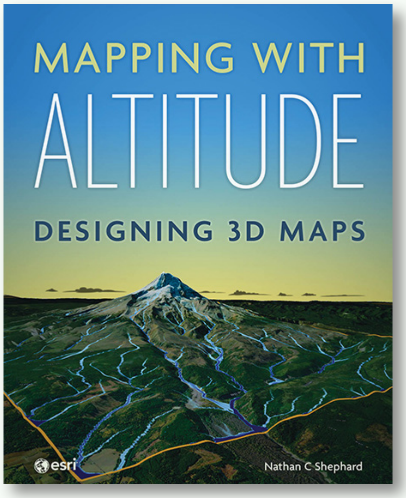
DOI: 10.14714/CP107.2019



MAPPING WITH ALTITUDE: DESIGNING 3D MAPS

By Nathan C. Shephard

Esri Press, 2024

280 pages

Softcover: $84.99, ISBN: 978-1-58948-553-2

eBook: $84.99, ISBN: 978-1-58948-554-9

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We live in an inherently three-dimensional (3D) world, yet traditional cartography has been predominantly organized around two-dimensional (2D) maps. In this new book, *Mapping with Altitude*: *Designing 3D Maps*, Nathan Shephard makes the case that the evolving complexity of the modern world, together with advances in digital mapping technologies and the demand for more immersive use cases, has now made 3D maps increasingly useful, relatable, desirable, and perhaps even necessary, to both technical and non-technical users. Shephard's goal is to "catalog and explain the many challenges and opportunities available for today's new generation of 3D cartographers and to define a series of general rules that can simplify the many design choices available" (vii), and he draws on his extensive experience as a project team leader working in 3D—and even 4D—research at Esri to deliver an informed view of the theoretical and practical aspects of this topic.

Each of the book's sixteen chapters draw on principles from 2D cartography to provide a strong conceptual basis for understanding and explaining 3D maps, presented in easily digestible portions of content offered at a level of detail calculated to keep the reader engaged. The ease of understanding each chapter is enhanced by text boxes highlighting important concepts, copious colour illustrations, a chapter summary, and (for some chapters) key tips. The author makes his case for 3D maps in Chapters 1 and 2, using examples to illustrate some of the new affordances 3D renderings create, such as vertical/elevation information and the capability to move around the digital scenes as one would navigate in the real world. The inevitable challenges related to scale, projection, hidden content, and scene navigation are also identified and discussed.

In Chapters 3, 4, and 5, he progresses to the structural components of 3D scenes and maps. While 3D maps in many ways resemble 2D maps—panoramas or birds-eye views, for example—3D scenes are more like stage sets or immersive environments, providing a digital world with realistic (physical models and rendering), thematic (cartographic themes and styles), and mixed-reality (combinations of realistic and thematic) content types where the user is able to wander around and explore the inside of the world presented. Cartographic 3D products can be output as either static or interactive maps or scenes, or as scripted animations. As an example, both static maps and static scenes can be output as 2D images but the scene can also be output as a physical 3D model using a 3D printer. These chapters also address the variety of considerations that must be kept in mind when deciding which outputs would be the most appropriate.

Chapter 6 provides a comprehensive overview on how digital surfaces or meshes serve as the foundational building blocks underlying every scene, on top of which the other content is rendered. Various surface types, such as elevation, as well as thematic or statistical surfaces, are discussed; including their attributes such as visual quality and display performance. The role of traditional cartographic effects such as exaggeration, offset, extruded elevation, hillshading, and transparency are all contextualized within the 3D environment.

In Chapters 7 through 12, the discussion moves through the various ways that visual content can be displayed in a scene. These chapters are focused on the technical and creative challenges that arise from the key concerns for data resolution, visual seaming effects, and connecting multiple levels of detail. At a fundamental level, content can be displayed by *draping*—where vector and raster spatial data layers are overlaid on the scene, conforming to the elevations of the surface—and one can also drape text and labels to, for example, support navigation in these virtual worlds. The need to represent 3D objects verisimilarly, so as to bring the 3D world closer to reality, constitutes the next level; and this is where the familiar cartographic geometry types of location points, linear paths, and polygon areas come into focus. In 3D scenes this basic set of geometries expands to create 3D models formed by an integrated collection of modelled faces. Anchor points play a crucial role in locating objects in this 3D world—defining their position, say, above a defined base height and in relation to subsequent deformations arising from viewpoint changes and scaling as one zooms in and out. Once a 3D object is represented, it can be symbolized in multiple different ways to improve the map's message and storytelling. The object's form—its shape, extrusion, rotation, scale, texture, and colour—can be defined and edited, and further refined by tweaking dimensions such as transparency, highlighting, and shading, as well as applying a photograph or other image texture to its surface. Animated symbols capturing changes and movements can also be used to increase the level of realism experienced by an end-user navigating the immersive 3D world. In addition, the book discusses numerous ways to aid clarity and/or navigation in the 3D scene or map by adding, editing, or even animating, the displayed text and labels that appear either in the scene itself or on the interface screen.

The 3D display discussion extends, in Chapters 13 and 14, to tackling the display of volumes and to representing time. Volumetric data plays an especially important role in 3D mapping when representing spatial depth, density, and sub-surface structures. There are many display options for representing time, such as static content, individual animated slices, and space-time cubes.

In the final two chapters (15 and 16) the discussion ties back to some of the earlier chapters dealing with the structural components of a 3D scene, but focusing instead on an exploration of the process of combining individual data layers to develop the complete 3D map and effective navigation controls to "better communicate your content to the users" (231). In his "Afterword," Shephard distills the book's key messages into six general tips for constructing well-designed scenes, and he concludes with a call to action for mapmakers to know about and use 3D cartography to "explain any data set in the world to any audience in the world" (260).

Overall, this is an excellent book. Shephard has assembled an engaging text that skilfully touches, in effective depth and breadth, on many of the key topics encountered in 3D mapping. The readability of the book is enhanced by clear illustrations, informative highlighted text boxes, succinct chapter summaries, and useful key tips. *Mapping with Altitude* would be suitable as either a reference resource for seasoned cartographers or as a textbook for upper-level cartography students looking to extend their work to 3D representations.

While the book achieves its stated objectives of cataloguing and explaining 3D mapping challenges and opportunities, and of providing some useful design rules, there were a few elements I wish would have been present. First, it would have been beneficial to have an end of chapter list of references and/or citations so that interested readers can pursue further in-depth explorations of specific topics interest. Second, some interactive and engaging learning assets such as hands-on exercises or website simulations would have allowed readers to have a stronger connection between the conceptual and the practical. Third, it would have been beneficial to have a chapter dedicated to an extended discussion of ethical responsibilities in cartography, with a focus on how they might apply to 3D mapping—specifically: data privacy and security, representation bias, environmental impacts, and the role of artificial intelligence in digital mapping. The lack of these elements does not, however, detract from the excellent overall contribution this book makes to the GIS, cartography, 3D mapping, and spatial visualization communities. Perhaps the author will consider these suggestions when preparing a second edition.