TITLE: The Development of a Marine GIS

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ABSTRACT
The sea moves: the land usually stays still. It is not surprising that the underlying structure of a land-based GIS is rarely appropriate for marine applications. Add the third spatial dimension and it is clear that an attempt to simulate the sea requires a major overhaul of the appropriate algorithms and data structures.

It has seemed obvious for some time that spatial data structures need to adapt locally to change. The opportunity to work on real marine data for the Hong Kong area provided the incentive to put our ideas into practice. The challenge was to produce a dynamic three dimensional equivalent to the classical "Pilot Book", which contains the rules for navigation in the proximity of individual harbors.

While we have done some work on true dynamic three dimensional data structures, as required for marine profiling, the Pilot Book application could be achieved with a kinetic two dimensional structure, but in several layers. The terrain (above and below the sea surface) was modeled, and the coastline at any particular tidal time was captured by its intersection with the current local sea level. This, together with the locations of individual ships and other surface features, was used to form a two dimensional dynamic Voronoi diagram at the sea surface for proximity and collision detection. Other layers were used to indicate fairways, marine markers, submarine contours, etc.

However, in order to provide a realistic simulation, we needed to take concepts from 3D games development and to model marine markers such as lighthouses and buoys, and to simulate fog and darkness. We also needed to provide a variety of camera views: overhead and on board a selected ship – a deck view, above and behind, below and behind. . Real-time querying can give sea depth based on the most recent bathymetric observations, as well as permitting querying of displayed objects, such as lighthouses, buoys and chart features. The result may provide a feasible replacement for the Pilot Book, especially for practice simulations. Full 3D volumetric modeling is under development.

This is the state of prototype development so far. The tutorial will start by outlining the differences between a land-based GIS and what we would imagine to be the requirements for an equivalent marine system. The prototype will form the basis for further discussion and suggestions. Participants will be invited to comment on the results so far, and suggest additional features that they would like, as well as to review the whole concept to date and to propose alternative models. It is hoped that the resulting discussion will spawn a working group of those interested in contributing to the development of the next "Marine GIS".

BIOGRAPHY

Professor Christopher Gold currently holds an EU Marie-Curie Chair in GIS in the School of Computing at the University of Glamorgan. Previous positions include Professor of GIS in the Department of Land Surveying and Geomatics, Hong Kong Polytechnic University, and an Industrial Chair in Geomatics at Laval University, Quebec. He has experience in geology, geography, forestry and agriculture, as well as a particular interest in terrain modeling, spatial data structures, visualization and software development. He has authored or co-authored over 200 conference or journal articles.

In his current EU position he is preparing and giving various workshops on GIS development, algorithms and methods. Topics include: basic mathematics, the appropriate concepts of space, elementary graph algorithms, spatial data structures, simple Voronoi diagrams, dynamic spatial structures, landscape modeling, surface (b-rep) models of 3D objects (including the Earth), and volumetric 3D modeling. In addition, there are modules on object-oriented programming and 3D interactive graphics.

In particular, his position is intended to strengthen the interaction between computer science and the various geo-sciences, including oceanography. Traditionally the GIS community has focused on static, land-based mapping and analysis. The challenge is to go beyond this, using the more recent concepts and methods from computer science, visualization and game development. In all aspects of GIS there are new challenges in dynamic mapping and updating, simulation, 3D modeling, and adjacency relationships or collision detection. Consideration of the needs and features for a Marine GIS involves all of these issues.

He maintains a web site at www.voronoi.com dedicated to the promotion and understanding of Voronoi diagrams – both for the dissemination of algorithms and for the sharing of experience and applications of these methods in any of the spatial sciences.