Lenné 3D® - The Making of a New Landscape Visualization System: From Requirements Analysis and Feasibility Survey towards Prototyping

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1 Abstract

3D visualization techniques enable an intuitive mediation of complex, space related facts. Civic participation in community landscape planning or visual simulations of landscapes could benefit from emerging computer graphics technologies. However, interactive visualization tools matching the special needs of landscape planning only exist in their beginnings. In 2000, the Centre for Agricultural Landscape and Land Use Research (ZALF) conducted a feasibility study of a 3D landscape visualization tool. Basic findings are a demand for a new 3D landscape visualization system, its technical feasibility and identified user groups. Users are laypersons or stakeholders on the one hand and professional users like landscape planners on the other hand. Sophisticated user requirements have been identified. These include features like interactive rendering, support for GIS data, convincing representation of vegetation and the scenery from stroller’s view. Since May 2002, the research project “Lenne3D” has taken up this challenge and begun development of a system for real-time 3D landscape visualization.

2 Introduction

The research project “Lenné3D” and its emerging software system are named after Peter Joseph Lenné (1789 - 1866). The famous German landscape architect innovated landscaped park design: His “beautification plans” harmoniously combined isolated but beautiful buildings and gardens into an integrated whole with the intention of an aesthetic education of people. He aimed to unify aesthetical and economical considerations, e.g. maintaining agricultural functions of the fields while beautifying the landscape. Lenné had no difficulties in getting across ideas to his customers since he drafted the beautified landscape in a comprehensible and persuasive way, e.g. from an inclined bird’s eye view.

Today’s landscape planners have to deal with issues like scenery, landscape ecology, sustainable development, environmental law, appropriations, etc. Only very rarely, these planning contents are mediated to the public by means of understandable and visually interesting presentations. Although people are curious to know “What would it look like?”, there usually is a lack of concrete, visual representation of the landscape known to the participants from their own experience. Abstract and often graphically insufficient maps, imprecise and manipulative perspective presentations, non-representative still pictures or high-speed fly-throughs from bird’s eye views neither convince the stakeholders nor the public. Instead, the observer is confused and easily deterred by nature conservation related
planning contents and action strategies. The communication and civic participation process seems to be in need of improvement.

The use of new technological and non-technological communication tools has the potential to provide a move towards innovation for landscape planning. Visual simulations of landscapes and planning options could benefit from emerging computer graphics technologies. Although there are common planning tools like GIS and CAD, interactive visualization tools matching the special needs of landscape planning only exist in their beginnings.

3 Feasibility Study of a 3D Landscape Visualization Tool

In 2000, the Centre for Agricultural Landscape and Land Use Research (ZALF) conducted a feasibility study of a 3D landscape visualization tool. Basic findings are a demand for a new 3D landscape visualization system, its technical feasibility and identified user groups.

In a case study, a computer graphics assisted civic participation in landscape planning was tested by using high-quality animations on the one hand and low budget game engines on the other hand (cp. HERWIG AND PAAR, 2002).

3.1 The Survey

In the context of the feasibility study, the ZALF, the Anhalt University of Applied Sciences and Atelier Bernburg made a survey among potential professional users of a new visualization system (cp. BUHMANN AND JÜNEMANN, 2000; JÜNEMANN ET AL., 2001). Results from this survey were supposed to assess and determine users needs of and the potential demand for 3D landscape visualization tools and its necessary features. A Germany wide survey by post began in the middle of July 2000 in which one thousand potential users from planning and engineering firms, authorities and visualization service companies were questioned. The survey was finished in the middle of September 2000. Out of all questionnaires, approx. 30% were answered and returned.

In order to determine the requirements to develop new or enhanced 3D visualization tools, previous users were questioned with regard to their experiences. 28 percent of planning and engineering firms and 7 percent of authorities and offices acknowledged practice of 3D software. The following estimations are not representative due to the small number of answers. In comparison with others surveys however, (e.g. MEINEL AND LIPPOLD, 1999) they show coherent findings.

The answers reflect the following user experiences:

− The generation of 3D visualizations usually is very time-consuming.
− The representation quality of the visualization often is unsatisfactory.
− In particular, the representation of plants and biotypes used is insufficient.
− Hardware equipment is costly.
− Data exchange with other programs is prevalent.
− Customers show increasing interest in 3D visualizations.
− An adequate payment of the human labor is hardly possible.
While respondents without user experience feared high investment costs, those with user experience had no concerns about the hard- and software costs.

Stakeholders and the public do not expect the existing GIS with 3D extensions like ESRI’s ArcGIS 3D Analyst to meet the aesthetical demands regarding scenery visualization due to missing sophisticated 3D/ 4D functionality. In non-GIS based software tools as well as in game development software, georeferencing for data is missing.

So-called landscape generators like Corel’s Bryce are focused on fantasy sceneries. GIS data-compatible tools like MultiGen-Paradigm’s SiteBuilder 3D or Asset Information Systems’ K2VI, which can operate as an ESRI SDE client, provide real-time visualization and advanced interactivity techniques. However, they are designed for urban and infrastructure planning.

Regarding the tools, users complain about the following issues:
- They do not satisfy professional criteria (e.g. Bryce).
- A convincing representation of the vegetation is not provided (e.g. K2VI).
- Interfaces to GIS or databases are missing (e.g. Bryce).
- Development has come to a standstill (e.g. CLR’s PoliTRIM).
- There are high investment costs (e.g. AMAP).

The effective 3D Nature’s World Construction Set (WCS) and Visual Nature Studio (VNS) are an exception, both being capable of generating photorealistic-looking scenery on the basis of GIS data. Respondents complained about the slow rendering and the complicated user interface. Both tools are widely used to produce stills and animations.

### 3.2 User Needs

Sophisticated user needs have been identified. They were derived from the results of the survey, the case study and a workshop with experts in landscape planning, visualization and computer graphics. Key features are:
- Interactive rendering in real time
- Support for GIS and CAD data
- Convincing representation of vegetation
- Scenery visualization from the stroller’s view
- PC software
- A modular design
- User-friendliness

In a technical treatise, the progress of information technology, particularly in computer graphics, and the expenditure of software development were estimated. The treatise predicted a technical feasibility of the designated system and a first concept of its software architecture.
4 Developing a New Landscape Visualization System

4.1 Aims of Lenné3D

Lenné3D (www.lenne3d.de) is the successor project of the feasibility study. Since May 2002, the research project has developed a system for interactive 3D landscape visualization both from map view and from stroller’s view. The 3D visualization system should support the dialogue on community landscape planning and decision-making. In the course of 3 years, the interdisciplinary project focuses on visualization of vegetation and GIS data as well as interactive exploration. The system visualizes spatial data (in particular data from landscape planning), of scenery and vegetation. Lenné3D will provide interactive exploration of the data and support landscape planning with interactive editing techniques.

Fig. 1: Targets of the Lenné3D research project (target scheme according to Coverdale International)

4.2 The Lenné3D Software System

The software was developed iteratively and incrementally. This nonlinear approach is state-of-the-art in software engineering and recommended for distributed projects with complex software systems. It provides an early implementation and test of key features and enables continuous user evaluation, concept refinement and feedback to the developers.

Besides a GIS, there are two main components: a “3D map editor” and a “3D player” (Fig. 2). The 3D map editor is based on HPI’s LandEx software. LandEx already provides...
interactive real-time 3D cartographic visualization techniques for large terrain models, different types of high-resolution raster data and different types of vector data.

The 3d map editor generates and manages Lenné3D projects by transforming data and linking it with a project.

The 3D player was developed from scratch for interactive rendering of complex landscape scenes. In order to attain the demanded real-time visualization and the realistic generation of vegetation complexes, algorithms, for instance, for image synthesis and computer graphics representation of varying complexity levels must be developed and efficient methods for the reduction of geometry data must be found.

**Fig. 2:** Components and data of the Lenné3D system.
Both interactive 3D viewers use one component, which is also new developed, for vegetation modeling and plant distribution. Plants are distributed by using heuristic-algorithmic vegetation models, biotope types, regional reference vegetation mappings and topographic data. The results can either be rendered and edited cartographically by means of the 3D map editor or rendered from the stroller’s view by means of the 3D player.

The components are implemented in C++. The 3D graphics implementation of the 3D map editor is based on OpenGL 1.4; the 3D-Player runs with OpenGL and, due to some experimental rendering techniques, with DirectX, too. Currently, Windows PCs with NVidia GeForce graphics cards are supported.

4.3 Testing

With a first prototype system now complete, the testing in practice can be started. There will be three case studies:

1. One site within the framework of the project “Interactive Landscape Plan” in Königsloutter in cooperation with the University of Hannover, sponsored by the German Federal Office for Nature Conservation (BfN).
2. One site in "Park Sanssouci" (Potsdam), in cooperation with the Foundation for Prussian Palaces and Gardens in Berlin & Brandenburg. Potsdam’s park landscape was chiefly designed by Lenné.
3. One site in the main research area of the ZALF (“Uckermark”). With respect to soils, topography, hydrology and land use systems, this region is typical for northeastern Germany as well as Eastern Europe.

In order to guarantee practice suitability, thematic expert workshops with landscape and visualization experts take place regularly.

5 Conclusion & Outlook

The purposeful use of today’s interactive 3D-visualization techniques enables an intuitive mediation of complex, space related facts. At present, visualization tools matching the special needs of landscape planning only exist in their beginnings, which is why the research project “Lenné3D” wishes to react with a new approach.

Considering the development of Lenné3D and the progress of other three-dimensional tools and PC hardware, an open question is raised: Will landscape planners widely use digitally generated 3D scenery and plan representations? A majority of the polled landscape professionals as well as those stakeholders questioned in the first case study of the feasibility study considered 3D landscape visualization as a “conditio sine qua non” of tomorrow’s landscape planning. Time will tell.
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7 References


