How are we to Represent Abstract Information in 'Realistic' 3D Environments?

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In his famous speech, Gore (1998) described a vision of the "digital earth" as an access point for all georeferenced data and information. The availability and use of desktop Virtual Reality environments or 'geo-browsers' such as Google Earth (Google 2006) or NASA's World Wind (NASA 2006) make this metaphor a reality. Up to 80% of all data have a spatial component and this spatiality is no longer a hidden quality - users across the globe are able to display and query a whole range of information through a common spatial framework and accessible 'front-end' that uses the 3D earth as interface metaphor.

Not only can geographic objects such as streets and buildings be represented through these 'realistic' interfaces to photorealistic data but also abstract information such as statistics or measurements for specific points or regions can be visualised. This combination can make the virtual world more revealing than real environments or 'more real than real' (Gillings 2002). Advances and standardization processes regarding Sensor Web Enablement (OGC 2006) provide access to thousands of different sensors that are collecting data all the time all over the earth (Reichardt, 2003). Integrated and accessible ways of combining, synthesizing and analysing this huge amount of data are still to be found – particularly in the context of the realistic 3D environments provided by the widely accessed and popular 'geo-browsers' (Thomas and Cook, 2005).

In practice, the use of 'geo-browsers' to provide and access geographic information is by no means straightforward. Various levels of realism can be applied. Appleton and Lovett (2003) found high levels of realism to be appropriate for landscape interpretation in environmental decision-making. Elsewhere, it has been suggested that certain users might benefit from higher levels of abstraction (Gillings 2002). The most effective solutions in many contexts may result from a combination of abstract and realistic information in displays (MacEachren et al. 1999).

Our research explores the relationships between realistic and abstract data representations for visualization in 3D environments such as those employed by ‘geo-browsers’. Preliminary experiments reveal that for certain tasks certain users of the Geonova desktop VE (Geonova 2006) use 3D visualizations to orient themselves more quickly and effectively than when using a traditional 2D map. Additionally, two-thirds of the participants in our tests preferred the 3D visualization over the 2D map for tasks such as acquiring an overview of a known or unknown region. However, they require additional information, such as elevation details, and high levels of interaction to perform more complex tasks and to be more confident in their performance even if they are less successful in task completion (Bleisch and Dykes 2006).

Taking advantage of the rapid orientation typical of realistic 3D environments and combining it with the representation of abstract data for detailed information about a region or phenomena might provide a mechanism for successful information analysis and faster decision making. But as Meng (2003) notes, the techniques available and use of visualization tools are developing much faster than the cartographic theories and methods. This lag or ‘knowledge gap’ makes it difficult to use cartographic or cognitive rules and theories to visualise effectively in realistic 3D environments.

We aim to contribute to closing this gap. Many rules and techniques from traditional cartography and information visualization (e.g. Bertin 1974, Tufte 2001 and Keim et al. 2005) may be applicable to data visualization in realistic 3D environments and/or enhance them when considering cognitive and usability aspects (e.g. Baird and Noma 1978 and Ware and Plumlee 2005). We will establish whether such rules apply in realistic 3D environments under certain conditions and prepare guidelines for using abstract representations in this context. This will be achieved by conducting tests in selected application areas with potential users and experts.

The research will establish empirically tested recommendations about how abstract data can be visualized in Virtual Environments for analysis and decision making in the chosen application areas and more generally.

At this stage of the process we are interested in discussing our preliminary results and techniques for abstract data representation and symbolism. We are interested in sharing ideas and invite comment and discussion.

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