1. Background and Objectives

A lot of touristic, travel and thematic maps are produced by using Desktop Publishing (DTP) software like Macromedia FreeHand, Adobe Illustrator or CorelDRAW. The advantage of these software programs are that they have a wide range of drawing and editing tools, a flexible layer structure creating map content and the map layout within one file and has low costs comparing to GIS (Geographic Information System). DTP software is most often used by smaller cartographic companies, for education and training at cartographic departments of universities or even in national survey departments.

However, maps made with DTP software are limited in order to keep the state of the art in digital cartography. Unless the DTP software has been enhanced by customizing or plug-ins its main weaknesses are:
1. No functionality for dissolving map distortion,
2. No Georeferencing system,
3. No imposing for a structured map set-up,
4. No specific cartographic drawing and editing tools, and
5. No database connection.

2. Approach and Methods

2.1 Map Distortion

In the early nineties' – when digital cartography emerged – paper copies of maps have been scanned, loaded as background layer and vectorized in DTP software. Improvement or updating maps has been conducted by adjusting manually scanned parts of maps into the background layer. The adjustment methods are limited in DTP software in order to dissolve distortion – due to poor scanning or paper distortion – by stretching the background map only horizontally or vertically or by rotating. Therefore, DTP maps are often completely or partially distorted in various directions, which cannot be solved by linear stretching.

Today, a lot of commercial or volunteer geodata are available to improve and updating existing maps. However, due to the distortion of the map they do not fit properly. Therefore mapping software should have possibilities to deal with map distortion in order to widen the range of the map's use. Moreover geodata cannot be placed accurately due to the missing reference system to real world coordinates.

2.2 No Georeferencing

DTP software has no possibilities to use a reference system for real world coordinates. Therefore, a graticule has often been drawn to give the map a reference to real world coordinate systems. However, this is only a workaround; geodata still cannot be placed automatically and accurately.

Today, the use of geodata is getting more and more important in order to produce and update map efficiently. This could be by using commercial and volunteer geodata (e.g. from geodata servers, geo-portals or OpenStreetMap data) for the basic content of a map, or by using specific geodata gathered with a GPS device by map publishers or customers e.g. hiking trails, favourite routes or point of interests.

On the other hand, the shifting from using paper maps towards digital maps, in order to profit of their advantages, like geolocalization and navigation, makes it essential that maps are

georeferenced nowadays. Consequently, mapping software should have possibilities to handle real world coordinate systems.

2.3 Unstructured map set-up

A structured map refers to a map set-up, where spatial objects (point, line and area features) can be topologically integrated and separated in a layer structure, which allows selecting features by its properties. These requirements are keys for data management and integrity in GIS. DTP maps do not fit into these requirements in many ways.

2.3.1 „Area" point features

In DTP software, point features are represented as area features, which are defined by several vertices (see Fig. 1a) and its centroid must be treated as the centre of its location. This coincides not always with its real location. In cartography point features may be located either by its bottom, centre or top etc. of the graphic implementation. An object represented with a plain view graphic implementation (e.g. boundary stone, height spot or tower) will be probably placed by its centre. An object represented in front view graphic implementation (e.g. camping ground, ruin or radio antenna) will be probably placed by its base. This causes problems when exporting these features into a GIS environment, because the export process cannot respect the map author's intention of the placement of the symbol. In order to achieve that point features of DTP maps can be used topologically integrated for GIS, mapping software should have possibilities to convert "area" point features into "real" point features, which are represented with one single vertex (see Fig. 1b) and its position according to its true location.
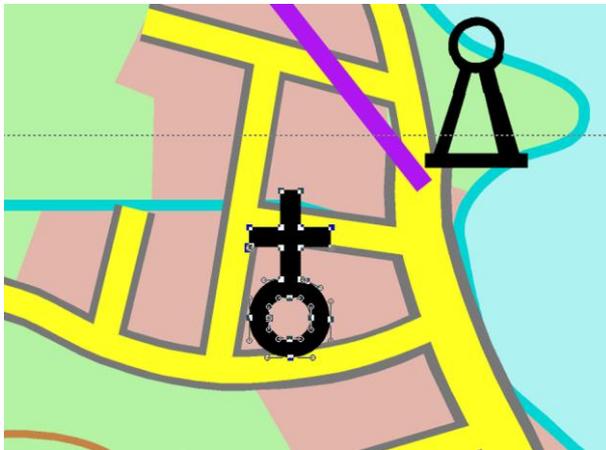

Fig. 1a: "Area" point feature represented by several vertices.

Fig. 1b: "Real" point feature, represented by one single vertex.

2.3.2 Redundant map features

With DTP software, features from a single type of symbol are usually placed within one layer. This gives the map a certain structured map set-up. However, for multi-coloured point or line symbols, other layers must be used achieving its proper graphic implementation. The symbol highway is composed by three line features; a very wide grey line (1st line; see Fig. 2) and on top a smaller orange coloured line (2nd line, see Fig. 2), both together appear as a double line with an orange fill-in and two grey side lines. Another line (3rd line, see Fig. 2) is placed on top of the two lines to represent the dual carriageway. This construction of a symbol produces a lot of redundant data, makes drawing and editing very time consuming and does not fit into a topologically integrated environment. Therefore a mapping software must manage sophisticate graphically implementation in such a way that it can be drawn and edited as a single line.
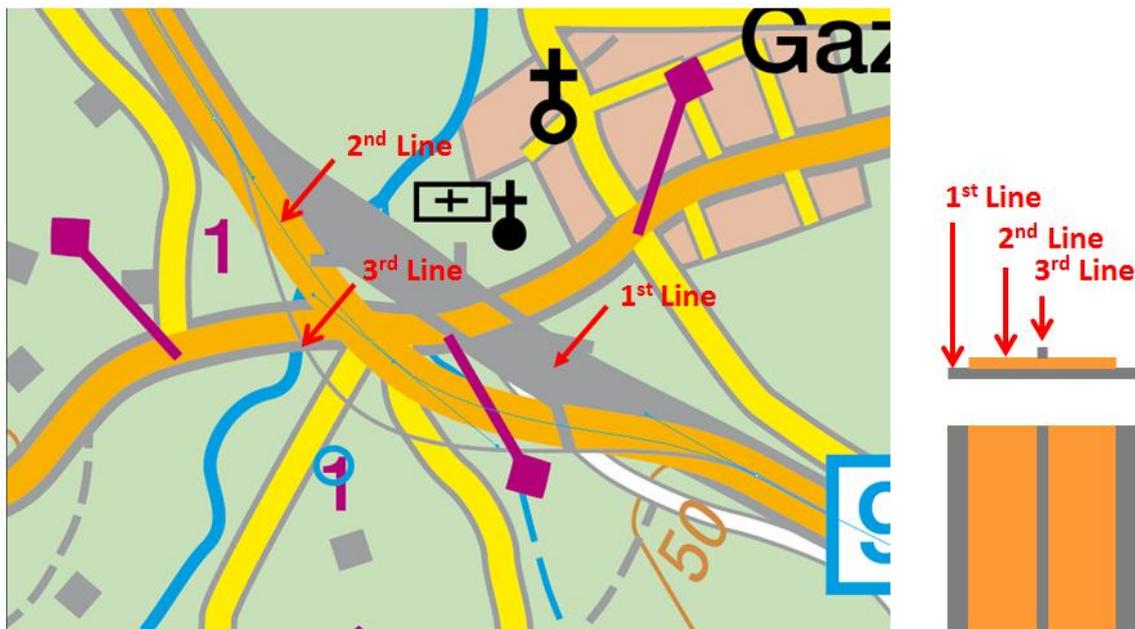
Fig. 2: Construction of a multi-coloured map symbol in DTP software. This example stands for many other multi-coloured or composed symbols like tunnels, bridges or pictograms.

2.3.3 Unique identifiable map features

In DTP software, features of a single type of symbols are usually placed into one layer. However, this can easily be side-stepped by dropping a single feature out of the related layer into any other layer. This causes a big disorder within the map. If a symbol is dropped out, it loses its original identification. Therefore, map features are not anymore unique identifiable and the map is becomes unstructured. Such an unstructured map set-up complicates the import into GIS very much. Hence mapping software must support a well-defined and structured map set-up to ensure proper import and export functionality for GIS.

These three problems, "area" point features, redundant map features or not unique identifiable map features – stated as *unstructured map set-up* – makes it difficult to manage maps in topologically integrated environments like GIS or mapping software.

2.4 No specific cartographic drawing and editing tools:

Graphic implementation in cartography is very important in order to produce legible maps. Hence specific cartographic drawing and edition tools like line tracing, automatic block out of street intersections or the influencing of dashed lines are required to produce maps efficiently. DTP Software has no own specific cartographic drawing and editing tools. Therefore, very time consuming workarounds – mostly carried out by cloning of existing features – have to be accomplished to achieve proper graphic implementation.

(a) To avoid sliver polygons, those tiny gaps between two neighbouring features (see Fig. 3a), line features are cloned identically and merged with other cloned lines to get an area which fits into its boundary properly. A sophisticated line tracing tool would improve an efficient map production.

Fig. 3a: Sliver polygon

(b) To ensure efficient drawing of street intersections, their side-lines should be blocked out automatically (see Fig. 3b). Instead of defining a proper style, this can be done by cloning the street features into a layer above and changing its graphic implementation in such a way that they will cover the side-lines. This causes redundant data and is inefficient in drawing and editing (see 2.2).
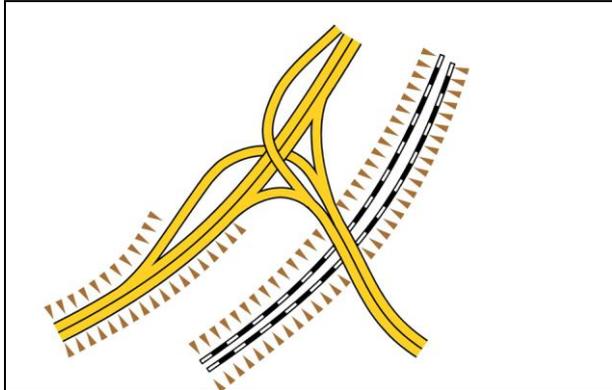
Fig. 3b; Automatic block out of intersections, under- and overpasses

(c) The use of dashed or dotted lines can lead to poor graphic implementation at intersections or sharp corners, if there is no option to influence the position of dashes or dots. Dashes are not automatically positioned perfectly and lead to misplaced gaps or to a single dot which does not represent the sharp corner point. Therefore, it should be possible to influence dashes, dots or any other periodic tags of line features.
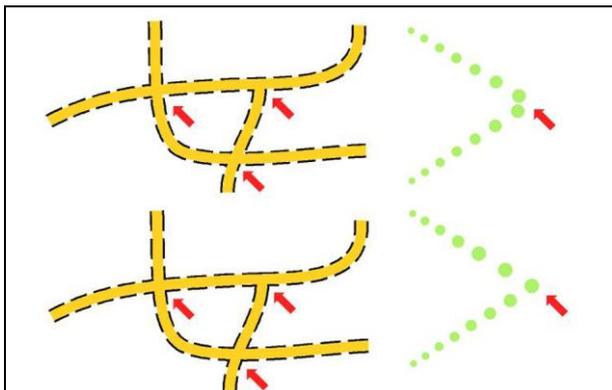

Fig. 3c: Influencing dashes and dots

These examples are representing only a few of many other specific cartographic drawing and editing tools, which are not directly available in DTP software.

2.5 No data base connection

DTP Software has no own data base connection to store additional information of map features, which should not be represented on the map but would be helpful for other authors, for instance information about objects, date of capturing, last editing or revision etc. Moreover, if the map should be used interactively to query properties of map features it is essential having possibilities to connect or set up databases.

3. Results

During the last few months, OCAD Inc. has been contacted frequently by map publishers who are still producing their map with DTP software. It seems that thousands of maps have been created by this method around the World. This is why map publisher are worried about getting stucked in a dead end, because DTP software has obvious weaknesses or will not be any more supported. For that reason, OCAD Inc. developed in collaboration with Huber Cartography (Munich, Germany) a workflow with its cartographic software OCAD 10, to

recover the data of DTP maps by migrating it into its cartographic software or even into a GIS.

3.1 Importing DTP Maps into OCAD

Importing DTP maps into OCAD 10 has been solved by a PDF interface, in order to reduce the number of interfaces for each DTP software and version. Therefore DTP maps have to be saved as PDF files by enabling the option for ASCII format, editable text format and embedded fonts. However, the experience of importing PDF files shows that the most critical parts are text and labels. Depending on the original software and versions, words could be split into single characters, which are useless for further editing. Supplementary investigation on this issue has to be done.

3.2 Dissolve Distortion and Georeferencing

Once the PDF file is imported, the next step is to dissolve the distortion. Therefore a rubbersheet function has been implemented into OCAD 10. This process adjusts the relative positions of features within a dataset based on a multiquadric equations interpolation [1] over the entire or optionally a section of the map. This can be done interactively by choosing iteratively several pairs of corresponding reference points. Using a georeferenced background map or a list of survey stations determining the corresponding reference points, the map will be georeferenced while dissolving the distortion.

3.3 Reduce redundant data

The OCAD software provides a powerful symbol editor, which imposes a structured map set-up: point features are treated as "real" point features, multi-coloured features can be composed within a single layer and features are unique identifiable. However, to accomplish such a structured map set-up the layers, imported by the PDF file, must be assigned to the current set of symbol (symbol library), which must be predefined. The assignment can be done iteratively or by creating a cross reference table, which can be executed for all imported layers automatically. This process reduces the redundant data.

3.4 Convert "area" point features into "real" point features

In another step, the "area" point features have to be converted into "real" point features. This can be done by a recently implemented tool of OCAD 10.

Processing the assignment of the imported layers and the conversion into "real" point features, the map is passed towards a topologically integrated environment and the whole functionality of OCAD, especially the specific cartographic drawing and editing tools, can be applied.

3.5 Database connection

Finally, all map features can be connected to a database, either by an ODBC interface to an existing database or by setting up a database from scratch by default. At this level, all map features can be exported into a GIS environment by a SHP or DXF file.

4. Conclusion and Future plans

With this workflow DTP maps can be structured in a way that they fit into a GIS environment or could be enhanced with other geodata and maintained with specific cartographic drawing and editing tools in its migrated cartographic software as well. However, if any GIS analysis has to be done with these data, it can be exported and re-imported anytime and it ensures that

map publishers do not have to rely on single mapping software. This workflow has been implemented successfully by Huber Cartography (Munich).
OCAD Inc. will improve this conversion process currently according the customer requests and wishes.

[1] Hardy, R. L. (1971): Multiquadric Equations of Topography and other Irregular Surfaces. Journal of Geophysical Research, 76, pp. 1905–1915.