Biographical Box 10.3

Shashi Shekhar, Computer Scientist

Shashi Shekhar (Figure 10.21) received a computer science and engineering (CSE) education from the Indian Institute of Technology, Kanpur (1981–1985) and the University of California, Berkeley (1985–1989). He is presently a McKnight Distinguished University Professor of CSE at the University of Minnesota. His knowledge of GIS started in the early 1990s from sponsored research projects on computational aspects of in-vehicle and Web-based navigation systems (USDOT), high-performance GIS for vehicle simulators (USDOD), Minnesota Mapserver (NASA), and the like. Soon, he realized there was a strong and growing demand for CSE advances for GIS, yet very few CSE scholars were dedicated to this promising area. Thus, in the mid-1990s, he decided to focus his research on understanding the structure of very large spatial computations (e.g., data analysis via spatial querying and spatial data mining). Illustrative contributions include: the Capacity Constrained Route Planner, an evacuation route planning algorithm, which is orders of magnitude faster than traditional linear programming-based methods; the Connectivity-Clustered Access Method, a min-cut graph-partitioning-based storage method, which outperforms geometry-based indices (e.g., R-tree family) in carrying out network computations; and the notion of "co-location" patterns in spatial datasets to provide a trade-off between computational scalability and spatial statistical rigor.

His textbook, *Spatial Databases: A Tour* (Shekhar and Chawla, 2003), describes object-relational database concepts for GIS at conceptual (e.g., entity-relationship models with pictograms), logical (e.g., SQL3, OGC simple feature types), and physical (e.g., R-trees) levels and introduces trends (e.g., spatial data mining). In a more recent project, *Encyclopedia of GIS*, he uncovers broader CSE issues in GIS, for example, open-source and commercial software, standards, geosensor networks, the geospatial semantic Web, privacy, and indoor positioning.

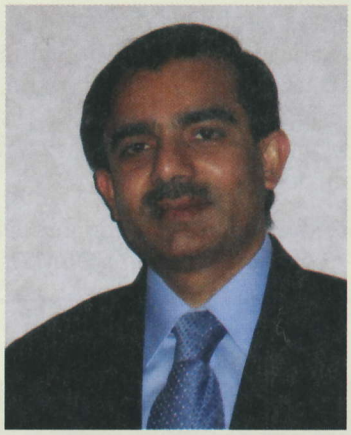

Figure 10.21 Shashi Shekhar. (Dr. Shashi Shekhar)

Reflecting on the interplay between CSE and GIS, Shashi says:

> GIS problems often reveal limitations of current CSE methods, stimulating advances in CSE. At the same time, computational methods are becoming the third leg of science (e.g., GIS) complementing mathematical models and controlled experiments. In addition, scalability to large spatial datasets will often be expected from GIS in the post Google Earth era. As for the future, I believe that GIS work driven by stove-piped disciplines may be limited in solving complex problems facing our society, and will increasingly be replaced by interdisciplinary approaches leveraging ideas from and advancing multiple disciplines, e.g. GIS and CSE.

science and engineering (see Box 10.3). They bring with them standardized approaches for storing and, more importantly, accessing and manipulating geographic data using the SQL query language. GIS provide the necessary tools to load, edit, query, analyze, and display geographic data. DBMS require a database administrator (DBA) to control database structure and security, and to tune the database to achieve maximum performance. Innovative work in the GIS field has extended standard DBMS to store and manage geographic data and has led to the development of long transactions and versioning that have application across several fields.

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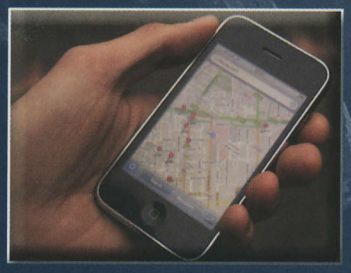

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organizing principles, techniques, analysis methods, and management practices that we believe to be important. The material in each section of the book progresses in a cumulative way, yet we envisage that very few students will start at Chapter 1 and systematically work through to Chapter 20. Learning is not like that anymore (if ever it was), and most instructors will navigate a course between sections and chapters of the book that serves their particular disciplinary, curricular, and practical priorities.

That said, we have prepared a number of pointers to the ways in which the course might be used in education and training. Some of the ways in which three of us have used the book in our own undergraduate and postgraduate settings are posted on the book's Web site (www.wiley/college/longley), and we hope that other instructors will share their best practices with us as time goes on (please see the Web site for instructions on how to upload instructor lists and offer feedback on those that are already there!). Our Instructor Manual (see www.wiley/college/longley) provides suggestions as to the use of this book in a range of disciplines and educational settings.

Inevitably, it is impossible to provide a comprehensive treatment of all that is distinctive about GI-Science in a book of this length. We have provided a primer on the most important geographical methods and techniques, and in seeking to go further, users may find themselves faced with the many options presented by an online search engine. A very positive characteristic of the evolution of GIS in recent years has been the move to open-source software and creative-commons data, much of which is principally documented and disseminated online. Yet a search engine is not the same as the index of a book, and search-engine returns may be dictated more by the market share of leading vendors than by relevance to the problem at hand. Accordingly, two of us have been involved in a related project that aims to provide an authoritative and independent guide to the principles and techniques of geospatial analysis, and the best software tools that are available to put them into practice. The result is a free-to-access Web site, www.spatialanalysisonline.com, with a comprehensive search facility, and related printed and PDF versions of the Web materials (see Further Reading). In many cases, this also provides the reader with the opportunity to further pursue the technical discussion of material discussed in this book, and we reference it at numerous points for this reason.

The format of this book is intended to make learning about GIS fun. GIS is an important transferable skill because people successfully use it to solve real-world problems. We thus convey this success through use of real (not contrived, conventional textbook-like) applications, in clearly identifiable boxes throughout the text. But even this cannot convey the excitement of learning about GIS, which only comes from doing. With this in mind, an online series of laboratory classes have been created to accompany the book. These are available, free of charge, to any individual working in an institution that has an ESRI Inc. (Redlands, CA) site license (see training.esri.com/campus/catalog/licenses/courselist.cfm?id=43). They are cross-linked in detail to individual chapters and sections in the book, and provide learners with the opportunity to refresh the concepts and techniques they have acquired through classes and reading, as well as the opportunity to work through extended examples using ESRI ArcGIS. As de Smith et al. (2009) make clear, this is by no means the only available software for learning GIS: we have chosen it for our own lab exercises because it is widely used, because one of us used to work for ESRI in California, and because ESRI's cooperation enabled us to tailor the lab exercises to our own material. The course catalog for the six-module 'Turning Data into Information' course can be viewed at training.esri.com/acb200/sowdetl.cfm?DID=6&Product_ID=821. There are, of course, many other options for lab teaching and distance learning from private and publicly funded bodies such as the UNIGIS consortium (www.unigis.net), the Worldwide Universities Network (www.wun.ac.uk/ggisa), and Pennsylvania State University World Campus (www.worldcampus.psu.edu).

GIS is not just about machines, but also about people. It is very easy to lose touch with what is new in GIS, such are the scale and pace of development. Many of these developments have been, and continue to be, the outcome of work by motivated and committed individuals—many an idea or implementation of GIS would not have taken place without an individual to champion it. In the first edition of this book, we used boxes highlighting the contributions of a number of its champions to convey the idea that GIS is a living, breathing subject. The second edition set the precedent of removing all of the living champions of GIS and replaced them with a completely new set. We have followed this precedent in this third edition—not as any intended slight of the remarkable contributions that these individuals have made, but as a necessary way of freeing up space to present vignettes of an entirely new set of committed, motivated individuals whose contributions have also made a difference to GIS.

Students today are seemingly required to digest ever-increasing volumes of material. We have tried to summarize some of the most important points in