The 3-D Global Spatial Data Model:
Geometrical Foundation of the Spatial Data Infrastructure

Preface

"The right tool for the job" is a simple phrase with profound implications. The proliferation of tools for handling spatial data is somewhat daunting as benefits associated with their use spawns development of even better tools. Although we are where we are because of where we came from, the path to the future should be viewed in terms of the analog-to-digital revolution. Given the many specializations associated with developing technology, it is impossible to write a comprehensive book about an umbrella topic like spatial data. Therefore, acknowledging that others will add details to illuminate the path ahead even better, this book is written to define and describe a global spatial data model (GSDM) that:

- is easy to use because it is based upon rules of solid geometry.
- is standard between disciplines and can be used all over the world.
- accommodates modern measurement and digital data storage technologies.
- supports both analog map plots and computer visualization of digital data.
- preserves geometrical integrity and does not distort physical measurements.
- combines horizontal and vertical data into a single 3-dimensional data base.
- facilitates rigorous error propagation and standard deviation computations.
- provides (and defines assumptions associated with) various choices with respect to spatial data accuracy.

In a way, this book is organized backward. Chapter 1 contains the results and Chapter 2 justifies Chapter 1. Fundamental geometrical concepts are developed in terms of more traditional material in subsequent chapters. That is done to accommodate readers with various backgrounds. Managers and those with a strong technical background might concentrate only on the beginning chapters. Spatial data professionals at various levels who wish to gain a better understanding of geometrical relationships should start with the beginning chapters so they know where the rest of the book is going. Given Chapters 1 and 2 are not easy reading, they should be read first as an overview. It is expected then, as the reader progresses through subsequent chapters, that Chapters 1 and 2 will be re-visited as required to help refresh the focus on the overall objective of defining an appropriate spatial data model. For those just beginning to work with spatial data, serious reading and study should begin in Chapter 3. With that said, the plan for building a comprehensive spatial data model is to present fundamental mathematical concepts in Chapter 3 and to add concepts from surveying, geodesy, and cartography in subsequent chapters.

The material is presented as simply as possible without compromising technical rigor. Some readers will find the review of mathematical concepts redundant and some readers may never have occasion to use linear algebra, matrix manipulation, or error propagation. Acknowledging the certain diversity of readers, the goal is to provide a logical development of concepts for those who wish to follow the theory and to provide all readers a collection of

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tools that can be used to handle spatial data more efficiently.

Whether the reader is involved in technical applications, is making managerial and administrative decisions with regard to spatial data, or is a programmer writing software for handling spatial data, all should agree that the most appropriate tools for handling spatial data are those which are, at the same time, both simple and appropriate. The GSDM is simple because it uses existing practice and rules of solid geometry for manipulating spatial data. And, the GSDM is appropriate because it is built on local coordinate differences, preserves true 3-dimensional geometrical integrity on a global scale, accommodates modern digital technology, handles error propagation with aplomb, and supports subsequent computation of complex geometrical relationships in geodesy, cartography and other sciences. In the past, spatial data models were selected by default as people (rightfully) focused on impressive gains in utility and productivity made possible by automating existing processes. But the GSDM is a result of examining those processes in terms of digital technology and fundamental geometrical concepts. With features of the various models described and compared, it is anticipated that spatial data analysts in various fields will, as a matter of conscious choice, begin using the GSDM because it establishes a common geometrical link between spatial data sets, applications, and disciplines and because it provides an efficient method of defining, tracking, and evaluating the accuracy of spatial data.

What does it mean to "think outside the box?" Is thinking outside the box something beneficial and desirable? Or is thinking outside the box to be avoided? What do elephant jokes have to do with boxes? Without answering those questions, consider the following: (To whom does one credit elephant jokes?)

1. How does one determine the number of elephants in the refrigerator? Answer: Count their tracks in the butter.

2. How does one kill a blue elephant? Answer: Shoot it with a blue elephant gun.

OK, now the pattern is established and the reader is ready for whatever else comes along.

3. How does one kill a red elephant? No, you don't shoot it with a red elephant gun because you don't have one. The correct answer is, "Choke it until it turns blue, then shoot it with your blue elephant gun."

Elephant jokes may have no place in a rigorous technical book (except maybe in the preface), but these illustrate a very important point. Humans are very good at using whatever tools are available to do what needs to be done. Without being critical, many wonderful accomplishments have involved (figuratively) choking the elephants. But, everyone should be aware that sometimes it is better, easier, and more appropriate to look for a red elephant gun than it is to keep choking those red elephants. Most red elephant guns are found outside the box.

The GSDM is viewed as a red elephant gun for handling 3-D digital geo-spatial data.

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