DATA-BASED MAP PRODUCTION IN MICROCOMPUTER ENVIRONMENTS: A PROFESSIONAL SOLUTION WITH THE NUAGES SOFTWARE PACKAGE

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Abstract

A joint project with ADAC (the German Automobile Club), Karlsruhe Polytechnic University and Pietruska Verlag & GEO-Datenbanken GmbH a concept for the production of a road map of Germany on different scales (1 : 150 000 to 1 : 500 000) has been developed. The concept aims at the cost-effective production of digital road maps of Germany from a uniform data base. This paper takes a closer look at the program employed, Nuages, and disusses its application on a practical production example.

1. Introduction

Over the last three decades the development and implementation of widely accepted computer systems have become a standard in map design and production. While the first computer-generated maps were rather simple in terms of graphic, modern desktop publishing programs (DTP) like FreeHand meet nearly all requirements regarding map design and illustration. Creating just „nice little pictures" is no longer satisfying - today the calculation of reference points in coordinate systems and the derivation of variations as well as the integration of these programs into data bases is required. The general trend is towards geo-information systems (GIS). However, these systems are still lacking a broad range of design features. In cooperation with the ADAC a concept has been developed which aims at the cost-effective production of digital road maps of Germany from a uniform data base.

2. Concept

The basic idea of this project was the creation of a digital graphic data base for the scales 1 : 150 000 - 1 : 500 000 [1]. All scales should be managed in the data base on a standardized scale. To derive smaller scales, sophisticated generalization steps are sometimes necessary. Automatic generalization in the computer would be ideal [2]. Despite intensive research, today only simple programs which select among identical items and which smoothen lines, work satisfactorily [3].
Generalization steps like simplification, displacement, classification and typification as well as evaluation [4] must be carried out before in the draft. In this context, some generalization tests have been performed. They showed that a single draft cannot cover the whole required scale range. As a consequence, 2 draft scales (1 : 150 000 and 1 : 300 000) were chosen that can cover scale ranges from 1 : 100 000 up to 1 : 500 000.
To accelerate the work and to reduce costs, the entire area to be depicted will be modeled by tiles. These tiles measure 40 cms x 40 cms. In order to put them together exactly, a new map grid for this area has been calculated. In a digital form, this grid is already stored in the computer. The corners of the tiles correspond to the geographic coordinates at the intersections of the grid. Now, any tile can be „inserted" into the grid and larger areas can be put together.

3. Production Process

In the following, the production process [5], as described in fig. 1, will be explained in detail.

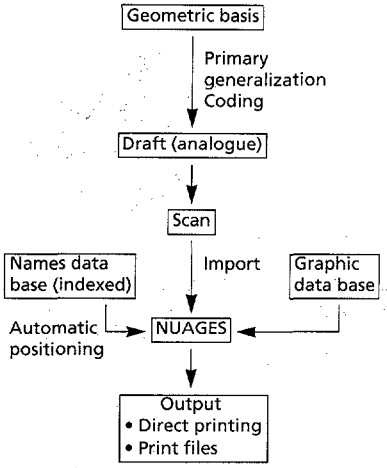

Figure 1: Production process.

3.1 Draft

The draft is created in an analogue way and refers to the layer structure of the Nuages program. Here, the map elements like hydrography, traffic networks etc. are stored in layers. Each of these layers is divided into sublayers. The traffic network, for instance, comprises the following sublayers: Highway, Expressway, Major Road etc. [6].

Topographic maps can be employed as a geometric basis. The draft on the foil is in ink and focuses especially on user-specified generalization requirements. On a road map, for instance, roads are the most important subject. If necessary, even the course of a drainage channel will be changed in order to achieve accurate depiction of roads.

Fig. 2 shows a segment of the topographic map 1 : 100 000. Fig. 3 contains the same detail with regard to the representation of roads.

On scale 1 : 150 000 the roads are depicted in black. The single road classes are indicated by different line widths. Therefore the course of roads is indicated by the middle line only. Later, during digitalization, the roads are pictured in their final width.

On scales 1 : 300 000 to 1 : 500 000 the roads are depicted in gray.

Generalization steps, as in displacing or simplifying, are easy to identify.

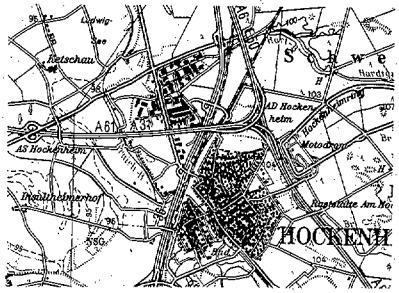

Figure 2: Segment of the topographic map 1 : 100 000.

Figure 3: Segment of the draft (roads) 1 : 150 000 (black) and 1 : 300 000 – 1 : 500 000 (gray).

The draft was specifically prepared for the computer. As such, the draft for the depiction of drainage channels (Fig. 4) also includes the line widths and the changes of line widths. This type of draft can reduce considerably the working-time at the computer.

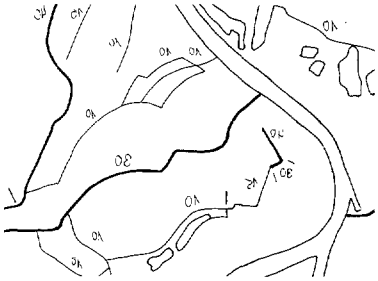

Figure 4: Draft (waters) 1 : 150 000.

13	Rössingen	6314	51,000	17,000	67308
14	Biedesheim	6314	90,000	2,000	67308
15	MARXHEIM	6314	97,000	43,000	67308
16	BELA	6314	103,000	57,000	67308
17	NIEDERHEIM	6314	110,000	47,000	67308
18	Zellertal	6314	95,000	50,000	67308
19	Einselthum	6314	82,000	61,000	67308
20	Eibisheiserhof	6314	38,000	11,000	67297
21	HEINSHOF	6314	21,000	33,000	67297
22	St. Paul	6314	1,000	81,000	
23	Kirchheim-Bolanden	6314	24,000	74,000	
24	"Deubergerhof"	6314	37,000	98,000	
25	Gollheim	6314	9,000	11,000	
26	Pfrimm	6314	20,000	11,000	
27	256	6314	28,000	21,000	
28	229	6314	6,000	27,000	
29	Leiselbach	6314	61,000	65,000	
30	299	6314	51,000	59,000	
31	317	6314	43,000	88,000	
32	296	6314	81,000	71,000	
33	Rhmsinger Berg	6314	36,000	23,000	
34	Nungerberg	6314	27,000	61,000	
35	Osterberg	6314	74,000	73,000	
36	HEUBERGERHOF	6314	11,000	96,000	67294
37	Alzey	6314	95,000	159,000	55232
38	Erbes-Budesheim	6314	25,000	182,000	55214
39	Neck	6314	8,000	161,000	55214
40	Bechenheim	6314	7,000	152,000	55214
41	Offenheim	6314	30,000	146,000	55234
42	Mauchenheim	6314	17,000	126,000	67294
43	Morschheim	6314	8,000	113,000	67294
44	Ilbesheim	6314	63,000	102,000	67294
45	WIMSHEIM	6314	74,000	153,000	55232
46	Frolsheimerhein	6314	69,000	129,000	55234
47	Wallheim	6314	64,000	131,000	55234
48	Zeselborn	6314	85,000	122,000	55234
49	Kertenhe.	6314	75,000	139,000	55234
50	HEIMERSHEIM	6314	45,000	185,000	55232

Figure 5: Segment of the name data base.

These drafts form the so-called analogue data base. Here changes, corrections and continuations are first registered before they are transferred to the computer. One reason for the development of this „complex" projection concept is based on the idea of create completely new road maps. Because of the new legend key, an adaptation of the previous maps to this key can no longer be realized. Since also new map elements will be added and due to the development of a whole series of scales, a completely new projection, that meets the requirements of computer based mapping, has been chosen. In this context especially the acquisition of text should be mentioned. All text is registered with regard to the coordinates and stored in a name data base (Fig. 5). With the help of a conversion program, the flat names can be placed automatically and then be imported into the respective program (Fig. 6). This option saves time and reduces the amount of corrections. Proofreading the names is possible prior to placment on the map. With the help of these data an index can be created within seconds. All names can be sorted in any desired way [7].

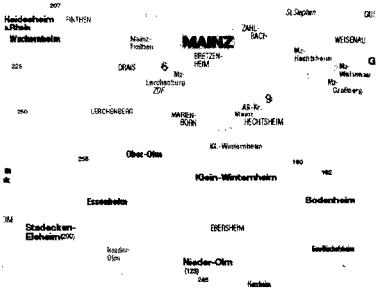

Figure 6: Segment of the automatically placed names.

3.2 Graphic Representation

The individual draft foils are scanned and digitized separately, depending on the subject. This means that the final formats and layers are assigned to the vectorized data.

Compared to ordinary DTP programs Nuages offers a far larger variety of tools for the cartographer, since the software has been developed by cartographers for cartographers [8].

For the experienced DTP user, the graphic user interface and the toolbar look familiar. Therefore, the training period is considerably shorter and mapping can be started almost immediately.

In Nuages the surface has no limits of the format. For the grid of Germany a file with a size of 6 x 7 m could be generated. Of course not all tiles can be „inserted" into it. However, with this program larger formats than with previous ones can be created. It is even possible to process files of several dozen MBs size. The largest map file handled in this context was approx. 60 MB which corresponds to a PostScript file of 80 - 90 MB.

Within fractions of a second background pictures and also other elements can be assembled exactly. For this, an identical point on the map is assigned to both pictures which must be made congruent. Several background pictures can be managed at the same time. While the scan on top covered all following ones, now the transparency of each scan can be adjusted individually. This way also the background pictures which are superimposed, remain visible. The size or the number of the background pictures have only little influence on the processing speed in Nuages.

There are unlimited zoom options. Any increase or reduction of size is possible. The zoom-stage receives the resolution of the original picture (Fig. 7).

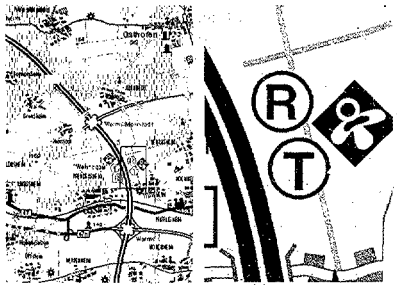

Figure 7: Left side: Original picture. Right side: Zoom.

The individual elements are filed in so called layers, which are divided into sub layers. By assigning additional priorities to certain formats another layer can be added. The layer structure created can be stored externally, i.e. it can be imported into any document. Files with the same layer structure can be added or put together at any time (Fig. 8).

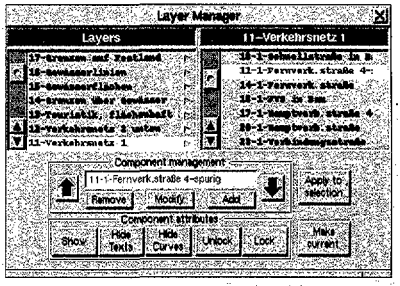

Figure 8: Segment of the layer structure.

In other graphic packages a road symbol had to be generated with the help of different formats and layers (contours and filling). Now complex formats, called „Special curves", can be generated with Nuages. A highway symbol that was created this way for instance is assigned to one layer only.

During digitalization of this format the complete symbol is displayed immediately and steps like „Cloning, Assigning a format, Assigning a layer" are not employed at all. These special curves can be stored in a unique format file making them available for all documents.

Another function that has been especially developed for road cartography is the bridge function. To date, over- and underlying of streets could only be created with sophisticated methods, but they were nevertheless necessary for the sake of accurate and high quality cartography. For this problem Nuages offers a smart solution. Only the superimposed segment of the road is marked and then the bridge function is used. Now this road lies over the other one, although no modifications were made in the layer structure.

Another advantage, the automatic placement of names, has been mentioned before. Text can easily be imported into Nua-

ges. However, text can also be handled in the usual way. Furthermore, text management in a data base offers the option of storing additional information like zip code or administrative district for each name.

Generally, Nuages offers a broad range of options for the representation of text. Text can be placed along any line without having to generate an additional, parallel line. Self-defined text settings (Font, size, effects, lockings) can be stored in a text format. This data is included in a unique format file which can also be used for other documents. The possibility of combining special curves and text formats is very advantageous (Fig. 9). A distinct line type can be assigned to every text format. If a text is being placed along a line, it immediately receives the attributes of the text format that is linked to the line. Especially for the creation of city maps (street names) this function saves a considerable amount of time.

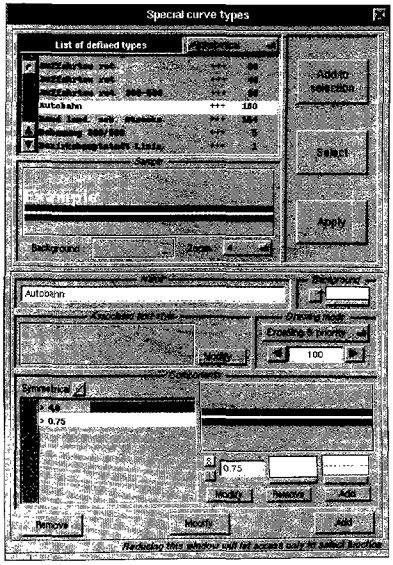

Figure 9: Special curve panel. Combination of special curves and text formats are possible.

Symbols can be generated by the user and be imported. Later they can be stored in a symbol library, which is part of a unique symbol file. The symbol library can also be used with any other document. Placement of the symbols is performed by selecting a symbol from the library. By means of a special symbol tool it now can be directly positioned at any point. Here duplicating and moving the symbol is not required.

Lines with a parallel offset are generated automatically (Fig. 10). This way e.g. colored strips along certain roads can be generated immediately by simply entering the format and the distance to the road. The adaptation of curves is performed automatically.

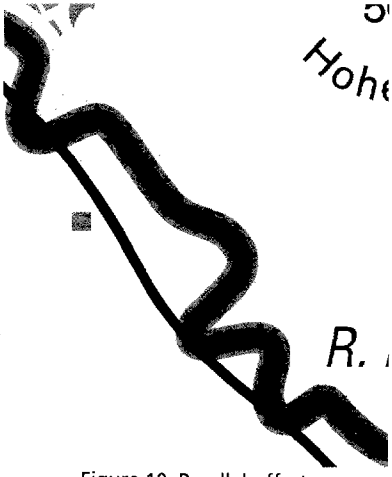

Figure 10: Parallel offset.

Any detail can be copied from an existing file. One example for this option is the production of an atlas page. Here the layer structure, the formats as well as the symbol and the text files are copied too. This function and the capability of generating large surfaces ensure easy work without sheet cuts.

Nuages offers the option of generating *user-defined search grids automatically.*

With the help of this search grid an index of all text items can be created. But Nuages does not only have a right-angled search grid. It can also generate geographic grid projections. Presently the Lambert projection is already included and Mercator as well as UTM are being prepared for the system. Furthermore, efforts are made to create an option which allows the user-defined creation of grids.

It is easy to see that apart from existing graphic design possibilities Nuages offers a broad range of additional functions which will meet with general approval among cartographers. Development and optimization of the program is making rapid progress. Storing is already performed in a coordinate-related Nuages format. The next step would be a direct link to the data base and the display of coordinates for each object.

3.3 Derivations of Scales

The elements that are now stored in a digital form are referred to as total data stock or digital data base. First interactive corrections can now be performed on screen. Here, the boundary between two tiles should also be reworked. The required detail can then be determined, even over several tiles. The desired scale can now be obtained by reducing the size of the entire detail. For a page in an atlas for instance, a frame can be created. Also page numbers can be added or a search grid can be superimposed. Output data can directly be transferred to the printer medium (film plotter, color inkjet, . . .).

Figs. 11 - 13 show a proof of the derived scales 1 : 150 000, 1 : 300 000 and 1 : 500 000.

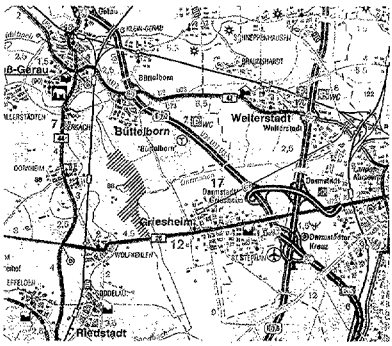

Figure 11: Segment of the scale 1 : 150 000.

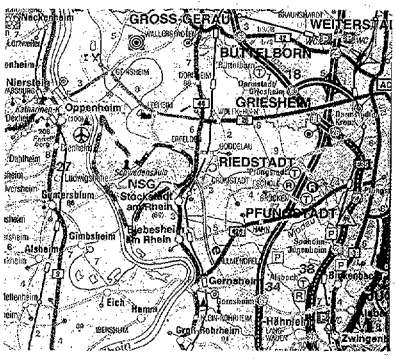

Figure 12: Segment of the scale 1 : 300 000.

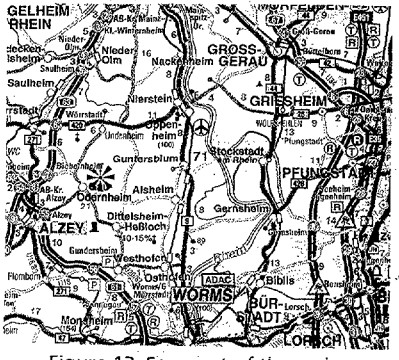

Figure 13: Segment of the scale 1 : 500 000.

4. System Requirements

Nuages is a software package for the vector-oriented creation of maps. It was programmed completely with Display PostScript and will therefore deliver PostScript-files. Links to DOS and Macintosh are possible. There are no restrictions on the choice of input- and output devices (PostScript compatible).

According to the manufacturer, the hardware requirements for this project include:
- 486 CPU, 66 MHz
- Special video card
- Special Bus architecture
- Min. 500 MB hard disk (because of the dynamic memory)
- VGA monitor, any size
- NEXT operating system (combination of graphic user interface and UNIX)

Practice has shown that these are absolute minimum requirements. Processing speed is not very high and files larger than 20 Megabyte cause problems. For the creation of larger maps, a hard disc with at least 1 Gigabyte should be available. A computer with a Pentium processor or a workstation are strongly recommended. All components should be well-suited to each other in order to avoid compatibility problems. Such a system is more expensive, but less troubleshooting is required. The monitor should be as large as possible for ease of use.

5. Investments and Prospects

Creating completely new road maps on scales of 1 : 150 000 to 1 : 500 000 involves investments and costs exceeding 10 million DM. By incorporating additional funktionality like auto rooting systems (in connection with GPS) the turn around period will be reduced to a few years. Today there are no differences between digitally designed maps and conventional analogue ones. The representation of details in a digital map (especially on scale 1 : 150 000) can even be better than in an analogue version. By linking additional background information, an interactive product can be created from the digital map data which offers a completely new range of applications to the map user.

6. Summary

After the project had been completed and evaluated, it turned out that this mapping concept is feasible. Nevertheless, the draft must be prepared very carefully since it is the basis for all subsequent working steps.

Since a program like FreeHand had not been able to meet all requirements optimally, the Nuages program was chosen. The decision not to use a GIS was made due to the lack of sufficient and flexible cartographic design capabilities of commercial productions. This decision was also made against the background that neither color- differentiated output in Euroscale nor automatic generalization were possible. Other reasons were the long training periods and high investment costs of the system.

Primary digital acquisition can partly be performed by other vector-oriented graphic programs. This way production costs can be reduced. All elements that are depicted as lines or areas can easily be imported into Nuages. For elements that are depicted as points Nuages offers faster processing capabilities (symbol library) than other programs. Text on the map is managed in a data base and can be positioned automatically.

NUAGES is a software package that was especially designed for use in cartography. It offers many additional functions and new tools. Later the workstation can be turned into a complete geo-information system by linking it to a data base. Since the program is an open system, there are no special hardware requirements. The program is being constantly enhanced, so

further new features can be expected.

The mapping concept was tried out on a detail that comprised 2 tiles. After evaluation, it can definitely be stated that this concept makes cost-effective production possible. Enlarging the project throughout Germany would of course lead to additional optimization of the working process and time-related coordination.

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