book review

Geographic Information Systems, An Introduction, Second Edition

By Tor Bernhardsen
English translation by Michael Brady Consultants and Mahala Mathiassen.
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This attractively designed book presents in a single, handy volume an encyclopedia of GIS. In twenty-one chapters, the author presents a wide-ranging overview of GIS that encompasses nearly every aspect of the technology and its use. Bernhardsen intends this as an introduction for those who have little or no knowledge of GIS. The first three chapters offer a definition of GIS in the context of information technology, a brief history of geographical information, and a summary overview of contemporary geo-spatial data concepts.

Chapters Four through Six present a more detailed review of spatial data models, attribute data, and map projections. Hardware and software for GIS are presented in the next two chapters, followed by a lengthy excursion into data-related topics occupying Chapters Nine through Thirteen. This section presents such topics as data collection, data quality and database management systems.

Spatial analysis is covered in the next two chapters, followed by one on visualization. Implementation receives lengthy treatment in Chapters Seventeen and Eighteen. Chapter Nineteen reviews standards and data exchange issues, and Chapter Twenty contains a discussion of legal and financial issues. The final chapter offers a brief recapitulation of the book's major topics in the context of future possibilities.

This book uses many two-color graphics and tables to illustrate and exemplify the author's ideas. There is a map, diagram, or table on nearly every page. The text is well organized in logical, numbered chapters and sections; the prose is generally clear and easily understood. A generous list of references, including a number of Nordic works that North American readers may find intriguing, completes the volume.

Bernhardsen sets out to ". . . meet the need for a comprehensive presentation of the various fields currently associated with… GIS," and admits that an appropriate alternate title might have been "Geographic Information Technology." This work is largely descriptive with little theory or analysis, and in this respect seems to be a compilation of topics in GIS technology. The major contemporary topics of GIS, from cartography to metadata, are methodically delineated, but few are presented with depth or context.

The extensive treatment of data found in this book is a refreshing departure from texts grounded in the cartographic and spatial analysis paradigms for GIS. Bernhardsen repeatedly emphasizes the importance of data as a foundation of GIS and of information technologies in general. From the beginning, he places data at the center and in different ways reminds us of its importance: the difference between maps and data, the fact that data represent imperfect measurements of reality rather than a presentation of re-ality; that spatial analysis operates on such data as is available, for better or for worse. He presents a serviceable introduction to formal data modeling and its im-portance to designing useful data-bases. He describes the essential concepts distinguishing accuracy from precision. He effectively explains mechanisms for linking spatial and attribute data.

Data quality issues are discussed at some length in this volume. Bernhardsen provides clear, sensible descriptions of how data can be misused by exceeding accuracy limitations or by making assumptions about the compatibility of disparate spatial data. In addition to quantitative accuracy, he includes logical consistency, completeness, and timeliness to provide a well-rounded and instructive review of the elements of data quality. A summary outline of "Probable Sources of Error" along with a list of strategies for reducing errors are examples of the author's consistently practical approach to his topic.

The difficulty that many novice GIS users and map customers have in grasping the significance of data resolution, accuracy, and scale for analysis and mapping is something that GIS practitioners and cartographers are all too familiar with. Many geographic analysis projects have deteriorated into disappointment and frustration as the real capabilities and limitations of the available data were recognized. This book brings out the distinction between data and its representation on several occasions, and repeatedly makes the point that uses of data should be constrained by the quality of the data. The idea is presented as relevant to both geospatial data and tabular attribute data, and is one of many

instances when GIS is presented as a discipline interrelated to a larger realm of information science and technology. This is a thoughtful approach not widely found in books on GIS.

Another way that Bernhardsen places GIS in context is his applied approach to the discipline. He consistently discusses issues of design, implementation, and use in terms of people using a tool. The human context is never far from the topic at hand. Throughout the book, technical matters arise as explanatory background underlying the practical applications of GIS. There is little celebration of technology and science for their own sake.

Considerable attention is given to GIS implementation issues. Two large chapters delineate the organizational and technical issues surrounding GIS acquisition and deployment. These appear to be the most carefully written chapters and reveal some of the author's conceptual foundations. In the historical background offered under "Choosing a GIS—Organizational Issues," Bernhardsen argues that GIS technology presents advantages and opportunities for applied geography questions, but that there are associated costs—both apparent and invisible—for an organization adopting new technologies and methods. Readers who have worked with large organizations trying to adopt GIS will recognize the issues and find Bernhardsen's recommendations sound. He states that GIS projects ". . . tend to overfocus on technology and underestimate the organizational tasks." Most veterans of IT implementation projects will readily acknowledge this and appreciate his methodical and thorough analysis of how GIS can be planned for and introduced into an organization. In the implementation discussions, he attempts to consolidate the more technical chapters as background for a careful examination of how one might plan, organize, implement and measure the efficacy of a GIS. A partial list of his topics includes Business Concept, Appraisal of Current Setting, Review of other GIS's, Cost/Benefit Analysis, Strategic Planning, and Data Modeling. The technical issues chapter presents such topics as Pilot Project, Request for Proposal, Contracts, and Database Maintenance.

This book succeeds in circumnavigating the world of GIS, but at the cost of overlooking some of the most important places along the way. While we are introduced to nearly every GIS-related topic one can imagine, it is apparent that compromises were made to contain the size and scope. Bernhardsen admits explicitly to having made choices, and it is this selection of what to emphasize and what to de-emphasize that is problematic.

First, there is the problem of map projections. The chapter devoted to georeferencing and coordinate systems falls short of a reasoned, clear, orderly explanation of these complicated topics. In an introductory text, one expects a methodical description of the earth and its shape, the logic of geographic coordinates, the need for map projections and grid coordinate systems, the methods employed in creating them, and some thoroughly developed examples to illustrate these concepts. Instead, Bernhardsen starts with a discussion of "continuous" and "discrete" georeferencing as types of measuring systems and then abruptly pursues a very abbreviated description of datums, map projections, and coordinate systems. Those new to geographic concepts will certainly be confused by his use of inadequately defined terms ("projection," "geometrical computations," "meridian") and minimally explained concepts (the ellipsoid, local grid systems). He claims that geographic coordinates provide ". . . only relative . . ." positions. Only after studying the context repeatedly was it apparent that this was intended to say that longitude-latitude values could not be used directly for planar calculations.

The diagrams provided with this chapter are minimal and confusing. He presents the "three groups" of map projections ("cylindrical, conical and azimuthal") in a diagram that is very difficult to interpret. The depiction of the azimuthal case is a graphic I have yet to understand. A lengthy narrative about the Universal Transverse Mercator system is offered with a graphic that fails to illustrate the method of identifying zones. Other technical and theoretical problems abound in this chapter.

The second major problem is the chapter on visualization. This is the mapping chapter, but Bernhardsen seems unsure of exactly what he wants to say about cartography. He considers "visualization" an extension of cartography through sound, imagery, animation, and text. He states that maps are often the primary product of GIS and contribute to the decision-making processes that GIS is supposed to support. Given this importance of presentation as a part of GIS, his treatment of cartography seems inadequate. He presents the basics of graphic variables and map symbology in a condensed but adequate manner, but fails to provide specific guidance on some of the challenges he identifies. He notes that color is the most frequently misused variable in mapping, but does not take this issue anywhere. He offers no remedy for a non-intuitive color sequence for classes of data. He

offers no strategy for selecting point-feature symbols.

Although "multi-media" is mentioned in this chapter there is nothing about Internet mapping. There is nothing about lithography, nothing about title, scale, or page layout, and no examples of finished, presentable maps.

The final paragraphs of this chapter reveal Bernhardsen's limited concept of cartography. He indicates that GIS is an analytical tool with ". . . few aesthetic capabilities," and that it is ". . . unable to manipulate the overall aesthetic appeal of a map . . ." Cartography, on the other hand, is said to be an ancient, well-developed art and craft. His conception of maps as "static presentations" suggests that for Bernhardsen "cartography" is for manual paper map construction, whereas "visualization" is an extended set of presentation capabilities, some of which are drawn from cartography. I would expect many contemporary practicing cartographers and GIS practitioners to disagree. He makes no mention of the perception studies that have provided quantifiable design principles, nor of the desktop publishing software that now makes GIS data so readily available for presentation design, nor of the eagerness with which GIS vendors are developing mapping capabilities for the Internet.

Many other principles, techniques, and theories of the mapping sciences fall victim to Bernhardsen's approach to describing GIS. Photogrammetry, surveying, satellite imagery, and spatial analysis are some of the other topics laced with various shortcomings in this book. The two problems discussed above, however, are for me the key indicators of this book's principle trouble. There is no theoretical framework embracing and organizing the many topics discussed. As noted earlier, his conceptual foundation appears to be that GIS is essentially an IT tool set, and an understanding of its components is an understanding of GIS. He devotes 154 pages to implementation issues and only 22 to geo-referencing and cartography combined.

Clearly, geo-referencing methods and map projections are fundamental to GIS. The brief treatment given this topic by Bernhardsen is especially surprising given his data orientation. Map projections are data transformation methods that affect all later spatial operations applied to the data. Cartography is another kind of data transformation method. In cartography, the outcomes of all forgoing GIS analyses are brought to life in a presentation intended to communicate, provoke, or inspire—in short, to influence in some way. A more extensive, careful treatment of such core concepts of GIS might have contributed to a unifying idea, weaving together all of the chapters, but this opportunity was missed.

This book may serve best as a general reference for IT professionals participating in GIS development and management or for business people working with GIS staff. There are moments of striking clarity as Bernhardsen describes a concept in a refreshingly non-geographic way, and this is a genuine contribution to expanding the appreciation of GIS among other disciplines. It would not serve well as a textbook or reference book for a GIS practitioner, however. It lacks a consistent, organized presentation of those core principles of geography that thread together spatial data frameworks, transformations, analyses, and presentations. Without such a unifying presentation, the book remains a catalog of GIS methodology.

Letter from the Editor
(continued from page 1)

our campus. Some students in my introduction to maps course have talked about mapping terrorism. There are "donation cans" scattered everywhere for surviving families of NY police and firefighters. I have seen numerous memos from our University's President reminding us of the campus' staunch policy on equal rights. I think about the potential consequences of the war in Afghanistan. It weighs heavy on my mind when I look at my 4 sons . . . my two oldest 1.5 years away from age 18 . . . I never had to register for the draft . . . I wonder if they will? In spite of this, we move forward. We have to. So CP moves forward.

Over the past several years, under the guidance of Michael Peterson, CP enjoyed steady growth in article submissions and journal circulation. On behalf of all the members of NACIS, I would like to thank Mike for his commitment and dedication to CP. Under his leadership, CP has prospered. It is my intension to build on this prosperity, and encourage CP to grow and prosper. The members of NACIS enjoy a journal that is dedicated to issues central to cartography and geographic visualization. CP is unique when compared to other cartographic journals. Our journal is different; our journal is inclusive. We recognize the breadth of cartography, and publish papers across a wide spectrum of sub areas within cartography. Consider the current issue: we have papers on semiotics, on historical cartography, and on human perception of map symbols.

To continue this spirit of change, CP has a mostly new editorial board. With much guidance and input from the previous editor, a slate of people was assembled that represents all walks of cartography and visualization. The board includes Jim Anderson, Florida