What struck me most about the journal were the references Treat made to sharing a meal and spending a night with many of the settlers he met along the way. He uses words like "politely" and "very politely" to describe the treatment he and his party received from people who were essentially total strangers. It is hard to envision taking any kind of trip in today's society and relying solely on the kindness of strangers for occasional food and lodging. The dangers it would present to parties on both sides would simply be too great for such a journey to be feasible.

Pawling's Introduction includes details about the 1842 Webster-Ashburton Treaty that eventually determined Maine's northern boundary, but little information about the later lives of Joseph Treat, John Neptune, or Jacob Holyoake. I suppose this is in keeping with today's cruise ship mentality, where people travel closely together for a set length of time and may even form attachments, but ultimately go their separate ways and lose contact once their home port is reached. Even so, after vicariously joining the Treat expedition and traveling in harsh conditions with these men for nearly two months, I would like to have learned more about what happened to them, both personally and professionally, after the expedition was over. References are made in the footnotes, however, to other textbooks that might provide this information.

That being said, I would still highly recommend this book for anyone with an interest in surveying, biographies, American history, American geography, Native American culture, or Maine in particular. *Wabanaki Homeland and the New State of Maine: The 1820 Journal and Plans of Survey of Joseph Treat* provides a multi-faceted look at the complexities of human relations in the burgeoning United States and the important role that cartography played in both documenting and influencing historical events.

Cartographic Science: A Compendium of Map Projections, with Derivations
Donald Fenna
CRC Press, Boca Raton. 2007.
ISBN 0-8493-8169-X, hardbound, alkaline paper. 491 numbered pages; hundreds of diagrams, tables, and illustrations.

Reviewed by daan Strebe
Reviewer's Note: *The author used software (Geocart) I wrote to illustrate much of the text, cites Geocart and me in the acknowledgments, and illustrates three projections I developed. I did not edit, review, or contribute to the text in any way; nor did I know of Dr. Fenna or his enterprise until it was effectively finished. My contact with Dr. Fenna was largely in the form of Geocart technical support.*

The last quarter of the twentieth century saw publication of many English language encyclopedic works on small-scale map projections. D.H. Maling published the seminal *Coordinate Systems and Map Projections* in 1973, significantly revising and expanding it for a 1992 edition. The prolific John P. Snyder led out the 80s with *Map Projections Used by the US Geological Survey* in 1982 and expanded it into 1987's *Map Projections — A Working Manual*. His 1989 *An Album of Map Projections* presents a wide array of projections in a standardized format, along with generating formulæ in the appendix. He cemented his credentials as a historian of map projections with 1993's *Flattening the Earth —Two Thousand Years of Map Projections*, describing hundreds of projections, many with formulæ. Frederick Pearson II issued *Map Projection Methods* in 1984, polishing and expanding it in 1990's *Map Projections: Theory and Application*. Canters and Decleir systematically catalogued many dozens of world map projections in a highly regular format in their 1989 *The World in Perspective: A Directory of World Map Projections*.

Someone interested in map projections would have muddled through a very lonely hobby in 1972. Formulae for simply generating a wide variety of projections were not to be found consolidated in any source. While plenty of texts were published on the topic, they tended to be monotonous repetitions of the basics of cylindric, conic, and azimuthal themes. If you wanted to know how to construct a van der Grinten projection—long the mainstay of National Geographic's world maps—you might likely have needed to refer directly to van der Grinten's original patent. Yet less than twenty fecund years later, one could choose to drown oneself in projections both celebrated and obscure for the price of a text or two — and rather well-written ones at that. One might suppose the needs have been sated.

Against that history, Dr. Fenna sets an ambitious agenda. Yes, his *Compendium* is yet another catalogue of map projections; yet it is more. Most of the aforementioned encyclopædic works present mathematical derivations of the foundations of map projection theory and of the basic categories of projections. They also all present final formulæ for the profusion of projections that appear in passing. Derivations of those formulæ, however, are largely absent. Fenna aims to fill this void, specifically aspiring to be "a companion to [Snyder's] *Album* and a bridge to there from his [*Flattening the Earth*]." Audacious, perhaps, but not impossible. We shall see if he succeeds.

The book begins with a careful explanation of the text's purpose, scope, structure, nomenclature, idiosyncrasies, and sources. This same minute care is perpetuated throughout; the style is an antithesis to the breathtakingly terse texts of the early twentieth century. A mathematician already possessed of all the mathematical tools and insights might find the derivations tedious and the pedantry unwelcome, but Fenna anticipates this, stating that the needs of those without specialized knowledge are given priority. Given my later remarks on audience, his choice might have been wise.

He first describes the "curved world"; progresses into the "spherical world" (comprising the bulk of the book); devotes a few dozen pages to the "ellipsoidal world"; and finishes with a few pages about the "real world." This progression, of course, mirrors successively less abstract models of the earth while concentrating most heavily on the fittest abstraction for small-scale maps. Conveniently, it also parallels successively more complicated mathematics, a progression important to the book's purpose and design.

Each of these parts is divided into very focused chapters. Many chapters come with "tutorials" describing the mathematical concepts used thenceforth. Theoretically, no more than high school algebra is required to start the book, and, theoretically, one could learn what one needed from the text as one progresses. Practically, however, few of those who never took a calculus course have any business picking up this text. The earlier tutorials are far more likely to act as refreshers than as primers. Naturally, trigonometry appears immediately; differential and integral calculus follows by chapter 4; linear algebra appears in chapter 8; and complex analysis in chapter 13. One may stop anywhere along the way having learned important concepts about map projections.

After the requisite introduction of literal projections, the text moves into the pseudo- *thises* and *thats*, since these are generally mathematically simple projections, particularly the pseudocylindrics. The treatment of topics is commendably complete at each level of mathematics. By page 167, interruptions are dealt with, not just as a concept, but mathematically. Aspect (or case) comes next. Globular projections get their own chapter, showing how the early, geometrically motivated projections of Roger Bacon, Nicolosi, and others get developed algebraically. Fenna then goes on to describe some of the clever methods by which people have built on existing projections to achieve their own map projection designs without resorting to difficult mathematics. This is a novel treatment.

The text liberally intersperses formulæ, numbered according to Fenna's unusual scheme of using the page number followed by progressive alphabetic letters. There is no "it is obvious that" or "intermediate steps are left as an exercise for the reader" hand-waving; the formulæ are discussed as they are presented, and the author does not expect the reader to muster mathematical innovation just to follow a derivation.

If the roster of projection illustrations seems familiar, it is because Dr. Fenna chose, presumably in keeping with his stated agenda, to display at least the projections appearing in Snyder's Album, and in very similar format. A few others show up, including the only non-diagrammatic illustration: a reproduction of A.F. Spilhaus's 1942 polar aspect August epicycloidal oceanic map. The transverse Mercator on page 412 is not quite what it implies itself to be, since a whole world version on an ellipsoid is not rectangular. I would have gladly assisted in getting the correct map out of Geocart had I known he was trying, since I'm rather fond of the projection.

Moving decidedly into the later sections of the book, we find a thorough treatment of distortion and its optimization. This prepares the way for minimal-error conformal projections, an important and fairly advanced topic. Fenna finishes the spherical section with a chapter on novelty projections.

The author's treatment of ellipsoidal projections is comparatively brief, though he presents the entire mathematical foundation and then focuses on the ubiquitous Universal Transverse Mercator. The brevity is warranted. Ellipsoidal projections are the purview of geodesy, an enterprise very different from small-scale projections. The text ends with an even briefer description of the physics of the geoid and its mensuration. Several glossaries and indices complete the book.

As confirmed in private correspondence, Dr. Fenna not only wrote the book but also planned it, designed it, laid it out, digitally typeset it, and delivered it camera-ready to the publishers. They accepted this against their standard practice of typesetting the text themselves. It's probably a better book this way; Fenna was able to preserve illustration juxtapositions that he felt were important, and the chance of typographical errors in formulæ was reduced.

Still, a technical text like this is very hard to proofread, and this one suffers the occasional typo, though fewer than in Maling or Pearson. Table 6-15, describing the Robinson projection geometry, for example, shows the progression of the parallels along the y-axis as increments from the previous parallel and also as a resulting sum. Half of the table of increments shows the previous value incorrectly, simply repeating the same value over and over. Fortunately the resulting sums in the list, which are what one would use to realize the projection, are practically correct. (The x-value for the 55th parallel deviates from Pearson's 1990 amended formulation of Robinson by 7 in the fourth decimal place — a harmless discrepancy.)

The section on ellipsoidal geodesic lengths contains typographical errors in the final formula, 395b. One may detect and correct the errors by carefully following the derivation, yet that would be futile: they are obviated by a far more serious problem. Fenna follows Pearson's 1984 derivation, alluring in the simplicity and accessibility of the result. Sadly, Pearson makes a fundamental error early on in the derivation, and then unwittingly repeats it in his 1990 text. The result is a fiction. Correct computations require considerably more involved procedures. A generation of programmers following Pearson have banged their heads against their keyboards, unsure whether discrepancies between their programs' calculations and geodesic benchmarks arose from programming bugs or incorrect formulæ. It is truly regrettable to have the error repeated in a new text, particularly one so likely to be referred to. We may never be rid of the monster. I consider this particular error to be the most egregious of Fenna's work in its potential impact. (Dr. Fenna states in a private communication that he does not remember whether he used Pearson as a source. Fenna neither acknowledged nor disputed the error.)

Does Fenna's work succeed? Measured against his own agenda, it does, without a doubt. He recognized an important gap in the literature. His work fills that gap with a model of conscientious presentation. Yes, you could pore over hundreds of original journal papers for derivations if you needed them, but the purpose of an encyclopædic work is to relieve you of that chore. Fenna's predecessors packaged the formulæ for you; Fenna packages the derivations for you.

There is, however, the question of audience. Who actually needs this book? If, for example, you wished to write map projection software, what would the *Compendium* do for you that Snyder's books would not? Curiously, not a lot. Derivations are largely irrelevant to the enterprise of creating maps from map projections. That is not to say one can just hire a general programming serf, hand over *Snyder's Album*, and expect to end up with a professional-quality map projections package. The overwhelming bulk of a properly written map projection routine lies not in the literal expression of the mathematics as a computer program. That part is usually simple and sometimes trivial. The real work is in the infuriating, sometimes seemingly endless effort needed to make the program work for all inputs. That is because the pithy mathematics for many projections contain far-from-pithy traps and pitfalls. Computers aren't infinitely accurate; most numerical calculations of this sort carry sixteen digits. Stray too close to some special coordinate, and you will end up subtracting two numbers that are very close to each other, thereby losing most of those sixteen digits. Stray too close to another coordinate, and an intermediate calculation will balloon to infinity, destroying the remaining calculations for that coordinate. Naïvely programmed projections work across most of the map but fail in particular places or along particular paths.

As a case study, consider the transverse Mercator projection. We all know the standard Mercator: it shows regions away from the equator as increasingly large, ballooning to infinity at the poles. Therefore we cut off the map at some high latitude, typically below 80°. Whether you work with the sphere or ellipsoid, the normal aspect of the Mercator is infinite in extent. A sphere being completely symmetrical, it does not matter how you orient it; the result is the same infinite expanse, even if you tilt the developing cylinder over on its side so that it contacts the earth along the prime meridian instead of the equator. Developing the ellipsoid against that tilted cylinder results in the heavily used "UTM" (Universal Transverse Mercator) and the many Gauß-Krüger systems. However, surprisingly (and known only rarely), this transverse development is finite even applied to the entire ellipsoid. It is this map that page 412 illustrates incorrectly. While utterly unconventional, it's not a bad map as conformal world maps go.

Unfortunately, it is also fiendishly difficult to compute. I can express the mathematics in a single English paragraph, all the way down to the level of detail required to program the general case. Yet that modest expression belies the real complexity of programming for all inputs. My own computer implementation consists of a thousand lines of intricate program code, even excluding the usual named functions such as sine or logarithm. While the example is extreme, these regions of numeric treachery are common in map projections. If you seek a text to describe how to program each projection, Fenna's text is not that text. That text has not been written. On the other hand, derivations aside, Fenna's text presents formulæ for more map projections than any of the other works, effectively replacing them if that is all one needs.

As a reference for someone who researches map projections, I find the text convenient for finding, for example, which standard parallel Trystan Edwards advocated for the equal-area cylindric projection, or to follow the mathematical processes that motivated McBryde's and Thomas's pseudocylindric projections, or to refresh my memory of the mathematical development of Snyder's complex polynomials. While nothing replaces original sources, the consolidation is genuinely helpful.

I would choose this title for many reasons if I were to teach a course in map projections. For one, the pedantic text relieves a student's common frustration: what does the author mean by this term? Is it specialty nomenclature, and if so, what is its definition? Or is it meant in a more general sense? That same pedantry relieves the teacher of having to grant students leniency when they wheedle for credit based on an incorrect but (barely) plausible interpretation of the text. If the student did not get it, you can't blame the author. For another reason, the sequential development of the mathematics offers a natural curriculum for the course. For yet another, the tutorials sprinkled around the text assist the student in practical ways, ridding them of the need for a companion text on mathematics. And last, the book's execution is good on all counts: written well, designed intelligently, methodical, paced evenly, indexed and referenced well, and otherwise considerate of the reader's needs.

While one must be wary of treating any text uncritically — and the Compendium does not come without errors — I welcome Dr. Fenna's contribution to my library. I hope it wears my red annotations with honor.

The Natures of Maps: Cartographic Constructions of the Natural World
Denis Wood and John Fels
Chicago: University of Chicago Press, 2008.
Cloth: $49 ISBN: 13: 978-0-226-90604-1

Reviewed by Tom Koch
University of British Columbia

Reviewer's note: This review was based on page proofs received in August 2007 from ESRI Press. Minor changes that typically occur in the final preparation of the book make it likely any page assignments to quotes included in this review might change slightly. Precise attribution of quotes from the proofs have therefore not been included in this review.

Maps of Nature / The Natures of Maps

In 1986 Wood and Fels disassembled the map, describing ten codes through which its signs create meaning. Their argument was subsequently enfolded into Wood's *The Power of Maps*, one of the best selling books on mapping in recent decades. Twenty-one years later, Wood and Fels have put the map back together again "by replacing the whole idea of the map as a representation with that of the map as a system of propositions." In their new text, Wood and Fels insist that "The map is not a picture." Instead, they assert, "[i]t is an argument [; …] everything about a map, from top to bottom, is an argument."

The argument that maps are systems of propositions is made in two brief introductory chapters and then applied across nine subsequent chapters whose subject is nature and the natural world as constructed in more than fifty maps, typically a *National Geographic Magazine* supplement to a USGS map. Chapter titles, often echoing map titles, reflect the way the maps construct nature: "Threatened Nature," "Threatening Nature," "Nature as Cornucopia," "Possessable Nature," "Nature as Science," "Nature as Mystery," or "Nature as Park."

Each chapter proposes a view of nature that is instantiated in the maps. Because maps are *objects* in which the *subject* of nature is explored, the power of the argument is lodged in the maps whose unpacking reveals nature as "something drawn not from the world but from the minds of men and women; for maps are made not of wildlife, earthquakes, hurricanes, mountains, canyons, birds, but of signs–these themselves composed of marks and concepts. The map: a field of concepts." In that field two perspectives contend: Nature is not simply the maps' subject, but the maps are objects within which different conceptions of nature contend. This is elegant and subtle, a conjunction of subject and object that argues the nature of maps through maps of nature. Both the argument and its form are unique. Nothing like this has been attempted in cartography before.

To say it is unique is not to suggest its ideas are new but that they have never been applied in this way before to maps. The authors bring to their study a perspective that has been well articulated in the sociology of scientific knowledge by scholars that include, in a partial list: Ian Hacking (*The Social Construction of What?*), Bruno Latour (*We Have Never Been Modern*), Andrew Pickering (*The Mangle of Practice: Time, Agency and Science*), John V. Pickstone (*Ways of Knowing: A New History of Science, Technology, and Medicine*), Hans-Jörg Rheinberger (*Toward a History of Epistemic Things*), and especially Steven Shapin and Simon Schaffer (*Leviathan and the Air-Pump*).

Wood and Fels' goal is not, as David N. Livingstone's book title had it, *Putting Science in its Place: Geographies of Scientific Knowledge*, but putting mapping *into* science as a tool not of illustration, but of substantive argument, a tool of what the history of science folks call "knowledge creation." The map becomes the workbench on which ideas about nature are hammered out, not a frame in which the inhuman world is displayed. Nature is human, Wood and Fels argue, and so are the maps that present its many faces.