

INNOVATIVE TECHNOLOGY FOR THE CREATION OF 3D MAPS

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Abstract

“From Paper to Virtual Map” is an innovative technology for creating 3D (three-dimensional) maps. The technology proposed as a very cheap and easy way to create 3D maps. A powerful graphic station is not necessary for this aim. This is very important for countries such as Bulgaria where it is not easy to get expensive computer equipment.

This technology, proposed by the author was developed from a novel application – a 3D cartographic symbol system. The 3D city maps created consist of 3D geometry, topographic information and photo-realistic texturing and 3D symbols, which contain quantitative and qualitative information about the objects. Animated presentations are also available according to users’ needs.

Keywords: 3D map, 3D symbols, Cartography, Innovative technology

1. INTRODUCTION

Information on the Earth is collected from different sources – remote sensing data, GPS data, photogrammetric or surveying measurements. This allows the possibility of 3D presentations. Maps are one of the most commonly used tools for presenting such information. Nowadays, many companies create 3D models of urban or rural environments. These 3D models make it possible to understand and gain knowledge about the real world which can be easily communicated to users (Bandrova & Ivanova, 1999). The improved photo-realism of these models (see Figure 1) makes them accessible to a wide range of users: from the youngest pupils to highly skilled specialist from different fields of the science and practice (Bandrova, 1997a,b; Ivanova & Bandrova, 1998).



Figure 1. 3D modelling of a part of Varna city in Bulgaria (DavGeo, n.d.).

2. DIFFERENT USES FOR 3D MAPS

Not long ago, the user only had only 2D maps and media to depict real phenomenon at his disposal, which restricted analysis of the processes, relationships and behavior of real objects. Recent developments in hardware and software technology have shown encouraging results in the storage and maintenance of large amounts of data. This has led us to expect 3D images to dominate this millennium (Zlatanova & Bandrova, 1998).

Users of 3D maps can be found in different fields of science, industry and communications:

a) City planning and architecture – engineers and architectures need photo-realistic models of buildings and cartographic models of city environments to design and visualize new ones that can then be input into new 3D maps. 3D maps can be used for collecting information with the aim of restoring the unique facades of buildings.

- b) **Teaching in schools and universities** – Some students find using school atlases and wall maps in geography, history, and earth sciences difficult. Multimedia education that includes text, images, maps, diagrams, sound, video and others can improve the quality of the teaching as well as increase students’ interest in subjects.
- c) **Design and advertising** – 3D tourist maps will give a more realistic impression of a city than 2D maps.
- d) **Telecommunications** – The telecommunication companies could use 3D maps and data to calculate and visualize the wave distribution within the urban environment. 3D maps enable easy analysis and design.
- e) **Transport** – 3D maps are useful for simulating urban traffic and enable better planning of different kinds of transport schedules.

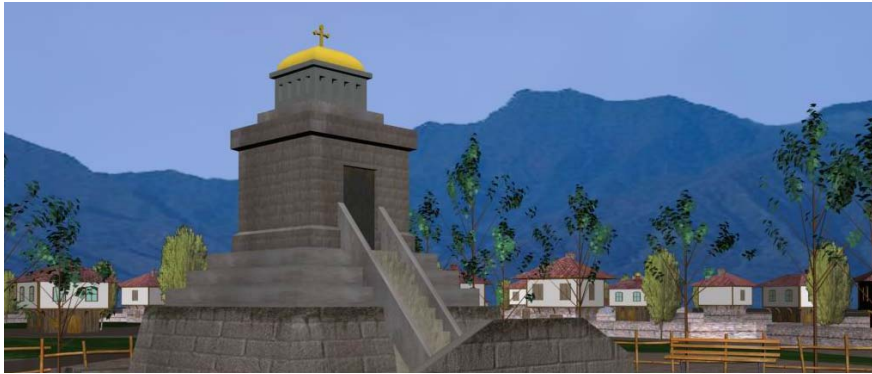


Figure 2. A monument, 3D symbols and buildings in a 3D map of small historical city in Bulgaria, created by Dimitar Rashev

- f) **Environmental pollution** –3D maps can be used to illustrate the distribution of different kind of pollutants, simulate global warming and noise distributions.
- g) **Tourism** – Tourism companies could present more realistic city views for different tourism proposals (see Figure 2). They could suggest interactive virtual rambles through such 3D maps.

3. A TECHNOLOGY FOR DESIGNING 3D MAPS

A 3D map can be defined as a computer generated, mathematical defined, three-dimensional, highly realistic virtual representation of the world’s surface (or another heavenly body), as well as of the objects and phenomena in nature and society. The represented objects and phenomena are classified, designed and visualized according to specific purposes. The content of the 3D map is designed after the objects and phenomena that are to be included have been defined. It could be subdivided into three categories:

- **Main content**, which consists of large topographic or landscape objects such as relief bodies, roads, buildings etc (see Figure 3). Most 3D maps designed by different companies in the world represent these objects.



Figure 3. 3D model of the territory of University of Architecture, Civil Engineering and Geodesy, Sofia, Bulgaria - the main content of a 3D map are represented.

- **Secondary** content, which carries the basic information. For example in 3D urban maps – objects such as traffic signs, facilities, transport elements, information signs, trees, etc are represented by symbols (see Figure 4). Some objects in rural or urban environment are more useful to different users. But they are “small objects” and their realistic representation in a 3D map is very expensive. Though users need to know that these objects are presented (for example, a traffic light) and where they are located, such objects could be represented by symbols.



Figure 4. 3D map “a street in Vienna”, created by ICG, TUGraz and 3D symbols created by T. Bandrova

- Additional content, which provides qualitative and quantitative information about objects. These attributes are often created and stored in a textural database, linked to each of designed objects or the map as a whole. The material of the roof and the grass view are represented in the 3D map, which can be seen in Figure 5.



Figure 5. A near view in 3D map of small historical city Koprivshtitsa in Bulgaria, created by Dimitar Rashev

The technology of “From Paper to Virtual Map” can be summarized in the following steps, given in Figure 6. If we start from a paper map it consists of eight steps. The second and third steps can be excluded if we have digital map and tree coordinates for every point.

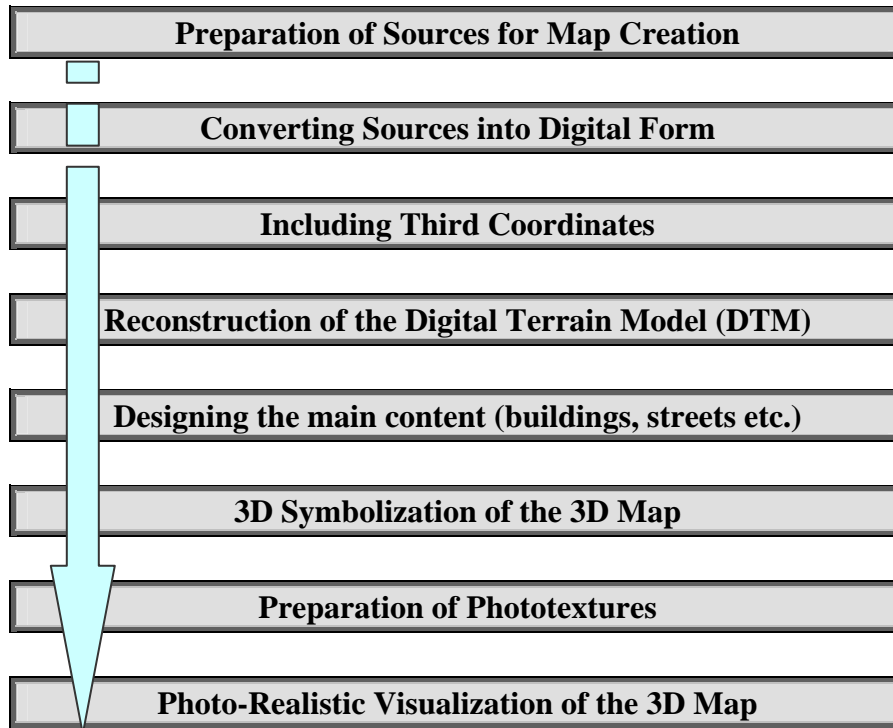


Figure 6. The procedure for creating 3D map

The sources for creating the map could include topographic or cadastral paper maps, photogrammetric or surveying data, which could then be converted into suitable digital formats depending on the available software (see Zlatanova, Gruber & Kofler, 1996). If sources are digital 2D maps then we apply the procedure for including the third dimension. The 3D information could be from topographic information, measurements, architecture drawings etc. The existing altitude points on the map are used to reconstruct the surface terrain. It can be visualized in a hypsometric way (see Figure 7) or in a photorealistic way (see Würländer, Gruber, & Mayer 1996). The next step “Designing main content (e.g. buildings, streets)” is done by most companies and institutions. The 3D models obtained are used for many purposes in 3D GIS analysis. If the creation of the model stops here, the end product will not be a map as one of the most important elements of a map, the symbol system, is not included. Symbol creation is explained in more detail in the next section, as well as in Bandrova (2001).

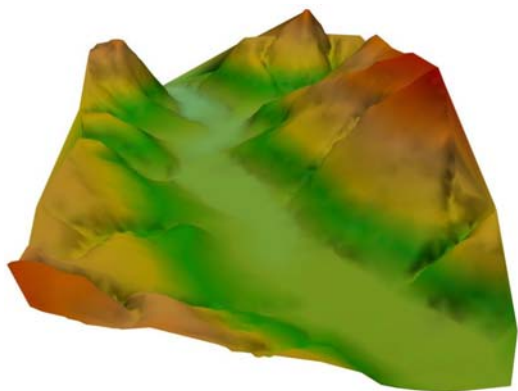


Figure 7. DTM (Digital Terrain Model) of small tourist city Koprivshtica by Dimitur Rashev

Preparation of the photo-textures is an expensive procedure but it gives 3D maps a highly realistic representation (see Figures 4 and 5).

4. SYMBOL SYSTEM FOR 3D MAPS

The utilization of 3D maps in various areas of urban planning and management has been surveyed and clarified. An investigation among 15 Bulgarian firms, working in the field of GIS, geodesy and cartography was completed and the results analyzed. 94% of them consider

cartographic symbols an important issue and even propose areas of utilization (Zlatanova & Bandrova, 1998).

The steps in creating symbols for 3D maps are distinguished as follows:

- a) **gathering information** about an object (quality and quantity characteristics, images, textures);
- b) **analyzing information** and collecting data about each object;
- c) **designing symbols** by visual and metric analysis and then applying computer graphics techniques;
- d) **visualizing symbols** in the virtual environment;
- e) **obtaining synthesized information** for an object.

The theoretical base of the cartographic symbol system in 3D modeling has been developed by Bandrova (2001). This is a result of extensive investigations that demonstrate the lack of a formally defined 3D symbol system. The requirements and stages for symbol design are specified. They provide cartographers with a standard approach for developing symbol systems for 3D city maps. The data structure for organizing vector and raster data (see Tempfli, 1998) facilitates the development of cartographic information systems and software for 3D maps.

5. CONCLUSIONS AND DIRECTIONS FOR FUTURE WORKS

3D maps represent urban or rural environments, objects, phenomena and territories well. In addition to the use of materials such as photogrammetric or remote sensing data a variety of other input data can also be used for this purpose. Such information is automatically imported into most modeling systems, which facilitates the repeated usage of such data in 3D maps.

The creation of a symbol system will help the compilers as well as users of 3D maps. Its existence will standardize 3D maps and this is the task of cartography nowadays (Bandrova, 1997b). The next step is to research the qualitative and quantitative features of the maps, using 3D GIS, extract data for them and solve different kind of managers and engineers' tasks. It will also be necessary to analyze and test the 3D maps with different groups of users.

Standardizing symbol systems is an ongoing task. Even the standardization of 2D topographic symbol systems is not simple despite their geometrical, non-realistic nature. 3D symbols represent small objects in an environment. They could be standardized for a country or for a small geographical region of the world. But it is very difficult to do the same for different countries, situated far way from each other, or with different cultures, economic levels, etc. The objects represented by symbol systems look different. Users will find it difficult to recognize the symbols if they are very different from the actual objects. The first task is to find the most popular representations. This is not too difficult with traffic signs. There are more than 200 types and they look similar around the world. The task is to find other objects, which could be represented by one symbol.

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