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Contemporary Map Design with Desktop-Publishing System Extensions

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Zusammenfassung

Eine ansprechende und nutzergerechte Kartengestaltung bedarf genauen Gundlagedaten kombiniert mit einem ästhetischen Kartendesign. Dessen Realisierung fragt immer mehr nach kostengünstigen, stabilen aber soliden und flexiblen Mitteln. Hierfür bietet sich an, genaue GIS Daten und Funktionen eines DTP Systems zu kombinieren. Eine Antwort auf die Realisierungsfrage wird durch Desktop-Publishing-System Erweiterungen gegeben. Diese ermöglichen den Umgang mit Geodaten in einem Grafikprogramm, die dem Kartographen die Gestaltung attraktiver Kartenprodukte ermöglicht.

Summary

Generating pleasing and consumer-friendly maps demands data accuracy combined with an aesthetically pleasing map-design. This realisation requires for a low-cost, stable but common and flexible solution. Therefore a solution might be combining the accuracy of GIS data and the graphic processing functions of a DTP system. The answer is to build Desktop Publishing System extensions that are essential instruments for dealing with geodata in an environment that enables the cartographer create attractive map-products.

1 The Smart Way of Geodata Visualisation

In view of the growing technical possibilities as well as affordable price categories for nearly everyone, the use of and access to digital geodata is feasible for a broad public. From the financial point of view this is enhanced by infrastructure for purchasing. Not only official institutions but also companies and smaller agencies deal with geodata from data capturing via data modelling and analysis to data presentation according to the client's requirements. More often, the work of geodata-analysis outcomes, together with statistics, ought to be presented in business reports or publications which ask for the involvement of cartographers with a good feeling for graphic design and qualifications in multimedia techniques.

Together with many different representation possibilities, the data-sources have diverse origins with variations in quality. Its pedigree can vary from digital to analogue map-data coming from various dates and institutions, each with different levels of precision. These datasets can come from the Internet or purchased as self-contained sets on CD-ROM, etc. On the other hand, there is the huge field of GIS data available. In contrast to the aforementioned data, GIS data are of homogeneous quality. If the target is for the integration of data with diverse origins and homogeneous GIS data, the question of combining these diverse sources arises at this point.

GIS's basic functionalities offer tools for capturing, storing, checking, integrating, manipulating, analysing and displaying data that are referenced to positions

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on earth. Comparing with the needs we formulated beforehand, these tools cannot meet our needs. It seems to be important to look for processing methods that focus on cartographic-and graphic-forming aspects to satisfy the customer's needs of creating aesthetically pleasing high-end maps and graphic products.

With that we can take the advantage and benefit (VISVALINGAM 1996) from 'the powerful insight-generating and communication potential of cartographic abstraction' as well as including 'words, numbers and images as complementary vehicles of thoughts, not substitutes', a GIS cannot offer since the nature of present GIS is to just barely provide applicable cartographic and graphic tools. We have to look for another solution that provides a common tool at low-cost.

Special cartographic software products exist on the market, but only address a small user group. While looking for a topical, stable and flexible, as well as cheap and far reaching solution, we place emphasis on the possibility of various geodata being integrated into a DTP (Desktop Publishing) System, featuring excellent graphic processing functionalities for print and web-media output. Making use of graphic-software does not solve the outright, since they do not offer cartographic editing tools we need for solving our problem at time of purchasing, but provides an interface for integrating cartographic software modules. Common DTP programs offer such gateways in which an integration of the so-called plugins, programmed in C/C++, Basic or various scripting languages is possible.

With this alternative of harmonising, symbolising, generalising and presenting data in a DTP, data from varying origin can be included and adapted, as well as GIS data imported and combined with existing data. After necessary steps of adaptations the data can be exported to a GIS or outputted as a map, digitally as, e.g. web-maps or analogue on paper.

The Focus

The Institute of Cartography of the ETH Zurich develops such plugins for DTP software and can count some twenty years of experience on development and application. Formerly started with the THEMATIC and DIAMANT (HUTZER, HOINKES & SPIESS 1980) system for diagramming, we have since extend the functionalities. Today, we cover a variety of cartographic instruments, developed for Macromedia Freehand (HUTZLER 2000) and Adobe Illustrator, open for public domain. Beside data editing we focus on two tracks of development. First is the generation of tools for geodata harmonisation and second, data symbolisation.

In this paper, we will first deal with the function of tools for data harmonisation, which include instruments for correction, like the removal of garbage

and achievement of geodata consistency. Secondly, we will examine functions for data editing before we come to the broad avenue of data symbolisation. This covers symbolising topographic objects, functions for re-symbolisation and the main focus of thematic symbolisation covering the generation of symbols, diagrams and textures. After a few words on functions for GIS exchange, we will give you the keys for getting started with these Desktop-Publishing-System extensions and give you a head-start in creating pleasing maps.

2 Cartographic Functions

Cartographic functions, integrated in a DTP program, can help improve graphic functions through essential instruments for cartographic challenging map-design. The following two examples examine this closer.

Example 1: Matching a borderline to a watercourse that has an identical course:

With a few interactions, a satisfying cartographic achievement, using cartographic functions, can be carried out (see Fig. 1). Using only DTP standard graphic tools for matching the two objects in the same direction would have been circumstantial and hard to do. Each separate node would have to be moved individually or a part of the connecting line cut, then cloned, moved and rejoined. This even would not have taken into account that the endpoints of the lines now have another position and angle, compared to the original situation.

Example 2: Resulting objects processed with graphic tools versus cartographic ones:

Figure 2 shows the result of point elimination once carried out by graphic tools of the DTP, leading to false results.

Working only with DTP's graphic tools, the Douglas Peucker algorithm does not consider nodes and the direction. The nodes are not considered in the

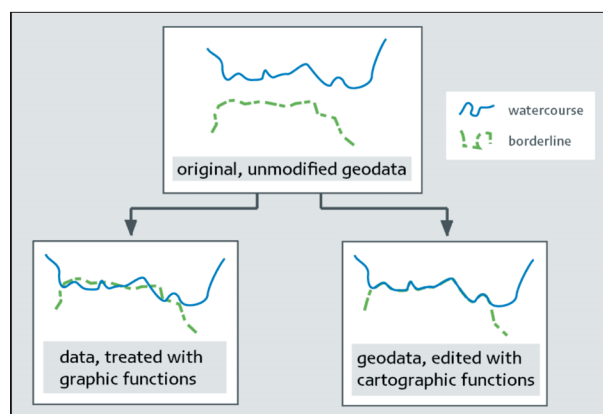


Fig. 1: Adaptation of Lines

DTP solution and its simplification is conducted in a specific direction. Therefore the data consistency is destroyed. Small, new and unintentional surface sections emerge.

These two examples show the importance of precise geodata processing done with cartographic functions in a DTP. The development of tools for editing the data in an accurate way for cartographic needs can be divided mainly into four parts, data harmonisation, geodata editing, symbolisation and GIS exchange. See Figure 3 for better visualisation and structuring, as the following chapters are based on this categorisation.

2.1 Data Harmonisation

The functions of data harmonisation deal with the revision, the qualitative and quantitative adjustment of datasets of varying sources and scales. Also, good-quality map-graphics often contain overlapping frag-

ments, copies or smaller objects. Those objects will not interfere with the presentation visually. Any further reuse in a GIS is thereby impossible. On the other hand, the data may have to be thinned out, i.e. interpolation points eliminated, before the vector-data can be utilised for map-graphics.

2.1.1 Topological Data Cleaning

The following tools are examples showing possible actions that belong to the category 'Topological Data Cleaning':

Marking and deleting equally positioned points

A point might exist with equal geometry in a series of successive points. As shown in Figure 4 there are 3 successive points with P2 and P3 at the same location. If not specially marked, this occurrence would not be visible and not be a correctable task. The occurrence of such phenomena can have various origins and can lead to insurmountable problems.

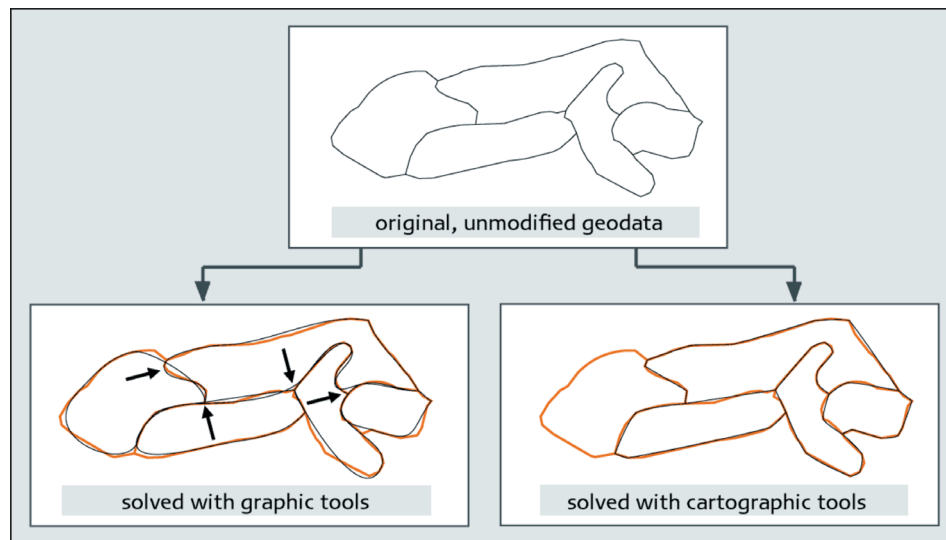


Fig. 2: Point Elimination

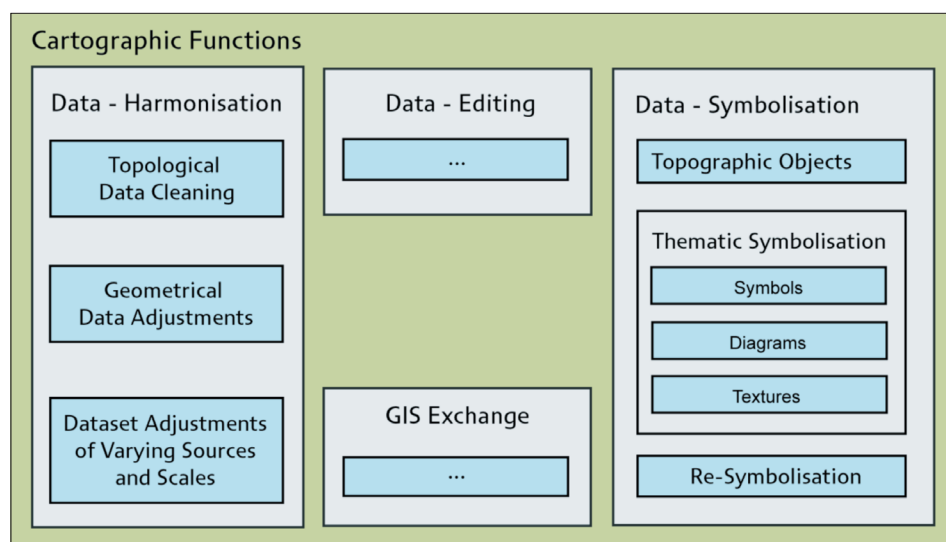


Fig. 3: Cartographic Functions, subjects of development at the IKA, ETH Zurich

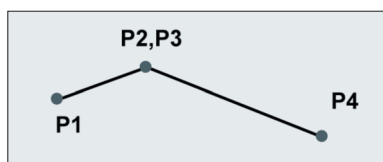


Fig. 4: Disposing equal points

Marking and selecting fragments as well as overlaying clones or copies

In the process of cartographic editing, e.g. blending of areas and lines, some elements which are not needed anymore, remain in the document. Similar to the first example are those fragments not visible if not selected. Applying this cartographic function selects these fragments and the cartographer can individually decide on relevance of the overlying elements.



Fig. 5: Overlaying copy (thick peace of line)

Connecting open polygons

Objects, connected at the ends are not necessarily connected in its topology but just graphically, although they might be defined with the same graphic style and lie on the same layer. Polygons with these geometric correspondences should be connected as one piece to be clearly addressable.

Next to these general applicable functions exist a series of DTP and object type related functions that help generate consistent data as there is the investigation and clearing of nodes from linear and/or closed objects. Other tools allow for checking the neighbourhood relationships of objects or combine and classify similar appearing objects, etc..

2.1.2 Geometrical Data Adjustments

Some main functions belonging to this part of cartographic functions will be described as examples:

Selecting small objects

Objects too small, e.g. in a dataset of an area with many small lakes that should be detected and filtered. Why? Especially when combining data of varying sources and the adaptation of scales, this function is often relevant. The tool can search for these little lake-areas by defined values of length or areas.

Snapping

Sometimes there are objects lying next to each other, just separated by small distances although they belong together. With help of this cartographic tool, a snapping distance can be defined and endpoints or nodes can be connected. On the one hand, there is the possibility of calculating the average distance.

On the other hand, one object or object-type can be locked on a layer and the unlocked point can move in the direction of the locked one and snap the chosen object-point.

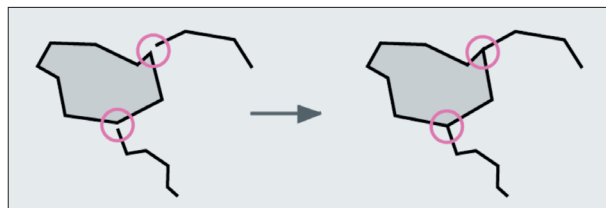


Fig. 6: Connecting nodes by snapping

Merging of points

When different map-sheets are compound, little off-sets can occur as shown in Figure 7. Those edges can be selected and points finally combined.

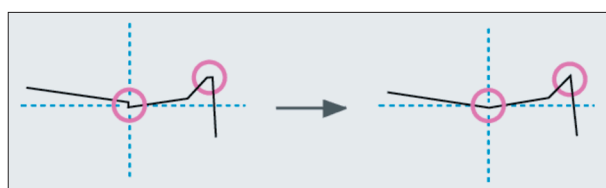


Fig. 7: Merging points

Reducing points

Please find this option explained in Chapter 2, cartographic functions together with Figure 2.

Pattern recognition

Scanned data mostly do not feature an exact presentation and are as often not combined to one object. This function detects such formations and substitutes it by a predefined symbol as shown in Figure 8.



Fig. 8: Recognising and placing substitutes

Rectifying and aligning

When raster-data is vectorised we mostly get displaced parts of objects that have to be readjusted. Using this tool can rectify the previously bent and slightly twisted houses as visualised in Figure 9. In a further step, these elements can be aligned to other objects automatically.

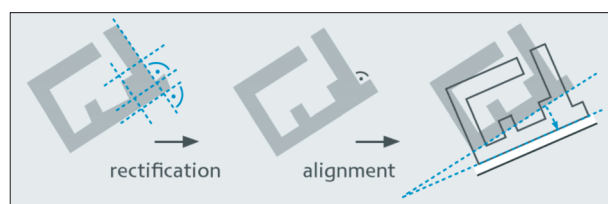


Fig. 9: Rectifying and aligning

2.1.3 Dataset Adjustments of Varying Sources and Scales

Additionally to the example and Figure 1, in Chapter 2 there are two further examples of local transformation to point out – the circular transformation and the local transformation with weighted vectors.

The Circular Transformation

With this cartographic function it is possible to move selected points which lie in a predefined circular area. The movement is declining from the centre point towards the outer edge-line. The black lines in Figure 10 are moved towards the upper-right direction. The original lines shine through in pink. The light orange dot marks the counterpoint, where the movement has its origin.

This function can also be inserted as Rubber Band Move, concerning small areas. The pink line in Figure 11 shows the centre-line while the black line is moved in direction of the vector for local adaptations.

The Local Transformation with Weighted Vectors

This function acts on the assumption that aligning two datasets of diverse sources and diverse scales include objects which are usable as reference for an adjustment. In many cases, these are watercourse-confluences which merge into larger rivers or into lakes (see Fig. 12).

Figure 12a shows the two geodata-sets laying on top of each other. The local transformation deter-mines

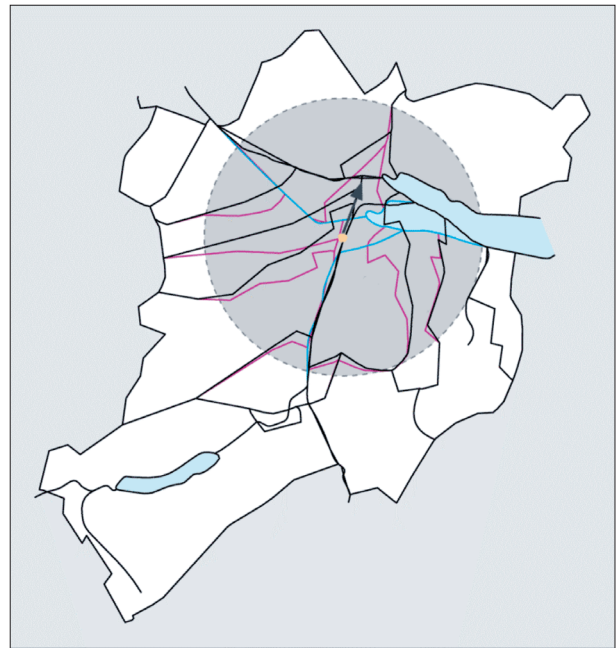


Fig. 10: Data movement based on circular transformation

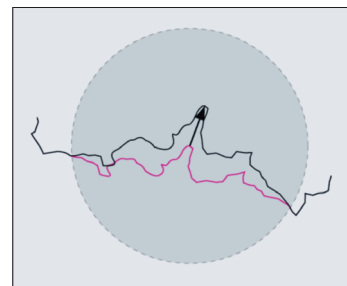


Fig. 11: The rubber band move function

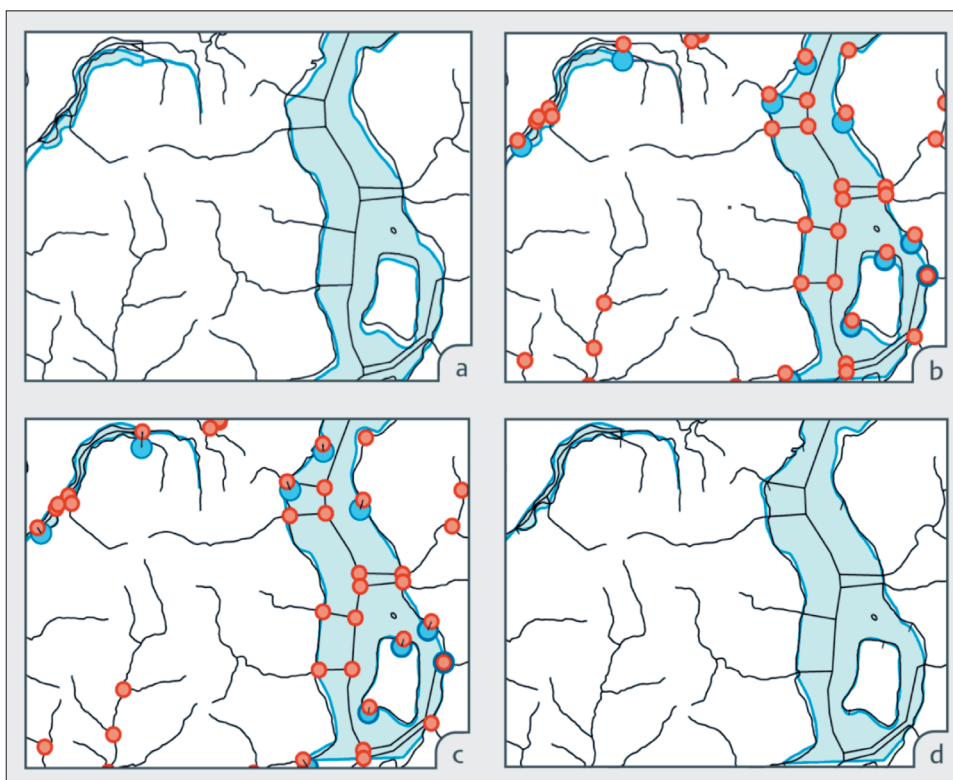


Fig. 12: Process of The Local Transformation

2.2.1 Dividing one object into peaces by placing nodes



Fig. 13: Making 3 path out of 2

2.2.2 Cutting between any objects after cartographic rules, e.g.:

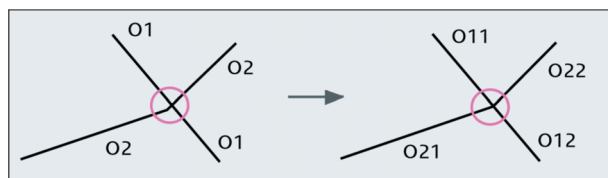


Fig. 14: Depressing too small, newly created objects



Fig. 15: Preventing from glancing intersections

2.2.3 Building areas

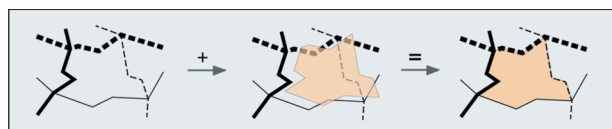


Fig. 16: Nodes of a selected area are detected and a closed polygon additionally created

2.2.4 Transforming linear objects into Bezier-curves



Fig. 17: Away and across several objects

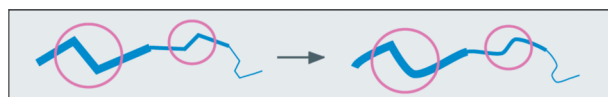


Fig. 18: With special conditions of tangents

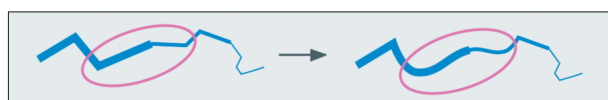


Fig. 19: Partially in-between a special section



Fig. 20: With smoothing; not heading through pre-defined nodes

the reference-points for the ideal value (red dot) and the actual value (blue dot) as nodes (see Fig. 12b). Now, those can be interactively revised and amended. After that, displacing vectors are determined (see Fig. 12c) and the proper transformation carried out. In this example-solution (see Fig. 12d) the weighted vector-elements are still visible as little black, straight lines. Controlled is this transformation by nature of the vector weight.

After this operational sequence, the cartographer can begin his individual corrective action. At this stage the question might come up if it affects the scale or generalisation. As matter of course, the generalisation should not be abandoned, but just the data of the smaller scale (see blue dots) adapted onto the larger scale by location.

2.2 Data Editing

Providing cartographic data for GIS use or data application in thematic maps asks for further and detailed structuring for example. Out of borderlines, watercourses and lakes, areas have to be built or areas need to be subdivided into smaller area-units. This or similar tasks ask for functions that are not provided by common DTP. Following, some functions of this category are presented.

2.2.5 Linearising Bezier-curves

Most GIS cannot recognise interpolated curves as graphic objects. For this case linearising of the curves need to be done. The point set and respectively the maximal accepted deviation can be controlled by parameters which can be individually chosen.



Fig. 21: Converting Bezier-curves into lines by a definite, maximum graphic deviation

2.3 Data Symbolisation

The main strength of DTP lays in possibilities to symbolise and this in relation to colour, texture and constructing symbols. For topographic objects we operate only with DTP functions. Merely for the pattern recognition of topographic symbols we make use of the replacing through symbol function (see Chapter 2.1. Data Harmonisation, Geometrical Data Adjustments). For this reason we can limit the cartographic supplement-functions in this chapter to a few focal ones, the thematic symbolisation of diagrams as well as textures and re-symbolisation.

2.3.1 Thematic Symbolisation

Diagrams

Statistical data in combination with positional coordinates stored in a table can be imported into a DTP system. The data is then converted and presented in symbol- or diagram-form with optional text-placement. The type of diagram may vary, depending on the data to be shown. An assortment of possible diagrams is presented in Figure 22. The first one (see Fig. 22 a) shows an area-proportional square-diagram similar to Figure 22b, a sector-diagram, where instead of the side length, the radius needs to be calculated. Here, the absolute total value shown as the radius is then converted into relative values of the sub-aspects. Variation Figure 22c shows one possibility of a wing-diagram, usable if values should be compared with each other. Figure 22d is another example of the same wing-diagram group that shows an area-proportional quarter-circle-diagram. Finally Figure 22e presents one more complex example out of the bar-diagram possibilities available, a divided bar-diagram. Simple bars or divergent bars can be generated as variation. Beneath these diagram-types the tool can automatically create choropleth-maps as well as triangular graphs.

When creating maps, we need to follow the commonly known and well described working process (for e.g. BERTIN 1983, SSC 2005, HAKE, GRÜNREICH & MENG 2002, IMHOF 1972, SPIESS 1992). Combined with the applica-

tion of these diagramming tools we suggest the following, based on detailed comments you will find in HOCHREIN (1986) and WERNER (2004).

1. Decision on a topic to be presented.
2. Analysis and concept.
3. Data gathering.
4. Scale, format and area of visualisation.
5. Base-map compilation.
6. Inquiry of possible type of diagram related to the statistical data.
7. Inquiry of scattervalue from statistic value – solution follows experience values of E. SPIESS, former Professor and head of the Institute of Cartography (SPIESS 1990).
6. Decision on graphic laws in terms of deciding on functions for representation.
7. Integration of statistical data into a DTP (at the Institute of Cartography this is Adobe Illustrator CS) & fitting in the diagram parameters from point 6 into cartographic functions for diagram creation.
8. Creating map-layout out of concept.
9. Checking graphic generalisation of diagrams and its elements; if not legible, the process starting at point 6 needs to be redone.
10. Re-positioning of diagrams, like creating less overlays or positioning the smaller one in the bigger diagrams and adjusting text-elements if inserted.

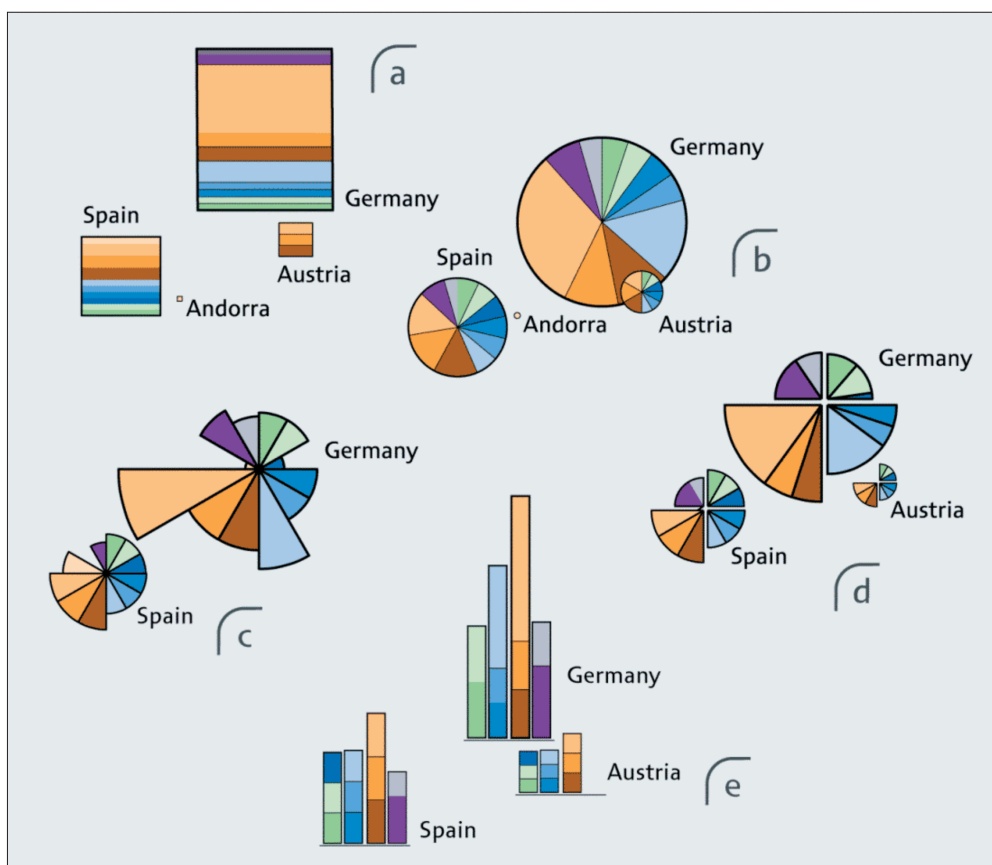


Fig. 22: Exemplary diagram-types generated with the diagram plugin

Texture

DTP software allows to generate patterns as a type of filling. Applying the pattern-filling to an area will create the same pattern you set as type 'filling' and multiplies it. Portrayed on a larger area the pattern-filling will look like a wallpaper-pattern, very similar and not scattered. Our cartographic solution relies on a basic pattern with a form of orthogonal, diagonal or honeycomb orientation. The first step for the cartographer is to create his basic shapes (example in Fig. 23).

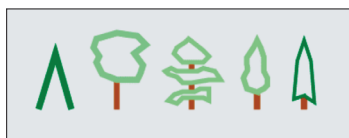


Fig. 23: Reference symbols

Then the cartographic function achieves an irregular dispersion by an independent X and Y random-deviation. Overlapping signatures will be demerged, that means dispersed or lead back onto the lattice points, and this until a minimal distance between the signatures can be achieved (see Fig. 24). For any of the areas, a raster is constructed and an individual minimal-distance to the edges defined. In the same way the tool observes separately defined minimal distances, observe obstacles which can be areas (islands) or lines (watercourses) (see Fig. 24b and c). This guarantees no truncation of signatures at no time. The pattern itself can be stud with various signature-types (see Fig. 24, e.g., a-pinewood, b-coniferous forest, c-mixed forest). Despite defined portions, the arrangement will be randomised (see Fig. 24c).

There is also the possibility to create various pattern-forms within one generation-process as to depict in Figure 25.

2.3.2 Re-symbolisation

This cartographic tool can change already placed symbols and creates substitutes in the legend, but the cartographer must take care of the surrounding neighbourhood. His job is then to re-adjust objects that surround the re-symbolised element.

2.4 GIS Exchange

Data imported from a GIS into a DTP system, have to be simplified, filtered and symbolised by cartographic functions discussed in the previous chapters. There is also a limited option to transfer attributes from GIS to DTP systems. For the GIS export it is essential to have consistent data and a data-structure that works with the GIS it will fit in. There exists also a tool for including non-graphic data as ID's, names or values to graphic objects. Those can then also be transferred into a GIS.

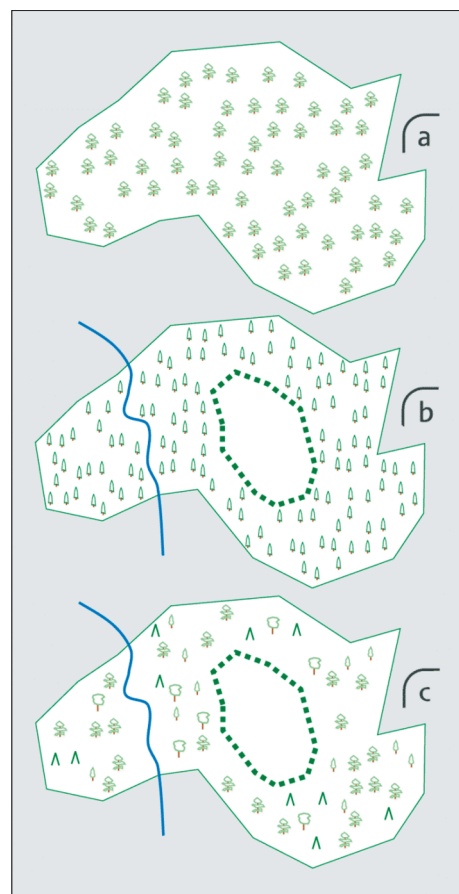


Fig. 24: Examples of irregular pattern

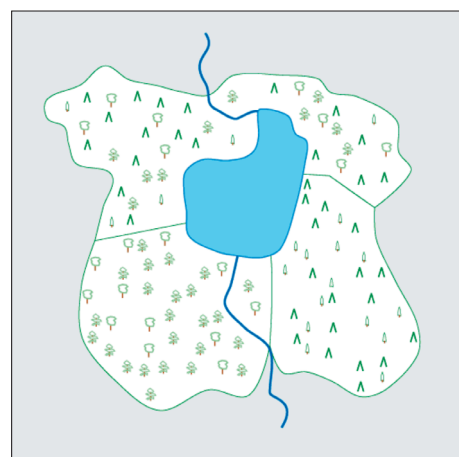


Fig. 25: Various pattern

3 Key for Getting Started

The first key leads you to the homepage of the Institute of Cartography at the ETH Zurich <http://www.karto.ethz.ch/>.

In the section 'services' is a link to 'downloads' where you will find the plugin packages together with the documentation. The DTP system extensions are now available for Adobe Illustrator CS2 and they are open to public domain. This service should also give en-

couragement for further development by everyone who might need special extras in accurate map-production. At the time of writing this report, we started to develop a problem-based user manual referenced to the Adobe Illustrator CS software version. Considering a dozen of real problems occurring during the map-making process, the interplay of the DTP, GIS and the additionally utilised plugins are shown. This step-by-step guide with accomplishing situation-examples and GUI-dialog-explanations, as well as its translations into English should introduce you to the efficient use of the DTP software system extensions.

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