HYBRID „WYSIWYG“ TECHNIQUES FOR UPDATING THE SWISS TOPOGRAPHIC MAP SERIES

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In this paper, the detailed functional demands for a new digital cartographic production system at the Federal Office of Topography in Switzerland are given. First results of interactively updated topographic maps in hybrid raster/vector mode are shown. Finally, future demands concerning the combination of cartographic and topological data models are presented.

1. Introduction

Modern geographic and cartographic information systems allow to record, to edit and to display spatial topographic and thematic information. The task of digital cartography is to finally make a useful selection out of the processed basic data and to present it in a perceptable, graphic form on paper or on electronic media (Hurni/Leuzinger 1995). The cartographer therefore must be equipped with an ergonomically designed graphics software containing a comfortable and powerful set of special cartographic functions.

In 1994/1995, an interactive cartographic system has been evaluated at the Federal Office of Topography, partly in collaboration with the Institute of Cartography at ETH Zürich. In a first step, the national topographic map series are being updated in hybrid raster/vector mode. Later, the vector-based production of entirely new topographic and thematic maps is planned.

One major functionality of the new cartographic system is its hybrid «WYSIWYG» («What You See Is What You Get») capability. The scanned binary color separations are stacked and displayed according to their correct priorities. Overprints and masking effects can be visualized. Additionally, newly digitized vector objects are truly symbolized and can be edited in real time mode. Interactions between raster and vector elements can be seen in true «WYSIWYG»-display as well.

The authors hope that this paper may help other cartographers when evaluating similar systems.

2. Functional demands for a digital cartographic production system

2.1 Input of analog and digital map data

2.1.1 Scanning

- Scanning of opaque and transparent originals in binary mode.
- Optical or mechanical devices for exact positioning of the originals on the scanner.
- Different (if possible variable) scanning resolutions (at least 1000 dpi).
- Scanning in continuous tone mode (256 gray values, 8 bit).
- Scanning in RGB color mode (3 x 256 gray values, 3 x 8 bit).

2.1.2 Digitalization

- Input of small data sets by manual digitalization on screen or using tablet.
- Input of large data sets using (semi-)automatic vectorization programs.

2.1.3 Data import

- Import of common raster data formats (e. g. TIFF, Intergraph, Scitex,…).
- Import of common vector data formats (e. g. dxf, dgn, PS,…).
- Possibility of unsupervised batch conversion of multiple files by command lines.

2.2 Visualization of data on screen

- „WYSIWYG“ („What You See Is What You Get“) display of fully symbolized map elements on screen.
- Fast build-up of screen image; fast change of screen images.
- Excellent display resampling in all zoom positions.
- Possibility to choose any zoom positions; standard zoom positions (1:1, 1:2, 2:1,…).
- User defined windows, scrolling in predefined steps in x/y direction.
- Overview window showing extent, position and coordinates of working window.
- Storing of user defined windows and zoom positions.
- Different shapes of cursors (point, circle, cross,…).
- User definable color tables.
- Statistical information about raster images (dimensions, resolution, histograms,…).

2.3 Internal coordinate system

- Pixel coordinates.
- Metric „drawing sheet coordinates“ (pixel coordinates x resolution).
- National coordinates (pixel coordinates x resolution x map scale denominator).
- Freely positionable origin for all three coordinate systems.
- Measurement of distances and areas (along linear, polygonal and interpolated elements) in all three coordinate systems and units.

2.4 Preparational work

2.4.1 Global raster image manipulations (binary or multicolored files)

- Rectification (Helmert, affine, projective, rubber sheet and other transformations).
- Change of projection; programming interface.
- Overlay of several raster files; structuring in different, multicolored layers; selection of one or more layers for editing.

- Transparent display of common overlapping parts of two or more layers; selection.
- Placement of a single raster layer in any level of the stack.
- Merge of several layers (also with different resolutions) into monochrome or multi-colored files.
- Separation of combined color raster image in original single color layers.
- Insertion of continuous tone images as background images.
- Global raster manipulations: Move (x/y), scale (x/y), rotate, mirror (x/y, specific azimuth), cut, append, recolor, resample (up/down), mosaiking, masking and Boolean operations.
- Line/area thinning/thickening by n pixels.
- Deleting or separation of isolated pixels or pixel groups.
- Skeletting of lines down to a one pixel axis.
- Line and edge smoothing, filter operations.
- Detection of line gaps and nodes.

2.4.2 Global vector manipulations

- Rectification (Helmert, affine, projective, rubber sheet and other transformations).
- Change of projection; programming interface.
- Overlay of several vector files.
- Move (x/y); scale (x/y); rotate; mirror (x/y, specific azimuth).
- Cut inside/outside: Edge elements cut, suppressed or fully included.
- Merge of several vector files or parts of files.
- Structuring of vector data in different layers; selection of layers or element groups.
- Turning on/off and change of line interpolation.
- Detection and elimination of duplicate elements.
- Algorithms for data reduction and line simplification.

2.5 Editing of raster data (line art)

- Different shapes of brushes (round, square, rectangular, flat,…).
- Variable line thickness (1–n pixel).
- Freehand drawing mode in order to create irregular structures (cliffs, hachures,…).
- Drawing mode for lines and linestrings.
- Drawing mode for geometrical objects (squares, rectangles, circles,…).
- Positioning of symbols: Interactive, automatic (using coordinate file), horizontal, vertical, rotated, reduced, enlarged, repeated (within an area, along a line).
- Selection of any section (pixel groups) and manipulation of its content: Delete, recolor, cut, insert, copy, scale, distort, rotate, masking and Boolean operations.
- Filling of areas formed by contours consisting of one or multiple colors (even in different layers); with incomplete contours („viscous“ filling): Global, local, full, textured.
- Area spread by n pixel.

2.6 Editing of vector data

- Editing of 2D and 3D data.
- Attributing, selection and manipulation of element by type color and layer.

- Symbolization of vector elements after map legend; „WYSIWYG“ display (Fig. 1).
- Possibility of detailed editing of symbolized elements (e. g. road junction).
- Global change of map legend and all symbolized elements.
- Construction, placement, deletion and modification of linear map elements:
  - Construction: Lines, polygonal lines, arcs, interpolated curves (splines, Bézier), combinations.
  - Placement: Single, connected, variable, parallel.
  - Deletion: Complete, partial, grouped.
  - Modification: Prolongation by distance x, prolongation till next crossing, cut, move, move vertex, move parallel, copy, copy parallel, group/ungroup, simplify, type, color, layer; underpass/overpass, tagging of contour lines.

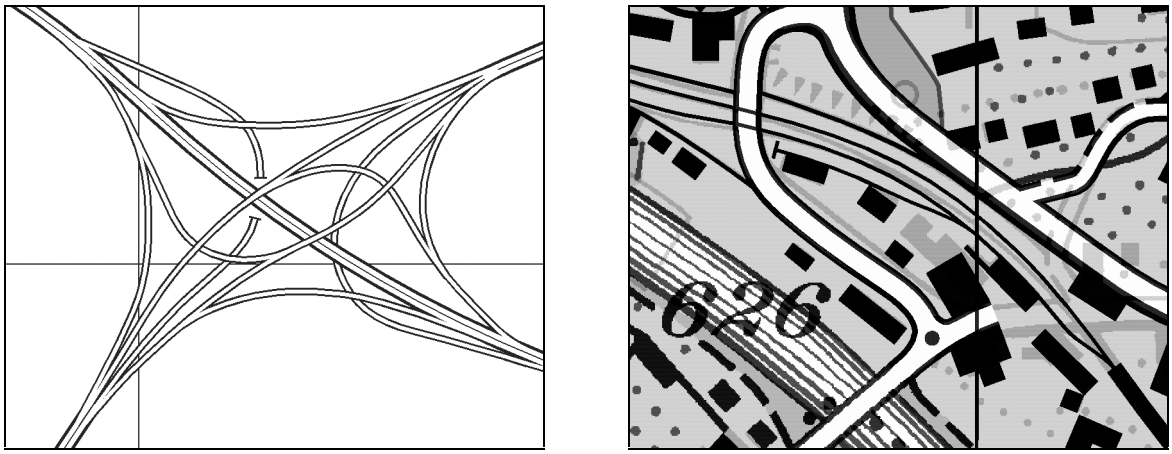

Fig. 1/2: Symbolization of vector-roads (left), hybrid WYSIWYG display (right).

- Construction, placement, deletion and modification of simple area map elements and symbols:
  - Construction: Rectangles, polygons, orthogonal polygons, circles, symbol cells.
  - Placement: Interactive, automatic (using coordinate file), horizontal, vertical, rotated, enlarged, reduced, repeated.
  - Deletion: Complete, partial, grouped.
  - Modification: Type, color, layer, group/ungroup, simplification.
- Construction and modification of complex area map elements:
  - Construction: Digitalization, construction from existing linear features.
  - Modification: Gap filling, closing of area, adaptation to neighbor areas, fill with textures, area attributing by centroids, other manipulations (like above).

2.7 Hybrid processing of vector and raster data

The combined (hybrid) editing of vector and raster data is essential in a modern digital cartographic production environment. The raster format is needed for scanning existing analog map originals. It is necessary for image transformations, for area manipulations and masking operations. Furthermore it is needed for the output of print-ready films on a laser film recorder. If necessary, new vector elements must be adapted to the existing map image. Then they must be symbolized according to the map legend (usually during rasterization) and be united with the raster graphics.

2.7.1 General demands

- Placement of vector and raster layers into foreground and background according to the user's needs. Possibility of almost simultaneous editing: Fast switching between the two modes.
- Cartographic objects can be extended over several layers. They must be simultaneously manipulateable.
- Possibility of hybrid plotfiles with raster data and symbolized vector data.

2.7.2 Vector ⇒ raster conversion (symbolization)

- Definition of all map elements in a symbol/style library according to the map legend.
- „WYSIWYG" display on screen to avoid conflicts between map elements (Fig. 2).
- Automatic adjustment of dashed lines between start and end point. Possibility of interactive, local adjustment in order to avoid gaps on bending points.
- High quality of symbolization/rasterization at any resolution.
- Definition of different styles of line terminators and bending points.
- Global and local vector ⇒ raster conversion.

2.7.3 Raster ⇒ vector conversion (symbolization)

- Batch vectorization, global and local.
- Supervised, semi-automatic vectorization.
- Vectorization of double lines (axis).
- Vectorization of dashed and non-symmetric lines (axis).
- Vectorization of lines with different thickness, classification according to thickness.
- Pattern, symbol and text recognition functions.

2.8 Text processing

- Import of any vector font in different formats (PostScript, TrueType,…).
- Interactive placement of text objects with different text attributes.
- Automatic placement of text objects out of name databases and other pre-formatted text documents, automatic attributing.
- Text placement along a smoothed (interpolated) vector line.
- Variable change of text attributes as font, size, orientation, character spacing, word/symbol spacing, line spacing, color, bold, italic, shaded, superior,….
- Interactive change of existing text objects: Move, rotation, alignment, centering, deletion, re-attributing.
- Global change of text attributes using a formatting table.
- Export of names, positions and attributes in a report file.

2.9 Processing of continuous tone data (image processing)

- Display of shaded reliefs and orthophotos with 256 gray values (8bit).
- Display of color images (RGB, 3 x 8 bit).
- Global transformation of gray values: Change of gradation, contrast, brightness,….
- Local change of gray values: Filter operations.
- Interactive retouching.
- Reduction of number of colors.
- Rectification, fitting onto vector data and binary raster data.

2.10 Data output

2.10.1 Output on film (laser recorder)

- Maximum film format needed?
- Devices for exact positioning of the film on the scanner.
- Variable resolutions; high resolutions (≥ 2 x input pixel resolution) recommended.
- Choice of variable screen percentages, angles, frequencies and dot shapes.
- Recording of different screen percentages, angles and percentages on one film.
- Recording of screened continuous tone images (AM and FM, Fig. 3/4).
- Combined recording of line art, screened tints and screened continuous tone images; clearing of single elements against background elements.
- Combined recording of raster data and symbolized vector data (RIP, online/offline rasterization).
- Batch oriented lithographic copy work: Screening table containing raster layers with information about priority, masking, overprints, effective depth, CYMK values.
- Output of map extracts.

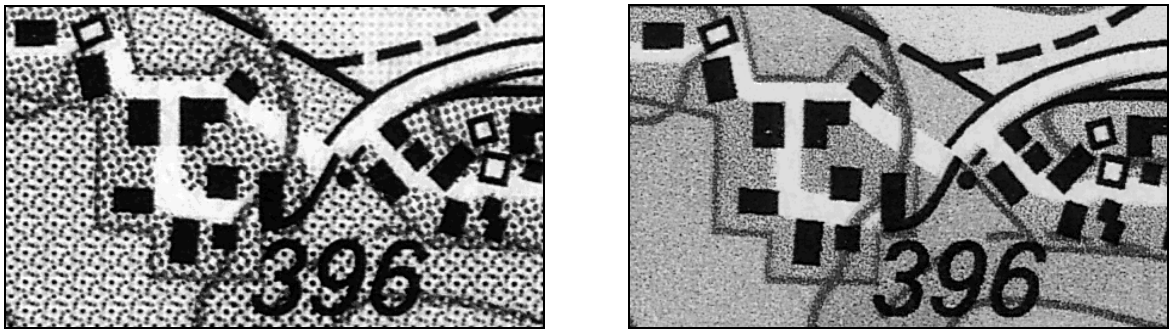

Fig. 3/4 Conventional AM- (left) and FM-screening (right), 4-colour offset printing.

2.10.2 Other output

- Output on hardcopy devices (printers, digital proof devices) and softcopy devices (computer screen).
- Output of map data in different raster, vector and hybrid formats.

2.11 General demands on computer equipment

In this section, general demands on hardware and basic software are given. Depending on the specific task, the configuration can differ from case to case, of course. Thus, only the most important topics are listed here. More information about how to define a „scope of duty“ for computer system evaluations can be found in SVD (1985).

2.11.1 Hardware

- General requirements (processor, RAM, etc.).
- Communication.
- Periphery devices.

2.11.2 Software

- Operating system.
- Graphics standards.
- System administration.

- Text processing.
- Backup, data safety.
- Communication.

2.11.3 Performance requirements

It does not seem useful to prescribe any MIPS, Spec, or similar indicators here. The interaction between different software modules and the peak load of graphic operations must be benchmarked separately using typical (large!) data sets and workflows.

2.11.4 General aspects

- Hardware maintenance.
- Update of software.
- Documentation of hardware and software.
- User training.
- Planning of installation.

3. Solution at the Federal Office of Topography

The major difficulty met during the evaluation process was to find a multipurpose system with good raster, vector and hybrid „WYSIWYG" functionality. This finally led to the decision to distribute the work on two systems: **MicroStation/IRASB** by Intergraph and **Dry/Nuages** by LORIK (Ertle/Lauinger, 1995). The resulting workflow consists of four major parts:

3.1 Input of map data

Existing map separates are scanned at a resolution of 50 lines/mm (1270 dpi) from film mounted on a white background. Extensive tests using the Scitex LRP scanner/laser film recorder have been made in order to obtain optimal results. Copying the films onto opaque material proved not to be necessary. At medium-term it is planned to replace the scanner by a newer model.

3.2 Preparational work

The scanned raw data is now imported into MicroStation/IRASB and MapPublisher/PixelPro by Intergraph. The system is mainly used for rectification, geocoding, Boolean and masking operations, automatic „dirt" remove and manual retouching in raster mode. Some deletion masks are also created in raster („brush") mode which proved to be more comfortable than in vector mode.

3.3 Interactive map updating

The main interactive cartographic work is done in DRY/NUAGES. Raster layers can be stacked and displayed in the background according to their correct priority. New, fully symbolized vector elements are placed on top of the raster background. The „WYSIWYG" mode allows to visualize interactions like masking and overprints between vector elements as well as between vector elements and raster layers. Finally, symbolized vector elements are „burned in" to the corresponding raster layers according to predefined color separation attributes of each element.

3.4 Output of the map data

The modified raster layers can be plotted on the same Scitex LRP laser film recorder. Conversion to Scitex Handshake format is done using Intergraph software. Special Boolean and masking operations could be done with Intergraph MapPublisher, if necessary. The Federal Office of Topography is currently evaluating a new large-format film recorder.

4. Future demands

Today, modern cartographic production systems allow to produce topographic and thematic maps entirely by digital methods. The produced maps have a high graphic quality comparable to analog products. In some areas like topographic area elements the production methods can be simplified and the quality of output and representation can be improved. Cartographic „finesses“ which are essential in order to create an easily perceptable map image can be worked out with modern „WYSIWYG“-based systems. The expenditure, however, is comparable to analog production. The advantage is effective when updating maps or when carrying out variant studies. In the future researchers and developers must focus on the combination of cartographic and topological (GIS) data models. Map elements often are placed according to design and generalization rules the way the map „looks well“. Topological rules are broken (Fig 5/6). Dual, consistent data models combining the two „worlds“ wait to be developed!

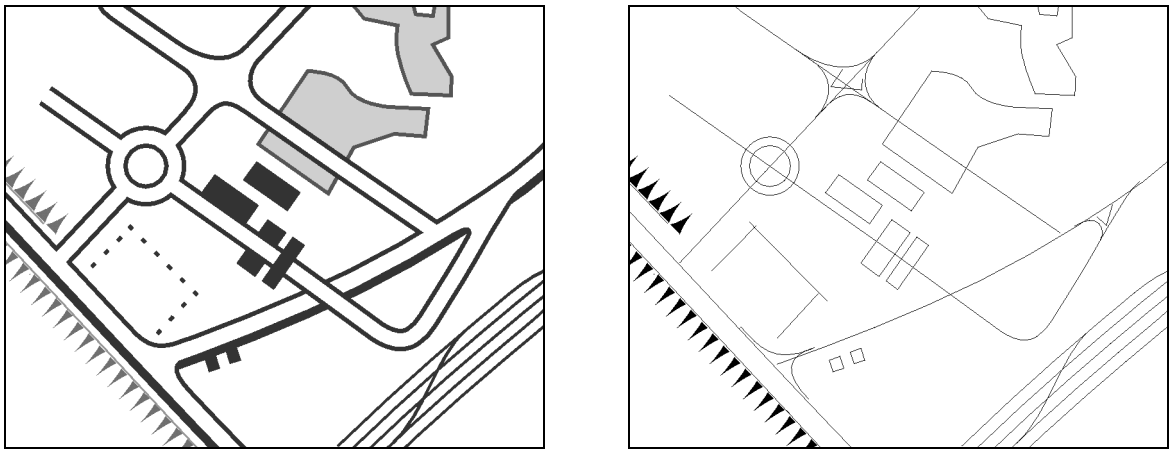

Fig. 5/6: Symbology turned on/off: Cartographic design breaks topology!

5. References

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