

Terrain Modeling with GPS and Real-Time in Landscape Architecture

Peter PETSCHKEK

GPS is the abbreviation for NAVSTAR GPS, which stands for Navigation System with Time And Ranging Global Positioning System. RT means Real Time. The research project addresses the application of GPS and RT in Landscape Architecture.

As early as 1788, the famous English landscape gardener Humphrey Repton used business flyers to promote his services. „Completely engraved, it shows an elegant Repton with a theodolite, directing labourers within an ideal landscape that is derived from Milton’s L’Allegro.” (G. Carter, P. Goode, K. Laurie: Humphry Repton Landscape Gardener 1752-1818. Sainsbury Centre for Visual Arts Publication, 1982, S. 12/13). 1000 copies of the flyer were made. This image also proves that long before dozers, graders and other machines became regular landscape construction tools, surveying instruments were the first high-tech tools in landscape architecture.

Repton was not only innovative in marketing and using surveying equipment but also in the visualization of projects. This landscape architect was the inventor of the Red Book. The name derives from the cover of the book which is red leather. On opening it you will first read a text which describes the landscape project. On the following page is a painting, in watercolours of the existing situation. But it is not a normal painting. Part of it is painted on a piece of cardboard which is removable. When you take it away, the proposed situation can be seen. Repton always presented his projects with a Red Book. Very often the clients were so impressed that he was immediately hired.

In recent years new developments in surveying and visualization have taken place, which also affect how we receive data and visualize terrain in Landscape Architecture.



Fig. 1: Humphrey Repton, Landscape Gardener (1752-1818)



Fig. 2: Red Book with an existing situation



Fig. 3: Red Book with a planned situation

1 GPS - Global Positioning System

GPS is a satellite based system. With the help of a constellation of 24 satellites any position can be located worldwide. The initial purpose of GPS was to provide an exact location for the military. In 1987 Leica-Geosystems was the first company which introduced GPS technology in surveying. Today the applications range from usage in the automotive industry to construction machines.

Basically a GPS station is a continuing development of a total station with the advantage of GPS-like flexibility and a one person operation. It uses the wireless data connection to transfer the satellite data from a reference station to the rover. There the exact calculations and display of coordinates are shown.



Fig. 4: Using the Leica GS20, the landscape architects recorded vegetation data for the Data model in three dimensions.

2 RT - Real Time

High Tech Graphic Cards are the standard in all personal computers. The graphic card calculates processes on a hardware basis, which otherwise have to be done by the software or the CPU. With the help of these cards real-time is possible. Real-time means 25 images per second. The very tedious rendering time of animations is no longer necessary. Not many years ago real time visualizations were only possible on high end computer systems. The driving force behind the development of fast graphics is the computer game industry and the huge consumer market asking for speed and realism. The gamers are the consumers who exchange their old pc, which would be more than fast enough for word processing and internet for a new one with more graphic power. Real time applications outside the game

sector profit from this development. Real-time can also be applied in landscape architecture.

3 GPS RT 3D P - GPS and Real Time 3D Planning

The research project “GPS RT 3D P – GPS And Real Time 3d Planning”, which was funded by the Commission for Technology and Innovation (KTI) of Schweizer Bundesamt für Berufsbildung und Technologie and other partners, looked into possibilities using GPS and RT in planning and landscape architecture.

With digital terrain models becoming part of every CAD package, an everlasting need for digital surveying data will arise in Landscape Architecture. Today the workflow is as follows: The surveyor provides the data, the planning office utilizes this data using GIS and CAD, the project data is given back to the surveyor to be staked out. Based on the stake-out the construction company models the terrain. This workflow is time consuming and costly. Additional reasons for the application of GPS by landscape architects are, that for small surveying jobs, a surveyor is too expensive and cadastral Information which is provided, is often incomplete. With the usage of GPS by non-surveyors the following questions arise:

1. What functions should an easy to use GPS for Planners and landscape architects have?
2. Could 3D-guidance of the construction machinery work also in landscape architecture?

Successful planning needs acceptance by the public. This is essential, especially in Switzerland. Every public project with a construction sum of above 10 million Swiss Francs has to be voted on. A convincing project presentation to the public is therefore extremely important. Plans are not very accessible for a lay person. Abbreviations and symbols are used in the drawings which every one cannot understand Usually the plan exhibitions are in city halls which people do not visit in their spare time. Analog 3D models also demand a high level of abstraction by the viewer. In brief, when kids play with a Game Boy, which has an extremely high quality 3D graphics, it is no longer adequate for parents to look at a black and white overhead presentation or having to study a difficult-to-read plan at the wall in a city hall. Internet is another platform for presenting projects. Some cities and towns have started to put their 2D plans on the net, combined with general planning information. What is missing and what one should expect today are realistic 3D presentations of the project, with the ability to view the project from all sides in a playful way.

A tool for real time based 3D internet plans is TerrainView from the Swiss company ViewTec (www.viewtec.ch). It is a virtual reality solution which comes from the high end area (military, medicine). As part of the project, certain adaptations were made in order to open TerrainView to the market for public presentations of planning projects. The ViewTec technology also allows presentations of large projects in real time. TerrainView

can be used online and offline. With the two worlds “Game” and “Planning” coming closer to each other, the research question in this part of the project is:

3. Which demands have different user groups such as computer kids, parents , lay persons, planners for using this tool?

To answer these three research questions, an experimental research approach was chosen and the pilot project Golf Course Bad Ragaz (Harradine Golf) was used.

In regards to 3D guidance of construction machinery, a start-to-finish digital landscaping process in Bad Ragaz was applied. A surveyor's office collected the data for the golf course by means of GPS. The planners recorded further terrain and vegetation data by means of the Leica GS20 professional data mapping device. Based on the 2D-CAD data a 3D digital terrain model using Autodesk's Civil 3D was created. As a result of an optimized interface between the programs 3d max and TerrainView, the data was made available for an interactive virtual fly through of the planned site. After the landscape architects had made some adjustments on the basis of the real-time 3D inspection tour, the planning data was transferred to the Leica Dozer 3D GPS system for terrain modeling with an appropriately equipped bulldozer on site. This removed the necessity for time-consuming measuring and stake out on site. At the end of October 2004, as part of a workshop in front of experts, a construction company modeled the terrain on a 10,000 sq m section of the Public Golf Course with a small Liebherr bulldozer.

In summary, one can now say that GPS machine automation can also be employed outside its traditional areas of application such as mining or road-building. The relevant technologies and technical components are available and are already supported by the machines currently in use on construction sites. This is with the condition that the planners hand over their designs and plans to the building contractor as three-dimensional data records, based on an elevation model of the existing terrain produced by the surveyor.



Fig. 5: In the driver's cabin one can see the terrain model on the machine operator's Display unit. The planning data is combined with the clear guidance data from real time GPS positioning providing the machine operator with all the necessary details for excavation, graphically and digitally, accurate to within a centimetre – more quickly, more comprehensively and more precisely than marker poles.



Fig. 6: The construction machine is equipped with a Leica dozer system, which determines the 3D position of the blade in real time to the nearest centimetre. The driver of the machine receives all guidance details directly from the system.

The HSR research team organized workshops in order to answer other questions. *Ergonomie & technology*, a company specializing in ergonomic research, was a partner in the two workshops. In these meetings the invited participants had to fulfill various tasks such as using the TerrainView program to navigate to the golf club house. Here a train timetable was put up on the wall and one had to find out when the next train leaves to Zürich. In the GPS workshop the invited professionals were introduced to Leica-Geosystems GS 20 and later had to locate certain points on the HSR Campus. All results were evaluated by the research team and presented to our economic partners. They are documented in written forms and as DVD films.

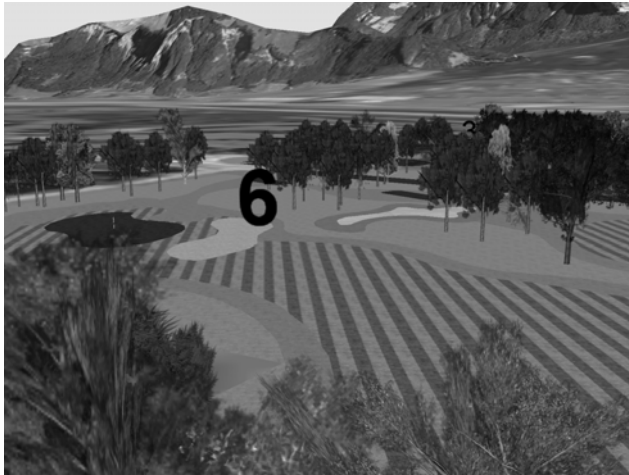


Fig. 7: Screenshot of the real time model golf course Bad Ragaz.



Fig. 8: Ergonomic test of Leica GPS-20



Fig. 9: Ergonomic test of Terrain View

Final results are available under <http://l.hsr.ch/forschung/it-la/it-la-frameset.htm>

4 References

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