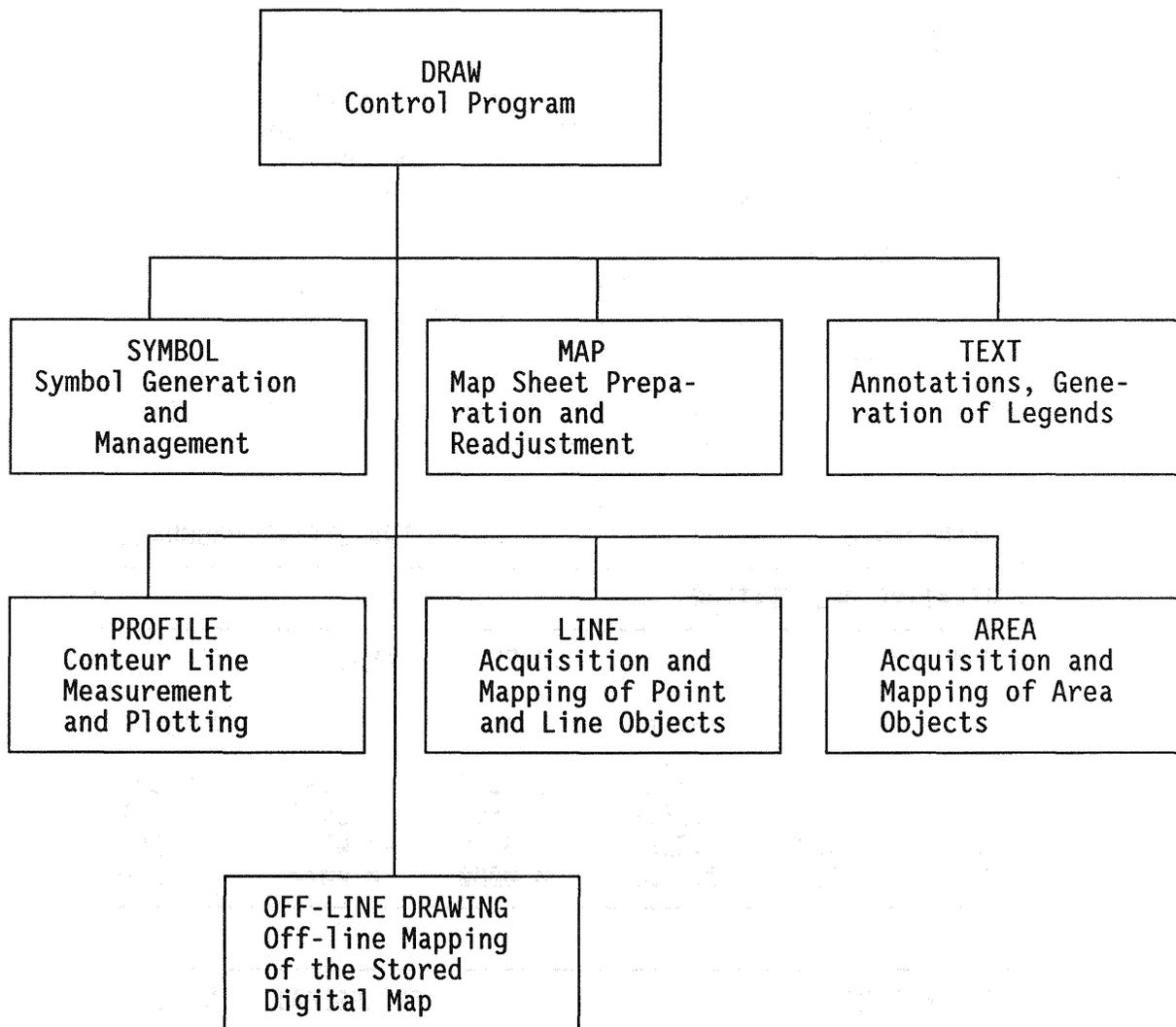
Auswertung am **STEREOCORD G 3** mit HP 7580 B Trommelplotter

Massstab **1:50**   IPO STUTTGART