Foreword

Language is our primary means of communication, yet humanity is divided into between three and four thousand speech communities, and in most cases it is impossible for members of two different speech communities to understand each other. There are problems of communication even within speech communities (as in Churchill's famous description of the U.S. and the U.K. as "two nations divided by a common language"). Pictures present no such problems, and a picture of a lone protester in Tienanmen Square is instantly meaningful to everyone, whatever the language of the commentator. A picture of Earth from space similarly transcends language, speaking directly to the humanity in all of us.

Maps fall somewhere between these two extremes. Almost any sighted person can draw useful information from a street map of London, though the names of features will be inaccessible to someone not familiar with the rudiments of English pronunciation and the Roman alphabet. Similarly, a foreigner in Tokyo might have no problem with understanding the city's layout from a map, but might be totally unable to recognize place names in Japanese characters. Common cartographic convention makes these two maps partially interoperable, though there may be no interoperability of language. This set of common cartographic conventions has developed over the past two centuries, and it has allowed maps to be exchanged freely as a geographical *lingua franca.* There has been no need (at least in recent years) for the British Ordnance Survey to make maps of the U.S. because U.S. maps are available and fully informative to British users. The number of map communities, in the sense of communities sharing a common geographic language, has been far less than the number of speech communities.

Geographic information systems (GIS) provide us with a way of capturing geographic information in digital form, and manipulating, sharing, and displaying it in myriad ways. The contents of a map can be flashed around

the world in digital form at the speed of light, vastly increasing the usefulness and value of our geographic knowledge of the world. So one might think that the advent of GIS would have increased the homogeneity of cartographic convention, just as increased travel has led to the dominance of English as the international language of tourism and commerce. Surprisingly, exactly the opposite seems to have happened. There turned out to be many different ways to convert the contents of a map to digital form, and many ways emerged to specify the various operations one can perform using a GIS. The command languages that were developed to control GIS were consequently almost completely incompatible. Apparently simple terms like "layer" and "object" turned out to mean different things in the context of each GIS. Moreover, commercial interest seemed to argue for uniqueness, as each software company tried to create its own market niche and to prevent its users from making an easy switch to a competitor's products. The result was a proliferation of GIS communities, each defined by one set of products and unable to communicate easily with others.

But times have changed, and today's users of computers are no longer willing to endure the long process of training needed to master the idiosyncrasies of one vendor's design, when the task that needs to be accomplished seems conceptually simple. Vendors have realized that openness, in the sense of easy compatibility, is a strategy whose advantages in the marketplace can outweigh those of the opposite strategy of secrecy and entrapment. The GIS industry has begun a long process of convergence towards open specifications and standards that will eventually allow one system to talk to another, and one vendor's components to be replaced by those of another vendor. These practices have dominated the electrical and automobile industry for decades, and the GIS software industry is finally beginning to see their advantages.

Andrej Včkovski is one of the foremost researchers in this new arena of interoperability and open GIS. He was among the first to recognize the true implications of interoperability, in the form of a new kind of GIS that would be easier to learn about and use. A common language between GIS is necessarily a simple language that replaces the arcane complexities of each system's proprietary approaches with one that is solidly grounded in theory. By removing all of the unnecessary details of technical implementation from the user's view, it allows interaction with a simple conceptualization. This book breaks new ground in showing how this basic principle works, using well-chosen examples. As a piece of research it is still some distance ahead of the industry, so in that sense this book offers a view of the GIS that is yet to come. At the same time the approach is very practical, and it is easy to see how it can be implemented, given the clarity of the author's presentation and the simplicity of the ideas. The publication of this book should help to move that process of implementation along faster.

Interoperability should make GIS easier to use and easier to learn about. It should make it possible to transfer skills acquired on one system to another, and make it easy to transfer data created for one system so that it can be

manipulated by another. All of this will have exciting impacts on how we learn about GIS, and how we make use of it. Thus far all we know is that future technology will make it possible to store data in one location, process it in another, and control the process from a third. It will also make it possible to unbundle GIS into simpler components that can be reassembled at will. But we have very little idea of how to take advantage of that potential, or of what it implies for practices of use, archiving, and analysis. In a world in which computing can occur anywhere, in any sequence, decisions will still have to be made about where to compute, and in what order. Entirely new choices become possible, and there will have to be rational grounds for making them, and for the new arrangements that will have to be put in place. As so often in the past history of GIS, new capabilities create new potential and new uncertainty. In that sense this book is a stimulus to a new round of research that will address the deeper implications of achieving interoperability, and a stimulus to educators to think about how to prepare the next generation of GIS users to work in a very different world.

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