Map Up-Dating by Digital Hybrid Methods with the Sicad-Map-Revisor

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ABSTRACT

In 1989, the State Survey of Lower Saxony, Hannover and the Siemens nixdorf ltd. (SNI) started a cooperation to produce a compiuter-assisted hybrid system to up-date the German topographic map series. This system -called SICAD-MAP-REVISOR (1.level)- has been developed in 1989, tested in 1990, and is used in production to revise the Topographic Map 1: 25 000 (TK 25) since the beginning of 1991.

This paper discusses the benefits of digital raster and vector data processing, illustrates the different steps of the hybrid up-dating method and the required hard- and software components, reports about experiences, and gives a brief overview about further developments.

INTRODUCTION

The demand for digital cartographic information is permanently increasing. To meet this demand the State Survey of Lower Saxony builds up the project ATKIS (Authoritative Topographic Cartographic Information System) /AdV 1989/ for the whole country within 5 years until 1995 regarding to the scale 1:25 000. As the prospected time period is very short and the amount of digital data to be captured is extremely huge, in the first phase the contents of the Digital Landscape Model 1:25 000 (DLM 25/1) will not cover all objects.

E.g. the digital data about buildings will be captured in the second phase of the ATKIS-project. So, the derivation of the Digital Cartographic Models (DCM 25/1) out of this DLM 25/1 by computer-assisted processes would not be equivalent to the customary TK 25. But as many users -like planers and geo- scientist- cannot renounce this complete TK 25 contents, a revision of the TK 25 is still necessary falling back upon the old fair draftings on plastic material.

With regard to the opportune establishment of computer-assisted techniques within the ATKIS-project a digital procedure based on raster and vector data was installed for this revision task - the SICAD-MAP-REVISOR. In a second step this software should be integrated to automatically derive the DCM 25/1 out of the DLM 25/1 GRUNREICH 1991/.

1. HYBRID UP-DATING OF THE TOPOGRAPHIC MAP 1:25 000 (TK 25)

1.1 Basic Conception

In the cooperation between SNI and the State Survey of Lower Saxony the productive appointment of the SICAD-MAP-Revisor for the computer-assisted up-dating of the TK 25 has been the first important point (see Fig. 1)

The whole process is based on scanning the 5 original out-of-date foils of the TK 25:
- planimetry
- woodland mask
- water mask
- water lines and
- contours

and on scanning the manually produced compilation sheet (CS 25) on a Hell scanner CTX 330. The 5 TK 25 foils are scanned in black-and-white mode. The CS 25 is scanned in colour mode as it contains different colours for different information:

- black indicates new objects,
- yellow indicates objects to be erased,
- brown indicates the old planimetric situation which is suppressed during the scan process
- other colours may be used optionally (e.g. to indicate a new classification of a certain street).

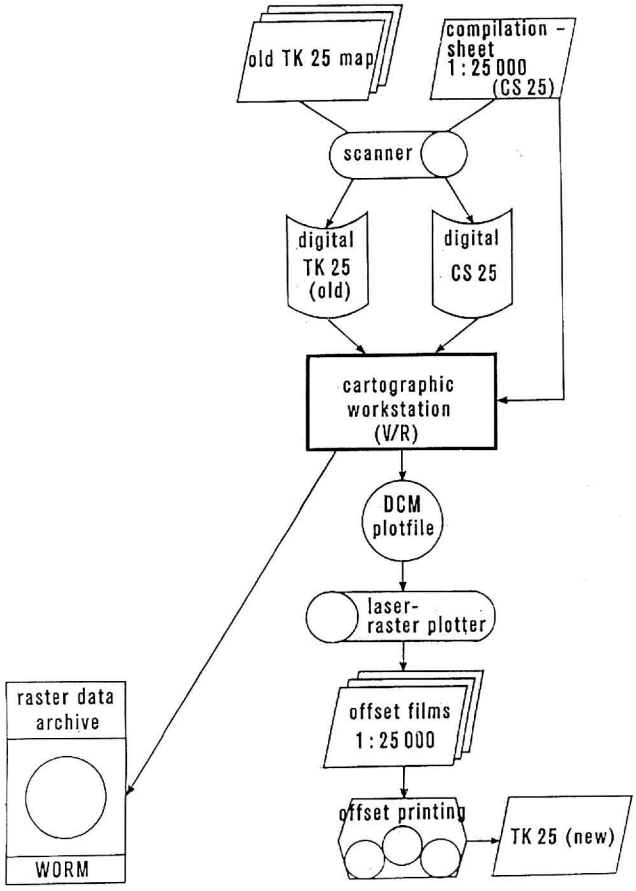

Fig. 1 - Computer-assisted process of up-dating the TK 25.

The CTX 330 scanner allows to recognize up to 15 different colours at once /KAISER 1991/. The standard scan resolution for all foils is 320 lines/cm (800 dpi).

In a pre-processing step the scanned, binarized and run-length- coded foils of the TK 25 and the CS 25 are geonetrically rectified and the raster information of each foils is assigned to one specific bit of a computer word. The use of a look-up-table makes the coloured presenttaion of the data possible on a cartographic workstation (Siemens WS 2000), where the SICAD- MAP-REVISOR (1. level)- software is installed.

On this workstation the cartographer revises the old TK 25 interactively by representing the TK 25 and CS 25 foils in raster format and new symbolized map elements in vector format simultaneously on the graphic screen. A vector-to-raster conversion combines the revised map data with the old raster background.

After a whole map sheet is worked out completely and correctly, four TK 25 plot-files - the colour separates black, green, blue and brown - are created to output them on offset films by means of the Hell laser rasterplotter CTX 502. These films are used to produce printing plates for offset printing of the new TK 25 map sheets.

In an additional step the revised TK 25 foils are stored on optical disks (CD-WORM) to build up a sheet line independent raster data archive 1:25 000 little by little.

1.2 Components of the Hybrid Map Up-Dating Process

1.2.1 Hard- and Software Configuration

the hardware configuration is illustrated in Fig. 2. The scanning unit is a drum-scanner Hell CTX 330 based on the laser technology. Documents may be sized up to 112 cm * 100cm in reflecting mode and 64cm * 40cm in transparent mode. The scan resolution varies from 140 to 800 lines/cm (400 to 2000 dpi). The scanner is connected to the Local Area Network (LAN) by interposition of a PC.
The UNIX-based MX300 workstation controls all input-/output- operations between the scanner-7recorder-station, the workstation WS2000 and an optical disk unit. One optical disk has a storage capacity a storage capacity of 2 GB, that is sufficient for about 100 TK 25 in raster format.

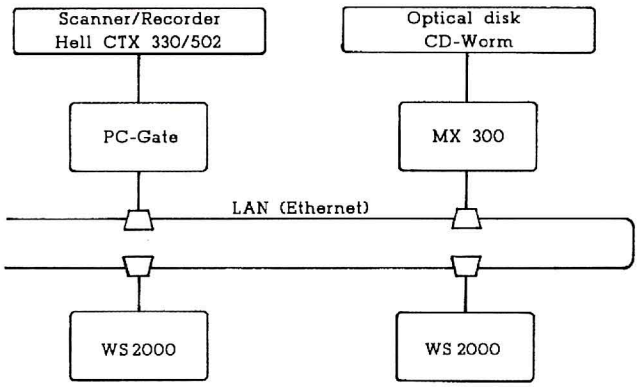

Fig. 2 - Hardware configuration.

To support parallel working the pre-processing steps are performed on the MX300 workstation, whereas all interactive processes of map up-dating are performed on the BS 2000-based WS 2000. Each WS 2000 contains a UNIX-based 16 bit advanced raster- graphics-processor. a colour graphic terminal (1280 * 1024 pixels) and a high quality ARISTO digitizer.

The revised raster data are recorded on the CTX 502

(maximum film sizes are 112 cm * 245 cm, plot resolution is selectable from 100 to 1000 lines/cm (250 to 2500 dpi) and full line or continuous tone plots are possible).

The SICAD-MAP-Revisor (1. level) software is composed from parts of the vector-oriented SICAD-base software and parts of the raster-oriented software SICAD-HYGRIS. The most important functions are:
- Interaction by procedures, table- or screen-menues,
- providing of map working-sets and selection of defined digital foils,
- rubberband,
- erasion and creation of single pixels and pixel areas, including the paste and cut function,
- production, management, and application of symbols (symbol catalogues) for cartographic visualization in vector mode,
- undo-function in case of incorrectly performed processes,
- handling of temporary vector data and permanently raster data,
- vector-to-raster conversion,
- zoom and pan.

Further software modules care for the geometrical rectification of the raster data and for controlling the scan process as well as the plot process on the laser ratserplotter.

1.2.2 Interactive Up-dating in Detail

To up-date a whole map sheet TK 25 parts of the map (maximally 10 cm * 15 cm, this are about 3200 * 4800 pixels) build the actual working set in an interactive session. Applying a look-up-table on defined bit levels each scanned TK 25 foil is represented by its analogous map colour on the graphic terminal. The CE 25 information is depicted in red colour indicating new map elements and in yellow colour indicating map elements to be erased. The patterns of the CE 25 are graphically non-perfect as they are manually drawn without care (Fig. 3).

The cartographically highly skilled operator sets one bit level active (e.g. the "black" planimetric foil). Then, he works out all revising tasks accurately by using the raster editor functions to model the ratser background and the vector symbolization software to create new map elements. The symbols are performed according to the TK 25 map symbology. For this reason, about 200 different line symbols and about 80 different point symbols have been generated and are stored in the symbol library. Vector symbols are presented by overlaying the raster background.

After all bit levels (all other foils) have been worked out the temporary vector overlay is rasterized by a vector-to-raster conversion and combined with the raster background. Subsequently, the relevant map cutout is stored permanently in the so-called Raster Data base (RDB).

This procedure continues until the last cutout has been completed.

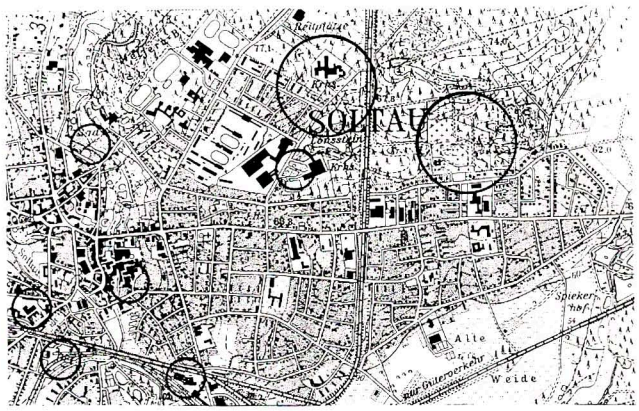

Fig. 3 - TK 25 and CS 25 raster data before hybrid up-dating.

1.2.3 Revision of the Lettering

So far, the lettering is still done in conventional way. The two lettering foils "black" and "blue" are revised manually producing letter-films and adhering them into the foils. Afterwards, these foils are also scanned on the CTX 330. The blue digital lettering information is added mathematically to the water foil of the RDB.

To derive a background removal for lettering the black lettering data run through a digital thickening process and perform a thickened negative mask. In a logical ratser operation all lettering pixels of the negative mask erase related pixels of the (black) planimetric foil of the RDB. Now, the original positive lettering data are added to the provisional result, so that all letters and numerals are cleared from disturbing other black map relements (see Fig. 3 before and Fig. 4 after the revising process).

2. EXPERIENCES AND BENEFITS

After more than 10 TK 25 map sheets have been up-dated by using the SICAD-MAP-REVOSIR the all-over impression of the new hybrid method is very positive /KAISER 1991/. In particular there are the following advantages:
- The computer-assisted process saves about 25% of time

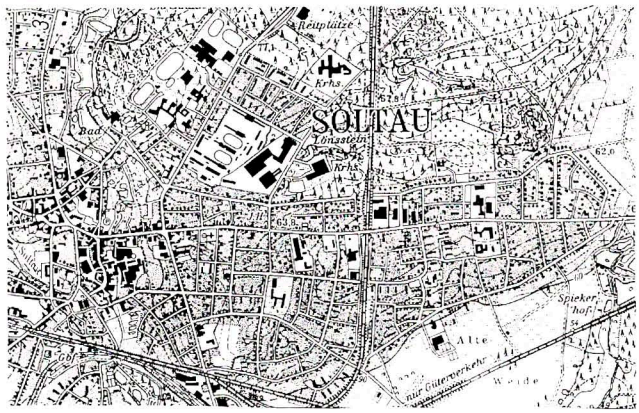

Fig. 4 - Up-dated cutout of the TK 25.

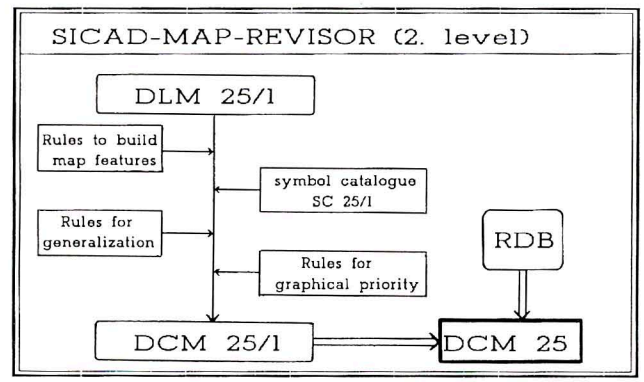

Fig. 5 - Function of SICAD-MAP-REVISOR (2. level) in the project ATKIS.

compared to the conventional manually drawing and engraving.

- The digital procedure saves films and reprographic materials (like foils and developer). So, its ecologically highly beneficial.

- The new procedures is based upon the conventional method of working, so that the cartographer is retrained easily in about 4 to 8 weeks.

The cartographers get used to computer-assisted methods of making. The acceptance of the high quality products of digital cartography is growing.

- Once the TK 25 data is digital, there are no further problems realted to the dimensional stability of the map.

Compared to a fully automated symbolization no design and generalization problems occur as these matters are solved interactively by the operator.

3. FURTHER DEVELOPMENTS

In a second phase the cooperation between SNI and the State Survey of Lower Saxony will be carried on to integrate the SICAD- MAP-REVISOR into the project ATKIS. The goald is to derive Digital Cartographic Models (DCM) in vector or raster format out of Digital Landscape Models (DLM) which are established momentary.

The SICAD-MAP-REVISOR (2. lebel) has to support the connection of the DLM 2571 object-oriented data (see chapter 1) with the ATKIS symbol catalogue SC 25/1. For this goal rules to build map features, rules for generalization and rules for graphical priority have to be compiled, supervised and executed (Fig. 5)

The digital execution of these rules generates a DCM 25/1, which is not a complete DCM 25 as a lot ofnecessary objects are still not part of the DLM 2571. In order to complete the DCM the missing map elements (e.g. single buildings or complexes of buildings) are inserted interactively from the ratser information out of the TK 25 - RDB. At htis stage the results of the automated generalization and symbolization processes will be adjusted to the raster background as is has been discussed before.

When the development of the ATKIS-project is terminated a complete DLM 25 will be established and connected to a complete DCM. Up-date information will be inserted to both the models, the DLM and the DCM simultaneously. The Map-Revisor will still be needed for interactiv correction and improvement of the DCM

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