CHAPTER 1

Introduction to terrain modelling—application fields and terminology

Introduction

- **The techniques of terrain modeling are in widespread use and have been applied widely in the physical and earth sciences. In particular the technique has been applied to problems in the following fields.**
  (i) Topographic mapping. **Digital representations of the terrain often form one of the main elements of the mapping process. However, unlike surface modelling where a unique mathematical expression can often be used to define the feature of interest, it is virtually impossible to define precisely the structure of the terrain by a single mathematical function. Consequently, many different approaches to the problem have been advocated.**
  (ii) Civil engineering. **Terrain models are in widespread use in the field of civil engineering. Initially they were used almost exclusively for the determination of earthwork cut and fill volumes for highway engineering projects. Nowadays, however, the same principles are applied to both linear projects (such as roads and railways) and projects with a large areal extent (such as landscaping and estate development). Furthermore, the modelling techniques can also be used to create digital design models of proposed structures (such as roads, buildings, etc.).**
  (i ii) Hydrographic/bathymetric mapping. **Small-scale models of the sea bed using depths obtained from the echo sounders can also be produced. Compared with their topographic equivalents it is less easy to gain access to, or visualize the sea bed, and difficult also to identify, locate and measure distinct lines on the terrain (such as ridges, valleys and breaklines) which play such a vital role in modeling terrain surfaces.**

- ***(iv) Geological and geophysical mapping.*** **Geology has been a discipline where terrain modeling has found widespread application over a long period of time. Besides terrain surfaces, models of underground surfaces defining specific geological strata can also be created. Models of this type are often derived from sparse or scattered data obtained during drilling.**

  (v) Mining engineering. **The application of terrain modeling in this field is closely related to that of geology and geophysics. Again much of the data used is highly clustered, and poorly distributed. Consequently much work has been made by mining engineers with such data; in particular, the work done by Krige is highly regarded and has led to the term 'Kriging' coming into widespread use in all forms of modeling and interpolation.**

  (vi) Simulation and terrain visualization. **Many people take the view that the most advanced and sophisticated forms of terrain modeling are in the fields of simulation and visualization, particularly for flight and radar simulation. In the former case, realistic representations of the Earth's surface, derived from terrain models, are combined with the requirement for real time and constantly changing simulations of the pilot's view of the ground. Finally, terrain modeling using fractals can be used to produce**

  (vii) Military engineering. **An understanding of the terrain is of vital importance to a military commander. It is therefore not surprising that substantial effort and large sums of money have been spent on research and development into the military applications of terrain models and other digital mapping products.**

Terminology

From these definitions, some differences begin to manifest themselves between the different terms.

(i) In the case of the *Digital Elevation Model (DEM)*, the term elevation emphasizes the measurement of height above a datum and the absolute altitude or elevation of the points contained in the model. DEM is a term which is in particularly widespread use in the U.S.A., and generally refers to the creation of a regular array of elevations

(ii) Digital Height Model (DHM): DHM is a less common term and has the same definition as DEM since the words elevation and height are normally regarded as synonymous. The term seems to have originated in Germany.

(iii) Digital Ground Model (DGM): seems to lay its emphasis on a digital model of the solid surface of the Earth. In this way, there is presumed to be some connection between the elements which are no longer considered discrete. This connection generally takes the form of an inherent interpolation function which may be used to generate any point on the ground surface.

(iv) Digital Terrain Model (DTM): is a more complex and all-embracing concept involving not only heights and elevations but other geographical elements and natural features such as rivers, ridge lines, etc. In the narrower sense, a DTM only represents terrain relief.

(v) The term *Digital Terrain Elevation Data (DTED),* as used by the US Defense Mapping Agency (DMA), describes essentially data produced by the same process although it specifically uses a grid-based method of data storage.