CO-270

AUTOSTEREOSCOPIC DISPLAYS FOR THEMATIC MAPS

KNUST C.(1), BUCHROITHNER M.F.(1), DICKMANN F.(2), BRöHMER K.(2)

(1) Dresden University of Technology, DRESDEN, GERMANY ; (2) Ruhr University Bochum, BOCHUM, GERMANY

BACKGROUND AND OBJECTIVES

Autostereoscopic visualisation methods are nothing absolutely new or unknown for cartographers. For about fifteen years the Institute for Cartography of the Dresden University of Technology, Germany, has been working with various visualisation techniques that allow the user to perceive a spatial impression of the geovisualisations spontaneously and without any additional viewing means respectively that enable to see multi-view effects combined in one single map. (Please note, if in the following the authors refer to autostereoscopic displays, these include both the possibility to create truly three-dimensional effects and also the so-called multi-view effects which will be described in this paper in more detail.) Within the scope of several research projects different autostereoscopic display techniques have been tested at the Institute for Cartography of the Dresden University of Technology and have been used for innovative products, but mostly for the visualisation of the relief (cf. El Nabbout 2007, Gruendemann 2004, Kirschenbauer 2004, Knust and Dolz 2009, Marschner 2006, Schneider 2008). These projects demonstrate the high potential of autostereoscopic display techniques for the true-3D visualisation of relief information. Thus, we can guess that there is also a high potential for thematic cartography, but up to now this has not been investigated in detail. Actually, so far no concrete test studies are dealing with this topic.

In a current research project, a cooperation between the Institute for Geography of the Ruhr University in Bochum, Germany, and the Institute for Cartography of the Dresden University of Technology, the project partners are studying the potential of autostereoscopic display techniques, especially the lenticular foil technique, for thematic geovisualisations. A second step is envisaged to investigate the barrier stripes technique and how it compares to lenticular foil technique.

APPROACH AND METHODS

In the aforementioned research project a systematic investigation shall be carried out by means of empirical studies. The test persons must belong to groups as homogeneous as possible. In a first stage students of the Faculty of Geosciences of the Ruhr University Bochum as well as students of the Institute for Cartography of the Dresden University of Technology will be interviewed. From time to time it will be necessary to change the test persons in order to avoid learning effects which might distort the conclusions to be drawn from spontaneous actions.

In this project it is intended to study the perception ability of the map users and the information transfer efficiency of the thematic maps. How do they perceive the single map elements and how do they understand and interpret the context of the visualised topics of the maps. One objective is to find out which cartographic visualisation methods (choropleth maps, isoline maps, diagram maps, etc.) could be the most effective ones for the map use. The second objective is to derive guidelines for the adaption of the cartographic design elements (minimal sizes of the elements, colours, diagrams, etc.). This will be necessary, because without any doubt there will be differences between the requirements for well legible and aesthetic printed respectively digital maps (e.g. Neudeck 2001) and maps for the visualisation on an autostereoscopic display.

It is foreseen to answer the question which effects are practical to be materialised with autostereoscopic display techniques in (thematic) cartography. Besides the true-3D effects also 2D effects, so called multi-view-effects, are possible. These are the flip effects as well as zooming, morphing and animation. And of course all combinations of two- and three-dimensional effects are realisable. Hence, autostereoscopic display techniques offer versatile possibilities for cartographic visualisations. The 3D-effect cannot only be used to visualise the relief. For example, also the lettering can be displayed virtually hovering above the terrain to enable the user to look “around” the lettering, at least up to a certain degree, and thus reduce the occlusion of the map elements below. The flip effect can be used to compare different situations like low and high tide or to show different languages, the morph effect can visualise changes e.g. the shifting of coastlines and the zoom effect can be used to change the map scale. The animation effect can be a combination of the other 2D effects and can be used to visualise any type of motion. If the user changes the viewing angle by tilting the map or moving her/his head perpendicular to the arrangement of the lenticular lenses or the barrier mask, she/he may perceive different images from one display.

For their study the authors possess five autostereoscopic displays at their disposal. These do not only have different resolutions but they also use different techniques to let each eye only see the stereo-information allotted to it. One of the displays uses the barrier stripes technique, three work with the lenticular foil technique and one uses a prism mask which is very similar to the lenticular foil technique. The resolution reaches from 1280 x 1024 pixels up to 1920 x 1200 pixels and the sizes vary from 20 inches up to 42 inches. Thus the authors will not only be able to study several thematic test patterns and maps generated in the scope of the project per se, but they will also be able to compare them in connection with all these different display parameters.

For detailed information about the principles of the lenticular foil technique as well as the barrier stripes technique the reader is kindly referred to former publications of the authors, e.g. Buchroithner et al. 2005, Buchroithner and Knust 2010, Dickmann 2010, or to McAllister 1993 and Okoshi 1976. The essential point for both techniques is the provision of distinct images to the viewer's eyes. For stereoscopic viewing the viewer simultaneously perceives a different stereomate with each eye. In contrast, for two-dimensional effects like flip- or zoom effects the viewer sees the same image with both eyes. When changing the viewing angle by flipping the display or moving the head, both eyes perceive another image which shows another time slice or scale etc. Figure 1 illustrates the principle of the lenticular foil technique. The difference between lenticular foil technique and barrier stripes technique is the kind of making the single images available to the viewer's eyes. While the lenticular foil technique uses the optical characteristics of the lenses to deflect the distinct images, the barrier stripes technique works with a barrier mask consisting of opaque and transparent stripes that hide some images and leave others visible to the viewer's eyes.

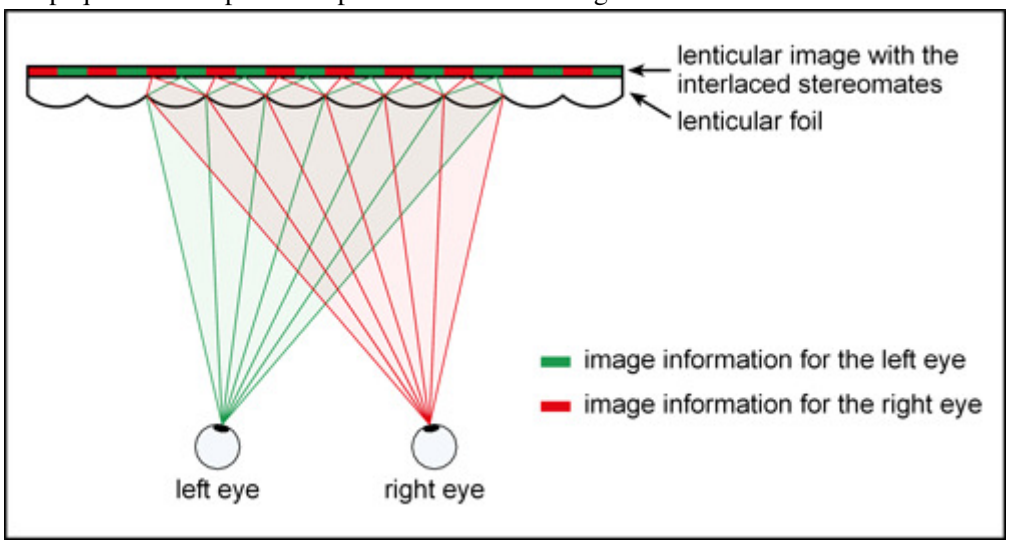

Fig. 1: Principle of the lenticular foil technique

RESULTS

Figure 2 illustrates how the individual map elements can be located to generate a spatial impression. In this example the three-dimensional modelling of the terrain has been left out. The base map is located in the display plane which implies that the viewer sees these elements in the same distance as the actual physical display. Several other map elements are located in different layers, which hover above the base map at different levels. If the viewer looks at such a map she/he will perceive some elements closer to her/his eyes than others. The varying distance of a hovering object to the display plane is generated by the cartographer. The closer the virtual object/image is located to the virtual camera which creates the stereomates from the virtual scene, the higher the map user will see this object hovering above the terrain. This, however, also means that it might be difficult to locate the right position of these objects on the ground. One possibility is to include shadows which show the correct position on the base map, as visualised in Figure 2, or to apply "threads" pointing at the actual geolocation.

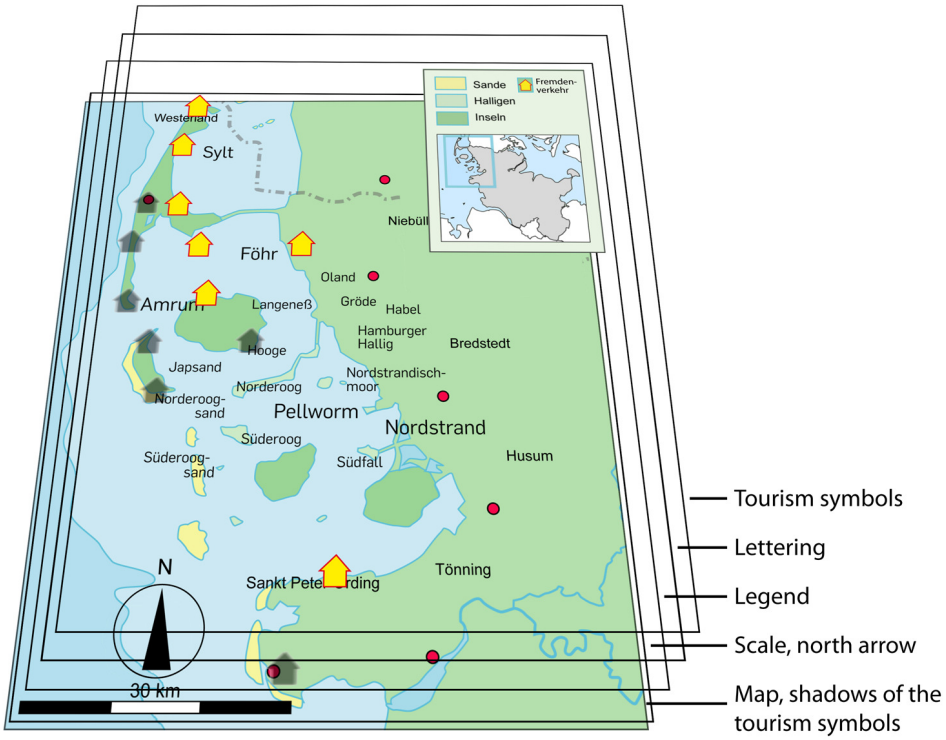

Fig. 2: Northern Frisian Islands – arrangement of the different layers.

The example in Figure 3 shows that the map user can look around several map elements depending on the viewing angle and the virtual distance of the map elements from the eyes. The map elements are virtually located as seen in Figure 2. This means that the yellow house symbols are the closest objects to the viewer's eyes and also the lettering hovers above the base map as well. If the map user moves her/his head perpendicular to the lenticular lenses or the strip mask, she/he changes the viewing angle and thus perceives different stereomates with slightly different content.

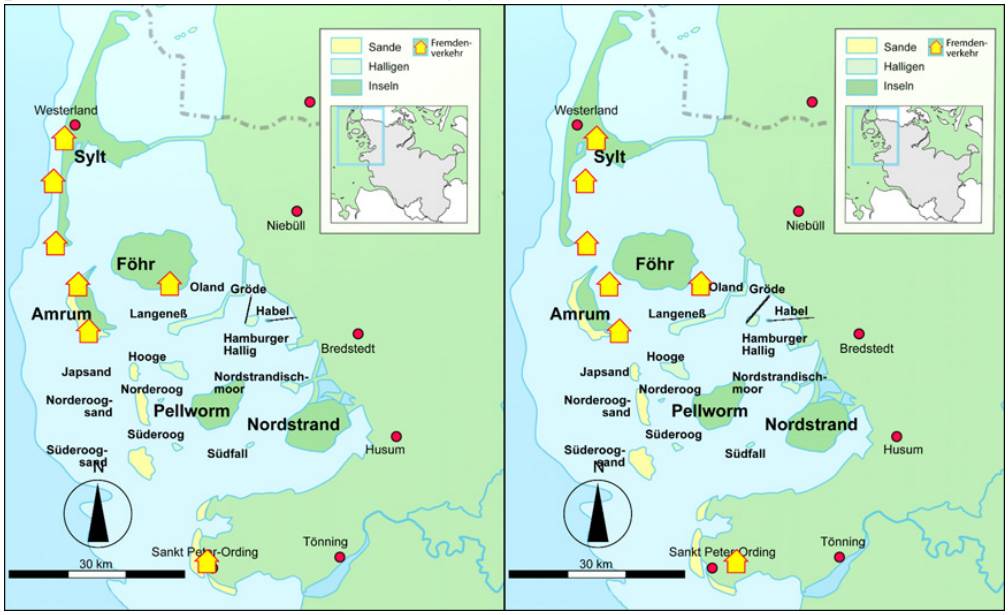

Fig. 3: Northern Frisian Islands seen from different viewing angles.

CONCLUSION AND FUTURE PLANS

Although these examples show that there exists a more or less high potential of the autostereoscopic display technique for thematic cartography, this assumption has to be scientifically verified during the research project. The project partners will not only compare different autostereoscopic displays but also

the efficiency of map use between normal 2D maps, be they analog or digital, and the multi-view maps generated for the visualisation on an autostereoscopic display.

At first so called pretests will be made. Therefore, multiple test patterns already have been prepared and a comprehensive questionnaire has been worked out in close collaboration between the two participating institutes. These tests will be carried out in the middle of February this year, just a few days after this paper will have been submitted. Both at the Institute for Geography of the Ruhr University Bochum and at Institute for Cartography of the Dresden University of Technology for about ten students are going to attend the tests. Figure 4 shows two of the multiple test patterns. The left test pattern shows rhombuses in different sizes and colours, which have to be identified by the test persons. The right test pattern shall give information about the minimal line width depending on the angle the line is drawn. The test patterns are visualised in different planes which will be perceived by the test persons in front, in or behind the display plane. The test persons have to choose for each plane the symbols and lines they can recognize barely well enough on the autostereoscopic displays.

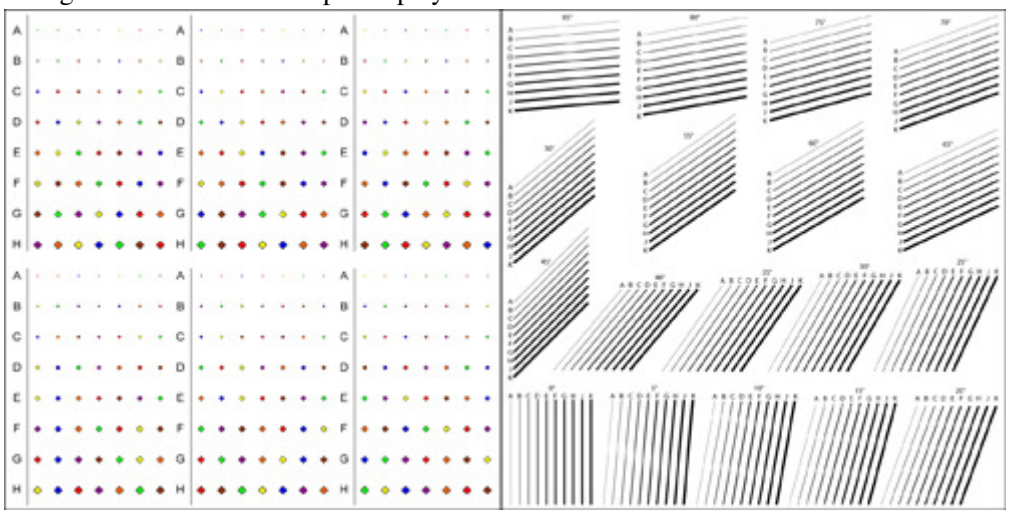

Fig. 4: Two test patterns of the pretests

After the analysis of the results of the pretests the main tests can be started which include the investigation of the perception ability of the map users and the information transfer efficiency of the thematic maps visualised on autostereoscopic displays. Therefore, several thematic maps will be created according to the requirements which will have been detected with the help of the pretests. To be able to gain representative results between thirty and fifty students should participate the main tests. The authors are positive that by the end of the project in spring 2013 they can give well-funded guidelines for an optimal design of thematic multi-view maps using autostereoscopic display techniques.

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