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PHOCUS - CONCEPT AND PERSPECTIVES

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1. INTRODUCTION

PHOCUS, a photogrammetric and cartographic system, has been **successful** in the market. This statement may be made after two years of deliveries to all over the world. In photogrammetry in particular PHOCUS plays a leading role, but in the meantime it has also established itself in cartography.

The **initial development phase**, which has been concluded by now, involved the production and improvement of the basic components for **HP 1000** Series computers, of the photogrammetric and cartographic application modules, the different data interchange options, and the implementation on **MicroVAX** and **VAXstation** computers. PHOCUS development is based on a concept which, from the very beginning, included far-reaching perspectives also for the coming years.
Today PHOCUS can be used for the most diverse applications in photogrammetry and cartography and for some GIS data aquisition tasks /1/.

In the **second PHOCUS development phase**, in which we are now engaged, we want to improve the PHOCUS potential for GIS applications in addition to making various other improvements.

Some **objectives of the second PHOCUS development phase** are:

- Upgrading to a Geographic Information System
- Inclusion of geodetic measuring methods
- Improvement of the terrestrial plotting functions
- Provision of special editing functions

Some details of these development objectives are discussed in the following.

2. UPGRADING TO A GEOGRAPHIC INFORMATION SYSTEM (GIS)

Compared with mapping systems, Geographic Information Systems offer the following additional advantages:

- Multi-level data structuring (objects, object items, ...)
- Allowance for the topology
- Allowance for attributes
- Logical relations
- Data analysis

On the other hand, mapping systems and Geographic Information Systems have a number of common features such as:

- Storage of large data volumes
- Various digitization units
- Various graphical output units
- Data updating methods (map revision)
- Graphics code changing options
- Vector and raster data

For the user, the major difference is that a mapping system "only" produces maps while a GIS can answer most diverse questions.

Such questions may be, for example:

- Who owns this lot?
- Which lots belong to this owner?
- Which spaces are suited for industrial use?
- Which houses are connected to this water main?
- What is the size in square kilometers of the sick-tree stands in this area?

The answers to these questions can be given in plain language or in the form of thematical maps, or simply by highlighting on the screen provided, of course, that the information required to answer such questions has been entered in the GIS beforehand with an appropriate structure. This takes time and is very expensive.
Therefore PHOCUS development in this field at first emphasized fast, easy and space-saving data acquisition as well as data output components and data interchange with existing GIS.

For attributes, different data types can be used, especially object names and object item names, which may consist of strings of random characters. The user can structure and interpret the character field freely.

The sample object "road" illustrates the options:

Object name = 'ROAD NO. = 29 | STATE=Baden-Württemberg'
Object item name = 'WIDTH=12.5m | SURFACING=Asphalt | LANES=2'

The object name applies to the whole road while the object item name only applies to road sections because the number of lanes may vary.
The user can search for all road sections surfaced with asphalt by entering the search key "@SURFACING=Asphalt@" (where the "@" character is a wild card for a random number of characters at that string position).
It is also immediately apparent that transferring these attributes to other systems is very easy if these systems provide this option.

More sophisticated GIS applications require further aids and features such as:

- Definition of attribute structures and ranges in the system
- No restrictions on the number of atttributes, the ranges and the data length
- Structure definition change and enhancement options
- Structure validity checks by the system
- Comprehensive selection criteria (AND/OR, EQUAL/NOT EQUAL, GREATER/LESS THAN, BETWEEN, LIKE/UNLIKE, ...)
- Different output options (especially free-format reports)

A number of commercial data base systems satisfy these requirements. These data bases can be classified in three groups:

a) Hierarchical data bases
b) Network data bases
c) Relational data bases

This order not only reflects the historical sequence in which these products appeared on the market but also a rating regarding the flexibility and the field of applications, with relational data bases (RDB) being the winners. Hierarchical and network data bases suffer above all from the fact that defining and modifying data structures is more difficult and time-consuming, a considerable drawback in daily work. For most users this disadvantage is not compensated by the better response times to interactive queries. This is why RDBs are being used more and more also for GIS /2/.

Since RDBs - just like the other two data base types - do not provide adequate tools for managing multi-dimenionsional geometric data, there are two methods for integrating an RDB in a GIS:

- Storage of all the data (also the geometry data) in an RDB and use of special directories (e.g. the quadtree method /3/) for fast access to coordinates with geometric conditions (e.g. rectangular window)

- Storage of the attributes in an RDB, storage of the geometry data in special data base components, and linkage of the geometry and the attributes by means of pointers and identifiers.

(A third option will be provided by a new enhanced type of relational data base that also provides geometry functions. However, these data base types are still in the research phase and will need some more years to become available /4/.)

The first solution offers the advantage that the data is all stored in a homogeneous data base and that the development effort for the GIS designer is relatively small. However, the performance of the geometry section is generally not very good despite the use of quadtrees etc.

The second solution requires the development of the data base components for the geometry - including all directly related attributes (line connection types, precision, object structure) - and the topology.
This investment is justified because adequate response times can be achieved even for large amounts of geometry data.

This is the reason why the PHOCUS concept uses the second method.
The data base components for the geometry and the geometry-oriented structure elements have been completed. Data elements for logical linkage with attributes in an RDB have also been provided but are not yet visible on the user level. One of the most important subtasks of the current PHOCUS development effort is to include the RDB in the user shell.

Current PHOCUS users will be enabled to upgrade their systems with these components and any required hardware.
Future users can acquire PHOCUS with or without these complete attributing options depending on whether they need a mapping system or a Geographic Information System. Both versions have in common fast access to the geometry also during data acquisition and editing and fast creation of graphical representations.

3. INCLUSION OF GEODETIC MEASURING METHODS

In addition to photogrammetric methods, many organizations also use geodetic methods and instruments for producing and revising maps or for implementing a GIS. Since PHOCUS was initially developed mainly for photogrammetric and cartographic applications, our development efforts now concentrate on the geodetic components.

- PROCESSING OF GEODETIC MEASUREMENTS

A major difference between photogrammetric and geodetic data acquisition is that

- photogrammetry directly yields ground coordinates, while

- geodetic measurement (e.g. with electronic tacheometers or with tape measures) only supplies directions and distances from which the ground coordinates have to be computed.

Modern electronic field books (e.g. the Zeiss REC500) afford geodetic data processing up to ground coordinates computation. Therefore the PHOCUS concept for this field has three levels and provides the following options:

A) Interactive entry of individual coordinates
B) Interactive entry of terrestrial updating measurements
C) Processing of coordinate files that may also contain information on line and object formation.

A) was implemented by means of the 'event input' principle already in the first development phase and affords keyboard coordinate input at any time. Coordinate entry with the keyboard has the same rank as digitizing with an analytical plotter, a digitizer or a graphics terminal.

B) will soon be available in an initial implementation stage /1/.
The objective is to complement photogrammetric data acquisition by entering individual terrestrial measurements. Examples may be:

- Measurement of new buildings (e.g. garages) that had not been completed at the time the photographs were taken;
- Measurement of parts of passages or buildings that are hidden on the aerial photographs;
- Measurement of roof projections.

PHOCUS allows for the different geodetic measurement methods, e.g. forward section, polar tying (including the special case of continuous rectangular tying in the case of buildings), orthogonal point measurement, line sections etc. during coordinates computation.

Regarding the procedure, coordinates computation ranks equal to direct coordinate measurement, i.e. all options are available for object formation, assigning object codes, object item codes etc. without any restrictions.

C) provides for the complete measurement of large areas by means of terrestrial methods. Since line and even object structures are often also collected in the field, the input interface for coordinate files also allows for structure-forming elements such as object codes, point numbers etc. Line structures can be defined, for example, by means of ascending point numbers with the points being unsorted in the coordinates file.
Such structures can also be entered by interactive graphical means by consecutively assigning the measured coordinates to objects (e.g. with the SNAP POINT, SNAP LINE, SNAP AREA functions).

- DATA FOR GEODETIC MEASUREMENT

The following list contains some of the data required for geodetic measurement:

- Map with nominal measures (setting-out plan)
- Data to be entered in the electronic tacheometers (station and target coordinates for computing the nominal and setting-out data with the field computer)

The tacheometer input data can be produced with the different data base output options of PHOCUS. Graphical dimensioning will be implemented in two ways:

- by interactive graphical means for selected objects or object items;
- by batch processing for selected object types of a data base subset.

The selection options offered by the data base as well as graphics code assignment allow maps to be produced either with or without dimensioning.

4. TERRESTRIAL PHOTOGRAMMETRY

Terrestrial photogrammetry differs from aerial photogrammetry in at least two major points:

- Camera
  Cameras with optical reference grid (reseau) are often used for terrestrial photography /5/ to allow for film deformation during plotting, while cameras featuring film flattening by vacuum and deformation-proof film are primarily used in aerial photography.

- Projection during graphical output
  Terrestrial plots are made in different projection planes using orthogonal or central projection, while aerial plots are generally output with normal map projections, i.e. orthogonal projection in the XY plane of the ground coordinates system.

PHOCUS will allow for the mentioned features of terrestrial photogrammetry more intensively in the future. The following two enhancements are being developed for this purpose:

- ALLOWANCE FOR A RESEAU

A reseau in the metric camera will be allowed for by the following three software components:

- Reseau measurement with the Planicomp Analytical Plotter with automatic positioning to the reseau points, redundant measurement, correction etc.
- Computation and storage of the reseau corrections.
- Online correction of the photo coordinates during data acquisition.

These modules afford film deformation correction for increased plotting accuracy.

- OUTPUT WITH DIFFERENT PROJECTIONS

The following projection parameters will be implemented:

- Projection type (orthogonal or central)
- Projection direction (defined by the XY, XZ or YZ plane, by 3 points of a plane or by a spatial direction)
- Projection center (only for central projection)
- Output window
- Map orientation on the output unit

These aids allow, for example, perspective views of building façades or of whole buildings or of a terrain on a graphics terminal or a plotter.

5. SPECIAL BATCH MODE EDITING FUNCTIONS

Apart from further graphical-interactive editing functions, PHOCUS is going to be expanded by special batch mode data manipulation functions.

Batch programs are being developed e.g. for the following tasks:

- Contourline clearing in buildings, roads etc.
- Smoothing of lines (for cartographic generalization and data compression)
- Changing object codes, object item codes and attributes
- Updating 2-dimenisonal data (e.g. digitized maps) with the 3rd dimension by means of digital terrain models (Z interpolation) for optical photo/map superimposition in the Planicomp with VIDEOMAP

These modules will feature all of the data selection options which are so typical for PHOCUS. For example, all contourlines to be cleared as well as buildings, roads etc. can be selected by means of the object code and a coordinates window.

The target of PHOCUS development is to provide the user, where possible, with a choice of several aids for a given task. The contourline clearing example illustrates this: clearing is possible already during contourline measurement by means of a special command (with immediate graphical result display especially with VIDEOMAP), but also after data acquisition in the checking phase.

6. CONCLUSIONS

The above surveys some PHOCUS development objectives for the next years. Specific implementation dates are deliberately not given because this paper is an outline of perspectives only.

Carl Zeiss continues to pursue the strategy of subdividing development tasks into subtasks that can be made available to the user earlier. This strategy makes sense in particular for the GIS project because product-independent personnel training for GIS can then keep up with product development. GIS is a very young discipline that still has to be established in the curriculae of colleges and universities before it can be implemented sucessfully on a wide basis.

In addition to the product enhancements described above there will be some more innovations that have in part been developed by users. Universities in particular have to be mentioned here, where PHOCUS is used not only for training. The programming interfaces also open up a multitude of research and expansion possibilites, of which the users will profit in the future.

The Carl Zeiss policy is to further the success of the PHOCUS product by intensive communication and close cooperation with its users and by reliable product information.

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ABSTRACT

This paper surveys the future development of the Carl Zeiss PHOCUS system. It emphasizes four objectives: Geographic Information System (GIS), geodetic measuring methods, terrestrial photogrammetry, and special editing functions.

PHOCUS - KONZEPTION UND PERSPEKTIVEN

ZUSAMMENFASSUNG

Dieser Beitrag gibt einen Ausblick auf die weitere Entwicklung des Produktes PHOCUS von Carl Zeiss. Er konzentriert sich auf die vier Schwerpunkte: Geographisches Informationssystem, geodätische Meßverfahren, terrestrische Photogrammetrie und spezielle Editierfunktionen.

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