# CONTINUOUS DEVELOPMENT OF CARTOGRAPHIC VISUALISATION

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***Abstract:*** *The most important changes in cartography are associated with the development of computer technology and geoinformation systems (GIS), and regarding the function and usage of maps, the accent has been given to cartographic visualisation. Animation, multimedia presentation, internet, Web, three-dimensional models, ambitious expert systems, artificial intelligence, cartographic holograms, non-visual procedures, market economy, politics, etc. have remarkably influenced cartography. Cartography is changing – from the one conducted by offers to the one conducted by demands. Maps are changing – from final product giving spatial information to temporary product making visual thinking easier. Maps are the basic means in interactive, real time and dynamic environment used for researching spatial databases connected among each by means of Web. Scientific cartography has the task to develop and research new methods of cartographic visualisation. For that purpose the knowledge about cartographic presentation of spatial data must be connected with the contemporary digital techniques of visualisation. Modern cartographic visualisation encompasses digital cartography and computer graphics. Considering the quality, it is a remarkable change of visual presentation in almost realistic time that leads to better understanding of many spatial objects. Referring to the quantity, it is the possibility of faster and cheaper production of a wide range of various cartographic products – real and virtual maps. In manuals of cartography various demands are stated that the cartographic visualisation should meet. The following three conditions can be therefore demanded: legibility, plainness, and accuracy. Apart from that, the cartographic visualisation should meet also the demands that can be posed upon any graphic presentation. The following is of the greatest importance for the cartographic visualisation: clearness and aesthetics. The tools of cartographic visualisation give users the possibility to carry out extensive transformations*

*and changes of data presentation. Digital tools are being developed continuously, and hence, it is expected that more convincing visualisation tools for the presentation design will appear. The paper emphasizes the need for closer collaboration of experts in informatics, geodesists, geographers, spatial planners and others with cartographers. It is pointed out in the paper through examples of various possibilities in continuous development of cartographic visualisation.*

## 1.    Introduction

In the last few centuries a map had two important functions: it was a medium for saving information about space and it was the image of the world that helped people to learn about the complexity of the environment. Digital mapping has brought the coordinates in digital form in order to establish databases and cartometric usage, and referring to the space image, a map being in digital or analogous form, intrudes itself upon us as being the most important cartographic visualisation of space.

Modern cartographic visualisation encompasses digital cartography and computer graphics. Considering the quality, it is a remarkable change of visual presentation in almost realistic time that leads to better understanding of many spatial objects. Referring to the quantity, it is the possibility of faster and cheaper production of a wide range of various cartographic products.

## 2.    Concept of Cartographic Visualization

Modern cartographic visualization encompasses digital cartography and computer graphics. Considering the quality, it is a remarkable change of visual representation in almost realistic time that leads to better understanding of many spatial objects. Referring to the quantity, it is the possibility of faster and cheaper production of a wide range of various cartographic products (Taylor, 1994; Kraak and Ormeling, 2001).

Scientific cartography has the task to develop and research new methods of cartographic visualization. For that purpose the knowledge about graphical representation of geoinformation must be connected with modern digital visualization tools. Today, we have services which support mobile concept (positional services) and telecartography. In handheld computers and car navigation systems simple data and pictures are being used.

Small hand devices (accessory GPS – devices, PDA – devices) do not have visual clarity of big paper map, but they have great potential for specific usage. The importance and the power of virtual and analytical cartography is created by these systems, but the need for good and appropriate design, static or dynamic, is always present (Gartner, 2004). The main focus in modern cartography is on understanding the processes and methods "how to efficiently communicate with spatial information". Geoinformational demands and needs, viewed through the prism of mobility, differ from stationary surrounding.

## 2.1. Demands posed upon cartographic visualisation

Before the consideration and making of demands has commenced, one should reflect upon our experience of a cartographic presentation or upon what is necessary to experience a cartographic presentation. This question touches the essence of cartographic communication itself. According to Uçar (1979), cartographic presentation is a visually very clear and to a certain extent intuitive model of space. Cartographic communication is graphical and visual communication.

It should be considered in this case that the sense of sight is created on the basis of received impulses as completely psychic event experienced individually. In order to have the sense of sight become the experience of sight, some higher psychic function should be involved as well, as for example memory, abstraction and similar. Hence, it can be concluded that we actually "watch" with brain (Knizhnikov, 1997).

In manuals of cartography various demands are stated that the cartographic visualisation should meet. The following three demands can be therefore demanded: legibility, plainness, and accuracy. Apart from that, the cartographic visualisation should meet also the demands that can be posed upon any graphic presentation. The following is of the greatest importance for the cartographic visualisation: clearness and aesthetics. Each of the above stated demands can be carried out on single ingredient parts of the cartographic presentation, but it is much more adequate to do it through their purposeful combining.

In "classical" manuals of cartography, as for example are those written by Peterca et al. (1974), Lovric (1988), Robinson et al. (1995) or Hake et al. (2002), various demands are stated that the cartographic visualisation should meet. The following three demands can be therefore demanded: legibility, plainness, and accuracy. Apart from that, the

cartographic visualisation should meet also the demands that can be posed upon any graphic presentation. The following is of the greatest importance for the cartographic visualisation: clearness and aesthetics (Figure 1).
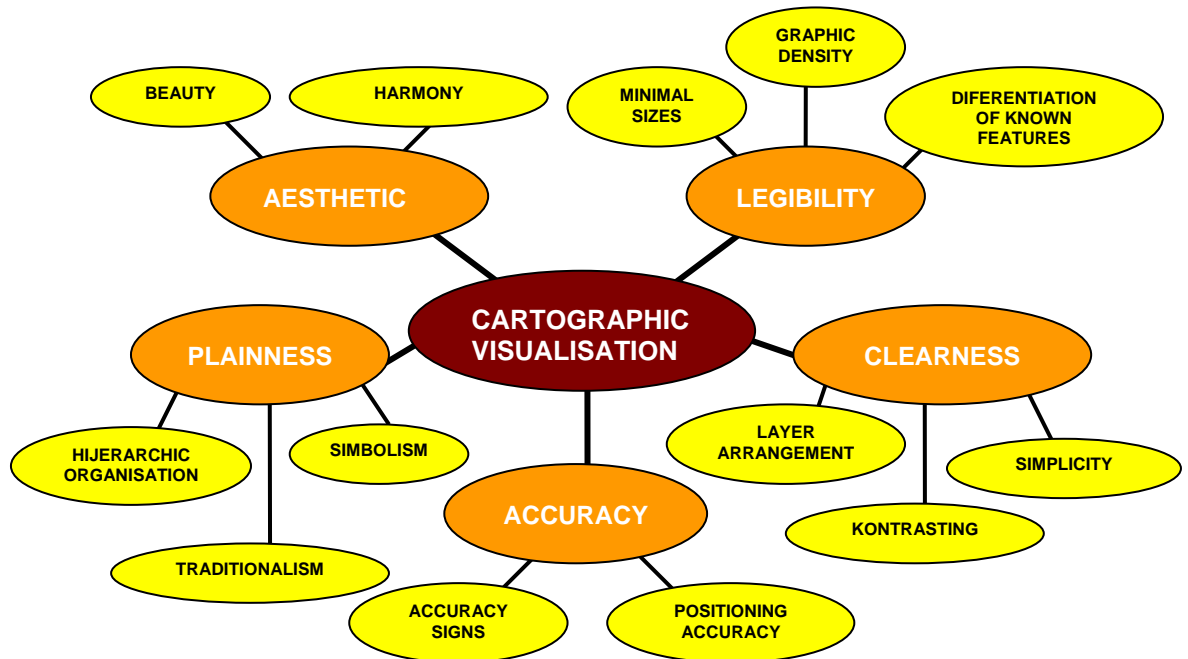
Figure 1: *Demands set upon cartographic visualization and conditions*

*that should be fulfilled in order to meet these demands.*

Each of the above stated demands can be carried out on single ingredient parts of the cartographic presentation, but it is much more adequate to do it through their purposeful combining. It has quite certainly much greater importance for the formation of the efficient cartographic visualisation, and thus also for the cartographic presentation appropriate to the user.

The order of the above stated demands is not especially important, because some demands are overlapping in part, and some are mutually opposed or set additional conditions for their successful realization.

In the process of carried out research (Franges 1998, 2000, 2002, 2007; Franges et al. 2000, 2001) the following demands were made for map visualisation: legibility,

clearness, accuracy, plainness, and aesthetic. Their realisation requires the fulfilment of some conditions (Figure 1).

### 3.      Visualisation tools

Digital tools are being developed continuously, and hence, it is expected that more convincing visualisation tools for the presentation design will appear. So far, focusing has been developed that is used for determining the contrast between objects and environment, defining thereafter the limits of clear distinctness. The accompanying effects are known as disappearing, fogging, and similar. Furthermore, zooming has been developed almost perfectly enabling the distinction between graphic, contextual and intelligent zoom, and also the work with the sections, windows, graphs and icons (Timpf and Devogele, 1997). There are also animated figures, three-dimensional representations, shading with various models of illumination, e.g. flat shading, the method of intensity interpolating (Gouraud shading), the method of interpolating normal onto the surface (Phong shading), the method of ray-tracing and the method of radiosity, blinking and glittering, various filters, simultaneous representation of various cartographic presentations, colour transformation and other phenomena (Kraak and Ormeling, 2003).

The tools of cartographic visualisation give users the possibility to carry out extensive transformations and changes of data presentation, e.g. different observation angle, changing various conditions etc. enabling the comparison of essential facts. It should not be exaggerated when using visualisation tools. One should, namely, try to achieve visual simplicity and, when it is not necessary, avoid any burdening of a user.

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interpolating normal onto the surface (Phong shading), the method of ray-tracing and the method of radiosity, blinking and glittering, various filters, simultaneous representation of various cartographic presentations, colour transformation and other phenomena (Franges at al. 2002).

Good cartographic presentation with adequate resolution, well-defined symbols, harmonious usage of colour, good legibility and optimally placed titles and optimal graphic density attracts users and gives them more information more quickly. Thereby it is especially important to apply colours systematically, e. g. according to the principle of similarity with the real situation in the nature or by adopting symbols. Also, the same objects should be presented in the same colour, different colour intensity should be associated according to the importance of an object, etc. The appearance of symbols should be almost perfect, because with their ability to express and save space on the map they can replace the presentation similar to plan with a description or they can intervene with additional information. Map symbols can vary differently, e. g. size, shape or colour, so that the map appearance is optimal. In the paper it is pointed out through examples how demanding the cartographic visualisation is because of demands posed in GIS, visualisation of spatial databases, and the production of detailed three-dimensional landscape presentation.

## 4.      Examples

New encouragement to the visualisation of GIS-data comes from animation, multimedia presentation, Internet, WWW etc. Some examples of various possibilities in cartographic visualisation are given further in the text. Figure 2 shows the interactive Internet map of Dubrovnik (Zupan, 2003). Figure 3 shows the segment of the visualisation of GIS of cultural and historical objects in the centre of the city of Zagreb. Figure 4
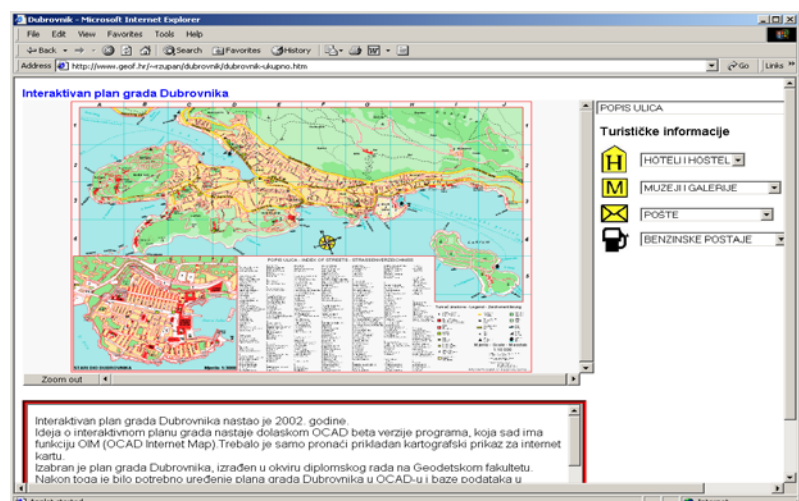
Figure 2: *Interactive Internet map of Dubrovnik*

gives the segment of the visualisation of island Mljet on the Adriatic coast (Posloncec-Petric, 2002).
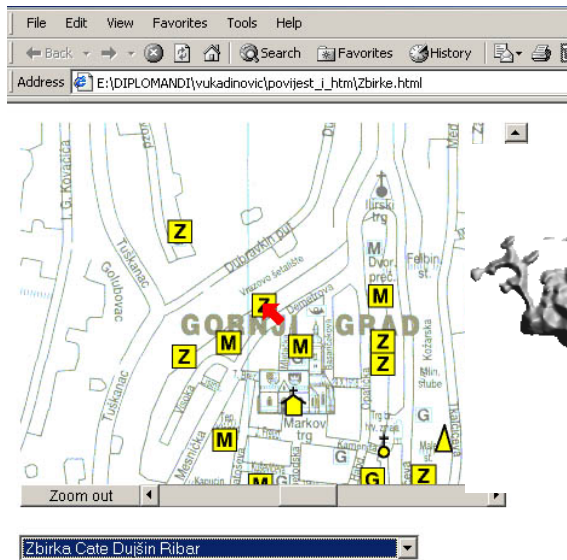


Figure 3: *Segment of the visualisation of GIS of cultural and historical objects in the centre of the city of Zagreb*
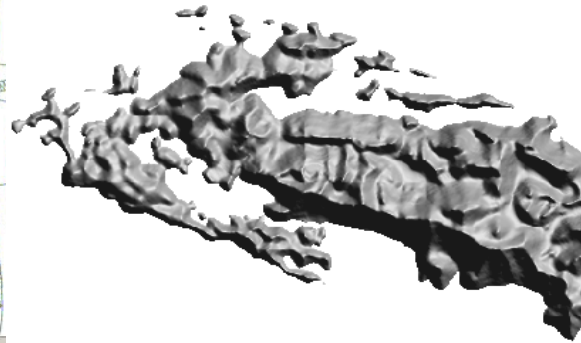
Figure 4: *Segment of the relief visualisation of island Mljet on the Adriatic coast*

### 5.    Conclusion

To the traditional cartographer, what started as a useful tool has turned into something monstrous, because almost everybody has an access to the tools that used to be exclusively in the hands of cartographic experts. In the world in which everybody can make a map, who needs cartography still? It is paradoxical, but the need for good cartographic creation is larger than ever (Goodchild, 1999).

Scientific cartography has the task to develop and research new methods of cartographic visualisation. For that purpose the knowledge about cartographic presentation of spatial data must be connected with the contemporary digital techniques of visualisation.

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