Photogrammetrische Woche 1987
Institut für Photogrammetrie
Schriftenreihe, Heft 12, 1987

PRODUCTION AND REVISION OF TOPOGRAPHIC MAPS WITH PHOCUS

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1. PHOCUS - A SYSTEM FOR PHOTOGRAMMETRY AND CARTOGRAPHY

In spring 1987 the PHOCUS system developed by Carl Zeiss, Oberkochen, was presented to public for the first time. It is for working of photogrammetric and cartographic jobs by computer assisted methods and instruments. The new analytic plotters of the P-Series Planicomp are a special element of PHOCUS.

The essential characteristics of PHOCUS as well as of the P-Series have already been described in several publications (/1/, /2/, /3/, /4/, /5/, /6/). So only the following items are mentioned here:

- The legitimate demand for a particularly comfortable and production friendly handling have been obtained. The emphatically ergonomic design of the P-Series Planicomp is efficiently used by PHOCUS.

- According to the present demand for data being as multi-purpose as possible, object oriented information are managed, which are independent of their graphic representation.

- By introduction of the terms "Project" and "Operator" there is an organizing frame available, facilitating the alternate working of different greater jobs.

- Conception as an "open" system with interfaces for program development by the user as well as for the exchange of data.

2. WORKING OF TOPOGRAPHIC MAP SERIES

PHOCUS can be used for different jobs, making use of photogrammetric and cartographic methods, e. g. topography, environmental mapping, architecture etc.
By the example "topographic map series" the essential elements of planning and realization of a project by PHOCUS shall be described here. In several parts this paper can be transferred on other scopes of application.

3. PROJECT PREPARATIONS

Each project needs a certain preparation before beginning the productive phase. In this case the project leader is especially required. He provides for the procurement of suitable tools, makes out directions of work in a certain frame and plans the personnel employment.
A system manager will be responsible for a many-sided computer-assisted system like PHOCUS. He prepares the equipment for the coming jobs. He also has to transfer system-independent directives given by the project leader into the specific system language. He trains new co-workers for the system. According to his knowledge a specialization of the operator may be advisable, e. g. in the handling and managing of the graphics codes connected with the transfer of appropriate responsibilities.
The following sections are pointing out essential items, a system manager of PHOCUS should notice during the preparation phase of the project.

3.1 OPERATOR AND PROJECT

PHOCUS offers organizing helps, basing on the terms "Operator" and "Project".
Starting PHOCUS you input the names of the operator and the project with which the system shall work. If there is a password, you have to input it too before getting access. These instructions are used by PHOCUS to build up automatically operator- and project-dependent standard settings. So many operations and inputs are saved, which would have been necessary with the change of the operator or the project.

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The following system parameters are connected herewith:

Operator: Planicomp
contents of menues, basic commands
configuration of workstations

Project : standard names for different files (camera file, control point file) as well as for the area of the object data base, coordinate system

Most of the mentioned items will be explained in detail in the following.

In PHOCUS the system manager has to define the operators and projects by name and optionally by password. Usually each co-worker working with PHOCUS will get his own operator name. The working of topographic map series and e. g. the interpretation of architecture photos will be treated as different projects.

3.2 WORKSTATION CONFIGURATION

PHOCUS permits the establishment of three workstations at one computer but with only one Planicomp. A possible configuration at a computer like the HP 1000/A 900 may look like the following

Workstation 1 for photogrammetric workings:
Planicomp P 1, P 2 or P 3
alphanumeric screen
VIDEOMAP
PHOCUS command panel

Workstation 2 for digitizing maps:
digitizer
graphic screen (e. g. Tektronix 4111)
alphanumeric screen

Workstation 3 for system management:
alphanumeric screen

This arrangement can be varied in PHOCUS. So the graphic screen can be used at the photogrammetric workstation in times.

The workstation configuration is logically attached to the operator (see above). After announcement of the operator the respectively last valid configuration will be recalled automatically.

With one computer all operators work together with the same operator code and the same project name. However, it is possible, to use files of other projects after the input of a possible password.

3.3 DEFINING OF THE DATA STRUCTURE

The working with topographic maps by the help of conventional methods is a process concluded in itself, whose final product is the printed map. The use of computer assisted methods opens new possibilities of using and exchanging gained information. The representation of the data as maps may be on a screen or a permanent drawing base is only one possibility. The same data can be used in combination with other information for numeric interpretations too (e. g. calculation of the distance between a building and mains) whose result can be made visible in special maps again. If this aspect is important for a project, it should be considered in time when a data structure is designed. For the production of only topographic maps it would be unimportant, if a house and garage are a logical unity or if they are independent of each other. By the assignment of attributes like owner or address the creation of such relations is necessary.

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PHOCUS permits at the present state of development the a priori definition of a three-level, hierarchic data-structure: object class (e. g. building), object (e. g. dwelling house), object item (e. g. garage). The elements are coded alphanumerically in the Object Code Table (OCT). At the same time you code in the OCT the geometrical type of the objects and object items (point, line, area, text) too, as well as the logical assignment between object class, object and object item.

As many places have already designed and laid down appropriate data structures, one mostly will have to transfer these definitions into the OCT. Of course, it is possible to develop simple data structures for simple jobs by not using the distinction of object classes and object items.

The OCT is for relieving the operator, too. During data acquisition PHOCUS prevents the using of object codes not existing in the OCT; it tests if areas are closed; assignments not known to the OCT are refused etc. By giving an object code the geometrical type, the object class as well as possible assignments are given automatically.

3.4 AREAWISE DATA ORGANIZATION

When producing a topographic map series there may arise data amounts of several Gigabyte. So the storage and management of these data have to be planned carefully. Because of the costs it sometimes will be efficient to keep data areawise on cheap data carriers as magnetic tape. Only those areas which are revised or are needed to give information, are in a direct access on a hard disc then.

For the determination of the size of an area you need experiences about the average amount of data per area unit. One can assume that a large scale topographic map in built up area takes about 0.5 MByte per km². This value may be individually different. So it is advisable to collect own experiences after the determination of the data structure.

PHOCUS permits several output processes per area done at the same time, e. g. for producing cartographic fair drawings. At the momentary state only at one workstation per area data can be collected and changed; at a second workstation of the same computer, however, one can work in another area or even in the data base of another project. For each of these processes work spaces can be chosen in the area. The work space of a data collection must be out of the work space of output processes.

For large-scale topographic maps it is recommendable to form areas from about 10 to 100 km² according to the disc capacity. So it is possible to pick up more than one area on one computer directly.

3.5 GRAPHICS CODES

The PHOCUS data structure being object-oriented instead of graphics-oriented, graphical output is easy and fast to implement without having to modify the object data. The user can define graphics codes for a specific map by means of three tables:

- Graphics Code Table (GCT)
  The graphics code table is the link between the object data structure specified in the two tables that are described below. It assigns specific symbol construction and execution information to each object code and object item code.
  These assignments are furthermore ordered by "overlays".

- Symbol Construction Table (SCT)
  The symbol construction table contains unscaled abstract symbol designs, for example the design of a tree symbol or the dash/gap pattern of a line symbol.

- Symbol Execution Table (SET)
  The symbol execution table specifies the symbol execution parameters, e. g. the size of the tree symbol as well as the pen width and color.

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The construction and execution of symbols is built up in a hierarchy beginning with the point symbol. On the next stage are line symbols which can refer to point symbols, e. g. to integrate periodically returning shapes into a line-pattern (example: circles). The line pattern may be empty as well. Area symbols refer for the shape as well as for two hatching lines maximum to execution and construction of line symbols. In contrast to this the graph of texts has an independent position.

The element "overlay" is primarily for ordering data on cartographic aspects. (The item object class is mostly used for thematic purposes.) So the classification of overlays can be done on printing technique aspects. For the output of a fair drawing you have to give only the wanted overlay. The classification of overlays can be varied by using another graphic code table or by changing a graphic code table.

Of course a graphic output with a complex graphics code needs more time than one with a simple code. Because of this and some other reasons it may be efficient to use geometrically simplified symbols when working on a graphic screen.

Examples for such simplifications are:

- Stronger utilization of the performance of the graphic device, e. g. using
  simple hardware symbols for points (. + * o x),
  lines (dashed, dotted, dashed-dotted),
  areas (solid, pattern, hatching)

- Using larger point symbol distances with lines

- Using larger hatching distances with areas

- Higher differentiation by colors but shapes

For the input of a simplified graphics code already existing tables can be used as a base, so that only changes have to be entered.

3.6 CONTENTS OF MENUES, COMMAND TABLES

The speed with which the necessary inputs for a certain function can be given, is decisive for the efficiency of a system.

Some factors play a part here

- noticeability of commands

- number of key strokes for the command

- accessibility of keys

PHOCUS takes the first two factors into account in giving for each command a detailed form (with up to ten characters) as well as a short one with only two characters. Also the user has the opportunity to change character strings for some basic commands according to his needs.

The most comfortable kind of input are the so-called menues of different kind. They render the input of one or more commands by only one single key stroke. The user can put together menues by himself, store them under any name and recall them.

The kind of menue depends on the device, e. g.

- paper menue on the table of the Planicomp or on a digitizer

- graphic menue on a graphic screen

- key menue on the PHOCUS command panel

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The mentioned devices determine the accessibility of the menue fields. By introduction of several menue levels the meaning of the fields can be exchanged quickly. It is used always when the inscription can change at the same time, that means on a graphic screen or on the PHOCUS command panel, on which another script-folio is put into a given frame. On the tablet of the Planicomp up to three independent paper menues can be used.

Generally it will be the system manager's job to design menues according to the project. For a graphic menue or a key menue one should combine commands for the input of the mostly used object and object item codes with the most important acquisition functions in one menue level. Another level might contain those object codes and acquisition functions needed more seldom, while the frequent functions should appear again here.

Such a plan of a menue could look like the following one being simplified:

Menue level 1

set object and object item codes	
most frequent buildings	most frequent waters
most frequent streets	.....
general functions (end, help, ...)	most important acquisition functions
---> other menue levels	

Menue level 2

set object and object item codes	
seldom buildings	seldom waters
seldom streets	.....
seldom acquisition functions	most important acquisition functions
---> other menue levels	

4. PROJECT REALIZATION

PHOCUS offers a number of functions being especially useful in the production and revision of topographic maps.

4. 1 FAST MODEL CHANGE

The photocarriages of the Planicomp P 1 have a size of 330 mm x 240 mm, so that generally two adjacent aerial stereomodels can be put in at the same time. The change from one to the other is quite easy. By this objects, e. g. streets running through two models, can be measured in one.

4.2 TABLET OF THE PLANICOMP

With the help of a map oriented on the tablet of the Planicomp P 1 or P 3 and the P-cursor one can directly move to any map point in the model. This simplifies i. a. the input of a field comparison. The tablet can also be used for direct digitizing e. g. when the running of a street is partially covered by trees.

4.3 VIDEOMAP

The superimposition of map and photo by VIDEOMAP is a worldwide success. In connection with PHOCUS, VIDEOMAP offers additional advantages: identified objects, object items or points are highlighted, after changing a coordinate the former graph of all concerned objects is replaced by the new one etc.

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4.4 TOPOLOGIC RELATIONS

While measuring topographic data topologic relations should be picked up explicitly. In PHOCUS for this one can use the functions "Snap Point" and "Snap Line". By Snap Line parts of existing lines can be integrated into a new object. In the object data base the former line will be devided in two respectively three new lines automatically. By this techniques one achieves that a point or a line is stored only once, even if it belongs to several objects. This is especially profitable to map revision.

4.5 SPECIAL DATA ACQUISITION FUNCTIONS

A number of special data acquisition functions make work easier for topographic maps. Here must be mentioned i. a.:

4-Corner-House - registration of a rectangular house by only 3 points

Squared Polygon House - rectangular adjustment by chosen tolerances, not measurable points are computed by extension of lines

Parallel line - a right respectively left parallel running line to the measured line (e. g. way edge) in a chosen distance is computed and separately stored.

Incremental registration - automatic registration of points dependent on curvature, distance, altitude or time increment with primary and secondary criterion. The P-processor of the Planicomp controls this task and relieves the computer of this routine work. Using example: measurement of contour lines, waters.

Delete last ... - delete the last 1 .....n points, the last object item or the whole last object for the immediate correction of acquisition faults.

Attributes - input of non-geometric attributes e. g. number of floors of a house. Marking of data which need a subsequent treatment e. g. hint for a field comparison.

4.6. SPECIAL REVISION FUNCTIONS

Map revision is more exacting than map production as it needs besides the whole extend of data acquisition also functions for the editing of existing data. Acquisition and editing stations do not differ in PHOCUS concerning the software, even if there are devices which are more suitable for one purpose or the other. That means that on the Planicomp together with VIDEOMAP just like e. g. on the graphic screen all functions for map revision are available.

The following editing functions for map revision shall be mentioned:

Delete - data can be deleted on different levels: object, object item, line, line sections, points

Insert - examples: assigning a new garage to an existing building; acquisition of an annex

Change geometry and topology - example: separation of a boundary and the edge of a building, moving of a boundary point

Create geometric and topologic relations - examples: determination and insertion of intersections (if needed by extending lines), clipping lines at intersections

Change non-geometric data - example: change object code (a meadow becomes a garden), cancel revision hints

4.7 DATA SECURITY

With the working of topographic maps by the help of computer assisted methods the gained data are of great material value. Therefore they must be protected against destruction.

PHOCUS offers this protection in three different stages:

Protection against operator errors - many functions for map revision (e. g. "Delete") are executed in the graphic output firstly. The operator has to confirm the action before it is executed in the data base, respectively he can undo it.

Protection against system breakdown - a system breakdown e. g. by power failure can leave a data base in an unusable state. A "recover" function recreates the former state of the data base. By a command for a final update the operator himself can determine this state during the measurement. He also can reset the data base on a state, which was determined with the moment of the last update. So one can undo several actions, which is especially useful during the phase of working in of the operator.

Protection against destruction of the data carrier - the destruction of a data carrier is seldom but it should be taken into account in the data management. Therefore it is advisable so save the worked on data on an independent data carrier in regular intervals of some days or even each day, usually on magnetic tape or magnetic tape cartridge. Besides it is wise to use two magnetic tapes according to the principle

1st day save data on magnetic tape A
2nd day save data on magnetic tape B
3rd day save data on magnetic tape A

and so on.

The suitable use of the protection facilities should be planned and controlled by the system manager.

5. CONCLUSIONS

PHOCUS offers a number of special aids, which facilitate the production and revision e. g. of a topographic map series considerably. For the utilization of these possibilities in a new project a certain preparation by the project leader and the system manager is necessary. The extent of these preparations depends on different factors, i. a. on the similarity of the project to a former one, as well as on the complexity of the necessary data structures and the graphics codes. By this not only greater and complex projects can be worked efficiently by PHOCUS but also smaller simple ones. This aspect will be important in future, too.

REFERENCES

/1/ Hobbie, D.: PHOCUS und Planicomp P-Serie
Die neue Produktgeneration von Carl Zeiss, Oberkochen
Bildmessung und Luftbildwesen 55 (1987), Seiten 71 - 75

/2/ Hobbie, D.: Introduction into the new Product Generation from Zeiss:
P-Series Planicomp/PHOCUS
Proceedings of the 41st Photogrammetric Week
at Stuttgart University, Heft 12, Stuttgart, 1987

/3/ Leidel, W.: Principles of the PHOCUS Software
Proceedings of the 41st Photogrammetric Week
at Stuttgart University, Heft 12, Stuttgart, 1987

/4/ Menke, K.: PHOCUS
Das neue universelle photogrammetrisch-kartographische
System von Carl Zeiss, Oberkochen
Bildmessung und Luftbildwesen 55 (1987), Seiten 83 - 91

/5/ Saile, J.: Planicomp P-Serie
Die neue ergonomische und intelligente Planicomp-Familie
von Carl Zeiss, Oberkochen
Bildmessung und Luftbildwesen 55 (1987), Seiten 76 - 82

/6/ Saile, J.: Performance Data of the P-Series Planicomp
Proceedings of the 41st Photogrammetric Week
at Stuttgart University, Heft 12, Stuttgart, 1987

ABSTRACT

PHOCUS is an interactive graphic system for photogrammetric and cartographic tasks. By the example of topographic map production and map revision essential elements of project preparations and realization by PHOCUS are described. This concerns i. a. the configuration of workstations, the definition of the data structure, the data management including data security, as well as particular functions for data acquisition and editing.

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