PUBLISHING TOPOGRAPHIC MAPS USING POSTSCRIPT PAGE DESCRIPTION LANGUAGE

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ABSTRACT

PostScript page description language is an excellent interface when transferring graphic data. Because of its power of expression it is also widely used in various publishing applications. Still, from a cartographic viewpoint several problems exist when dealing with topographic maps and the traditional concept of applying PostScript technique. This paper outlines these problems, it also gives a description of the solutions found and an overview of the developed systems using the language to publish topographic maps over Finland.

1 BACKGROUND

The National Topographic Data System (TDS) consists of the Topographic database (TDB) containing the most detailed general topographic data with nationwide coverage and the map databases, which are generalized from the TDB. All functions and data of the TDS are managed under the MAAGIS system - a geographic information management and map production software developed in the National Land Survey (NLS). The data compilation and map production are decentralized in our 12 local offices around the country.

The standard graphic products derived from the databases are
- the Basic Map 1:20 000, 3700 sheets (in four colours),
- the Topographic Map 1:50 000, 360 sheets (in five colours) and
- Aerial Photo Maps 1:5 000 to 1:10 000, a hybrid product consisting of digital orthophoto and selected set of vector features from the TDS on it (in four colours). This Topographic Map Series forms a new product family with a uniform outward appearance and cartographic representation intended to offer good readability and clarity. [1,2,3]

2 MAP PUBLISHING PROCESS

In this paper the term "publishing" means those late stages of the map making process in which printing film originals are produced from a map database. Later stages are, for example, the making of plates for printing and printing itself. Publishing processes is probably the field of graphic technology that has changed most rapidly during the last years. Desktop publishing has been daily work in newsrooms and advertising agencies for a long time. Also desktop map publishing has become general since the availability of map data and the capacity and features of PC-based systems have improved while their prices have become reasonable. Especially the status of PostScript page description language as the de facto standard has made it easy for the publishing systems to expand.

The topographic map publishing processes of the NLS have changed dramatically during the last few years since we have changed from manual processes to fully digital map production. First experiences were obtained by using commercial map publishing systems (Scitex R280, Intergraph Map Publisher). Now we are changing over from these to self-developed PostScript-based processes. The NLS has used these processes for more than a year now as a part of our geographic information systems; publishing topographic maps using PostScript is a new technique in Finland.

3 POSTSCRIPT PAGE DESCRIPTION LANGUAGE

PostScript (Adobe Systems, Inc. 1985) is an expressive programming language with a full set of graphic commands. Because of its stack logic it may call for a little habituation as a programming tool from those who have been programming with more traditional languages. Originally the PS language was intended as a device independent laser plotting tool but the use of it has expanded to storing images and more and more to transferring them from a system to another (EPS, Encapsulated PostScript). Typical fields of use are logos, labels, posters, advertisements.

By means of PostScript both vector and raster graphics can be presented. Hybrid graphics, i.e. the combination of these forms, is not a problem either. In vector graphics an image is expressed by means of a mathematical expression in an orthogonal system of coordinates, by using points, lines, areas and texts. In raster graphics an image consists of picture elements called pixels forming a regular grid. The basic idea of PostScript is that the graphics generated by the interpreter's raster image processor (RIP) paints an originally white drawing surface in the sequence of the PS program execution. Later drawn objects ink out those drawn earlier. White, "paper coloured" pen is a pen among the others. Patterns can be freely and handily defined as tiles, i.e. pattern elements, which are to be duplicated to cover the line or area object to be patterned.

Linear transformations are important when compiling or manipulating an image. The image or a part of it can be shifted, rotated and scaled. The orientation of the coordinate system can be altered, too.

The colours of vector graphics can be chosen freely from the colour space of the colour system in use. The most common colour systems besides the gray scale are RGB (red, green, blue), the colour system of visual display units, and CMYK (cyan, magenta, yellow, black), the process colour system widely used in printing. The colour resolution of a grey scale image pixel can be chosen from 2 to 4096 (1 to 12 bits). Correspondingly the resolution of a full colour image pixel can be selected from up to 4096 values per colour. The number of colours here is three (RBG) or four (CMYK).

The angles and density of halftone screens, as well as the shape of the litographic dots on the screen, can be selected freely. Most often round or elliptical dots are used, but a halftone image could also be made up of parallel lines crossing the image. Colour separation to a CMYK image is trivial. Good methods to "separate" cyan, magenta, yellow and black from an RGB image have been introduced, too.

4 SEEKING A SOLUTION TO THE BOTTLENECKS OF MAP PUBLISHING IN THE NLS

The map databases edited, ready to be published, come from MAAGIS environment. To be able to produce printing films as well, a commercial map publishing system, Intergraph Map Publisher, was acquired in 1992. The publishing process was based on resolving the map data in MAAGIS environment into its component parts - classified points, lines and text strings - and tranferring them to the files of the publishing system. In a map publishing system the graphics is generated over and over again for each map sheet. Thus, the map representation technique has to be defined for each separate product. The publishing process turned out to be rather complex, consisting of batch jobs and several necessary interactive operations between them. The final products, "digital printing films" are in a format that can only be plotted by using Intergraph's laser plotter.

The system worked and still works, but the elapsed time needed per a map sheet has not met our expectations. To achieve the planned volumes of production, remarkable additional investments to both hardware and personnel would have been needed.

NLS started to make some experiments with PostScript language in the beginning of 1993. At first the goal was to increase the efficiency of statistical thematic map publishing. A PS driver was programmed in the MAAGIS software the same spring. Good experiences from statistical thematic maps lead to experiments with topographic maps, too.

5 POSTSCRIPT: SOME SPECIAL PROBLEMS AND SOLUTIONS RELATED TO TOPOGRAPHIC MAPS

It was soon realized that the traditional straightforward concept of applying PostSript would not lead to the hoped-for result. Problems were related to
- high data volumes on large map formats,
- the memory limits of PS interpreters,
- the number of printing colours limited to four and
- the fact that the interpreters produce not more than one raster layer from a single PS source page, which makes it difficult to carry out some necessary aesthetic operations available in most map publishing systems. To our satisfaction, all of these problems turned out to be solvable.

5.1 The data volume

High data volumes, often hundreds of megabytes per map sheet, did not appear as a problem since there was a PostScript interpreter available in the Intergraph map publishing system. The RIP of the system can efficiently enough produce a raster file (RLE) from a quite large PS page. The resulting raster file is in a ready-to-plot format for the Intergraph's Map Setter laser plotter. Especially the PS files of Aerial Photo Maps are big because a raster image is generally presented by using unpacked ASCII character encoding (hexadecimals) in PS.

5.2 Interpreter's limitations

PostScript interpreters have some limitations due to Adobe's standards. The most annoying limit, when dealing with topographic maps, is the fact that the number of polygon points of an area to be filled must not exceed 1 500. However, a typical water or swamp area in the Topographic database can easily consist of 10 000 polygon points. One possible solution would have been to split the areas to smaller ones - containing less than 1 500 points each - in the interactive TDS editing phase. But the credibility of the system required a more sophisticated solution: the output tools of MAAGIS software were reprogrammed so that the big areas are split, during the plotting, into pieces small enough.

5.3 The number of colours

Differing from the other maps of the Topographic Map Series, the Topographic Map 1:50 000 is printed in five colours. In addition to the four process colours, a compact brown is used in presenting the elevation theme. PostScript supports only four colours: though there is only "black and white" in the printing films, only four colours can be separated from a single PS source page. The problem was solved by plotting the elevation theme into a separate PS file.

5.4 Only one raster layer

Since a PostScript interpreter produces not more than one raster layer, and each graphic element inks out the graphics generated earlier, the plotting order determines, which objects are left to be seen in the image. Generally, to determine the plotting order is not a problem. Drafting in four colours on paper or other media causes no problems. However, when the colour separation is done to a four colour image there is often something missing from the printing films. For example, in a four colour image black text is black "down to the paper". This means that after colour separation the black text appears also in the other films as blank "text holes". This always weakens the print quality. When imposing big films and registering large map printing plates, slight inaccuracy can not always be avoided. Thus, the printing paper grins from the narrow openings between, e.g., blue water surface and the black text on it. The solution to this and other similar problems is to plot the map into several PS files, for example, all black objects in separate file. Often one colour separation is not enough and special treatment is needed to achieve necessary aesthetic requirements.

This problem makes it also difficult to carry out some of the operations available in most map publishing systems. One of them is the use of framed text masks. In this operation, for instance, black lines intersecting with black texts are slightly removed around the letters to improve the readability of the texts. The solution to this problem, too, is to split the data into several PS pages. One of these files could, for example, consist of black lines drawn first, then the black texts' borderlines drawn with a white, slightly thicker pen than normal, to erase the lines, and finally the black text itself. By splitting the map into several PS files all necessary mask operations can be arranged.

The method to split the map into several images before colour separation leads to the need to unite the data of each process colour later, after colour separations. The unification is logically an "or" operation. It can be made by imposing the films of the same colour and exposing them as the final printing film. However, since the Intergraph system is available at the NLS, the RLEs or "digital films" produced by the PS interpreter can be united digitally by using logical RLE operation "or" available in the system. Thus, just the final printing films need to be exposed.

6 THE POSTSCRIPT-BASED PUBLISHING PROCESS FOR TOPOGRAPHIC MAPS AT THE NLS

A PostScript based publishing process for the Basic Map 1:20 000 was brought into use in september 1994. The publishing is decentralized in our 12 local offices around the country. Local offices are responsibe for the content and final appearance of the maps. For each office an A0-size colour PostScript raster plotter was acquired, with sufficient memory. With the plotters, offices can output proofs with final cartographic representation. The maps are generated using MAAGIS PostScript tool. A full WYSIWYG (What You See Is What You Get) is achieved, except for some aesthetic nuances discussed in chapter 5.4.

After the local office has compiled and approved the map sheet for publication, the map database file is transferred through network to the Geographic Data Centre to carry out the final publishing process. The final process consists of two batch jobs. In the first, the PS files are created using MAAGIS software. For the reasons discussed earlier, several files are produced per map sheet. In case of Basic Map 1:20 000 there are ten files, three for cyan, three for magenta and two for both yellow and black. The PS files are transferred over network to Intergraph system. The other batch job runs on Intergraph. PostScript interpreter generates ten colour separated RLE files from the ten PS files. In the same batch process the RLE files of each four (or five, in case of 1:50 000 map) colours are united (logical "or" operation) to produce the final "printing film" RLEs for laser plotting.

The experiences from the PostScript map publishing system have been good. The publishing consists of batch processes only. During one night, typically, the "printing films" for 5-10 Basic Maps are produced except for the exposure. The NLS seems to achieve the goal set for year 1995, 321 printed Basic Map sheets. The PostScript publishing process for Topographic Map 1:50 000 was introduced in May 1995 and the first Aerial Photo Maps, 1:5 000 and 1:10 000, applying both vector and raster PS methods, were printed in January 1995.

References

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