Developing a 3D Dynamic Map of New Zealand's Backcountry

Roger Smith
Geographx Ltd, Wellington, New Zealand

Abstract

This paper traces the development and ongoing refinement of a dynamic, interactive 3D topographic map of New Zealand. The initiative is a joint effort by two small private companies working in parallel. One has focused on the development of a high performance virtual reality software platform and 3D viewer. The other has been responsible for map data and the visual representation of topography and landforms. The development of backcountry map textures in particular posed a number of challenges, as a key objective was to create seamless, accurate and intuitive scenes, without the quilted mosaics and variation in shadow angles seen in Google Earth and many other 3D mapping applications.

1. Introduction

Geographx is a small New Zealand (Wellington) based private company that undertakes a range of mapping work for both print and electronic publication. Our niche areas are large format feature wall maps and dynamic 3D visualization.

For some years now, Geographx has worked with Data Interface Technology Ltd, another New Zealand company that has been developing and refining a 3D virtual modeling environment. The software application is branded as K2Vi (Key to Virtual Insight). Our role at Geographx has been to develop a 3D topographic dataset that could be used as a base map for K2Vi. Initially we worked to cover the New Zealand landmass (an area a bit bigger than the UK, but smaller than Italy). However we always intended to eventually build datasets for other countries, and we still plan to do this.

When we started, virtual 3D mapping was more a dream than a reality. Software and hardware constraints meant we invariably worked with small areas, fun to look at but of little practical use. "Eye candy" we called it. Now, however, we have a genuinely useful application. Development is ongoing and additional functionality is being added every month.

A major driver for this progress has clearly been the technological advance in hardware – we now have more powerful computers, more memory, and improved video graphics cards. Equally impressive has been ongoing development of the K2Vi software platform. I'm not really qualified to talk about the technical side of this, save to say that there are essentially two main products undergoing coordinated development.

Fig. 1: Virtual 3D model of Paradise, NZ, rendered using K2Vi Professional software.

One, K2Vi Professional, is an interactive virtual modeling environment, a construction set for simulating a real world situation. Typically such a model will focus on a specific site or area, and may include existing or planned future infrastructure – examples include tourist developments, proposed new roading / tunneling or bridging projects, hydro-electric dams, and wind farms). A range of high resolution input data may be used to construct these, including terrain models, land textures, 3D object models, and GIS point, line and polygon data (Fig. 1).

The second product is K2Vi V3, a dynamic 3D viewer, a globe similar in concept to Google Earth. This is the product we have tailored our Geographx base map for. The result is an interactive, dynamic tool for exploring and querying topography. It is also the real world environment into which we can drop and visualize the more detailed site models created with K2Vi Professional (above).

2. Development of the New Zealand 3D Dataset

The objective was to develop a 3D map:

- To a level of detail equivalent to 1:50,000 map scale

- Focusing on landforms and physical geography

- Using textures created from raw GIS map data

Now New Zealand is an interesting place to map. We are lucky to have a great variety of landforms tucked into a relatively small area. We are a geologically young country however, located on a tectonic plate boundary. Earthquakes, land slips and volcanic activity can and do change the face of the land.

Another cartographic challenge stems from our biculturalism and the lengthy nature of some Maori place names. Try working this name (Fig. 2) into your map and you will probably find you need a bigger piece of paper.

The raw data for the 3D map was drawn from the Land Information NZ National 1:50,000 topographic vector dataset.

The underlying 20 m cell resolution digital elevation model (DEM) that gives shape to the map was created by Geographx from contours and other height data contained in the LINZ data. The completed elevation model contains over one billion cells.

Fig. 2: Example of a lengthy Maori place name. It translates as "The summit where Tamatea, the man with the big knees, the climber of mountains, the land-swallower who travelled about, played his nose flute to his loved one".

The overlying map textures were created from point, line and polygon features sourced from the same LINZ dataset.

Place names were sourced from the NZ Geographic Place Names database.

From the outset we sought to differentiate our 3D map product from Google Earth.

The key differences are:

1. We created our map textures from the ground up using raw map data, rather than using satellite imagery.

The major reason for this was to avoid the "quilted bedspread" look you get in Google Earth. This results because satellite imagery from different dates, seasons, and time of day is mosaiced into a confusion of different vegetative textures, shadow angles and shadow depth. Satellite imagery also is prone to cloud cover and invariably contains too much clutter and unwanted information.

By creating our map textures from raw GIS map data, we could better control the information to be visualized, and present it in hierarchal fashion, the aim here being to visually represent the terrain as intuitively as possible. We only sort to include visual data clues to the features that could be readily identified from the air.

We have tried to enhance the "intuitiveness" through graphical techniques – examples lie in the bump mapping of forested areas and the reflectivity added to the larger rivers. You will notice that lakes, whilst recognizable as such, are not all the same colour (nor are they in nature), and that the hypsometric tinting of terrain is intentionally muted by emphasis on the overlying landcover.

Finally, and most importantly, the created map textures are seamless with no abrupt changes in colour, and constant shadow angles over the entire area of interest.

2. We have paid little attention to urban metropolitan areas. This is a high maintenance area and we simply do not have the resources to go there. Besides which, we are more interested in mountains and landforms - if you want to check out your own house, I recommend you stick to Google Earth.

3. Features and uses of K2Vi Viewer

As explained, the functionality of the K2Vi V3 Viewer and the 3D map continues to evolve. The following is not a complete list of features but is indicative of the development path being followed.

- Continuous readout of viewer position, altitude, heading

- Instant readout for any point of position, altitude, distance from viewer

- Scale and distance measurement tools

- Query place names and any associated geographical information

Fig. 3: Virtual Environment Modeling in real world context using K2Vi V3 Viewer.

- Style and scenario switching (eg: toggle between summer/ winter textures)

- Overlay vector point, line, polygon data

- Billboards – featuring attribute data, text, images, hyper-links etc

- Import detailed 3D site projects including 3D object models and animations

- Real time shadow analysis

- View corridor analysis

As commercially-driven operations, both companies are acutely aware of the need to find practical uses for any new products. We have identified the following end uses for the 3D Map in K2Vi V3. There will, we hope, be others.

- We have a Virtual Camera in that we can snap an aerial view of any place from any height or position without leaving the office – this also provides us with a source for 3D panoramic base maps.

- Interactives can be customized for visitor centres and education programmes – typically these utilize touch screens, "dumbed down" functionality, allow some form of free flight, and include themed "break-out" hta applications featuring additional media such as video, slide shows and sound bites.

- As real world context for Virtual Environment Modeling (site infrastructure modeling as earlier described and pictured on Fig. 3).

- Free Flight, particularly terrain familiarization for defence and emergency management (fire fighting, search and rescue).

- UAVs (unmanned aerial vehicle) and real time tracking

- Multimedia retail product for the recreation market (on DVD)

- The 3D map textures are currently also being used in conventional plan view vehicle tracking applications utilizing satellite telemetry and cellular networks, and also in 3D Television Weather Mapping applications.