

Chapter 11

A 3D City Model as User Interface Connected to an Energy Model

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ABSTRACT

Back in 2007 the municipality of Frederikshavn in Northern Jutland in Denmark decided to use only 100% renewable energy for electricity, heat and transport by the year of 2015. Frederikshavn, the largest city in the municipality, was naturally chosen as case city. To be able to verify whether the green energy balance is possible to achieve, it was necessary to create energy scenarios for the whole city and also give the possibility to alter the current energy production and consumption. At the same time the city decided to involve as many people living in the city as possible, making it a project for the citizens of Frederikshavn. One result of this decision was an interactive Web application developed at Aalborg University. The application uses a 3D city model of the city of Frederikshavn as interface and gives the possibility to alter inputs for the energy consumption and energy production of the city using sliders and buttons as part of the interface. While the 3D model gives an immediate visual result, a connection to an underlying numerical energy model developed in earlier years at the University delivers a quite precise calculation on all vital data involved in the overall calculation of renewable energy within a closed energy system. This chapter describes the underlying theories and methods for creating such a system and presents the system, which can be understood as a case story among many.

INTRODUCTION

Explaining non-professionals details about a quite complex issue puts you in the dilemma of choosing between superficial explanations risking to miss important details or include too many technical

details that give the right insight but makes it impossible to comprehend for people outside the professional domain. One need to find the right balance so that decision makers can make decisions due to facts and conceived information rather than believes and others conviction. Using

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graphics as means for a better understanding of complicated topics can be very tempting and the whole GIS domain does exactly that. When one moves into 3D using the spatial presentation as means one lowers the abstraction level considerably and makes the object in question more easy to perceive and at the same time more vulnerable to misleads and even misunderstandings (Kjems & Bodum, 2009).

However, this chapter will present the concept of using a graphical user interface including a 3D City model to enable non-professionals among them politicians and city planners to interact in an intuitive way with a complex energy model created for the city. This means an easy to perceive 3D model of a city connected to a tremendously complicated mathematical model of the energy flow in a city.

First of all you will find an outline of the two-fold system and the prerequisites and main components creating such a system. One part will be about the 3D city domain while the other will look at the energy system designed for a city and used in connection with the model, though the detailed setup and algorithms behind the model will have to be found in the references.

Finally the chapter presents the empirical findings of the attempt to use a 3D city model as user interface. Only very few systems have been developed for this kind of interaction, why the design method for this development was a mix of believe, trial, and error within an Agile programming framework. This chapter therefore can be used as a guide for what had worked well and what need to be improved and therefore help the reader to design an even better system.

One of the biggest challenges each software design is facing is the user interaction. A good interface is crucial to get people voluntarily to interact with a system or application (D. A. Bowman, Kruijff, LaViola, & Poupyrev, 2001; Fabrikant, 2005). The challenge is not only to make

the interface logically and intuitively appealing but also to find the right compromise between the numbers of adjustable features and system flexibility facing a clear and user-friendly environment. This challenge is even more demanding when the model scale is given by the extent of a whole country or “only” a city. Map makers and the GIS community have been working with this issue for decades but are quite often still lacking a good solution (Tomlin, 1990; Takeyama & Couclelis, 1997; Burrough, 2001). When it comes to 3D city models, it is very difficult to present information within a 3D environment due to the constructional details and textures one want to show on one hand and the information presented within the model on the other. But this is exactly the issue at hand. (Zanola, Fabrikant, & Çöltekin, 2009; D. Bowman, Kruijff, & Poupyrev, 2004; Dodge, Doyle, Smith, & Fleetwood, 1998; Hildebrandt, Klimke, Hagedorn, & Döllner, 2011; Döllner, Kolbe, Liecke, Sgouros, & Teichmann, 2006).

The background for this chapter is the development of an EnergyCity case study carried out by the Centre for 3D GeoInformation at Aalborg University. This project was initiated by the city of Frederikshavn in the northern part of Denmark. The goal for the project was to make a 3D city model act as an awareness tool allowing politicians as well as citizens to visualize and understand the change of energy consumption and energy sources in an urban environment over a period of time. The challenge here was not only to show geographic related information in a city scale but also actually convincing the user to be aware of consequences due to the production and use of energy in a city context. This system was supposed to be used by all kinds of laymen like school children, politicians and common citizens. The idea was to give the user an immediate response to their action so that they could realize how the change of energy consumptions matters, which helps them to realize a more sustainable while feasible energy scenario.

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