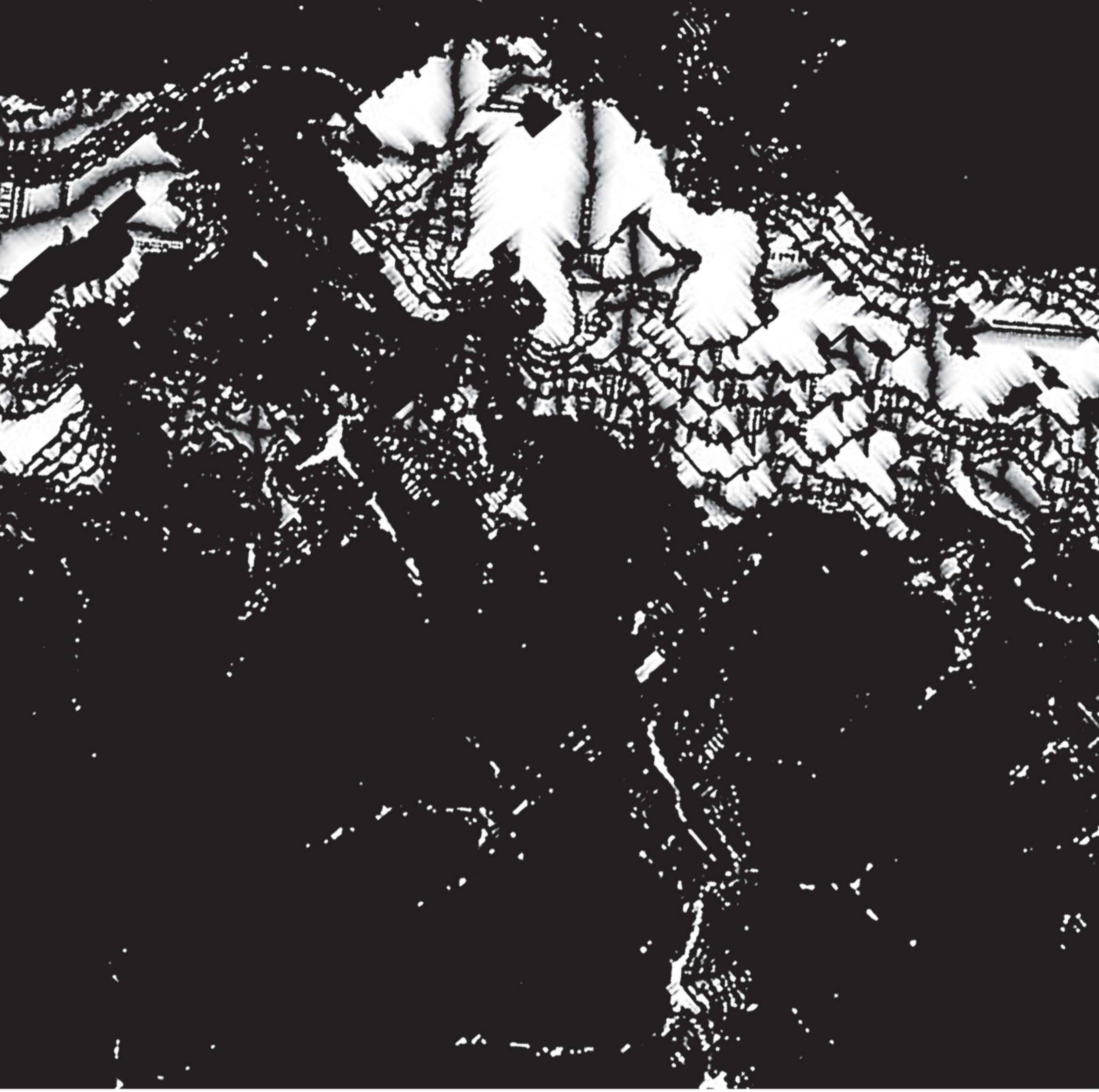

Cartographic Perspectives

Journal of the
North American Cartographic Information Society
Number 57, Spring 2007

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From the President

Dear Members of NACIS:

As you may have read in NACIS News, our quarterly electronic newsletter, distributed at the end of June, the editorship of Cartographic Perspectives is in flux this summer.

In early May, John Krygier informed me that he was resigning as editor of Cartographic Perspectives. After consulting with the NACIS Executive Committee, I asked Scott Freundschuh to step back in as interim editor. Scott agreed to shepherd the remaining 2007 issues through the editorial and publication process. As I write, Scott is recruiting a new editor to serve a 3-year term, 2008-2010. We hope to have the new editor on board in time for introductions to the NACIS membership at the annual membership meeting in St. Louis and for him/her to assist in preparation with the final 2007 issue of Cartographic Perspectives.

In the meanwhile, Cartographic Perspectives will continue to appear in your mailbox on time and full of interesting and thought-provoking material.

As for other NACIS business, I am delighted that the Board approved, at the spring Board meeting, meeting locations for both 2008 and 2009. Missoula, Montana, 7-11 October 2008, should be an outdoor adventure unlike anything NACIS has had before. Our site for 2009 will feel like a cartographer's class reunion for many of our members as we will be meeting in State College, Pennsylvania. We do not yet

(*continued on page 3*)

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Cartographic Perspectives

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The cover image is the result of a fractal slope analysis on a drainage area near Arcadia, WI.

In this Issue *(continued from page 1)*

(*letter from the president continued*)

have dates scheduled for 2009 - the Penn State football schedule for fall 2009 has not yet been posted!! I am hopeful that the Board will approve a location for 2010 and perhaps 2011 at its meetings in October. Being able to plan 3 or 4 years in advance will free the Board to discuss other matters at its spring and fall meetings.

Jenny Johnson
President

A Response to Denis Wood

Mark Denil
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Dear Editor

I was quite pleased to see that Denis Wood took the time to respond so fulsomely to my letter [*Denis Wood's article Map Art* CP 55], and I read his remarks with great interest. I think that his explanations certainly clear up a lot of ambiguity in the earlier article [*Map Art* CP54], and allow us to pinpoint quite precisely where Dr Wood's argument runs off the rails.

Clearly, the bone of this contention is what Wood has referred to as the mask worn by a map. He and I, as he points out, have no argument that the mask is the means employed by the map to connote trustworthiness. However, we discover from *A Map Is an Image Proclaiming Its Objective Neutrality: A Response to Mark Denil* [CP56] that Wood attempts to turn this circumstance, common to all maps, into a stigmata indicative of only certain maps; maps Wood identifies with a certain conceit. To accomplish this identification, he chooses to employ very narrow and carefully circumscribed definitions of the terms trust, trustworthiness, and map in order to plead for the recognition of specially privileged categories of maps. Unfortunately, his definition of these specially privileged categories is so imprecise as to make decidability extremely problematic, and to obscure the consequences of accepting his shaky thesis. Wood clearly has some pertinent things to say about the categories of map he chooses to highlight, but his tactic of subverting general theory to the make his point is a questionable one at best.

I would like to explore some of the statements Dr Wood makes in his *Response*, and evaluate some of the problematic ramifications they entail.

Early on, Wood singles out what he terms 'sketch maps' as maps which come into the world "naked"; that is, without a mask. In fact, he goes so far as to declare that "neither experimentally generated sketch maps nor sketch maps in general are maps."(CP 56 p.10) His confidence in this exclusionary declaration is based in part upon his assertion that:

> People save maps. They take care of them, they horde them, they catalog them, they pile them in libraries. People throw sketch maps away. Of the huge number we might imagine has [sic] been made – that so many authors are so fond of describing being sketched in sand and snow and on scraps of paper – almost none remains. Those that haven't blown away by the wind have been tossed in the waste basket. (p.10)

Now, it very much simplifies the construction of any theory if one can begin by setting up boundaries and definitions to carefully exclude anything inconvenient; but it is difficult to believe that this criteria for defining a so-called sketch map could be workable. Does an anonymous sketch of a walk to the drugstore [figure 1] only become a map only because Gudrun saved it? Did it become a map when she included it in a catalog? Does it cease to be a map when I lose the catalog? Can I be certain that, since there are other copies which are better cared for and stored, I can toss a dirty and torn National Geographic map of the world in the waste basket without compromising its status as a map?

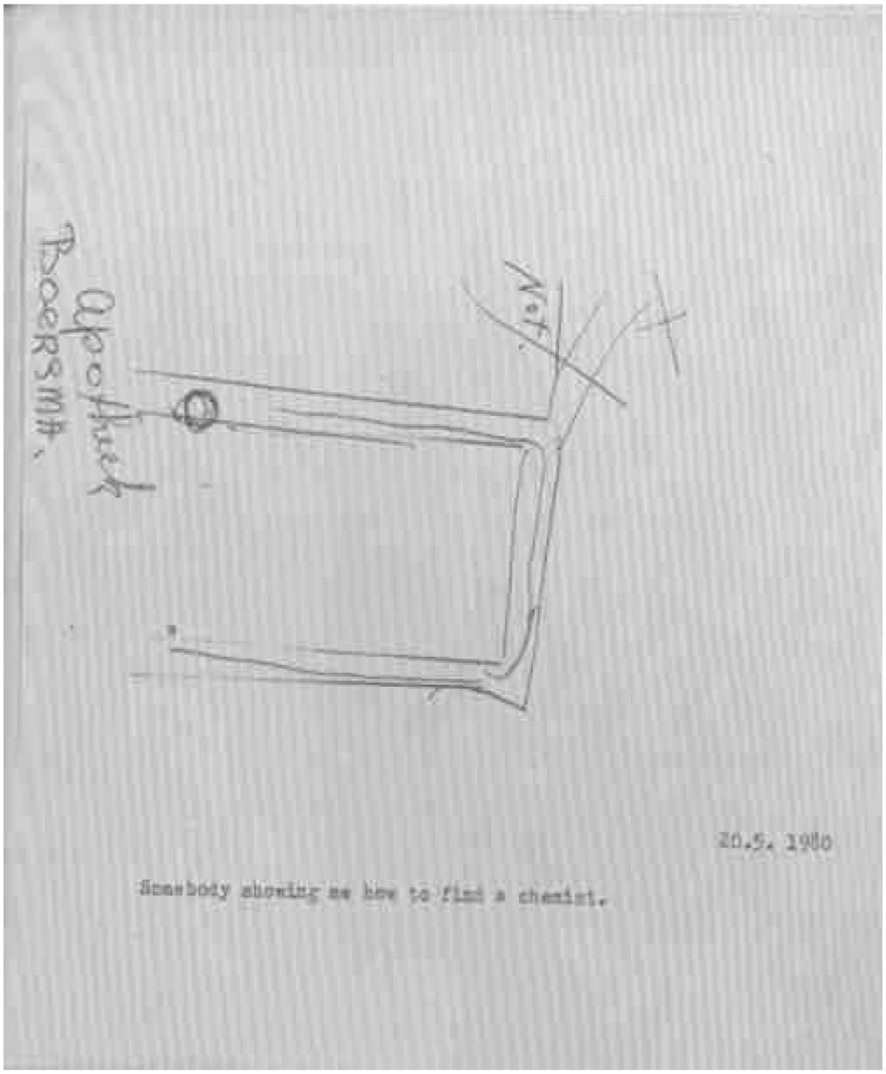

Figure 1

Granted, Wood does provide other (equally problematic) criteria for establishing a unique category of things called sketch maps, but why is all this hoarding and tossing brought in at all? It can only be to obfusticate an already murky position. And what is that position? At this juncture it seems to be that Wood would like us to accept that a sketch map is a special sort of thing that can simultaneously function fully as a map (at least to Wood) while not being a map at all (at least to Wood). Still, Wood is reluctant to throw sketch maps away completely; he will next claim that they are specially privileged maps.

For Wood, so-called sketch maps are naive or innocent products; a kind of noble savage among maps, or a sort of Mapping Degree Zero somewhat akin to Barthes' *Writing Degree Zero*. For our purposes, this is useful because it may allow us to see exactly where Wood would like to place his map / not-map boundary. In discussing the map of *Neal's Yard* (figure 5 p.11), Wood writes about how the drawing of the map was accompanied by a variety winks, nods, and grunts: things Wood says "sealed" the map. By contrast, he denigrates the addition of a title and border as a "grotesque" attempt to affix a mask to the map; as an attempt to embed something in the graphic that had earlier been conveyed by grimaces and hand flapping.

Somewhere between these points, then, is the line Wood would draw between the map and the not-map (sketch map, in this case). Clearly, Wood had no problem with the main features of the sketch of *Neal's Yard*: graphic figures that apparently represent features of the yard either significant for the game or for the context of the yard, or, perhaps, features purely random and anecdotal. Clearly, as well, he accepted the narrative explanation that accompanied the sketch (the looks and gestures). Thus we see what Wood found to be natural, acceptable, honest, trustworthy, and real: certain words and gestures, and certain marks on paper *up to a certain point and no further*. Why no further? What is it about the further marks on the paper that violated the pure and noble wholesomeness of the sketch so that afterwards everything new became simply grotesque?

It is to a certain *class* of markings on paper that Wood objects. There is nothing materially different between Kelly (the author of *Neal's Yard*) telling Wood that 'this is Neal's yard' and Kelly writing *Neal's Yard* on the paper before mailing it to, say, a grandparent with a description of the game. Yet Wood is outraged by the very simple devices Kelly added in an effort to embody something of the previously verbal and gestural narrative into the graphic (Wood declares the devices *grotesque*). The reason is that Wood *recognizes* that text centered at the top of the altered sketch, and that framing box: he recognizes it as confidently as Jerry Falwell recognized the triangle on Tinky Winky's head; this is *map furniture*, and (according to Wood) it violates sketch map virginity.

This gives us an idea of where Wood would draw his line, but it really doesn't help all that much. Would a label ("Home Plate") have violated the purity? How about an arrow (whether or not drawn while saying: "run this direction")? What if the house in the sketch had square corners? Do we have to assume that in this sketch map that the relative proportions of the yard are wrong (or at least not quite right)? Good grief; must I tear this page out of CP and throw it away (People throw sketch maps away)?

Obviously, Wood is placing valuations upon the legitimacy of means. Kelly's original drawn map was praised as spontaneous and naive, honestly "sealed" and delivered. Kelly's attempt to add an affordance to interpretation that might outlast or go beyond the magical moment of interpersonal bonding experienced with Wood is decried. Why is there this sharp divide? Wood tells us that it hinges on a pretense of neutrality. Somehow, according to Wood, Kelly's original work escaped pretending to be neutral. This is clearly nonsensical.

There is no question about the fact that Kelly was presenting the map from inside a argumentative position ('this is a context that shows the game'); but was Kelly insisting or admitting that the sketch was *not* an objective characterization of the game or the yard in question? Of course not. Every speaker (or map) claims objectivity, even when declaring otherwise ('... in my totally biased opinion...'): the pretense remain that the speaker's or map's prejudices are arrived at and delivered honestly and objectively. The map in question indeed forwarded a pretense of neutrality; the pretense that the world is this way, and that the map simply *reported* that reality. This is indistinguishable from the pretense of any topographic map. Only a political difference remains: Wood finds Kelly's original claim legitimate and dismisses other claims; including Kelly's later work. Apparently, Wood feels that the sketch map is an honest product that arises from a partisan position, but that an 'ordinary' map is a deceptive, pretensive product that also arises from a partisan position. We can see that the only difference between the early and late markings on Kelly's paper are the valuation of the legitimacy status which is assigned by Wood: a personal political difference, not a fundamental one.

Obviously, Wood's proposed boundary for the sketch map (and map / not-map division) is very unstable and quite undecidable in any dispassionate way. This is real problem for his case. On the one hand, one would think that decidability of the map / not-map boundary would be critical, but on the other hand any question so radically undecidable is moot. Clearly, Woods' identification of any boundary between maps and sketch maps (experimental or otherwise) is mistaken.

Sketch maps are, in fact, just like any maps, and they make similar appeals of trustworthiness as do all maps. Certainly, a sketch map is generally aimed at a restricted user community; one about which the map maker can confidently make many assumptions, and which may occasionally even be present to receive verbal or gestural explanations to supplement the lines on the paper (or in the sand, snow, etcetera). The map must always convince its audience of its veracity; if the sketch (map) had not convinced Wood that it was an attempt at a reasonable representation of Neal's yard and a game played therein, Wood would not have recognized it as a map (a sketch map or otherwise). He might perhaps have assumed it was a doodle undertaken to occupy an active hand while the child described the game, but he would not have seen it as a map. If Kelly had been unconvinced that it was a reasonable map it would have been scribbled out or otherwise abandoned. But both Kelly and Wood *did* recognize Neal's yard, and both recognized a *map*.

This is what it means to recognize a map, and to recognize a map as trustworthy. It does not mean that one would be able to measure on it for purchasing fencing; it doesn't mean that a zoning board would accept it as a valid plan, it doesn't mean it is good for anything *except* describing the game in Neal's yard to someone one could also provide with supplemental information. Its user community is sharply restricted, in part because it is so graphically terse.

In fact, it that very graphic terseness which is for Wood the telling appeal because it makes it appear unsupported and naked (to Wood), and so seems (again to Wood) honest, ingenuous, and amateur.

Different maps certainly use different means to forward their appeal, and sometimes an argument of nonprofessional-ity is adventitious to employ (I may not be an expert, but...), but such a pretense is simply a rhetorical device. All maps are, after all, rhetorical vehicles: they all forward a position. One of the appeals they make to their audiences is one of its own competence. Wood, clearly, has been hoodwinked by the sketch map's profession of honest amateurism. It is a mistake, however, to confuse an argument with its means of delivery, or to so privilege a particular means of delivery as to obfusticate its argumentative nature. Wood's attempt to claim special privilege for sketch maps must be disallowed.

Later, Wood claims that there is another special category of privileged maps on the other side (so to speak) of the general run of maps: the Art-Map. It is, Wood tells us, a map specially endowed with the power to throw off its mask and prance about naked.

In discussing this claim, Wood offers an interesting and illustrative comparison between Paul Eluard's *Surrealist Map* and my own *Villcabamba-Ambaro Conservation Corridor* maps. While I will refrain from repeating most of the very flattering things he says about the *Villcabama* maps, I would point out that he identifies them as (at least pretending to be) trustworthy. Eluard, on the other hand, Wood identifies as someone who (by virtue of his identification as a Surrealist) rejects trustworthiness as a virtue. It is quite clear, however, that each map is aimed straight at its audience and each appeals for an appropriate trust directly to its own audience by every means at its disposal. Each map uses every means that each map's maker knew would be recognized as a legitimate hallmark of trustworthiness *for each intended audience*.

The *Villcabama* map set was aimed straight at a major funding foundation. To be quite blunt, it went into the woods loaded for bear, and in the end proved to be dead on target. There is a good deal of testimony on all sides acknowledging that it was these maps, as a significant component of a large, detailed, and persuasive request, that secured what was at that time the largest funding grant yet given for Andes Biodiversity conservation. Yes, indeed, the *Villcabama* maps wear a mask that their audience recognizes as connoting trustworthiness.

The audience for the *Villcabama* maps had a predictable, and, one might say, a conventional set of criteria that for them connoted a trustworthy map. Surrealists, as one might expect, held a different conception of legitimacy. Surrealism was a movement which looked for value in (among other things) the act of turning established order on its head. An apparent rejection of trustworthiness (or at least of the outward, accepted trappings and signs of trustworthiness) was how one made a trustworthy Surrealist work. In fact, Surrealism is an excellent example in this regard because it was one of the most organized of art movements: one could be expelled from Surrealism if one were not sufficiently, or acceptably, Surrealist. One cannot imagine Paul Eluard daring to show André Breton any map that departed less from the "colonialist maps" (p.12) than did this. One need only recall the career of Jean Cocteau to know the danger in seeming insufficiently Surreal to Breton. Obviously, Eluard knew his audience, and knew his context, and knew how to persuade his audience that his was a reasonable characterization of the Surreal world. Eluard knew how to make a trustworthy Surrealist object, and that is what he did.

Is Eluard's map really all that innovative? Does it really present a wholly new vision ungrounded in previous usage? Of course not; without pedestrian bourgeois conventionality Surrealism could not have come about. Eluard's map is a distortion, engaged for particular reasons, of a familiar map form. The surrealists were engaged in leveraging transformation: "Transform the world, said Marx; change life, said Rimbaud; for us, these two watchwords are one" [Breton, quoted in: Brotchie p.82]. How this distortion is materially different from the 4th century *Peutinger Table* (which was distorted to fit on its scroll) or a standard Mercator map (which is distorted to make rumb lines straight) or any other map is an issue not really addressed by Wood. It would seem likely that to address it he would be forced to abandon his untenable position that there is any difference between Eluard's map and mine. Eluard's map is identifiable as a map even by someone who would reject all Surrealist practice as illegitimate. That particular someone may not accept Eluard's map as a reasonable characterization of the world; that is, he would not think it was a *good* map, but that particular someone would need be quite unreasonably doctrinaire to reject it out of hand as a *map*. That is because it *is* a map, like *any other*: like, in fact, the *Vilcabamaba* maps.

This is what I meant when I opined that Eluard and I made maps in the same way. We each identified a use for our map, and we each incorporated features into the map that afforded access to the information we wished to present, and finally (although not necessarily in that or any order) we framed our argument about the situation (a surrealist world, or the situation in the Andes and how best to engage it) in a manner that spoke to, and was acceptable to, our audience. We each constructed useful, usable, and trustworthy map graphics that each wear masks appropriate to themselves. Our practices are identical.

Setting aside for the moment the fact that Eluard and I are engaged in identical practices, What can we say to Woods' contention that the so-called art map removes its mask, where my map must perforce remain masked? To answer this, I think we need first to consider the nature of the mask itself.

In the course of his *Response*, Wood gets much rolled up in Barthes' terms myth and mythology, but it seems that his attention to Barthes' (sometimes questionable) vocabulary and detail rather obscures some important points. Both Barthes and Wood seem to miss the point that *all* myth is artificial: only *belief* makes it seem real. The critical issue about myth and mythology is not that one can be invoked to "break" the other, nor are issues of the "alienation" engendered by myth at all pertinent. What *is* pertinent and central is that myth, and mythic structures, are *naturalized* and are *believed* by interpretive communities of readers (map users). Myth is the cultural context within which a semiotic makes sense; within which it has any value whatsoever. *No one* can possibly understand *anything at all* outside of myth. Most people simply accept that framework and get on with things, while others can and do recognize the structure as a construct, but *no one* can escape it because outside myth there is no meaning.

It is clear that none of this is up to anyone alone. "The configuration of maps depends not only on the current state of geographical knowledge, but also on graphic codes and the visual and aesthetic universe shared by the author of the document and his or her readers." (Jacobs p.184) Furthermore, "the map results from a double construction, that of its author and that of its readers – a symmetrical process, a twofold construction as though reflected in a mirror, of encoding and decoding."(Jacobs p.185). It happens that human cultural and mythic structures overlap, and one can, metaphorically, step from one to another across the world and across the ages. We *can* learn to recognize a Marshall Islands stick and shell panel as a map, even when we can't use one, in very much the same way we learn to understand that a highway map is a map, or that a T-O map is a map . We learn what constitutes a legitimate map through our cultural / interpretive experience, and only things so constituted can, for us, be maps. The features that constitute the legitimate map are the map's mask. *Until* it is recognized, it is not a map. It is recognition of the mask that constitutes recognition of the map.

What, then, about the so-called Art Map? This is the map which Wood maintains removes its mask, to expose...... well, something (exactly what is never quite made clear). Let us set aside for the moment the fact that there is no map where there is no mask, and consider Wood's contention of special privilege.

How does one decide if a given example is an Art Map (that has ripped its mask away), or a regular old map (that cannot). Once again we find that decidability is an issue. Is it because the map was made by an artist instead of a cartographer? How is *that* status decided? How about me? Am *I* an artist or a cartographer? I am employed as a cartographer (a Chief Cartographer, no less); so, are my maps, by definition, not art? It happens, however, that I also have a Master of Fine Art degree, a terminal degree for an artist: I am qualified to teach in art school. My MFA thesis dissertation was about maps and map-making: it was titled *Cartographic Design: Rhetoric and Persuasion*, and was published in Cartographic Perspectives [CP45]. I clearly have credentials as an artist; does that make my maps Art Maps? Maybe I need exhibitions, or maybe gallery sales, to qualify? (As Andy Warhol said; it's art when the check clears). Setting aside the artificiality of these criteria (commercial gallery success has not been the benchmark of artistic value for some time now, at least since the time of

Figure 2

Figure 3

Corbet), I certainly have had both exhibitions and sales. I have not shown the *Vilcabamaba* maps, it is true; but I have shown and sold other maps: for instance, *The Seven Arms of the Ota* (figure 2) and *The Great Grey-Green Greasy Limpopo River, All Set About With Fever Trees* (figure 3). These works are maps, every bit as much maps as the *Vilcabamaba* maps. They are made in the same way; I make no differentiation in my practice. I challenge anyone to figure out if, under Wood's rules, they are Art Maps or plain old maps.

We could perhaps invoke issues of canon; maybe some maps are Art Maps because they have become recognized as such by a general (if elite) public. This is, after all, how one tells the difference between, say, William Carlos Williams' *Kora in Hell* and a prescription he wrote in 1918. Late in life Williams identified medical case histories as having the greatest influence on his writing; yet while one presumes medical histories had almost as much influence on the prescriptions as on the prose, of the two examples only *Kora* is in the canon.

Still, we know that both literature and the map lie in the eye of the beholder (the eye provided by he beholder's interpretive community), so a canon is itself an unstable and shifting authority wholly dependent upon that same beholder's interpretive community, which is itself mutable in its opinions. While a canon can help us judge the value or fashionablity of art, it is not a reliable guide to something as fundamental as a special privileging of the art map.

Maybe the only way to tell if a map is an Art Map is to get a certificate, in much the same way that only documented Dogma films are Dogma. Still, one can get the Dogma rules from the Dogma Films web site and thus make a dogma-type film without a letter from Lars von Trier. Where are the rules for Art Maps? Does one need a letter from Denis Wood?

The point I am making here is not that maps cannot be art; the point, in fact, is that map making is a legitimate art practice. Although I used my-self and my own work as examples, since Wood had already introduced the *Vilcabamaba* maps as an example, the arguments could be applied to any map maker. I am not claiming (at least here) that my maps are *good* art, or even that they are *good* maps, but I am instead drawing attention to the identicality of the practices. Anyone identifying a need or use for a map, who makes a map that is usable, and has that map accepted by an audience (even if that audience is limited to him or her self, in some cases) is engaging in an art practice called map making. Any special powers granted an Art Map is perforce granted to any map.

We have examined a few of the central points made by Wood in his "messy argument" (p.10), and found them uniformly wanting. In each case, Wood forwarded a special pleading as justifying privileged exis-tences for particular categories of map, and in each case we have seen both that the categories are based on undecidable criteria and that the special privileges claimed for the particular map taxa are unwarranted. The whole construct breaks down on the issue of the mask all maps wear connoting trustworthiness, in order to solicit belief from an audience. It is clear that the mask is the map, and that no map is born (or even conceived) with-out one and that no map can remove its mask (although it may switch to another mask for a different audience) without ceasing to be a map.

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The Many Uses of Maps: The Producer at the Center

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The Prime Meridian: Antique Maps & Books

Most of us encounter a map, or some sort of cartographic device, on nearly a daily basis. This is true whether or not we are conscious of the occurrence. We may be planning or imagining our travels, or conceptualizing a project, but we somehow interact with the map, whether written or visual. When we read an heroic novel, we track the journey. When we hear the news of wars or weather, the map functions as a communicator and guide. The purpose of this essay is to give an overview of map uses, but not strictly from the vantage of the individual use or user. The producer of the map -- whether an individual or group, whether a financier or artisan -- is at the center of this conversation. The producer will likely have planned uses for a map, and may themselves be a user, but without their construct the map does not exist.

Introduction

Almost every discussion of the history of cartography necessarily deals with implied or overt uses of maps (Edney, 2006). Very few essays, however, are specifically written as an overview of the uses of maps (Carter; British Library, 1989; British Library, 2006). While there may be a number of perches from which to view the subject, including the specific use or user, I think the most encompassing view is to put the map producer at the center. This is not conceptually unique:

> *"…we must be concerned that not only do we get the right data to the user but that we get the data right."* (Ormeling, 1997)

Although Ormeling's comment is focused on modern map use, the ideas conveyed are equally applicable to almost any map of any historical age, whether cartographic, cosmographic, or metaphorical. Even in the case of intentional misrepresentation (Monmonier, 1996), the producer still wants to get the "data right," albeit for what may be deemed less than honorable purposes.

Producers, Users, and Uses

The concept of map producer is more nuanced than may initially be apparent. This idea of a map producer can vary over time, hence the single hand of the manuscript map, the diverse participants in the letterpress and coloring processes from the early days of the printing press (Woodward, 1975), to the modern digital world where images are rapidly produced on demand for a variety of persons and circumstances. Even in the days of the manuscript map, the influence of royal or ecclesiastical patronage must be considered as part of the production process. A major funding source is often a substantive influence on the planned use for a map

The producer may be an individual or a group; the producer may control varied software programs to customize the map production intended for personal or outside use (Tulloch, 2007). A map may be of value to the producer for a variety of reasons including economic gain, intellectual reputation, imaginary or planned itineraries, or educational concerns. Sometimes the producer never intended a specific use of a map. For example, early mapmakers would not likely have predicted certain types of modern analysis of their cartographic outputs as historical documents. Modern digital overlays of historically significant maps were not considerations for early map producers. Waldseemüller would never have conceived that his maps might be "warped" (Hessler, 2005).

I do not intend to present a chronological tale of production methodology and its relation to varied map use. There is certainly a developing literature looking at the ties between map production and use (Pedley, 2000; Pedley, 2005). This essay is a synchronic analysis, considering that maps can be considered linguistic and semiotic constructs. The synchronic view of the history of cartography is hardly unique, and there has been longstanding criticism of the perception of the history of cartography as a temporally linear progress of scientific advancements (Blakemore and Harley, 1980). Christian Jacob recently emphasized the synchronic approach in his intellectually wide-ranging and thought provoking book, The Sovereign Map (2006, p. 263). Figure 1, while a simplified construct, depicts a mind-map summarizing the perspective used in this essay. It should be emphasized that many areas of use may intersect and overlap through the producer.

Figure 1. Mind map of the interrelationship of map uses, with the central producer.

It would not be unreasonable to take an historical approach analyzing the varied styles of map use: the authoritative iconography of medieval mapamundi; navigational maps reflecting various modes of land, sea and air travel; military maps for tactical, strategic and commemorative purposes; maps by and for religious and governmental agencies for purposes of administration, iconography and power display; maps for business use including surveying and advertising; fictional maps for metaphorical and artistic design, and imaginary places; educational maps for diverse classrooms and personal scholarship.

Detailing the specific dates of historical appearance for all these forms and functions is beyond the scope of this essay, although diachronic analysis of the varied linguistic and semiotic functions of maps would complement my central point: the map producer has always been a conduit connecting uses and users. Yet the producer is at times also the user, which is readily apparent in today's world of MapQuest (http://www.mapquest.com/), Google Maps (http://googlemapsmania.blogspot.com/) and Google Earth (http://earth.google.com/). These latter examples also highlight the role of software developer as map producer.

James Carter, in his online essay "MAP USE – The Many Dimensions" (http://www.ilstu.edu/~jrcarter/mapuse/) conceptualizes six basic dimensions of how and why maps are used, based on ideas developed by the Map Use Commission of the International Cartographic Association, 1995-1999 (http://www.ilstu.edu/~jrcarter/mapuse/commission.htm).

The uses of maps are one of those six dimensions, but are also integrally related to the other five (users of maps, environments in which maps are used, nature of the map or maps being used, communities of map users, societal uses and abuses of map use). All of these considerations implicitly involve the map producer, without whom none of the conversations would take place. The producer creates part of the environment for map use, has a significant hand in determining the nature of the map, and is simultaneously part of the map user community. The producer can and does influence societal uses and abuses of all maps. These considerations are applicable to virtually any method of map production in history. In addition, as implied above, any person or agency paying for map development is integrally linked to the role of producer (Barber, 1992), and hence an influential force in the eventual use of the map.

The British Library has, over the years, produced several small pamphlets directed at the idea of map use. In 1989 they produced a monograph titled "*What Use is a Map?*" (Note: Although the title, in modern parlance, might be taken cynically, that was clearly not the intent of the publication.) The publication was divided into six sections: Going Places, Running A Country, Attack And Defence, The Riches of the Earth, Having Fun, and Knowledge And News. As can be seen from the headings, one can create a good bit of overlap between the groups. The producer remains central to the perceived function(s), even if not consistently a consumer of their own cartographic output.

The second and more recent (2006) pamphlet from the British Library is titled "*DISCOVER How maps can help your research*." The short subsections are now expanded to fourteen in number: Business, Social History, Science and Environment, Family History, Law, Military History, Topography, Recreation, Travel, Local History, Art History, Landscape Studies, Creative Arts, and History. The basic centrality of the producer to the users and uses has not changed.

The mind-map conceptualized in Figure 1 emphasizes this centrality of the producer, and also emphasizes overlapping and intersecting uses by diverse users. The producers themselves are not excluded from user groups. This conceptualization diagram could be made much more complex, with an array of bidirectional arrows designed to show hypothetical interrelationships between the complex processes of map use and production. My interest is not, however, the creation of a conceptual maze.

I have empirically selected to portray eight main map user "nodes", each requiring one or more producers, who may themselves be consumers of the varied uses for maps. These groups are: Business, Conceptual/Mind, Government, Religion, Art, Educational, Private Consumer, and Semiotics. I am using the idea of user and producer conceptually, not necessarily embodied as a single individual. Others might add or subtract groups, but this does cover a broad conceptual expanse. The producer remains central to the map, able to influence the effectiveness and reach of the cartographic product.

Taking each group individually, business map use occurs for quite a large number of purposes: to advertise a product, emphasize retail locations, survey land holdings for legal or developmental purposes, or for insurance purposes. If the business relates to map production itself, there are the elements of economic gain and industry status from their own product.

Conceptual and mind mapping are tangential subjects in their own right (Novak, 1982; Mento et al, 1999), and have a diverse group of users, overlapping with many of the other groups. The main focus is the map as a plan, though intellectual rather than geographical.

Governmental uses of maps are numerous on local, state and federal levels. It is hard to imagine any modern government stripped of cartographic capabilities, either in terms of historical development or current function. Surveying becomes crucial for purposes of land use (Kain and Baigent, 1992), taxation, infrastructure development, maintenance of an existing political system (Monmonier, 2001; Black, 1997) and more. Map use by the state for purposes of tactical and strategic military functions are well described (Duffy, 1979; McElfresh, 1999), as are the related uses for displays of power (Crampton, 2001; Buisseret 1992) and other types of political propaganda (Harley, 1988; Harley, 2001 Monmonier, 1996; Wood, 1992).

The uses of maps by the forces of religion are likewise well entrenched, not infrequently overlapping with many of the same concerns as secular government. One can argue that there exists a spiritual way-finding function. The use of the medieval mapamundi as vehicles to enforce and maintain a particular worldview is well described (Edson, 1999), and virtually all civilizations have both cosmographic and cartographic mapping roles within their cultures. Religious users are also concerned with various administrative issues and propaganda (Harley, 1988; Kark, 1993), and specialized types of iconographic displays (Delano-Smith, 1990; Fiorani, 2005; Woodward, 1985).

Artistic uses of maps are likewise exceptionally diverse, and may appear in the worlds of literary, graphic and fine arts. Over the past two decades, a number of books (Casey, 2002; Fiorani, 2005; Harmon, 2004; Woodward, 1987) and articles (Cosgrove, 2005; Krygier, 1995) have discussed numerous and increasingly diverse aspects of maps in and as art. The artistic iconography of maps has been studied (Cosgrove and Daniels, 1988; George, 1969). Cartographic Perspectives (No. 53, Winter 2006) recently devoted the bulk of an entire issue to the theme of art and mapping, showcasing several thoughtful and eclectic perspectives, including the mapping impulse reflected in modern art.

The use of the map as a metaphorical literary device has a long record; the map has served as a guide to a hero's journey (Campbell, 1949; Tolkien, 1954-1955), representing places both real and imagined (Post, 1979). There are reflections on the poet as mapmaker (Haft, 2001). The concept of map can serve as structural scaffolding for the creation of an entire work of fiction (Turchi, 2004), or the map can be used as a backdrop to highlight the literary history of a region (Hopkins and Buscher, 1998).

Educational uses of maps are almost too numerous to mention, and can date to the very earliest appearances of letterpress books, beginning at least in the late fifteenth century (Library of Congress, 2002). Maps are used at most educational levels and cross the boundaries of innumerable intellectual disciplines, including (but not limited to) history (Black, 1997), literature, art, geography, cartography, science, medicine (Koch, 2005), linguistics (Kirk and Kretzschmar, 1992), urban studies (Kagan, 2000) and architecture (Greenberg, 2006). One recent publication discusses the roles of maps and geographical texts in the formation of literacy from early Colonial America to the early Republic (Brückner, 2006). Maps have, for generations, been a frequent device in the context of reporting the news (Monmonier, 1989) and weather (Monmonier, 1999). Maps can, therefore, serve educational roles for many user groups; these roles are not confined to a conventional classroom.

Individual citizens have a multitude of uses for maps, including visual and verbal itineraries (Delano-Smith, 2006), the pursuit of genealogic history (US Geological Survey, 2002), personal education, collection (Manasek, 1998) and artistic display (Welu, 1978). The use of maps for vacation and business travel has a long and rich history (Akerman, 2006).

The uses of maps to study linguistics (Chang et al, 2002; http://en.wikipedia.org/wiki/Linguistic_map) and as linguistic devices (Jacob, 2006, pp. 189-268; Warhus, 1997) have received distinct intellectual attention. Maps have long been considered a variant form of communication, requiring skills at times separate from those needed to interpret the written word (Harley, 1987; Winter, 2004; Woodward, D. and Lewis, G.M., 1987). Maps have, not surprisingly, been analyzed in conjunction with the field of semiotics (Edney, 2006, pp. 13-15; Collins-Kreiner, 2005). I am not arguing for the validity of any specific view of maps as linguistic or semiotic devices, although these discussions repeatedly surface in literatures in and out of the history of cartography.

Concluding Remarks

I have attempted to given some idea of the breadth and depth of map use in modern and past cultures, not in terms of chronologic history, but as an overview of what has already occurred. My perspective emanates from the producer, without whose efforts no map would exist. There is no attempt to provide a definitive list of producers, as this nuanced concept can range between a single individual to a network, from a financier to an artisan, and from a theological to a secular organization

It is difficult to imagine any major element of modern commercial, political or intellectual life that has not been touched by the cartographic wand. It is equally difficult to picture our current lives and cultural existence without the map (Linklater, 2002; Pickles, 2004). It is simultaneously ironic to consider some predictions of the demise of the paper map (http://ccablog.blogspot.com/2006/04/demise-of-paper-map.html), and the general lack of geographic and map-related education (http://www.cnn.com/2006/EDUCATION/05/02/geog.test/index.html). There are a few voices calling for broad improvements, emphasizing the "unity of knowledge", to supplement our specialized and fragmented educational system, so often focused on training for future employment (Gregorian, 2004). Many institutions have ceased instruction in basic geography, and access to instruction in the history of cartography is sparse (Campbell, 2005). I do not believe that these formal educational considerations are independent of the current or future use of maps in our lives, maps that touch many of us, consciously or not, on a daily basis.

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Introducing Plan Oblique Relief

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Plan oblique relief is a new digital technique for rendering three-dimensional terrain on otherwise planimetric (conventional flat) maps. Landforms shown realistically in side view have an illustrative quality that appeals to readers. Inspired by the work of manual mapmakers of the past, the paper begins with a historical review that includes maps by Xaver Imfeld of Switzerland, Erwin Raisz of the United States, and Heinrich Berann of Austria. In the next, digital techniques section, the projections and rendering parameters needed to create plan oblique relief receive attention, as does Natural Scene Designer 5.0, the first commercial software to offer this functionality. The section on design takes a candid look at the advantages and disadvantages of plan oblique relief. The paper ends on a practical note by discussing two maps made by the authors that feature plan oblique relief, one a panorama and the other a physical map.

Keywords: Plan oblique relief, 3D digital terrain rendering, landform maps.

INTRODUCTION

Terrain presented in side view and with three-dimensionality on planimetric maps has a long history in mapmaking. As a presentation style, it draws the attention of readers, is easy to understand, and spurs the imagination. This paper offers a digital solution for creating plan oblique relief—the name we use for the "standing up" style of terrain presentation exemplified by the landform maps of Erwin Raisz and other terrain mapping specialists of the manual era. The term "plan oblique" appeared in an article by Carlbom and Paciorek (1978) that described a technique for drafting three-dimensional buildings, which we have adapted for relief mapping. Plan oblique relief, however, is hardly new to mapmaking and goes by other names, most of which are arcane, polysyllabic, and difficult to remember[1]. For the sake of consistency, in this article we use the term plan oblique relief exclusively.

Although shaded relief maps and 3D perspective views are common today, plan oblique relief remains uncommon because, until now, no commercial software application has included it as a rendering option. The software and techniques introduced in the pages that follow provide cartographers with a means to produce plan oblique relief with relative ease. The choice now facing cartographers is not so much how to make plan oblique relief but when to use it and how best to present it—topics that this paper explores.

"Plan oblique relief contains the characteristics of both conventional shaded relief and 3D perspective views, such as panoramas."

Plan oblique relief contains the characteristics of both conventional shaded relief and 3D perspective views, such as panoramas. As the "plan"

[1]Other names for plan oblique relief include: 3D planimetric relief, high oblique relief, oblique orthographic shaded relief, landform map, morphographic map, physiographic map, and proportional relief landform map.

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in its name suggests, plan oblique relief uses a planimetric base for its initial construction, as do most shaded relief maps. The "oblique" in its name refers to the shallow angle used for rendering the terrain—but in a manner that eliminates the occurrence of perspective. On conventional shaded relief maps, terrain rendering occurs from a theoretical position directly

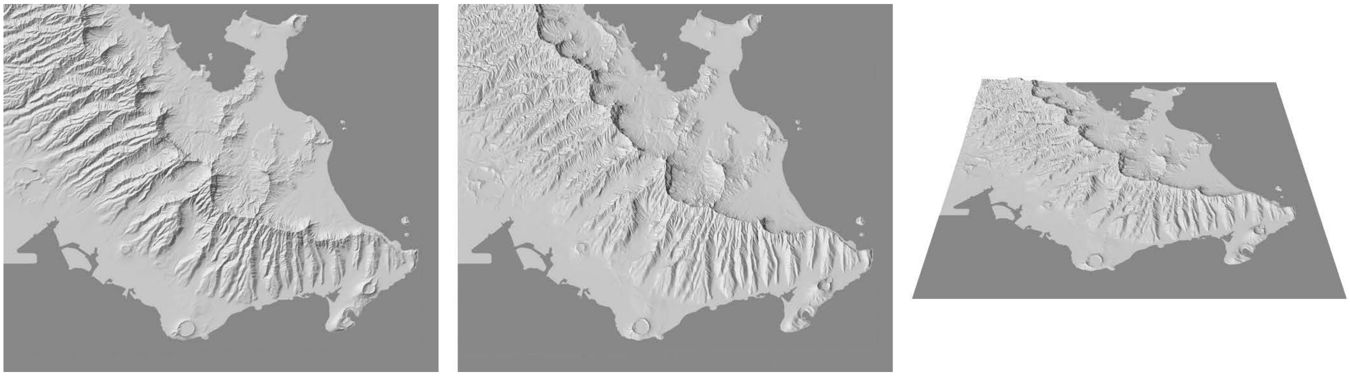


Figure 1. Southeastern Oahu, Hawaii, rendered as conventional shaded relief (left), *plan oblique relief* (center), *and as a 3D perspective view* (right). *(see page 88 for color version)*

overhead and infinitely distant. Plan oblique relief uses a lower position, somewhere between directly overhead (90 degrees) and the horizon (0 degrees). This results in 3D terrain that projects upwards, perpendicular to the bottom of the map and parallel to the reader's view (Figure 1).

The effect of plan oblique relief is not unlike axonometric city maps, such as the famous Bollmann map of Manhattan (Hodgkiss, 1973), but with three-dimensionality applied not to buildings but to terrain. Because plan oblique relief portrays the landscape much like how people see it in their everyday lives—from a horizontal perspective—the authors contend that it is easier for novice readers (and even experts) to understand it at a glance than to understand conventional shaded relief. High solitary mountains, such as Mt. Fuji and Mt. Kilimanjaro, which appear as indistinct dots on a small-scale shaded relief map viewed from above, reveal their recognizable forms and appear as the major mountains that they are when rendered in plan oblique relief. Compared to 3D perspective views that look most natural of all, plan oblique relief better preserves geographic shapes without any front-to-back foreshortening and convergence toward a distant vanishing point. 3D perspective views mimic the view from an airplane window; plan oblique relief is suited to mapmaking.

"Compared to 3D perspective views that look most natural of all, plan oblique relief better preserves geographic shapes without any front-to-back foreshortening and convergence toward a distant vanishing point."

The presentation of plan oblique relief on maps can appear in several styles ranging from high contrast line drawings to continuous tone renderings in grayscale or color. Regardless of its appearance, using plan oblique relief does come with a price, however. Points on the 3D terrain surface exhibit planimetric displacement with increasing altitude. For example, the base of Mt. Fuji at sea level would be planimetrically correct, but its summit would shift noticeably toward the top of the page, depending on the map scale and amount of vertical exaggeration. After the initial rendering of a plan oblique relief map, planimetric displacement makes it difficult to overlay data obtained from other sources, even if the projection and scale are the same. A later section will discuss this and other problems associated with plan oblique relief in detail.

PLAN OBLIQUE RELIEF OF THE MANUAL ERA

Although new to digital cartographers, plan oblique relief has not always been as rare and exotic as it is today. One of the earliest known maps, an approximately 5,000-year-old clay tablet from Mesopotamia, depicts mountains in profile with simple hump-shaped mounds. This example, a primitive form of plan oblique relief, was to reign in various forms for millennia as the dominant method of relief portrayal on maps. Leonardo da Vinci's map of Tuscany drawn in 1502-1503 portrays hills in an oblique fashion and with the refinement one would expect from that artist (Imhof, 1982). Even today, given a blank outline map and the pop assignment to depict the Andes, most people would fill the western edge of South America with a row of symbols that look like inverted V's. Few readers would mistake this symbology for anything other than mountains.

For the past two centuries as cartography became a formal profession and sought to become more scientific, so too has plan oblique relief. However, in this same period, plan oblique relief fell out of vogue in favor of other methods of relief portrayal, such as hachures, contours, hypsometric tints, and shaded relief. Although plan oblique relief declined in relative popularity as the profession modernized, relief maps made during this period are among the most accomplished examples of the genre—and for that matter the entire discipline. The following is a review of notable cartographers who have used plan oblique relief.

Xaver Imfeld (1853-1909)

Our review of plan oblique relief begins with Xaver Imfeld's "Reliefkarte der Centralschweiz" published in 1887, which shows the Lake Lucerne region of Switzerland with the detail and artistic refinement that has become a hallmark of later Swiss topographic maps (Figure 2). Besides being a cartographer, Imfeld was a talented topographer, relief model maker, and railway engineer (Cavelti Hammer et al., 2006), factors that may have influenced his ideas about mapmaking.

"Besides being a cartographer, Imfeld was a talented topographer, relief model maker, and railway engineer (Cavelti Hammer et al., 2006), factors that may have influenced his ideas about mapmaking."

Unusual features on the "Reliefkarte der Centralschweiz" include southwest orientation, illumination originating from the lower right, and a

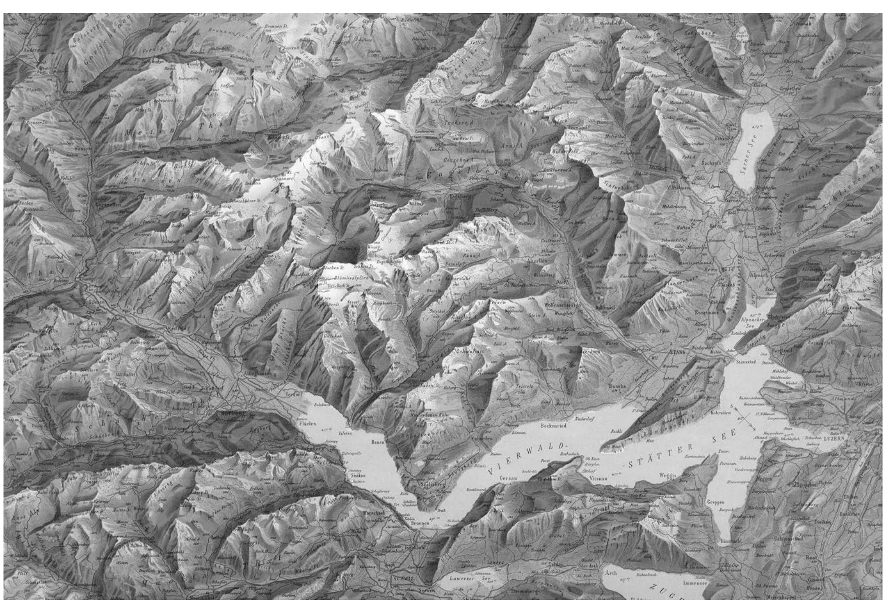


Figure 2. Xaver Imfeld's "Reliefkarte der Centralschweiz." (see page 88 for color version)

ground plane depicted at two different scales. The horizontal (left to right) axis of the map is at 1:100,000-scale and the vertical (top to bottom) axis is at 1:141,000-scale. According to Imfeld's explanation on the 1898 printing of the map, the southwest orientation shows the terrain as most tourists (the potential buyers of this map) would see it as they approached the Alps from the north. The "Reliefkarte der Centralschweiz" was the only map made by Imfeld with three-dimensional terrain depiction; contemporary cartographers did not imitate his technique. Although the varying ground scales technically disqualify the map as planimetric, the continuous-tone relief and inclusion of glacier textures are similar to that of plan oblique relief created digitally.

Erwin Raisz (1893–1968)

The landform maps drawn by Harvard lecturer Erwin Raisz a half-century ago are the cartographic outgrowth of the physiographic block diagrams pioneered in the late 1800s by William Morris Davis and later refined by Armin Lobeck (Raisz, 1956). Using only a pen, aerial photography and topographic map references, and his considerable knowledge of physical geography, Raisz depicted landforms with 50 classes of pictorial symbology selected from a pre-made library (Raisz, 1931). Raisz modified these pictorial symbols as needed to best represent intermediate landform types. With only a few expertly placed strokes of the pen Raisz captured the look of complex physical features. His maps are in essence caricatures, but with the landscape as the subject matter and accuracy a key consideration (Figure 3, left). The presentation style developed by Raisz using black strokes on a white background differs from plan oblique relief rendered in color or shades of gray by manual or new digital methods. Raisz's technique, however, relates closely to plan oblique relief, since it depicts mountains with a similar side view on an approximately planimetric ground plane.

"With only a few expertly placed strokes of the pen Raisz captured the look of complex physical features. His maps are in essence caricatures, but with the landscape as the subject matter and accuracy a key consideration."

Because Raisz constructed his maps on flat planimetric bases, they depict the relative elevation of landforms poorly. This is most problematic where the terrain is flat or slopes gradually. For instance, on his 1:4,525,000-scale "Landform Map of the United States," the Central Valley of California just above sea level and the San Luis Valley of Colorado at an elevation of 2,200 meters seem to be at the same elevation on the printed sheet, presumably at sea level. Further complicating matters, Raisz gave disproportionate emphasis to low, flat terrain and deemphasized high mountains, which exhibited no more than 2 millimeters of vertical offset in the Sierra Nevada and Colorado Rockies (Raisz, 1956). To make up for the lack of pictorial cues about elevation differences, Raisz sprinkled his maps with many spot elevations.

A proportional relief landform map of Utah produced by Merrill K. Ridd (1963) attempted to improve on Raisz's technique. Seeking to show the height of landforms properly proportioned, Ridd subdivided his map into a patchwork of "local bases," typically defined by valley bottoms or drainages, to which he assigned average lowland elevations. The average lowland elevations differed for each local base. He then plotted the height of mountains and plateaus within these local bases, taking into account the local relief. Despite this effort, Ridd's technique also failed to represent gradual slopes and the elevation of flat lowland areas correctly throughout the map. Because his base map (and the local bases that he drew on it) was planimetric, all flat areas occupied the same visual plane regardless of their differing elevations.

There are three probable reasons why Raisz and Ridd drew landform maps on a flat plane: the tedium of calculating accurate elevations over large sloping regions, such at the Great Plains, with little in the way of terrain variation to show for the effort; the difficulty of depicting these subtle changes with an inked line; and the desire to keep drainages and other map linework strictly planimetric. Given these factors, the purpose of their maps, and the tools and data they had to work with then, they made the right decision.

Heinrich Berann (1915-1999)

Austrian artist Heinrich Berann is best known for his painted panoramas of the Alps at large scales. Less well known is his prolific work with plan oblique relief. Most of this effort takes the form of small-scale views of continents and countries that to the average reader look little different from his large-scale panoramas. For example, arcing horizons, ethereal cloudscapes, background haze, and other typical Berann flourishes disguise the true nature of these maps. They are in fact planimetric base maps that Berann cleverly distorted near the top of the printed sheet to give them a false impression of front-to-back depth, much like a true panorama. Terrain representation in the fore- and middle-ground of these scenes, however, is plan oblique relief.

In the 1960s and 70s, Berann lent his considerable artistic skill to an important scientific project. Through contacts at the National Geographic Society, he teamed up with Marie Tharp and Bruce Heezen of Columbia University to create a series of maps showing the ocean floors as though drained of water (Figure 3, right). Tharp and Heezen had spent decades collecting and analyzing depth soundings collected by ships from around the world (Lawrence, 1999). Berann's job was to interpret these voluminous raw data so that the public could easily visualize them. He chose to depict the undersea topography with plan oblique relief. The work culminated in 1977 with a world map that revealed a previously unknown environment. Readers for the first time could see that the mid-Atlantic ridge was but one section of a 64,000-kilometer-long chain of undersea mountains—the largest topographic feature on Earth. The U.S. Navy and National Geographic Society published the map. Writing in *Mercator's World* (1999), David Lawrence stated "The masterwork by Tharp, Heezen,

"The work culminated in 1977 with a world map that revealed a previously unknown environment."

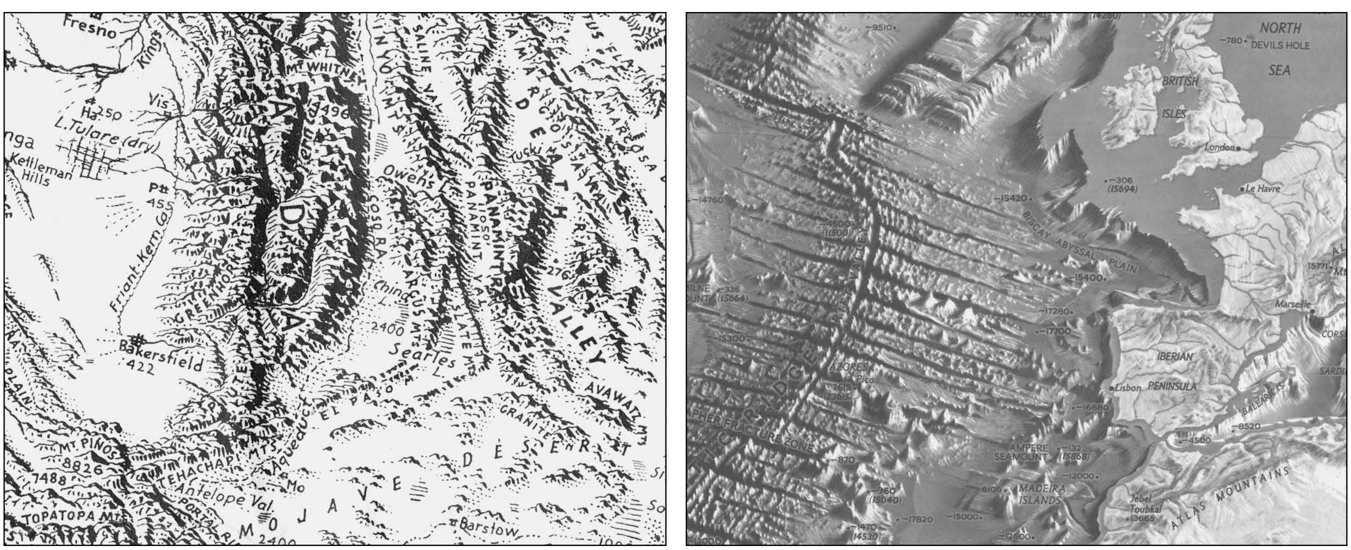


Figure 3. A sample from Erwin Raisz's 1957 "Landforms of the United States" (left) *and Heinrich Berann's 1968 "Atlantic Ocean Floor," published by National Geographic Society* (right). *Note that Raisz uses lower left illumination and Berann lower right illumination. (see page 89 for color version)*

and Berann is possibly the closest thing Earth science has to iconography." It helped win over remaining skeptics for the then still developing theories of plate tectonics and ocean floor spreading.

Inclined contours vs. plan oblique relief

No historical review of plan oblique relief would be complete without reference to the well-known inclined contour technique developed by Tanaka (1932) and later adapted by Robinson and Thrower (1957), which they renamed "traces of parallel inclined planes." Inclined contours are hybrids between typical contour lines and vertical profiles. Creating them involves tilting a series of inclined planes generally to the south and drawing traces where the planes intersect the terrain surface. To novice readers this technique could look like plan oblique relief, but it differs significantly. The resulting terrain is not truly three-dimensional and appears on a base that is entirely planimetric, both in the lowlands and on mountaintops. Despite the obvious advantages that planimetric terrain depiction offers, in the 75 years since inclined contours were first introduced, few mapmakers have used them for other than experimental projects. Possible factors preventing widespread adoption include: terrain portrayed with distracting parallel lines that interferes with other map information; the usual difficulties with manual production; and the conceptual leap of faith that readers must make to accept simulated 3D terrain on a flat planimetric surface. Because inclined contours lack the planimetric displacement found in plan oblique relief, the technique depicts terrain in a much less believable fashion. GIS technology now can generate inclined contours like those produced manually (Kennelly, 2002). Regardless of this development, the technique is likely to remain more intriguing than useful for mapmaking.

"Inclined contours are hybrids between typical contour lines and vertical profiles."

Current use of plan oblique relief

Today, plan oblique relief is perhaps most common on the decorative reference maps found in books on travel, history, and popular fiction—for example, the fanciful map of Middle Earth found in Tolkien's Lord of the Rings (1994). One occasionally encounters eye-catching tourist maps that feature hand-rendered plan oblique relief (Figure 4). Practitioners of this mapping niche, which undoubtedly includes more graphic artists than cartographers, draw or paint plan oblique relief by hand. In the sections that follow we discuss how cartographers can now do this with digital tools.

DIGITAL PLAN OBLIQUE RELIEF

To investigate the properties of plan oblique maps, we developed prototype software for rendering digital terrain. This software renders plan oblique relief with continuous-tone gray values similar to those found in conventional shaded relief. It uses standard digital elevation models and can drape raster imagery onto the terrain. Compared to the many parameters (position, azimuth, zenith, and field of view of the camera) that determine the look of typical 3D perspective views, plan oblique relief is very easy to configure.

Projection method

Rendering plan oblique relief (and other varieties of relief) involves projection methods that are unrelated to common 2D map projections, such as

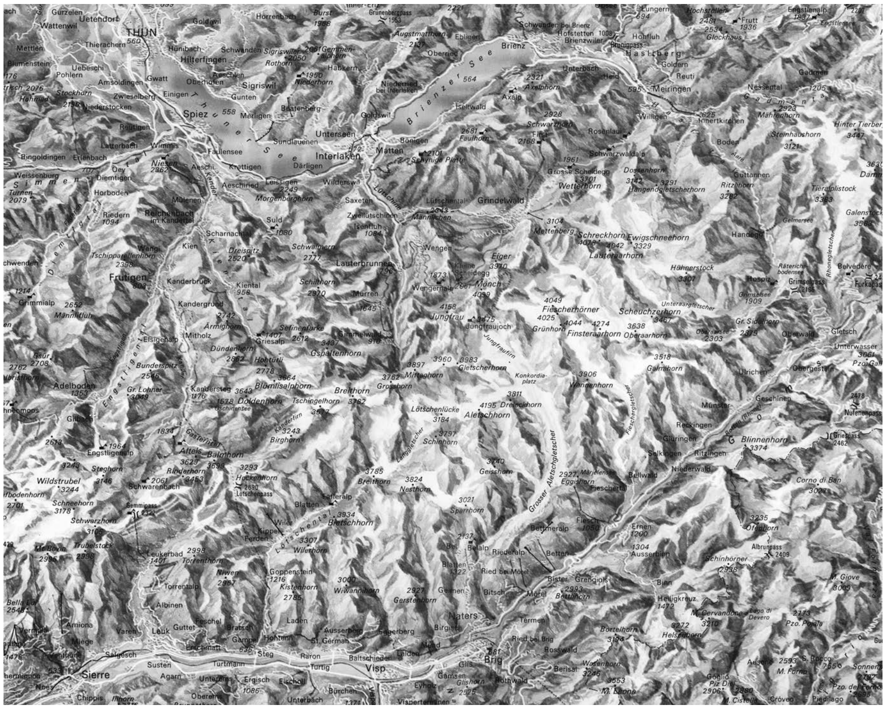


Figure 4. "A Bird's Eye View of Switzerland" by Bruno Kersten. (see page 89 for color version)

the Mercator or Mollweide. Instead, the concept of projecting rays is used. Roughly analogous to photography, virtual rays of light directed at a digital elevation model interact with it and create highlights, shadows, and intermediate tones. These tonal values then emit from the model in the form of projecting rays that cast a point onto a flat image plane that we see as rendered relief on the computer monitor. How the projected rays transfer from the model to the image plane depends on the type of projection.

Two families of projections exist for 3D relief rendering: the central perspective projection with projecting rays converging towards a focal point, and the parallel projection with parallel rays. Plan oblique relief uses the parallel projection. Starting from the left in Figure 5, the first two projections are members of the parallel projection family. In each, think of the image plane as a gigantic sheet of paper floating above the digital elevation model shown in profile. Arrows represent the projecting rays. For the orthographic projection, used for the creation of conventional shaded relief, the parallel projecting rays are perpendicular to the image plane (Figure 5, left). For the plan oblique projection, the parallel rays intersect the image plane at an angle less than 90° (angle α in Figure 5, center). Note

". . . the first two projections are members of the parallel projection family. In each, think of the image plane as a gigantic sheet of paper floating above the digital elevation model shown in profile."

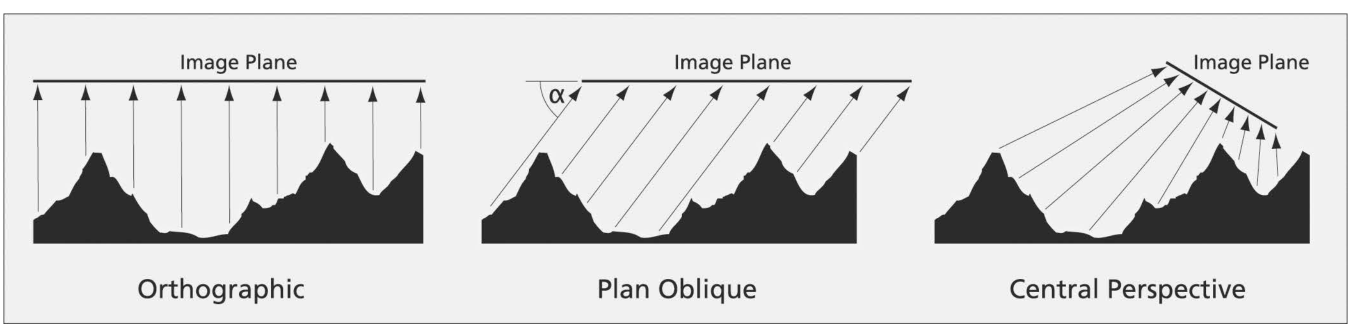


Figure 5. Projections for rendering terrain.

that for the first two projections the image plane is oriented parallel to the planar base of the model. For plan oblique relief, this guarantees that terrain features at the same altitude render at a homogenous scale with no distortion—which would not be the case for a non-horizontal image plane or non-parallel rays. The central perspective projection, for example, has non-parallel projecting rays that converge toward a focal point behind a tilted image plane (Figure 5, right). The central perspective projection is the basis for 3D perspective views.

The following projection parameters control the appearance of plan oblique relief when rendered:

- The position of the image plane determines the mapped area of the final rendering.
- The rotation of the image plane around a vertical axis orients the map (for orientations other than north).
- The angle (α) of inclination between the image plane and the projecting rays controls vertical exaggeration of the 3D terrain. The inclination angle can theoretically vary between 0 and 90 degrees. At 90 degrees, the rendered terrain is completely orthographic and without three-dimensionality, similar to conventional shaded relief. At more acute angles, the steeper and more vertically exaggerated relief appears when rendered (Figure 6). Plan oblique relief rendered with an intermediate inclination angle, 45 degrees, for example, results in intermediate vertical exaggeration. Note: vertically exaggerating the digital elevation model by a scale factor has the same effect as choosing a more acute inclination angle (see Appendix A for details).

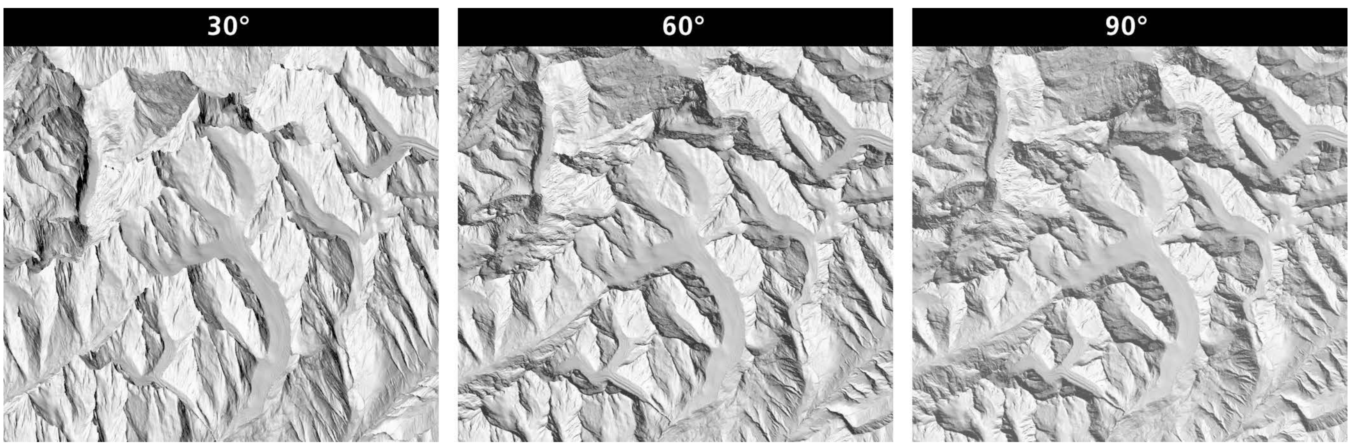


Figure 6. Plan oblique relief of the Bernese Alps, Switzerland, rendered at different inclination angles. Shallower inclination angles results in relief with greater vertical exaggeration.

- In addition to adjusting the angle of inclination parallel to viewing direction, it is also possible to tilt the projecting rays laterally (Figure 7). This action emphasizes slopes perpendicular to the viewing direction and is more investigational than practical. For most maps, altering the lateral tilt parameter from its default value of 0 degrees is not appropriate.

Appendix B explains how the angle of inclination determines the orientation of the projecting rays, and how the projecting rays transform the three-dimensional terrain model to a two-dimensional image.

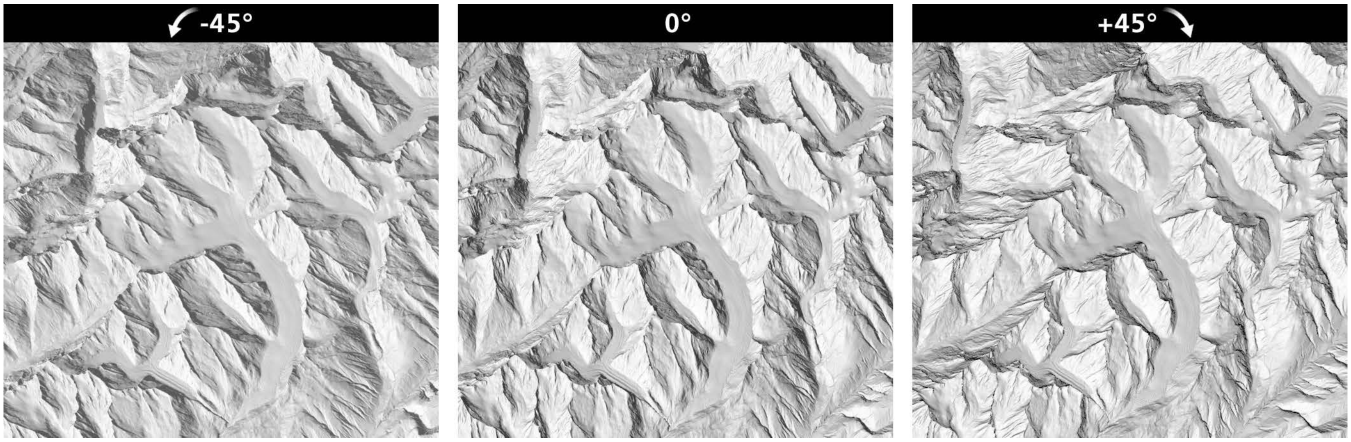


Figure 7. Plan oblique relief rendered with lateral tilt (left and right) *and without* (middle). *Note that -45 ° tilt reveals more of slopes facing to the right and +45° tilt reveals slopes facing to the left.*

Natural Scene Designer 5.0

The creation of plan oblique relief no longer depends on prototype software or workaround techniques. Natural Graphics, the developer of Natural Scene Designer software, has added plan oblique relief as a rendering option in version 5.0 due for release in autumn 2007. Until now, creating plan oblique relief with digital data and commercial software has been difficult. A technique based on Bryce and Photoshop proved cumbersome to use, yielded maps with spatial distortion, and resulted in poor render quality (Patterson, 2004). By comparison, Natural Scene Designer 5.0 generates distortion-free terrain at a uniform resolution and with high render quality. Natural Scene Designer uses the same projection and rendering methods as our prototype software described above. Plan oblique relief created with the two software applications align exactly when overlaid on top of one another.

"The creation of plan oblique relief no longer depends on prototype software or workaround techniques."

Creating plan oblique relief with Natural Scene Designer 5.0 is simple. It involves (1) opening a DEM; (2) selecting the "Render Planimetric Oblique Relief" from the Render drop menu; and, (3) clicking the render button. In most cases the default settings produce excellent plan oblique relief. For those seeking more options, the software permits users to set the vertical exaggeration, vary the illumination azimuth and angle, drape images, apply hypsometric tints, and control other functions that one generally expects from a mature terrain application.

DESIGN CONSIDERATIONS

Like other forms of relief representation, plan oblique relief is not the perfect solution for all maps. Understanding the technique—both the good and the bad elements—is essential for using it appropriately.

"Understanding the technique—both the good and the bad elements—is essential for using it appropriately."

Advantages of plan oblique relief

- 3D terrain – Figure 8 shows the close resemblance of plan oblique relief generated digitally to one of Erwin Raisz's landform maps drawn by hand. Writing about the advantages of his mapping style, in 1931 Raisz observed,
  "… the map appeals immediately to the average [person]. It suggests actual country and enables [them] to see the land instead of an abstract location diagram. It works on the imagination. What this means can be

best appreciated by teachers."

Three quarters of a century later, his claim holds true for plan oblique relief.

- Geographic shape – Maps made with plan oblique relief retain the shape of familiar geographic areas. Plan oblique relief is free of the severe spatial distortion found in 3D perspective views: the mapped space is non-hierarchical, depicting objects in the foreground and the background at the same scale; parallel lines are parallel and do not converge towards the vanishing point; and, major landforms do not diminish to progressively smaller sizes on the horizon. On small-scale maps made with either plan oblique relief or conventional shaded relief, large geographic shapes appear similar. Plan oblique relief is not perfect in this regard, however. In areas with rugged terrain, large landforms in the foreground can occlude small geographic shapes in the background, a problem exacerbated by vertical exaggeration.
- Distance measurement – Plan oblique relief preserves distances and angles for terrain lying at the same elevation, allowing for distance measurements within a flat plain or between locations of equal elevation, such as those at sea level. Because small- and medium-scale maps are usually those that receive plan oblique relief, measurement inaccuracies caused by the planimetric displacement of landforms are relatively minor. This effect contrasts with 3D perspective views where perspective foreshortening makes such measurements impossible.
- Gauging altitude – Like other 3D maps, plan oblique relief permits readers to roughly gauge the relative height of landforms within a proximate area. Improving on the inked landform maps of Raisz, plan oblique relief depicts the elevation of flat-floored basins and plateaus in their proper relation to sea level. Political boundaries and other map linework conform to the profile of the terrain rising over mountain ranges and descending into canyons, providing additional hints about relative elevation (Figure 8). Furthermore, if hypsometric tints (or possibly contour lines) are draped on plan oblique relief, readers can easily and accurately determine the elevation of all points, even flat areas on the landscape.

"Improving on the inked landform maps of Raisz, plan oblique relief depicts the elevation of flat-floored basins and plateaus in their proper relation to sea level."

- Reading by sections – Much as with conventional maps, to view a plan oblique relief map at alternating macro and micro zoom levels works

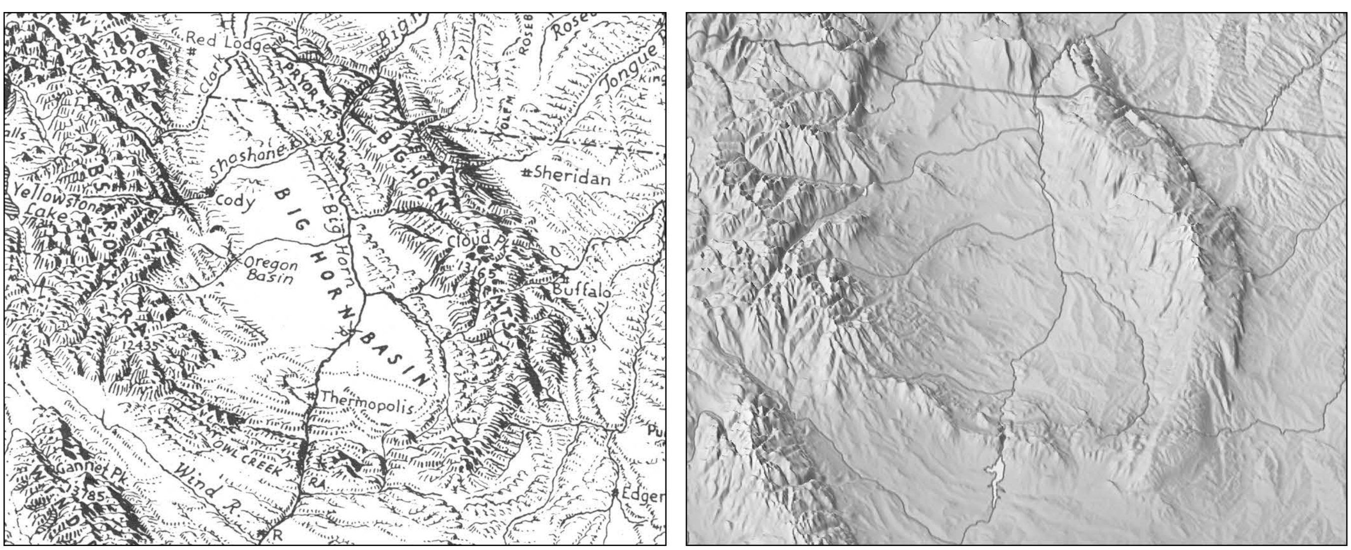


Figure 8. Bighorn Basin, Wyoming, drawn by Erwin Raisz (left) *and rendered as plan oblique relief from Shuttle Radar Topography Mission data* (right). *Note that the state boundary on the plan oblique relief follows the profile of the terrain. On Raisz's map the terrain does not influence the boundary position.*

efficiently. Because of the uniform scale and orthographic base, reading by sections is possible—the map is both zoomable and scrollable; i.e., the observer's eye can "zoom-in" on a section of the map to read details and then scroll the image—left and right, up and down—without conflicting with the pictorial space. If one were to hide one half of a plan oblique map from view, the underlying projection would remain intact and the map would still make sense to readers (Krikke, 2000). By contrast, on 3D perspective views based on the central perspective projection, reading by sections is difficult. The reasons for this include terrain geometry that splays outward at the sides, the presence of severe terrain occlusion, and scale that diminishes with distance from the viewer.

- Wide focus – Maps with plan oblique relief project a sense of calm. While a 3D view based on the central perspective projection is ideal to convey a dynamic notion of "going there," plan oblique relief based maps are ideal for conveying the contemplative notion of "being there" (Krikke, 2000). A typical perspective view directs the eye of the reader to a destination; a typical plan oblique map has wider focus and the eye looks everywhere at once.

"A typical perspective view directs the eye of the reader to a destination; a typical plan oblique map has wider focus and the eye looks everywhere at once."

Disadvantages of plan oblique relief

- Unfamiliar – Because plan oblique relief is relatively rare and combines traits from shaded relief and 3D perspective views, which are well known, it has the potential to confuse readers. This problem is perhaps a greater issue among mapping professionals than to the general public, which is less beholden to existing methods of relief presentation. Plan oblique relief is more prone to cause confusion on large-scale maps than on small-scale maps.
- Occluded terrain – As with all three-dimensional terrain representations, plan oblique relief suffers from partially obscured terrain—high foreground features that block low background features—due to planimetric displacement. The back slopes of steep mountains (typically north-oriented faces on north-oriented maps) appear shortened or partially invisible. However, because plan oblique maps lack perspective, these occlusion effects are more evenly distributed and less extensive than they are in 3D perspective views. Figure 9 compares the occluded area for a 3D perspective view and plan oblique relief, both created with an inclination angle of 45 degrees. Areas that are invisible in the 3D perspective view and in the plan oblique relief appear as black superimposed on gray shaded relief in standard orthographic projection.

  As map scale decreases so does the occluded terrain as a percentage of the total area depicted. For example, a plan oblique map of Mt. Rainier at 1:25,000-scale would occlude more of the total surface area than a map of the same size at 1:250,000-scale.

"Tilting the vertical axis of rendered 3D terrain ruins its effectiveness and looks odd—imagine the Matterhorn canted 30 degrees from vertical."

- Non-rotatable – Readers expect 3D terrain, such as that found on plan oblique relief, to point straight up. Tilting the vertical axis of rendered 3D terrain ruins its effectiveness and looks odd—imagine the Matterhorn canted 30 degrees from vertical. This limitation also precludes reprojecting most maps made with plan oblique relief (e.g., from Platte Carrée to an azimuthal projection). The exception to the rule is between maps with cylindrical projections where the terrain axis always remains vertical.

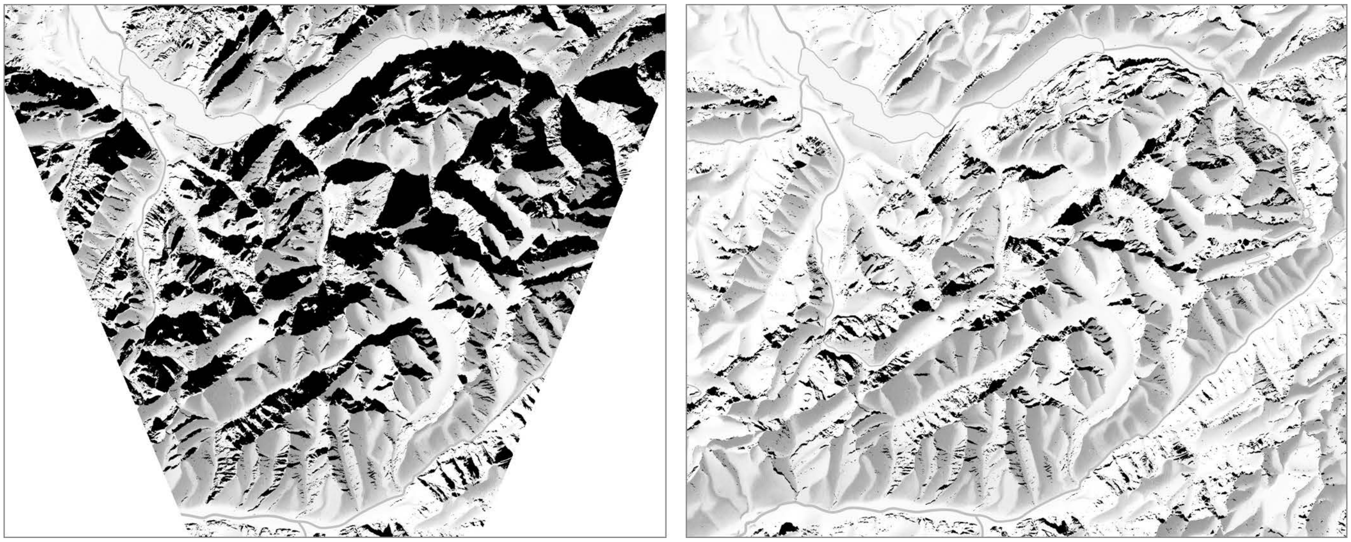


Figure 9. Occlusion maps for a 3D perspective view (left) *and plan oblique relief* (right) *of the same geographic area; both renderings look due north and use a 45-degree inclination angle. Black represents areas of the landscape hidden from the reader and the gray shaded relief represents visible terrain. The occlusion map for the 3D perspective view appears trapezoidal due to its limited field of view.*

- Linework unfriendly – The only way to fit vector linework such as drainages, boundaries, and roads on plan oblique relief is by rasterizing and then rendering it as a draped image. This process degrades the crispness of lines and requires post-rendering touchups in a paint program like Adobe Photoshop. Misregistered drainages in narrow valley bottoms are a problem because they blur and climb up hillsides in an unnatural fashion. This issue is less noticeable on conventional shaded relief maps because the drainages mask the relief below.

The following table compares the major characteristics of conventional shaded relief, plan oblique relief, and perspective 3D views.

	3D effect	**Depiction of landforms**	**Measurement of distances**	**Reading by sections**
Conventional shaded relief (Orthographic projection)	Faux 3D appearance due to illumination, shadows, and aerial perspective effect.	All major and minor landforms visible throughout map space, but major landforms not prominent.	Possible everywhere. Completely planimetric.	Possible everywhere.
Plan oblique relief (Parallel oblique projection with horizontal image plane)	3D effect due to local occlusion and side-view of terrain features.	All major landforms prominent. Most minor landforms visible. Minor occlusion and shortening of back slopes, stretching of front slopes.	Possible between points at equal elevation. Mostly planimetric.	Possible everywhere.
3D view (Central perspective projection)	Pronounced 3D effect due to occlusion and perspective foreshortening.	Landforms pinch toward the vanishing point in background. Large areas are occluded throughout map space.	Not possible. Not planimetric.	Occlusion of large areas and a varying scale hinders reading by sections.

Additional design considerations

- Illumination – Light interacts with plan oblique relief just as it does with conventional shaded relief to create modulated gray tones that give form to the terrain. Using cast shadows with plan oblique is generally not advisable because they can make valley bottoms appear misregistered with drainages.

  Light emanating from the lower left (southwest or west–southwest on north-oriented maps) represents the optimal direction for illuminating plan oblique relief. Illumination from the upper left, used on conventional shaded relief, does not apply—it places shadows on slopes facing the reader, which darken the map and decrease legibility. Illumination from the lower right (southeast), which is common on 3D perspective views, is not advisable because it tends to induce relief inversion. Xaver Imfeld and Heinrich Berann, however, successfully used lower right illumination for their maps—artistic skill and cooperative terrain helped them avoid the problem (Figure 2 and Figure 3, right). Plan oblique relief and conventional shaded relief appear very similar on maps in areas where the terrain is gentle. With this in mind, tailoring plan oblique relief to look more familiar to readers in flatter areas is possible by carefully rotating the direction of the light source from lower left toward due left. Rotating the light too much to the left, however, can result in lost detail and excessive contrast.

- Scale – Consensus exists that plan oblique relief is best suited for small-scale mapping, but at just what scale the cutoff happens is a matter for debate. According to Raisz (1953), plan oblique relief is appropriate at map scales less than 1:1,000,000. Ridd (1963) takes a broader position and advocates using it at scales possibly as large as 1:100,000. In general, however, mapmakers should exercise caution when contemplating the use of plan oblique relief at larger scales.
- Spiking – As with all 3D terrain, to apply vertical exaggeration to plan oblique relief tends to spike high solitary mountains upwards. Manipulating the DEM data with resolution bumping (Patterson, 2001) or resampling to a lower resolution before rendering can alleviate this problem.
- Vertical exaggeration – Choosing the right amount of vertical exaggeration (by varying the angle of inclination, or pitch, as it is called in Natural Scene Designer 5.0) is critical. The appropriate angle of inclination for plan oblique relief depends on the terrain's characteristics as well as on the content and purpose of the map. An angle that is too shallow generates mountains with extreme vertical exaggeration; at angles above 60 degrees, the difference from conventional shaded relief is hardly noticeable. Angles between 30 and 50 degrees generally produce the most visually pleasing plan oblique relief.

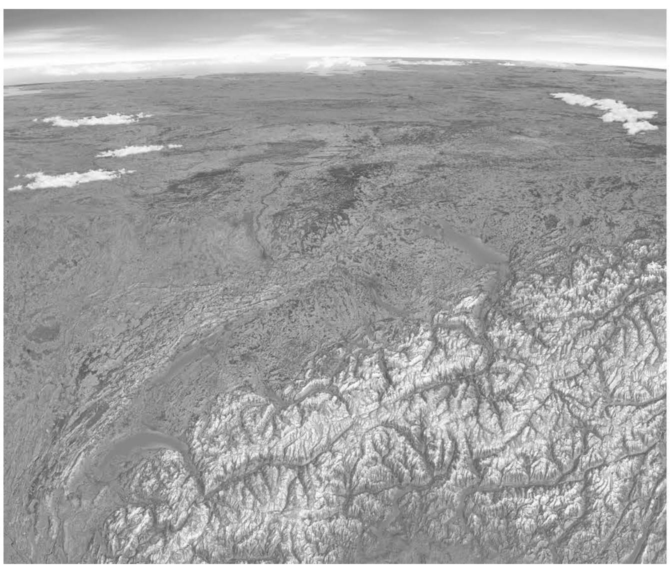
"Xaver Imfeld and Heinrich Berann, however, successfully used lower right illumination for their maps—artistic skill and cooperative terrain helped them avoid the problem."

PRACTICAL USES OF PLAN OBLIQUE RELIEF

To put theory into practice the authors of this paper each created a map with plan oblique relief that imitates the style of a famous mapmaker of the past.

Bernhard Jenny's panorama of Switzerland (Figure 10, left) follows Heinrich Berann's technique of combining plan oblique relief in the foreground (the bottom 70 percent of the map) with distorted terrain and a false horizon in the background (Jenny, 2006). He used his prototype software and Space Shuttle Radar Topography Mission (SRTM) elevation data to render the plan oblique relief draped with a satellite image. Patterson contributed a separate rendering of the sky and high-altitude clouds generated in Bryce 5.0, which when grafted to the top of the plan oblique relief in Adobe Photoshop, created the horizon. The sheer transformation in Photoshop brought curvature to the horizon. Seeking additional realism, Jenny added photographs of clouds, taken from an airplane, over the plan oblique relief in background areas. The end result is a faux panoramic image that combines the readability of a map in the foreground with the dynamic quality of a true panorama in the background.

Tom Patterson created the "Physical Map of the Coterminous United States," which draws its inspiration from the landform maps of Erwin Raisz (Figure 10, right). This 1:4 million-scale wall map also derives from SRTM elevation data. To produce the map Patterson used an alpha version of Natural Scene Designer 5.0. The map is comprised of multiple rendered elements that were composited in Adobe Photoshop. Besides plan oblique relief, it features cross-blended hypsometric tints that vary in color depending on how arid or humid a lowland region is—the California deserts appear brown and the Louisiana bayous are green, just as readers expect them to be. The simulated three-dimensional appearance of the map is reminiscent of the molded plastic relief maps used in school classrooms, but with subdued colors and with much greater terrain detail.



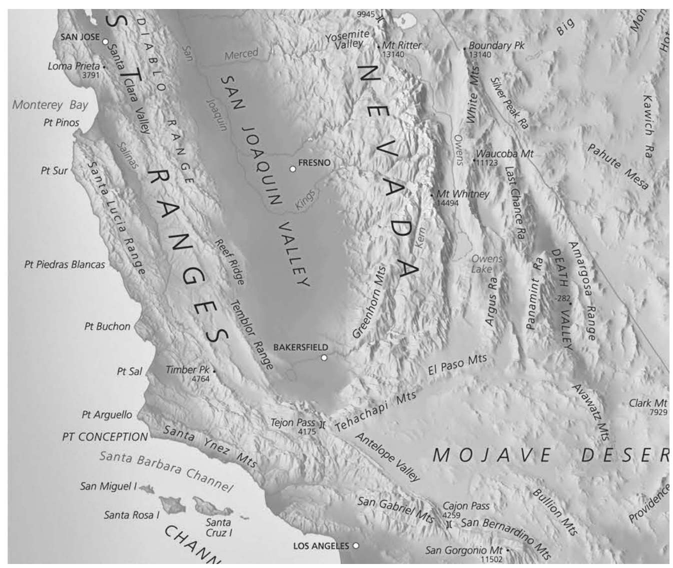


Figure 10. Panorama of Switzerland looking north (left) *and an excerpt from the "Physical Map of the Coterminous United States"* (right). *(see page 90 for color version)*

The maps discussed above are available online. For the panorama of Switzerland, go to www.reliefshading.com/planoblique. The "Physical Map of the Coterminous United States" is viewable at www.shadedrelief.com/physical.

CONCLUSION

Plan oblique relief is poised to shed its legacy as a manual technique used primarily by physiographers and artisans and to enter the mainstream of digital cartography. Thanks to Natural Scene Designer 5.0, a means to create it now exists at an affordable price.

The assumption throughout this paper is that for certain purposes plan oblique relief is easier for both novice and expert map readers to understand than conventional shaded relief. As Raisz pointed out: "It is a method that makes mountains look like mountains" (Raisz, 1948). However, whether or not plan oblique relief offers a benefit to map readers, and for what purposes, is a matter of personal opinion and anecdotal evidence. A need exists for usability studies comparing plan oblique relief to other relief presentation methods.

Having said that, the authors of this paper advise a conservative approach in using plan oblique relief. If there is any doubt about its appropriateness, use another relief presentation method. The best use of plan oblique relief is still landform mapping at small scales, especially terrain dominated by solitary peaks. As an example, when used with bathymetry data the technique yields results similar to the ocean floor maps painted by Berann (Figure 11). Having at least some dramatic terrain on a map is a prerequisite for using plan oblique relief; it makes no sense to use it when the terrain is entirely gentle. Plan oblique relief also is suited for generalized thematic mapping provided that intricate data do not overlay rugged terrain. Thematic maps that depict information broadly relating to the terrain, such as a map of South America showing the historical extent of the Inca Empire with a large area tint, lend themselves to depiction with plan oblique relief.

"It is a method that makes mountains look like mountains."

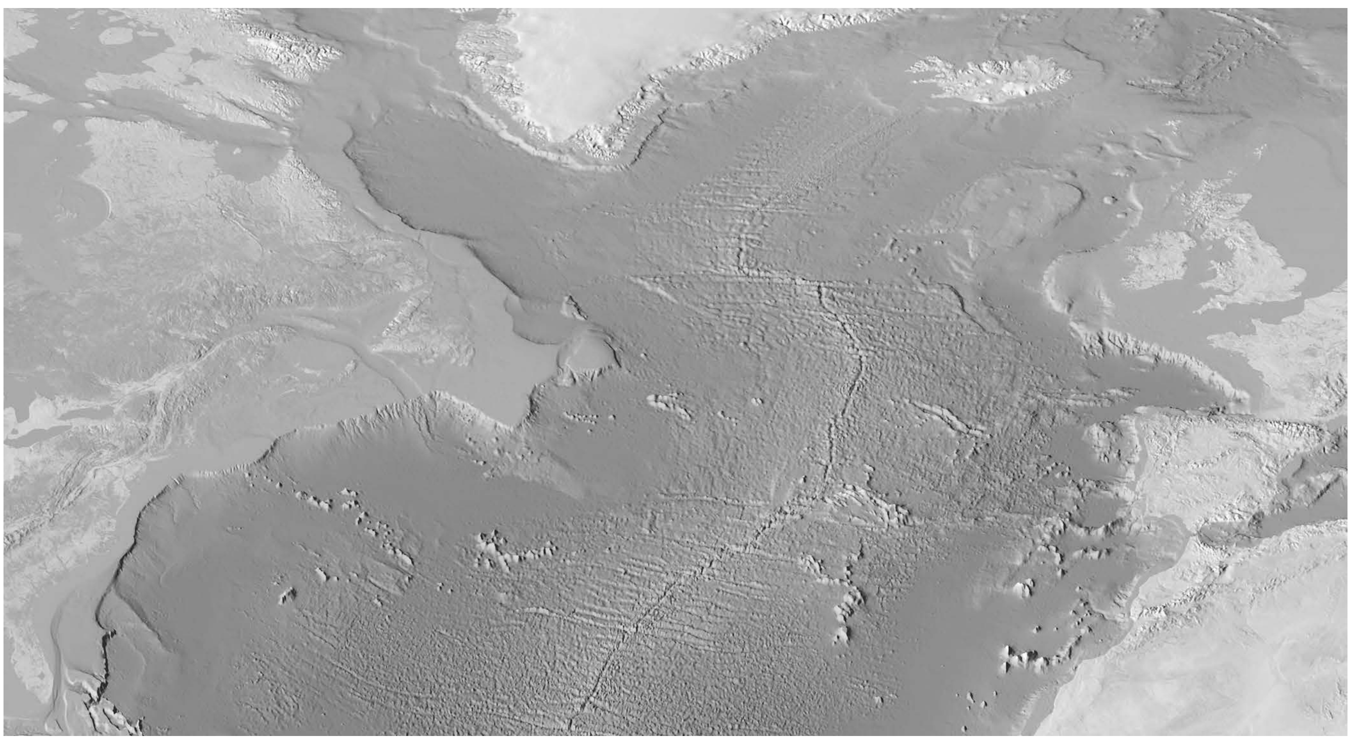


Figure 11. The North Atlantic rendered as a plan oblique relief. For a comparison with Heinrich Berann's work, see Figure 3, right. (see page 90 for color version)

There are other ways to depict plan oblique relief. For example, although plan oblique relief lacks the inked lines found on Raisz's maps, digital techniques could imitate this aspect of his work as well. Digital terrain sketching, a type of non-photorealistic rendering, is applicable to perspective views (Lesage and Visvalingam, 2002) and could be adapted to plan oblique relief. For an even closer match of Raisz's style, plan oblique relief rendered in the usual way could serve as a template for drawing pictorial landform symbols by hand (using a drawing tablet) or by cloning them in Adobe Photoshop.

Options for enhancing digital plan oblique relief abound. Now that mapmakers can more easily make maps that emulate the masterworks of Imfeld, Raisz, and Berann, plan oblique relief will no doubt gain in popularity, and new uses for the technique await discovery.

APPENDIX A – INCLINATION ANGLE AND VERTICAL EXAGGERATION RELATIONSHIP

When rendering plan oblique relief, lowering the angle of inclination α (see Figure 5, middle) produces 3D terrain with greater vertical exaggeration. As one might expect, applying vertical exaggeration to a digital elevation model by a multiplication factor larger than 1 has the same effect as lowering the angle of inclination. For example, rendering a digital elevation model with an inclination angle of 26.6° produces results identical to those when the digital elevation model is exaggerated vertically by a factor of 2 and then rendered with an inclination angle of 45 degrees. The equation below expresses the relationship between the angle of inclination and the vertical exaggeration.

Formula 1

$$k = \frac{\tan \alpha}{\tan \alpha'}$$

With

k: the factor of vertical exaggeration applied to the digital elevation model
α: angle of inclination for the terrain without vertical exaggeration
α': angle of inclination for the terrain with vertical exaggeration by the factor k

APPENDIX B – PLAN OBLIQUE PROJECTION ALGORITHM

This appendix explains the details of the plan oblique projection algorithm to facilitate the inclusion of plan oblique relief in other terrain rendering software. A projection transforms three-dimensional models to a two-dimensional image—a concept that is a well-known to cartographers. Projections used in computer graphics, however, differ from cartographic projections in that they do not project lines and points specified in longitude and latitude on a sphere or ellipsoid, but work with arbitrarily shaped models defined in a three-dimensional Cartesian coordinate system.

Rasterization methods

Digital elevation models are commonly modeled as grids (elevation values arranged in regularly spaced matrices) or TINs (triangulated irregular networks). Both forms can be treated as polygon-based models; i.e., they approximate the surface of the terrain with connected triangles or rectangles. The computer graphics field has developed various techniques to project such three-dimensional objects onto a two-dimensional raster image plane. A very common rasterization technique is the so-called graphics pipeline, which is commonly used by interactive games. The graphics pipeline offers an important advantage compared to other rendering techniques: It is hardware-accelerated by modern graphics cards, which animates detailed graphical displays in real-time. The graphics pipeline usually transforms the triangle-based model to a 2D image with the central perspective projection—or, less frequently—with the orthogonal parallel projection. With some additional programming, the oblique parallel projection for plan oblique relief could replace these two projections (see appendix A.8 in Carlbom and Paciorek, 1978 for the projection matrix). However, we did not extend the graphics pipeline in such a way, but developed a simple ray casting algorithm, which is an alternative rasterization method that is better suited for rendering large terrain models with high graphic quality.

Ray casting, also known as ray tracing, computes each pixel in the resulting image in succession. The per-pixel computations consist of two steps. First, the algorithm determines which part of the model is shown by the pixel. For this purpose, it casts a virtual ray starting from the center of the pixel, and computes its intersection with the model. Next, the algorithm calculates a color for this intersection point; this is known as shading and texture mapping. The color is finally assigned to the pixel in the resulting image, and the algorithm repeats the same procedure for the next pixel, and so on.

Ray geometry

Before the algorithm can compute the intersection point between a ray and a digital terrain model, it has to determine the geometry of the ray. The ray is defined by the position of the pixel P in the image plane floating above the terrain (Figure 5, center), and two orienting angles: the angle of inclination and the angle of lateral tilt. The direction vector d of the ray can be expressed in vector geometry as:

Formula 2

$$\vec{d} = \begin{bmatrix} 0 \\ \cos\alpha \\ \sin\alpha \end{bmatrix}$$

Variable α is the latitude or angle of inclination rotating around the x-axis, counted positive from the y-axis. In the standard configuration shown in Figure 12, α equals $-\pi/4$. Note that the orthographic projection is a special case of the plan oblique projection where α equals $-\pi/2$.

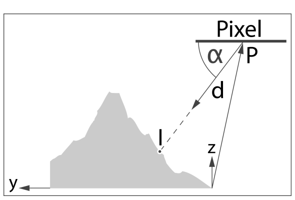


Figure 12. Ray-terrain intersection for one pixel.

Formula 2 above assumes that there is no lateral tilt. With a lateral tilt angle β, the direction vector is:

Formula 3

$$\vec{d} = \begin{bmatrix} \cos\alpha\cos\beta \\ \cos\alpha\sin\beta \\ \sin\alpha \end{bmatrix}$$

Variable β is the longitude rotating around the z-axis, counted positive from the x-axis. For the standard situation without a lateral tilt, β equals $\pi/2$. In Figure 7, β is $3\pi/4$(left), $\pi/2$ (center), and $\pi/4$ (right).

Ray-terrain intersection

The intersection point *I* of the ray with the terrain is (see Figure 12):

$$\vec{I} = \vec{P} + k\vec{d}$$

With
I: the position vector of the intersection point
P: the position vector of the pixel
d: the unary direction vector
k: a scale factor for *d*

To compute the intersection point *I* of a ray with an object, various algorithms have been developed for planes, spheres, boxes, etc. (Watts, 2000, and Foley et al., 1997). Specialized algorithms for digital elevation models in the form of regularly spaced grids also exist (Musgrave, 1988, Qu et al, 2003).

Shading and texture mapping

After computing the intersection point between the ray and the terrain model, the algorithm calculates a color for this location. A variety of techniques exist for this purpose, which generally combine texture mapping with a shading method. Our prototype software applies standard texture mapping: the x and y coordinates of the intersection point are used to extract a color from a geo-referenced image. The prototype also computes a diffuse Lambertian reflectance for the intersection point. The color from the texture mapping and the reflectance value are finally blended and stored in the raster image.

The Lambert reflectance model is computationally simple. The gray value is proportional to the cosine of the angle between the surface normal and the light vector, which is calculated by taking the dot product of the two vectors (Foley et al., 1997). Other, more complex models could be used that aim at rendering photorealistic images (Phong, ray tracing, radiosity, etc.). Non-photorealistic methods could be worthwhile alternatives: they could produce hachuring or silhouette lines that simulate Erwin Raisz's black strokes on a white background (Lesage and Visvalingam, 2002; Whelan and Visvalingam, 2003).

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SOFTWARE

Natural Scene Designer 5.0, Natural Graphics (www.naturalgfx.com).

MAPS

Figure 2: Imfeld, X. (1887). Reliefkarte der Centralschweiz. Vertical scale 1:141,000, horizontal scale 1:100,000. Winterthur: Topographische Anstalt Wurster, Randegger & Cie.

Figure 3 left and 8 left: Raisz, E. & Atwood, W. (1957). Landforms of the

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Figure 3 right: Heezen, B. & Tharp, M., painted by Berann, H. (1968). *Atlantic Ocean Floor*. 1:30,412,800. Washington, DC: National Geographic Society.

Figure 4: Kersten, B. (1980). *Die Schweiz aus der Vogelschau: A bird's eye view of Switzerland: La Suisse vue à vol d'oiseau: La Svizzera a volo d'uccello*. 1:300,000. Bern: Kümmerly & Frey.

Figure 8 right and 10 right: Patterson, T. (2006). Physical Map of the Coterminous United States. 1:4,000,000. Retrieved November 14, 2006 from http://www.shadedrelief.com/physical.

Figure 10 left: Jenny, B. (2006). *Biodiversität erleben – Die Naturschutzzentren und andere Erlebnisorte der Schweiz und ihrer Nachbarschaft*. Approx. 1:600,000. Zürich: Schweizer Vogelschutz SVS / BirdLife Schweiz. Retrieved November 15, 2006 from http://www.reliefshading.com/planoblique.

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Judgments of Size Change Trends in Static and Animated Graduated Circle Displays

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Despite the abundance of research on the perception of information presented as graduated or proportional circles on static maps, such experiments have been rare for animated map displays. However, such experimental results might be beneficial for selecting optimal methods for depicting temporal change on graduated circle maps. In the present experiment, participants judged whether a greater number of circles in an n x n array increased or decreased during a 1500-millisecond (ms) observation interval. The variable n represented values of 6, 8, and 10, and all circles changed size (some larger, some smaller) from a common starting size either in a discrete shift (static condition) in the middle of the observation interval, or in a smooth, apparently continuous shift (animated condition) over the same interval. In addition, the size changes were relatively small, moderate, or large. The proportion of "more bigger" judgments, plotted against the actual proportions of enlarged circles, produced an ogive function (a cumulative normal) with similar slopes in all conditions. However, the bias towards "bigger" judgments increased with the size discrepancies between the initial and final circle diameters, and the bias towards "bigger" judgments was greater for animated than for static circle diameter changes. The results are interpreted in terms of attentional precedence for larger items and also for those that appear to be continuously increasing in size (looming). These results have implications for the presentation of information on static and animated graduated circle maps.

Keywords: graduated or proportional circles, map animation, perception.

INTRODUCTION

The graduated, or proportional symbol is a common form of map symbolization for quantitative data that occur or may be conceptualized to occur at point locations. Graduated symbols are constructed by scaling the size of each symbol proportional to some data value (e.g., population for U.S. cities). Although a variety of graduated symbols such as squares, bars, triangles, spheres, and cubes may also be displayed on maps, the circle is perhaps the most commonly used symbol (Figure 1). Meihoefer (1969) cited a number of reasons for their popularity: circles use map space efficiently, are easy to construct, and map readers often prefer the visual aesthetics of circles over other shapes.

Animated graduated circle maps are common for depicting changes in geographic patterns over time. Animation may be beneficial for displaying temporal changes since the passage of time is depicted directly by the temporal length of an animated map display. The successive display of static frames in a map animation can create apparent motion, a visual effect in which objects appear to move continuously in the display. Apparent mo-

"Animated graduated circle maps are common for depicting changes in geographic patterns over time."

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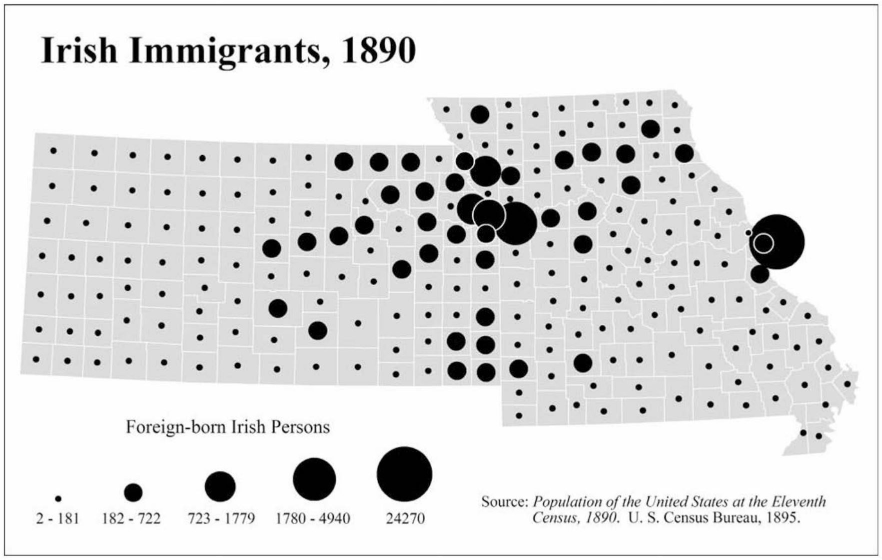

Figure 1. An example of a graduated or proportional circle map, this one shows Irish immigrants in Kansas and Missouri counties in 1890.

tion is evident in animated graduated circle maps as circles dynamically increase or decrease in size. Yet, it remains uncertain whether the apparent motion in animation aids the viewer in detecting change between graduated circles, or rather serves as a detriment since in some contexts animation may increase the cognitive demands associated with comprehension of a display (Tversky, Morrison, and Betrancourt, 2002).

"Yet, it remains uncertain whether the apparent motion in animation aids the viewer in detecting change between graduated circles . . ."

Background and Literature Review

As with all other forms of map symbolization, the effectiveness of graduated circles in both animated and static displays is limited by the perceptual constraints of human vision. Detection of the overall trend change (i.e., more total circles increasing in size or more total circles decreasing in size) between two graduated circle map displays may be described by the basic laws of psychophysics. For example, the discrimination threshold is the weakest stimulus change that can be detected. In the case of overall trend changes in graduated circle map displays, it would be the smallest proportion of increasing circles for one to judge an "increasing" trend change reliably, or the smallest proportion of decreasing circles for one to judge a "decreasing" trend change reliably. According to Weber's Law, the larger the physical intensity of a stimulus, the higher the discrimination threshold. Fechner's Law more precisely describes the relationship between the actual physical intensity and its perceived intensity as a decelerating, or logarithmic function.

". . . if the apparent motion in animation is indeed beneficial to the viewer, we would expect a lower discrimination threshold or sensitivity . . ."

By applying these psychophysical laws to graduated circle map displays in a general manner, we would expect that the number of circles either increasing or decreasing in size, respectively, must increase in number as the total number of circles in a display increases in order for subjects to detect the overall trend change between displays. Furthermore, if the apparent motion in animation is indeed beneficial to the viewer, we would expect a lower discrimination threshold or sensitivity in the task compared to static displays. Conversely, if animation increases the cognitive load associated with the task, we would expect a lower discrimination threshold or sensitivity for static displays.

Research in cognitive psychology and in cartography has revealed important characteristics of how individuals detect general and specific attributes of scenes, as well as any changes that might occur between displays. Some statistical properties of complex visual displays appear to be extracted by a more or less automatic and parallel process. The gist, or overall meaning, of a briefly-presented scene or the central tendencies of some of its components can sometimes be reported, even when details of individual objects in the scene cannot (e.g., Oliva, 2005; Rousselet, Joubert, and Fabre-Thorpe, 2005).

"Some statistical properties of complex visual displays appear to be extracted by a more or less automatic and parallel process."

Several studies of how people extract information about the mean object size and its variation in a scene have used simple displays of geometric forms such as circles. For example, Ariely (2001) showed that the mean judged size of a set of filled circles of various sizes was influenced only slightly by the number of circles (from 4 to 16), and Chong and Treisman (2003) found that similar judgments showed only a small effect of exposure duration (50 to 1000 ms). Further, Chong and Treisman (2005) found that average circle size was estimated more accurately if the displays were viewed while observers were engaged in a concurrent distributed attention task than if they were viewed during a serial scanning task. Such results support the idea that certain aspects of meaning and statistical properties of complex displays can be estimated from global processes operating quickly and in parallel over large display areas.

In cartography, a number of psychophysical experiments with static graduated symbols on maps (e.g., Flannery, 1971; Crawford, 1973) have revealed that, when asked to estimate the magnitude of graduated symbols such as circles and squares, individuals consistently underestimate actual size. Such results are consistent with the findings of Stevens (1957) who argued that the psychophysical relationship between an actual stimulus magnitude and the perceived magnitude is neither linear nor logarithmic, but might be best described by a power function. Related experiments with graduated circles on static displays have examined the effects of other variables on magnitude estimations, including sizes of adjacent circles (Gilmartin, 1981), individual differences between map readers (Griffin, 1985), and visual contrast and color of circles (Griffin, 1990).

Despite the abundance of research with static displays, markedly fewer studies have compared how individuals detect magnitude changes of graduated circles in both static *and* animated conditions (although see Slocum et al., 2004 for a qualitative evaluation of static and animated graduated circle maps). The lack of such research is regrettable since Slocum et al. (2001) have noted inconsistent findings regarding the effectiveness of animated maps in various contexts. For example, Patton and Cammack (1996) compared sequenced (animated) and static choropleth maps and found that both response speed and accuracy improved with sequenced maps compared to static displays. However, a comparison of animated and static flow maps by Johnson and Nelson (1998) did not reveal any significant differences between animated and static displays for either response time (RT) or accuracy rates. In another study, Koussoulakou and Kraak (1992) found that map animation did not improve overall accuracy rates, but RT was shorter for animated maps than for static displays. An experiment by Griffin et al. (2006) found that RT was faster and accuracy rates were higher for animation compared to static small-multiple displays for the identification of clusters that changed over time and space. Fabrikant (2005) has suggested that a failure to link perceptual salience with thematic relevance on the map may be a reason why map animations have not proved effective in some controlled experiments.

". . . markedly fewer studies have compared how individuals detect magnitude changes of graduated circles in both static and animated conditions . . ."

Inconsistent results regarding the general utility of animation have also been found by cognitive psychologists. For example, Morrison and Tversky (2001) found that animated graphics were not more effective than static graphics for learning purposes. In a review of several studies that compared animated and static displays, Tversky, Morrison, and Betrancourt (2002) concluded that animation does not improve comprehension of complex systems, and argued that the many studies that have found significant advantages to animation may be attributed to unfair comparisons between animated and static displays in the experiments. However, Tiritoglu and Juola (1994) discovered that animated icons in a computer-aided design (CAD) software package improved comprehension and retention of the functions represented by the icons.

". . . it seems necessary to define the specific conditions under which animation is effective, and just as importantly, when it is not."

Overview of Experimental Design and Results

Due to the mixed findings regarding the effectiveness of map animation compared to static displays, it seems necessary to define the specific conditions under which animation is effective, and just as importantly, when it is not. Such variables may include, among others, symbolization type, complexity of information in the display, and type of task performed by the map reader. In the present study, we investigated how two factors might influence the accuracy of size change judgments in graduated circle displays. Specifically, we were interested in the perceptual effects of relative degree of size change as well as whether the changes occurred continuously (animated) or all at once (static) during an observation interval. Rather than estimate the size of individual circles (i.e., a specific task), we devised a more general task to test both factors. Participants were instructed to judge if a greater number of circles increased or decreased in size in each display. The task was designed to replicate a general task that a map reader might perform when detecting geographic patterns in changes between maps. For example, in a comparison of graduated circle maps of populations for U.S. cities in two different time periods, a map reader might wish to determine if a greater number of U.S. cities increased or decreased in population.

". . . the bias toward "bigger" judgments was greater for large size changes than for small size changes, and there was an additional bias towards "bigger" judgments for animated over static size changes."

We used sets of filled circles that were presented in evenly-spaced arrangements of 36, 64, or 100 items of the same size. During an observation interval of 1500 milliseconds (ms; or 1.5 seconds), some proportion of them increased in size, and the remainder decreased. Further, the changes in size occurred over small (areas halved or doubled), medium (areas divided or multiplied by four), or large (areas divided or multiplied by six) ranges, and the size changes occurred either all at once (static condition) or continuously (animated condition) within the observation interval. The data of interest were the proportion of "more bigger" judgments as a function of the proportion of circles that increased in size during the observation interval. Psychometric functions revealed that sensitivities to the proportions of change were relatively constant across all conditions (number of circles, relative changes in size, and animated or static size changes). However, the bias toward "bigger" judgments was greater for large size changes than for small size changes, and there was an additional bias towards "bigger" judgments for animated over static size changes. The results are interpreted in terms of attentional priority for large items (a type of global precedence; e.g., Navon, 1977), and also for those that appear to be looming (continuously increasing in size; e.g., Franconeri and Simons, 2003).

Methods

Participants
There were 12 participants total, consisting of 11 students and 1 faculty member (10 males, 2 females) at the University of Kansas. Students were either graduate or upper level undergraduate students participating as lab members or as part of an advanced psychophysics laboratory course. The mean age of participants was about 24 years, and all but one were cartographic novices.

Apparatus and Stimuli
Stimulus presentation and data collection were controlled using a 1600/66 Power Macintosh computer with a 17-inch monitor. A custom computer program was developed to present the stimuli and record participant responses. The displays consisted of filled, black circles on a white background and arranged into evenly-spaced 6 x 6, 8 x 8, or 10 x 10 arrays. Circles were spaced in a grid pattern to control for circle overlap and other factors. Likewise, political boundaries and other map features were not included in order to simplify the displays and to ensure that the circles were the most perceptually salient objects in the displays. At the start of any trial, all circles had a radius of 4 mm and an area of 50.3 mm^2. From a viewing distance of about 50 cm, their diameters subtended a visual angle of about .8 degrees. During a trial some proportion of the circles increased in size, and the remainder decreased. No circles remained the same size in order to minimize sources of noise in the data. Three ranges of final sizes were used, with the differences between the smaller and larger radii being 2.8 and 5.6 mm (initial areas multiplied by .5 or 2, respectively), 2.0 and 8.0 mm (initial areas multiplied by .25 or 4, respectively), and 1.6 and 9.8 mm (initial areas multiplied by .167 and 6, respectively) for the three size change conditions (Figure 2). In this regard, the circles were similar to range-graded or classed symbols found on graduated symbol maps in which a limited number of circle sizes represent specific ranges or classes of data. The outer boundaries of the initial circle size arrays measured 793

"The displays consisted of filled, black circles on a white background and arranged into evenly-spaced 6 x 6, 8 x 8, or 10 x 10 arrays."

"During a trial some proportion of the circles increased in size, and the remainder decreased."

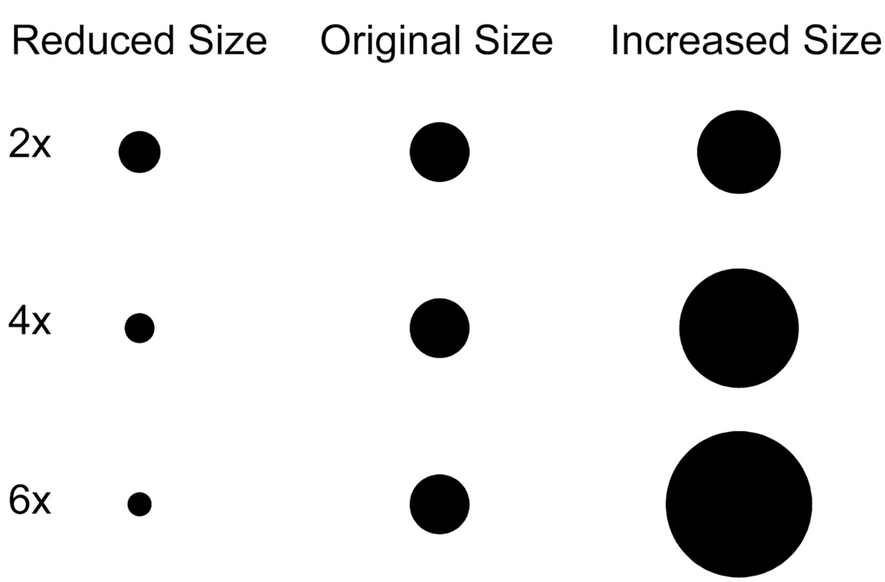

Figure 2. Circle sizes displayed in the trials. All circles started at the "Original Size" and then either decreased to the "Reduced Size" or increased to the "Increased Size." Circles increased or decreased in size by a factor of 2, 4, or 6.

mm per side for the 10 x 10 array, 624 mm per side for the 8 x 8 array, and 455 mm per side for the 6 x 6 array.

Procedure and Design

The changes in circle size occurred over a 1500-ms observation interval in either the animated or static condition. In the animated condition, the initial circle array appeared for 500 ms, after which all circles changed size gradually in a smooth, apparently continuous fashion over the final 1000 ms of the observation period. In the static condition, the initial array appeared for 500 ms, followed by a 500-ms blank screen and then a 500-ms exposure of the final array (Figure 3). The static condition was designed to replicate the process of how a map reader might compare two static maps by viewing each successively. The 500-ms blank field served to prevent the illusion of apparent motion during the size change in the static change condition as well as to equate the overall observation time of 1500 ms used in the animated condition. An important objective when designing the static and animated conditions was to develop comparable displays for both conditions and to control for other factors. Tversky, Morrison, and Betancourt (2002) have argued that one flaw in many experiments comparing animated and static representations is that both displays do not contain a similar amount of information necessary to ensure a fair comparison. Although the animations in the present experiment displayed continuous information or microsteps for the final 1000 ms of the 1500-ms interval, the final display in the static condition appeared in its final form for a longer period of time (500 ms) in an attempt to compensate for relative difficulty of the two conditions. In addition, the static condition was not designed as a small-multiples display (i.e., both displays viewed side-by-side simultaneously for comparison) in order to ensure that the tasks for the static and animated displays were as similar as possible and to control for other cognitive processes that may have influenced participant responses as a result of any significant differences.

"The changes in circle size occurred over a 1500-ms observation interval in either the animated or static condition."

At the end of the 1500-ms observation interval, the screen went blank, and the subjects depressed one of two keys on the keyboard labeled "more bigger" (/ key) or "more smaller" (z key) to indicate whether they judged most of the circles to have increased or decreased in size, respectively. In this way, the proportions of "bigger" and "smaller" judgments summed to 1.0 in all conditions for each participant. Participants were required to choose one of the responses on each trial, even if they thought they were guessing. The next trial began after a two-second interval. Participants received no feedback except for two beeps that sounded if a response was not registered within the two-second interval following the completion of a trial.

"At the end of the 1500-ms observation interval, the screen went blank, and the subjects depressed one of two keys on the keyboard labeled "more bigger" or "more smaller" . . ."

The trials were divided into blocks by array size, with the two display types (static or animated) and the three magnitude of size change conditions occurring randomly within each block. The proportion of circles that increased in size varied randomly from about 40% to 60% of the total, or from 13 to 23 (11 proportion changes) for the 36 circles in the 6 x 6 array, from 24 to 40 (17 proportion changes) for the 64 circles in the 8 x 8 array, and from 40 to 60 (21 proportion changes) for the 100 circles in the 10 x 10 array. These ranges were determined from pilot studies which showed that when the proportions of circles that increased in size was less than about 40% or more than about 60%, the overall trend in the display was easily recognized as changing respectively smaller or larger, regardless of the means of presentation. That is, when less than 40% of circles grew larger, subjects were nearly perfect at responding "more smaller," whereas when more than 60% of circles grew larger, subjects were nearly perfect

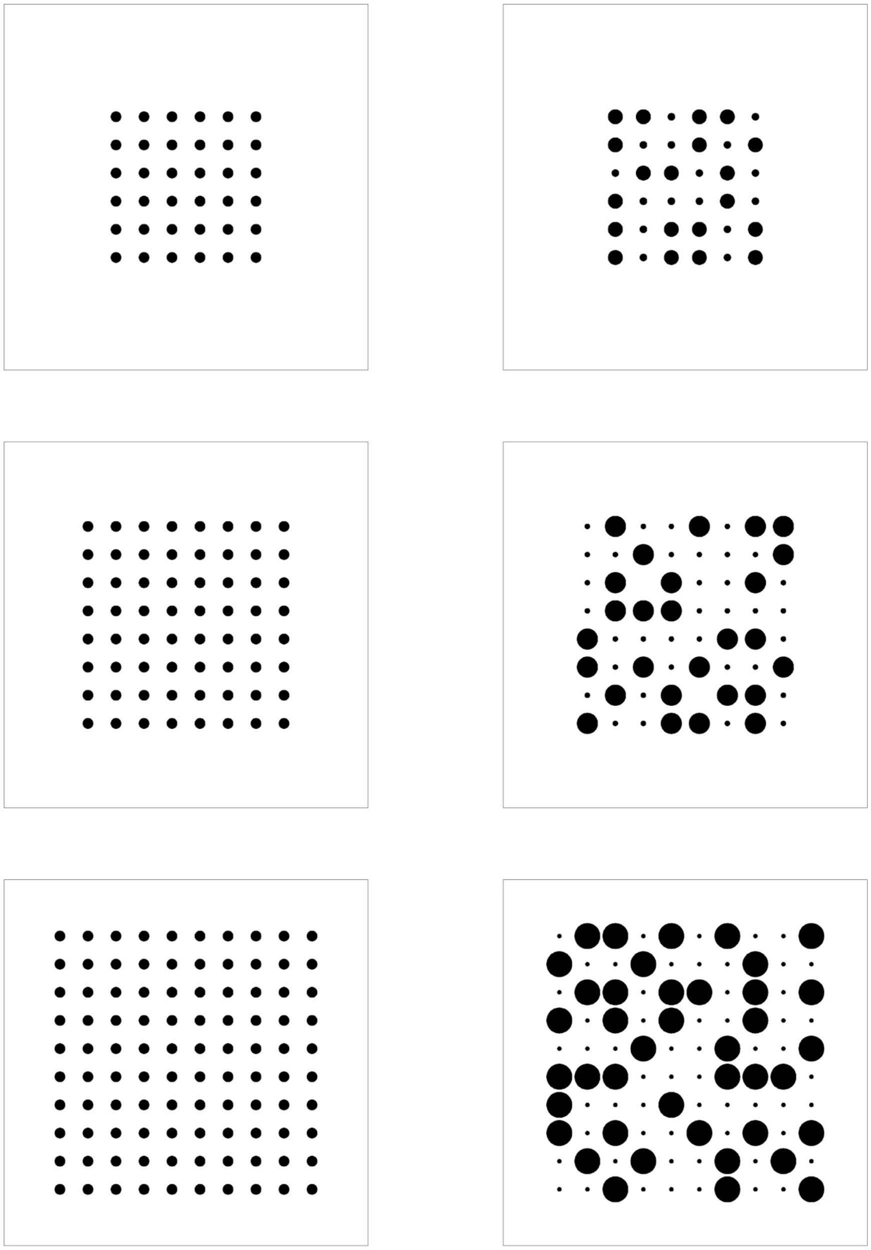

Figure 3. Illustration of the various displays used. The left column shows the three arrays with initial circle sizes. The right column shows the three circle size changes, with the smallest magnitude change in the top row and the largest magnitude change in the bottom row. In the static condition the initial array was displayed for 500 ms, followed by a 500 ms blank screen, followed by the 500 ms final array. In the animated condition the initial array was displayed for 500 ms, followed by the gradual change in circle sizes during the final 1000 ms of the 1500 ms observation period.

at responding "more bigger." The design was thus a 2 (display type) x 3 (magnitude of size change) x 11 (proportion changes) design in the 6 x 6 array block (66 cells), a 2 x 3 x 17 design in the 8 x 8 array block (102 cells), and a 2 x 3 x 21 design in the 10 x 10 array block (126 cells).

Each participant completed three experimental sessions and contributed an equal number of observations. Each session included one block of each array size, with order of block presentation counterbalanced across participants. Each block included four trials per cell, presented randomly. Thus, each participant completed 1,176 trials per session, or 3,528 total tri-

"Each participant completed three experimental sessions and contributed an equal number of observations."

als in the experiment. Each session included break opportunities between and within blocks of trials, and took about 80 minutes to complete including breaks.

Results

The main results are the mean proportions of "more bigger" judgments plotted against the proportion of circles in each display that increased during a trial. The data are shown separately for each array size (Figure 4), and within each size for displays that had small, medium, or large changes in the relative circle sizes (Figure 5), and for changes that were animated vs. static (Figure 6). Visual inspection of the psychometric functions in Figures 5-6 indicates general trends in all three arrays of a smaller proportion of circles increasing in size required for participants to give the correct response "more bigger" (i.e., a lower discrimination threshold) for animated changes and when the magnitude of size change was larger.

"Visual inspection of the psychometric functions indicates general trends in all three arrays of a smaller proportion of circles increasing in size required for participants to give the correct response . . . for animated changes and when the magnitude of size change was larger."

Two statistics are of interest. First, the slopes or gradients of the psychometric functions plotted in Figures 4-6 determine the relative sensitivity of subjects in making size change judgments. These sensitivities appear to be about the same in all conditions (number of circles, display type, and magnitude of size change). Second, the proportion of items that were increased in size that resulted in 50% "more bigger" judgments is the indifference point, and represents the "point of subjective equality" (PSE) for size change judgments. In the present case, the PSE is the actual proportion of size changes that appear to be balanced between increases and decreases. The PSE obviously changes across conditions. For example, note that the PSE is smaller (as indicated by its position further to the left on the x-axis) for large circle size changes than small size changes for all three grid sizes

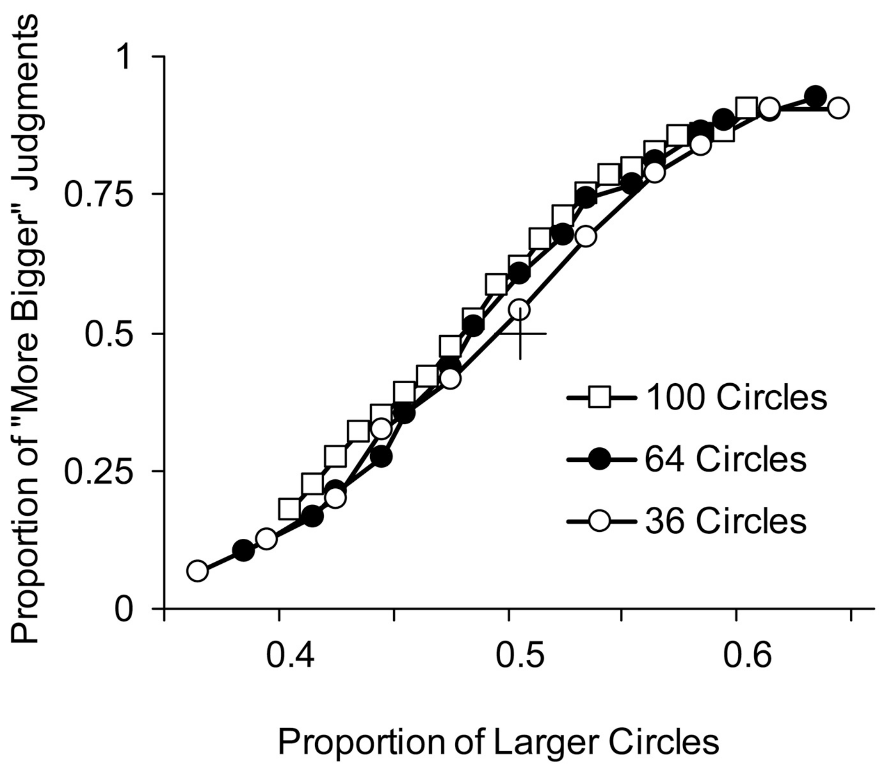

Figure 4. Mean proportions of "more bigger" judgments plotted against the proportion of circles that increased on any trial for arrays of 36, 64, or 100 circles.

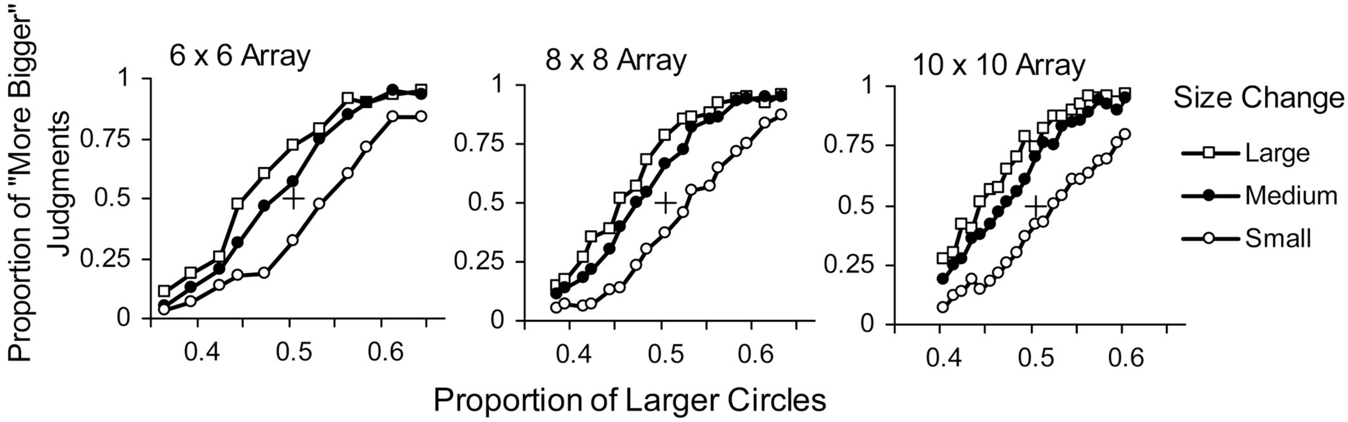

Figure 5. Mean proportions of "more bigger" judgments plotted against the proportion of circles that increased on any trial for small, medium, and large relative size changes.

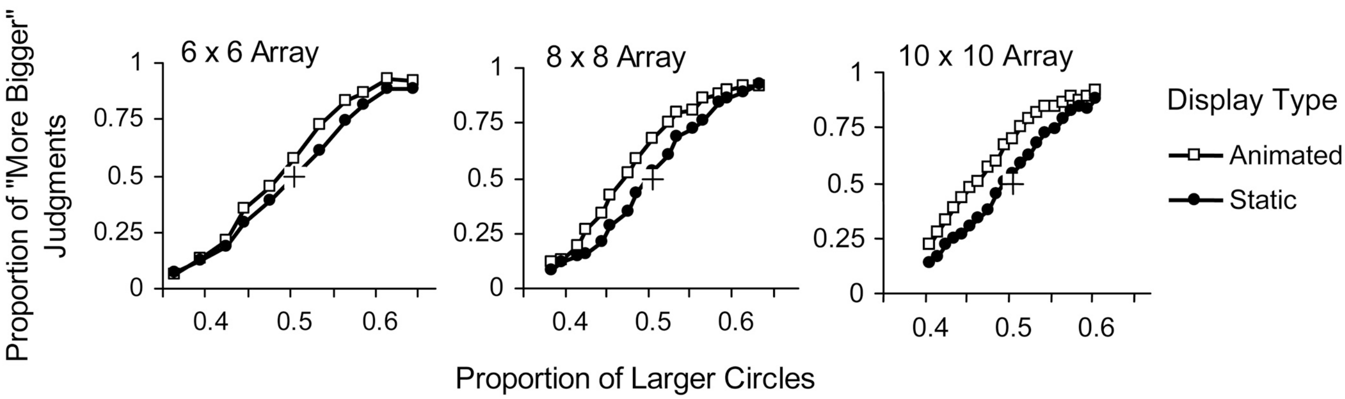

Figure 6. Mean proportions of "more bigger" judgments plotted against the proportion of circles that increased on any trial for animated vs. static size changes.

(Figure 5), and is also smaller for animated displays than static for all three grid sizes (Figure 6). The overall trends were confirmed by examining the data from individual participants. Due perhaps to the large number of observations collected, they showed remarkable uniformity in demonstrating the trends observed in the overall data.

In order to perform a statistical analysis of the results, the data for each participant in each cell of the design were fitted by a cumulative normal (Gaussian) distribution relating the proportion of "bigger" judgments to the actual proportion of circles that increased in size. These psychometric functions were fitted using the *psignifit* toolbox version 2.5.6 for Matlab (see http://bootstrap-software.org/psignifit/) that implements the maximum-likelihood method described by Wichmann and Hill (2001). The fits yield two parameter estimates for each subject in each cell, namely the means (μ) and the standard deviations (σ) of the assumed underlying normal distributions. The mean represents the 50% point of the judgments, or the PSE (i.e., the proportion of increasing circles that was as likely to be judged "smaller" as "bigger" in a given condition). The standard deviation corresponds to the sensitivity of the judgment, as a smaller standard deviation indicates a steeper slope of the psychometric function, and a greater ability to differentiate between small degrees of relative change in circle sizes.

". . . the data for each participant in each cell of the design were fitted by a cumulative normal (Gaussian) distribution relating the proportion of "bigger" judgments to the actual proportion of circles that increased in size."

The resulting parameter estimates, averaged over participants, are shown in Table 1. These were submitted to two separate within-subject analyses of variance (ANOVAs), with the same three factors used in each design, namely, number of circles (36, 64, or 100), magnitude of size change (small, medium, or large), and type of change (static or animated). In the analysis of the means, there was no main effect of the number of circles, but the effects of magnitude of size change and type of change were both highly significant, $F(2,10) = 31.2$, $p < .001$, and $F(1,11) = 13.0$, $p = .004$, respectively. These results supported the conclusions that the tendency to report an increase in average size was greater as degree of circle size change increased and for animated rather than static changes.

"In the analysis of the means, there was no main effect of the number of circles, but the effects of magnitude of size change and type of change were both highly significant."

The ANOVA of the means resulted in three significant two-way interactions, but these results did not limit the conclusions based on the main effects. That is, the interaction between number of circles and magnitude of size change showed that the PSE moved more to the left for large and medium size changes as the number of circles increased than for the small size change, for which the PSE remained fairly constant, $F(4,8) = 5.4$, $p = .021$. The difference in the PSE between animated and static changes increased with the number of circles, $F(2,10) = 6.1$, $p = .019$, and the difference in mean PSEs between the static and animated conditions decreased as the size change increased from small to large, $F(2,10) = 5.7$, $p = .023$.

	Number of Circles	36		64		100	
Degree of change	*Type of change*	μ	σ	μ	σ	μ	σ
Small	Static	.56	.09	.55	.08	.56	.11
	Animated	.51	.09	.51	.08	.51	.09
Medium	Static	.49	.08	.48	.08	.48	.08
	Animated	.48	.08	.46	.08	.44	.08
Large	Static	.45	.08	.46	.07	.45	.07
	Animated	.46	.09	.43	.09	.42	.09

Table 1. Statistics derived for all cells of the design using the curve-fitting methods described in the text. The results are the average points of subjective equality (PSE) for size change judgments (μ), and the average sensitivities of the judgments determined by the steepness of the discrimination gradients (σ).

The ANOVA of the standard deviations revealed two significant effects, a main effect of magnitude of size change, $F(2,10) = 4.5$, $p = .04$, and an interaction between magnitude of size change and type of change, $F(2,10) = 6.7$, $p = .014$. These results do not detract from the general conclusion that size change sensitivity was relatively constant across all conditions, because the data show relatively minor inconsistencies across conditions when compared with the consistent changes in the PSEs. Specifically, both the main effect and the interaction in the standard deviation ANOVA appear to be due to the relatively low sensitivity in the 100-item, small size change, static condition (see Table 1).

Discussion

Judgments of size changes for arrays of circles show smooth psychometric functions with sensitivity relatively unaffected by the number of circles in the display, the magnitude of size changes, and whether the changes were animated or static. However, the bias of these judgments was affected by the magnitude and manner of the size changes. Subjects were more likely to respond that there were "more bigger" items when the size changes were large (areas increased or decreased by a factor of 6) than when the changes were small (areas increased or decreased by a factor of 2). That is, the results showed a type of global precedence effect, in that as the ratio of areas of the large to small circles increased, the apparent numerosity of large circles also increased. Further, animated changes in size produced a greater proportion of "more bigger" responses than equivalent changes that occurred in a single discrete step. Both of these results can be explained by a perceptual bias for large display elements over smaller ones, and for continuous size increases (looming) over shrinking (e.g., Franconeri and Simons, 2003; but see also Abrams and Christ, 2005 and a response by Franconeri, Hollingworth, and Simons, 2005). That is, statistical judgments of display properties are determined in large part by what is attended to in a display, and there is an apparent attentional bias to select large or looming objects over small or receding ones.

"Subjects were more likely to respond that there were "more bigger" items when the size changes were large than when the changes were small."

These results have implications for both theoretical and practical reasons. First, it is obvious that the perception of global aspects of display elements, such as size change, depends on the extent and manner in which the changes are effected. Large changes in size are perceived differently than more subtle changes, and such differences affect numerosity or average size judgments such that large objects are perceived to be more numerous than smaller ones, and this bias increases with size discrepancy. Similarly, continuous (animated) changes also seem to affect relative numerosity judgments differently than static changes. Although a simple interpretation in terms of attentional bias to larger and looming objects neatly accounts for the results, it does not by itself explain the underlying differences in perception. Such differences are important in situations in which continuous changes (e.g., "morphing") are used to convey information. If attention and perception are affected by such changes, then it is possible that the same information can be perceived differently depending on the methods used to arrive at the final depiction of that information on maps.

". . . animated changes in size produced a greater proportion of "more bigger" responses than equivalent changes that occurred in a single discrete step."

In practical situations, it has been argued that animations could be more effective than single or even a succession of static views, particularly when the desire is to demonstrate changes that occur over time. Such arguments have been made, and validated with mixed success, in diverse domains such as cartography (e.g., Patton and Cammack, 1996; Johnson and Nelson, 1998; Slocum et al., 2001), computer-aided design (e.g., Tiritoglu and Juola, 1994), and rule learning (e.g., Morrison and Tversky, 2001). Perhaps one of the reasons for the mixed effects, sometimes showing advantages in perception of animated displays over their static counterparts and sometimes not, is that the information selected from the two presentation formats might result in different internal representations. Further, changes that involve increases in size or apparent looming appear to be more likely to attract attention and bias perception of the overall statistical properties of a scene and, by extension, change aspects of its meaning.

". . . the apparent motion in animation appears to be beneficial for attracting attention to overall circle size increases . . ."

These findings have practical relevance both to the general discussion of the effectiveness of map animation, as well as to the development of specific guidelines for the design of graduated circle map displays. Since the discrimination threshold for responding "bigger" was lower for animated displays compared to static displays, the apparent motion in animation appears to be beneficial for attracting attention to overall circle size increases in graduated circle map displays. None of the experimental results indicate that animation increased the cognitive demands associated with the task of identifying general trends in graduated circle size changes. In practical situations in which the cartographer wishes to emphasize a general trend that increases over time, animation may be utilized to enhance the figure/ground relationship as circles increasing in size will appear to emerge into the foreground of the display. However, by attracting attention to circles that become larger, animation may conversely detract attention from those circles that become smaller and therefore may go undetected as they recede into the background. For this reason, animated graduated circle map displays may be most appropriate for phenomena that generally increase over time, such as population of major U.S. cities over the last century, as animation is more likely than static displays to attract attention to the general patterns of population increase as represented by graduated circles larger in size. Likewise, static graduated circle displays may be more appropriate for phenomena that generally decrease over time, since static displays are not as likely as animated displays to detract attention from circles that decrease in size. Additionally, since larger size changes seem to bias judgments of the number of circles changing in a display, this may be another factor for consideration when a size scaling method (e.g., mathematical or perceptual) is selected for the construction of graduated circles.

". . . animation may be utilized to enhance the figure/ground relationship as circles increasing in size will appear to emerge into the foreground of the display."

CONCLUSIONS

Additional research is necessary in both cartography and cognitive psychology to assess the effectiveness of animated and static displays in various contexts. The current experiment examined the effects of three variables on size change trend judgments for graduated circle displays: magnitude of size change, display method, and number of items in the displays. Important findings include a bias toward "more bigger" judgments for large size changes, and an additional bias for changes presented with animation.

Useful follow-up experiments should include testing additional factors common to graduated circle maps. Such variables include specific items related to the map display, such as overlap of circles, and the addition of other map features, such as political boundaries. Research with unfilled circles as well as those filled with gray tones (light, medium, and dark) would also be valuable for determining the effect, if any, of luminance or degree of blackness on participant responses. Although range-graded or classed graduated circles were implemented in the present study, a follow-up experiment could present unclassed graduated circles, in which all circles are scaled in proportion to unique data values, to determine any differences between symbolization methods. It would also be useful to experiment with more complex displays that include circles of different sizes, rates of change, and variations in fluctuation (e.g., increasing in size, then decreasing). In addition, it is unclear whether the results from the present experiment were subject to any sequence effects (Stewart, Brown, and Chater, 2002), in which participant responses are biased by stimuli that immediately precede another stimulus. Additional research would be valuable for determining the effect, if any, of such sequence effects on participant responses for comparisons between animated and static displays.

"Useful follow-up experiments should include testing additional factors common to graduated circle maps."

Other follow-up experiments could include modifications and variations to the map task. For example, the static displays that were displayed sequentially in the present experiment could be displayed side-by-side for comparison, similar to small-multiple map displays that are commonly utilized to depict change over multiple time periods. Further, a more specific map task in which participants judged magnitude size changes for individual circles rather than overall size changes in the display would likely reveal other important differences between static and animated displays. Collectively, such research might uncover important characteristics of static and animated maps that cartographers could use as a guide for the design of graduated circle maps.

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Reviews

Thoughts on Two New Map Design Texts

Designing Better Maps : A Guide for GIS Users
By Cynthia Brewer
ESRI Press, 2005.

Making MAPS: A Visual Guide to Map Design for GIS
By John Krygier and Dennis Wood
Guildford Press, 2005.

Reviewed by Peter Keller
University of Victoria

Introduction

These are not dull times for those interested in cartographic design and communication. Advances in digital information visualization are creating exciting opportunities for innovations in communication, including the practice of map design and geo-visualization. The advent of initiatives like MapQuest Maps [http://www.mapquest.com/maps/], Google Earth [http://earth.google.com/] or ESRI's mapping modules [http://www.esri.com/products.html] remind us that there exist powerful and highly motivated commercial interests advancing the cartographic status quo. Those of us who have an academic interest in cartographic communication and design are caught in a dilemma about how to respond.

On the one hand, we all wish to participate in the cartographic agendas of commercial giants like ESRI, Google Earth and Map Quest. We want to help shape their product development by contributing our longstanding knowledge of excellence in cartographic design and communication, and we would like to play an active part in the cartographic future shaped by these giants. But only very few of us, if any, are invited to play.

Those of us not invited need to follow new products, trends and innovations closely. We need to take a position on how new products and cartographic innovations contribute to cartographic theory and past practice. There are many instances where innovations in cartographic design are delivered by those who have received little or no formal education in the theory of cartographic design; thus, we, who are conversant with theory, need to offer critical analysis of their creations while keeping an open mind to advance our theory and practice to embrace what is worthy of embracing. If nothing else, we can not allow the cartographic design we teach to become antiquated.

The challenge is how to deliver an education and training in map design and geo-visualization that is up-to-date. In an ideal world we should be able to access the latest textbooks on map design to help us: texts that offered a careful blend of long established theory and practice with coverage how map design and geo-visualization is taking advantage of technological innovations to deliver new communication excellence. A comprehensive text should, amongst other things, include coverage of:

- basic communication theory
- the purpose and power of cartographic communication
- fundamentals of geographic data
- step-by-step guide how to manipulate geographic data to get to a message
- different types of maps and their use/abuse (from antique maps to virtual worlds)
- basic map and geo-visualization components
- fundamental map and geo-visualization design principles
- history and evolution of graphic tools supporting map design from earliest days to modern software and hardware options
- practice through application (learning by doing)
- practice through critique and comparison (learning by engaging) and
- abilities to deconstruct maps (engagement through critical thinking)

There exist a number of well-established excellent textbooks in cartography that include sections on design. But few, if any, address all the above points.

Into this situation come two new books on map design, namely: *Designing better Maps* by Cynthia Brewer and *Making Maps* by John Krygier and Denis Wood. What do these two texts contribute? How do they help us cover the topics noted above?

Designing better Maps: A guide for GIS Users
by Cynthia Brewer

Brewer's book is a basic design text that offers a healthy discussion of theory combined with a practical guide for GIS users wishing to communicate their analyses. The theoretical parts of the book are generic, and the practical side offers step-by-step guidance how to produce a map using ESRI's GIS software language.

In her introductory preface Brewer acknowledges that "the book is intended as a basic guide for people who want to improve the maps they make". She goes on to note that the book "describes a subset of basic knowledge taught in introductory cartography courses". She acknowledges that in her own teaching she encourages students to consult other texts to complement this new book of hers.

The book meets and indeed exceeds its intended goals. It can be used as a stand alone reference by any GIS user as well as by students in an introductory GIS course. It is logically organized so that it can either be read cover-to-cover, or accessed specifically (to learn, for example: how to improve on the use of colour in map design, how to arrange the different elements that make up a map, or how to select and place text on a map). The book is filled with examples demonstrating different design approaches, and the reader receives high level instructions how to turn theory into reality using ESRI's GIS. The book encourages the reader to take a critical look at any map produced by GIS. On the other hand, the book is limited by its silence about the world of cartographic design and geo-visualization outside GIS.

Making MAPS: A Visual Guide to Map Design for GIS
by John Krygier and Denis Wood

Krygier and Wood's book is a constructively provocative introductory text that draws attention and creates enthusiasm and excitement. The book challenges the reader to engage and to think. It promotes creativity. It is packed with examples to demonstrate why maps are important.

The book covers considerable ground on map design theory in an unconventional manner, and is packed with introductory information to engage the mind. The end of each chapter contains a guide to follow-up references where students can get more detailed information.

The book does not offer step-by-step or spoon fed guidance. Because of this, it is not a text that will be of much help to the GIS user wishing only to get on with the details of fine-tuning a GIS output. Neither is the book by itself sufficient as a stand-alone introductory text. It does, however, offer potential as a powerful guide if it could be combined with a well written laboratory manual instructing how to complete exercises to turn ideas and theory into reality. Ideally, such laboratory exercises would take advantage of a combination of graphics, animation and GIS software options.

In summary, this text will appeal to those who enjoy being challenged, and to those who wish to explore an introduction to the powers of cartographic communication.

Reflections

There is more to map design and cartography than GIS. Society today is exposed to cartographic communication more than ever before. Maps that are part of an on-board car navigation system, or that render space to facilitate travel in video games, interactive maps on the internet inviting exploration to facilitate tourism planning, the creation of community maps to facilitate civil action, or the down-loading of GPS recorded data from the latest paragliding trip to relive the experience in Google Earth are but a few examples of how contemporary society engages with cartographic communication.

The exciting world of cartographic communication in which we live today cannot be captured by a teaching of map design restricted to thematic mapping via GIS. There exists a bewildering choice of traditional and modern digital tools offering amazing opportunities for powerful communication using the language of cartography. Ideally, we should teach students what each of these tools are about and how the tools can help achieve geo-visualization excellence.

Reality looks different. Most of us are constrained to teach map design as part of an introductory or advanced GIS course. Few of us have the support, time and energy to offer a dedicated course (or, indeed, courses) in cartographic communication and geo-visualization.

I therefore sympathize with the authors and congratulate them on delivering two excellent texts that are both opportune and timely. They have written two books that meet a huge market demand; in Brewer's case, how to draw better maps with conventional GIS, and in Krygier and Wood's case how to get stimulated to think about the power of cartographic communication.

I encourage you to take a look at both books. I highly recommend Brewer's book to anybody who wants to produce a Map in GIS, and Krygier and Wood's book should be a mandatory reference for any introductory cartography or GIS course.

Nonetheless, I will continue to look for that new text in cartographic communication and geo-visualization that ignores a focus on GIS, that goes beyond thematic mapping, and that is grounded in an exciting combination of graphics, cartography and communication theory with a strong coverage of how the latest state-of-the art in graphic design can inform the language of cartography.

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Reviewed by Tom Koch
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http://kochworks.com

The difference a verb can make

Both Cynthia Brewer's book on map design and the book on making maps by John Krygier and Denis Wood cover the same pedestrian areas of layout, font size, scale, and color balance: the practical issues of mapping. They are distinguished, however, by very different views of the nature of maps and the goal of the mapmaker.

Brewer is interested in map *design* and the application of a visual aesthetic that is both its own reward and a means of maximizing the map as a medium of communication. "I encourage you to push the software to make maps more readable and beautiful," Brewer says at the end of her introduction. She sees herself as the inheritor of "map design principles [that] have been fairly stable over time," and she wants everyone using new GIS technologies to know how to implement those "fairly stable" principles in the color maps they make.

"Maps are a powerful way of thinking about the earth," begin Krygier and Wood, and they present an Ojibwe birch map of historical migration as an example of the thinking a people do about their history in space over time. Krygier and Woods' interest is in the rhetoric of maps[a]: the potential of the medium to present a point of view. In writing about Abraham Verghese's maps of AIDS in the United States in the 1980s, published as crudely simple dot maps in a scientific journal, they write approvingly that, "the maps Verghese made . . . may not be much *to look* at, but *the thinking* they inspired was rich" (p. 10-11).

Cynthia Brewer is *designing*; Krygier and Wood are *making*. For Brewer the mapmaker works with the thinker to present the best possible map that will carry that thinker's argument onto the map plane and to the reader. Krygier and Wood make maps to advance an idea: an authorial point-of-view. For Brewer, the map aesthetic exists both as a quality on its own *and* as a means of communication. For Krygier and Wood, map aesthetics serve (where they serve at all) to enhance the clarity of the argument put before the reader in its graphic form.

Making Maps

That is not to say Krygier and Wood don't share many of Brewer's interests in aesthetics. They do, but for them that interest is subservient, second-order. Nor is this to suggest Brewer is wholly uninterested in the subject of her maps. It *is* to insist, however, that her principal goal is not map *thinking* (the generation of arguments in a two-dimensional, geographic medium), but the aesthetic virtues inherent in the professional presentation of arguments and ideas developed by others who seek a designer to make their work look good. For Krygier and Wood, by contrast, the map *is* the argument: its virtue stands or falls on the ideas it presents.

The essence of Krygier and Wood's argument is exemplified in their map of Luke Helder's two-week bombing spree in the United States in 2002. Each bombing was part of a planned series whose result would be an insipid "smiley face" written across the Mid-western states. The resulting map is not beautiful in the way Brewer urges us to beauty. It is, in fact, a grotesque whose argument is bombs exploding across the landscape over time. Like all maps, the authors imply, this map articulates a relationship among physical events in space that the map declares. While Krygier and Wood craft the result with loving care the execution is secondary to the idea. The real-time argument of Helder unfolds, as map geography becomes map geometry, a relation across the two-dimensional map plane.

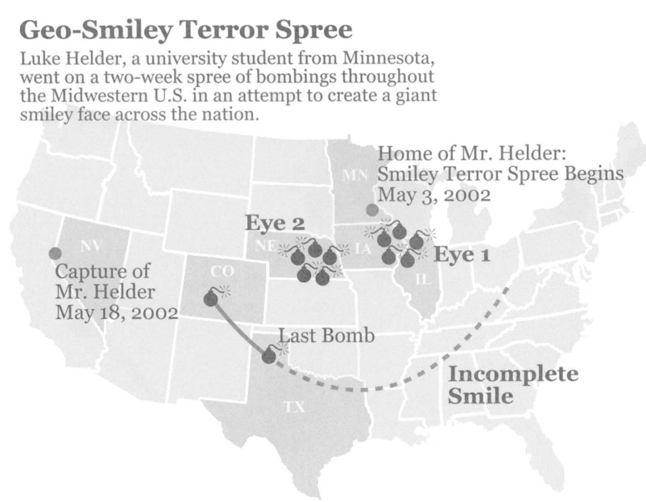

Figure 1. Krygier and Wood's map of Luke Helder's bombing spree makes their argument. Understanding the pattern of Helder's attacks is in the landscape, an argument in the shape of the "smiley face" it marks on the land.

Designing Better Maps

Brewer is a craftsperson and artist who makes maps for others. Her client list includes the U.S. Census Bureau, National Center for Health Statistics, National Cancer Institute, and National Parks Service. She is not, however, a demographer, an oncologist, an epidemiologist or a forest ecologist. Brewer transposes the work of experts (clients) into maps that meet an aesthetic standard that, at least in theory, best presents the conclusions of the demographer, oncologist, epidemiologist, ecologist, etc. Like many before her, most notably Arthur Robinson[b], she is a guardian of the geographic frame in which the researcher's data is placed in a manner that meets the standards of a design aesthetic.

The problem with that focus is that it keeps us from thinking about the limits of the data being mapped. Brewer, for example, includes several versions of a map of "Child Mortality and Accessibility," that argues "that mortality increases as access to [health] markets decreases." In the maps, "percentage of children dead before age 5" is represented by colored dots while "accessibility" is symbolized as a color ramp that changes, map to map. We are told to prefer the map in which the color ramp of accessibility is "inverted", with the darkest color showing greatest accessibility, rather than with a lighter color at the peak of the ramp. Maybe, but neither map is clear to me.

The real problem lies not in its presentation, however, but in the data the map presents. We don't know what "markets and infrastructures" means in this map. Are they hospitals, presumably required to treat all patients in crisis, or private offices and clinics from which sick persons legally can be turned away? What distance is being described (Euclidian, taxi distance, walking distance, what?) and how does that distance effect infant mortality? In fact, what constitutes a high mortality—and what is "acceptable"? —and what does the accessibility index ramp mean? If the issue is childhood mortality, what about socioeconomic elements the broader literature insists are responsible, like poverty? And since the map is of infant mortality in Burkina Faso and Mali, what is happening in healthcare there: what is the critical context in which the relation between mortality and proximity to the "market" occurs?

"A successful map," Brewer instructs, begins with knowing why the map is being made." The knowing to which she refers is about client interests, however, not the broader critique of preventable childhood mortality in a post-industrial world. It's about map *design*, not map *thinking*. Krygier and Wood's *Making Maps* opens the door to the thinking that goes into the argument the map will hopefully reveal, and therefore, necessitates a critique of the data and methodology that will be distilled in the map. One may not like the Smiley Bomber's argument but one sees it clearly.

Publishers

At the annual meeting of the North American Cartographic Information Society (NACIS) in 2005 the University of Victoria's Peter Keller argued Brewer's book was somehow tainted by its publisher's position as a division of ESRI, the company that markets and sells ArcGIS software. Keller did not suggest Brewer advanced ESRI software over that of other providers; he simply judged it unseemly that a software producer is also a book publisher.

Distaste for the commercial is as old—and as useful—as the Letraset rub-on symbols and Leroy letter-

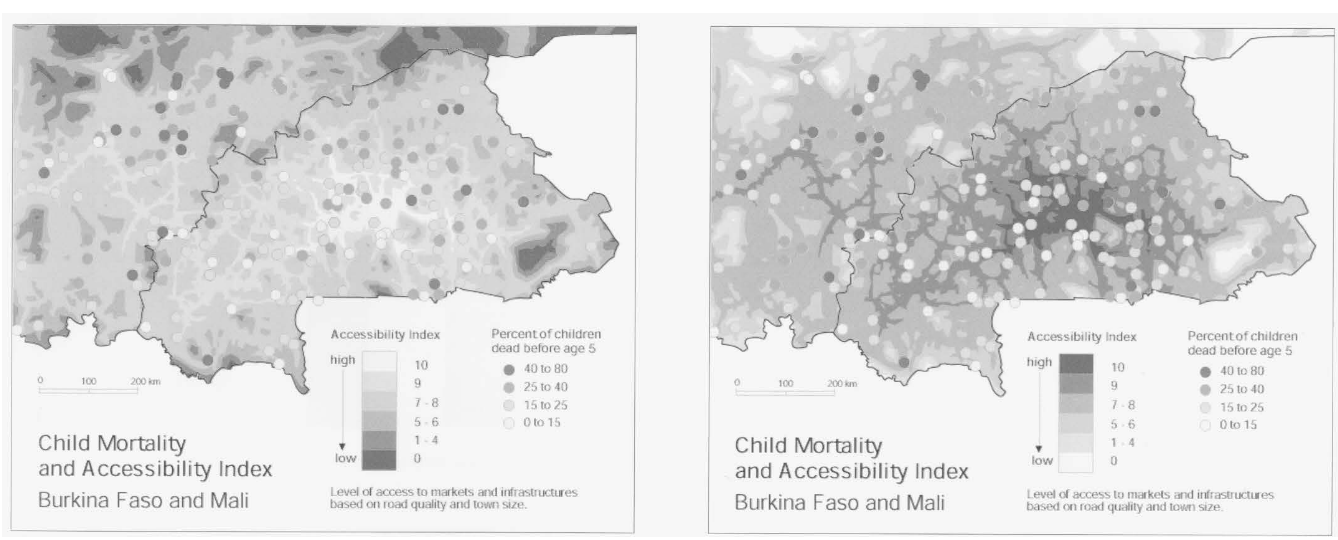

Figure 2. Two different maps prepared by Brewer to show methods of presenting a relationship between childhood mortality and accessibility to the health "market". The left-hand map is supposed to be better than the right-hand map. Brewer, C. Designing Better Maps, *p. 117. Courtesy: ESRI Press.*

ing templates of old style map production. *All* publishing is commercial; Guilford and Oxford presses no less than ESRI's produce books in hopes of making money. That ESRI Press is part of the greater software corporation means it can afford to subsidize the scores of color maps Brewer presents while Guilford Press was forced to limit severely the amount of color that Krygier and Wood could include in their book. Somebody is going to pay; somebody hopes to make money. ESRI's support of Brewer's project strikes me as appropriate and responsible.

Conclusion

I like these books. What I really like is having both on my shelf. Rhetoric needs aesthetics if its argument is to be carried forcefully. Aesthetics needs a point of view if the result is to be anything but vacuous. The map is argument. It is also image. Brewer holds the line as a craftsperson, the old tradition of the designer. Krygier and Wood open the door to a critique of the ideas presented rather than simply the design of their presentation. Together these books promise another book that we can hope for, a book that begins with the argument a map will make and then considers the most forceful way that argument can be presented in the two-dimensional map plane. That's what I wanted these books to be. Together they take us halfway there.

Tom Koch [*http://kochworks.com*] *is an adjunct professor of geography at the University of British Columbia and the author of 14 books, including Cartographies of Disease: Maps, Mapping, and Medicine (ESRI Press, 2005).*

Endnotes

[a]Denil, M. Cartographic Design: Rhetoric and Persuasion. *Cartographic Perspectives* 45, Spring 2003, 8-67.

[b]Cook, K. S. A Lifelong curiosity about maps. *Cartographic Perspectives Commemorative Issue* 2005, 45-55.

Thoughts on Two New Map Design Texts

Designing Better Maps : A Guide for GIS Users
By Cynthia Brewer
ESRI Press, 2005.

Making MAPS: A Visual Guide to Map Design for GIS
By John Krygier and Dennis Wood
Guildford Press, 2005.

Reviewed by George McCleary
University of Kansas

In 1938, when Erwin Raisz produced the first American textbook in cartography, he pointed out [vii] that … when we look for literature on the science and art of map making, we find that surprisingly little has been written. … Most of the American books … are written from the point of view of the practical draftsman. There are a number of works on map projections … We find also a few treatises on historical cartography. Finally there are some excellent books for use in military schools. There is, however, no American book which collects the scattered material in a manner satisfactory to the student of geography in our colleges.

Raisz' *General Cartography* joined the stream of other types of cartographic literature that had swollen in the late nineteenth and early twentieth centuries with dozens of new map projections, journal articles applying innovative cartographic methods to the explication of geographic processes and regions, many maps and atlases (the first national atlas, that of Finland, appeared in 1899), and a wide variety of technical manuals. Quarterly issues of the principal American professional journals (*Geographical Review*, *Economic Geography*, and the *Annals* of the Association of American Geographers) often included an article on cartography, which had become a very dynamic part of geography. Beyond these, *National Geographic Magazine* added monthly to its outstanding repertoire of maps.

There were, in the first third of the century, a great number of publications, but, as Raisz pointed out, many were manuals; ranging from the task-specific volumes of the U. S. Coast and Geodetic Survey (*e. g., Elements of Map Projection with Applications to Map and Chart Construction,* Deetz and Adams 1945) to elementary guides such as *Maps and Map Drawing* (Elderton 1890). The first courses in academic cartography lacked textbook support.

The array of activities requiring cartographic problem-solving that preceded the Second World War led to the production of the first 7.5-minute quadrangles (1:24,000) of the U.S. Geological Survey, the founding of the American Congress on Surveying and Mapping (1941), and the publication of even more atlases, books, and articles. The insightful comments of Guy-Harold Smith (1928) (see also Fawcett 1935), and the 1938 and subsequent papers by John K. Wright, among others, demonstrated the need for research in the field.

It was the wartime effort and postwar global politics, however, along with the technological advances associated with military mapping, that promoted new perspectives. "Geographic Cartography", the last chapter of *American Geography: Inventory & Prospect* [James and Jones 1954, 553-577], captured the situation just as cartography became a research-based discipline; before the advent of computer-supported mapping systems, and a decade before the implementation of the first Geographical Information Systems.

During the past half century, Arthur H. Robinson's *Elements of Cartography*, first published in 1953 and continued through six editions, adapted to the shift from analog to digital cartography and became, as Robinson anticipated with concern in the first edition, an encyclopedia. In comparison, other textbooks in cartography have been relatively ephemeral (note, for example, Keates). As this sub-discipline of geography emerged and grew, it filled the void that had developed when it became obvious that the technical production of maps was no longer within the interests and capabilities of the average geographer.

The cartographer thus became for the geographer what the engraver had been for mapmakers and cartographers several centuries before: salvation! Here was technical expertise and a growing understanding of the concepts and processes involved in map conception, development, and production that could be applied to maps explicating concepts in physical and cultural geography, to the descriptions of regional geography and the reports of field expeditions, and for the explanations of models and the portrayal of systems.

Some cartographers were (and are) simply practitioners; no more than technicians who, with little basic knowledge of geography, mathematics, cartography, and graphic design, produced unimaginative and, too often, inappropriate maps. At the opposite end of the spectrum, other cartographers tied the practice of production to their academic research agenda and making every project, every map, a research project. As a project developed, the cartographer became a subject specialist in whatever was being mapped, be it the Russo-Japanese War, Mongolia, trails across the Great Plains, or genocide. Sometimes authors (transformed into clients) found that they had to reconsider what they had requested simply because what had been proposed for the content and the structure of the map was wrong. The cartographer, like it or not, became an integral component of the research process.

However, one person's salvation can be another person's purgatory. From some perspectives, cartographers became "the map police", and, like other groups of dialecticians and grammarians, they came to be regarded very negatively as exerting too much control over the map. With the new freedom from technological constraints provided by Geographical Information Systems, cartography as a profession came, in too many quarters, to be viewed in the same way that many appraise lawyers, used car salesmen, and politicians! When GIS made it possible for anyone to make maps, the middle man was gone.

Returning to the nature of the cartographic process and the role of the textbook …

Cartographers generally have a textbook on which they rely (a type of personal security blanket). Even more likely, they have a small library, including a "morgue" (the collection, from many sources, of insightful and incite-full maps) that can be consulted for ideas and information about design, graphic structure, symbolization, and the many other aspects of the cartographic process that are considered when producing a map.

It is obvious that the utility of a textbook lies in two areas: first, how it will work in the traditional class-laboratory setting as a vehicle complementing the other components of the academic process, particularly the instructor. Second, how it will serve as a guide for those who, lacking the opportunity to use it in an academic learning venture, will refer to it as a guidebook for making maps or designing better maps. The question in this case is how well will it function as a map design and production process reference: as a cartographic encyclopedia?

The missions of these two books are:

Brewer: "This book is intended as a basic guide for people who want to improve the maps they make. … [It] describes a subset of the basic knowledge taught in introductory cartography courses." Further, "the text and figures for this design book began as material for an online course …" [ix-x]. At the end of the volume, "Content in this book is complemented with ArcMap exercises in the ESRI Virtual Campus course *Cartographic Design using ArcGIS 9* by Cynthia Brewer" [203].

Krygier-Wood: "[shows] exactly how maps should be if they are to meet your goals … including instructive examples of both good and poor design choices, the book covers everything from locating and processing data to making decisions about layout, map symbols, color, and type" [cover]. "I wanted good examples to show why map design matters and how it works … and I wanted to promote creativity – fundamental to good map design" [JK personal communication].

Krygier-Wood has approached the entire cartographic process (from initial idea to completed map) in an innovative and captivating way. Chapter by chapter, Krygier-Wood goes from "Why Are You Making Your Map" to "Finishing Your Map": from intention to evaluation. "Maps are visual, so make the book visual … to promote visual thinking and creativity … focus each page on maps and arrange text around the maps." It is a good and useful approach and one long overdue. Unfortunately, some parts of the work lack conceptual and operational depth. Further, some of the illustrations, both "good" and "poor," are not effective.

Brewer, on the other hand, has chosen to deal in depth with only a subset of the mapmaking process (principally typography and color). There are many components that receive inadequate consideration, including map projections and layout. Graphic design involves significantly more than balancing blank spaces.

Further, in both books there is a failure to recognize that there is a user at the end of the process. Both volumes also ignore major issues with respect to the capabilities and limitations of the human visual information processing system. The authors should perhaps have examined their products as did Kosslyn, a cognitive psychologist, when, in 1985, he reviewed five volumes on statistical graphics and mapping (including Bertin, Fisher, and Tufte). His staged information processing approach fits reasonably with the process approach taken by Krygier-Wood and could well have been employed.

The bibliographic resources provided are not very substantial. Actually, in the Brewer volume, they are ridiculous: ten books and four journals! Krygier-Wood is much better, dealing with references chapter-by-chapter. In some cases, however, the "More Information" section tends to be elusive in terms of advice. That Brewer does not include an index is a problem, while the Krygier-Wood index would be more helpful if it were more detailed.

In the first edition of *Elements of Cartography* [1953, vi], Robinson pointed out that

A definite attempt has been made to restrict the textual presentation of the various elements to a minimum in order to promote the indispensable classroom and laboratory discussion. It is expected that the instructor will supplement the text with lectures fitted to his particular group of students and the type of course he wishes to teach. Specific instruction on varieties of methods … and the more complex techniques … have been held to a minimum, for they can better be demonstrated and discussed in the freedom of the classroom or laboratory than on the pages of a book.

While this situation has not changed, other aspects of the classroom-laboratory situation have, and what Brewer and Krygier-Wood are trying to accomplish requires the "freedom" (well, salvation) of the computer-supported solution. More important, however, is the "guide": a teacher or coach who will merge the text with the software (if necessary, step-by-step) to promote success in the learning process.

To accommodate the "home-schooled student", however, requires a very different book, and a very different approach, than is offered by either of these books. With GIS, the software is supposed to be the guide: see the manuals and the Help menus. The question is whether there is enough information and advice in these resources, supplemented by either or both of these books, to allow you to go beyond the software and become a good designer, even an innovative one.

Both books are useful and should, when used with the necessary support, be effective. In terms of the total picture, Brewer is the more limited, but Krygier-Wood has its limits as well. Each of these two books contain good (and bad) examples (by design!).

While either of these volumes will work in a classroom-laboratory setting, their effectiveness will in large part derive from the degree of support provided by the instructor. In the same way and for the same reasons that the twentieth-century mapmaker had to be familiar with the tools and toys of the trade, the twenty-first century cartographer will be dependent on an ability to use the software that will be employed to produce the map; and that in turn raises a whole new set of issues and concerns.

Bertin, J. 1967 (1983). *Semiology of Graphics: Diagrams, Networks, Maps* (translated by W. J. Berg)

Fawcett, C. B. 1935. "Population Maps. A Discussion …" *Geographical Journal* 85, 142-159

Fisher, H. T. 1982. *Mapping Information.*

Keates, J. S. 1973. *Cartographic Design and Production.*

Kosslyn, S. M. 1985. "Graphics and Human Information Processing: A Review of Five Books." *Journal of the American Statistical Association* 80 (391) 499-512

Smith, G. H. 1928. "A Population Map of Ohio for 1920." *Geographical Review* 17, 422-427

Tufte, E. R. 1983. *The Visual Display of Quantitative Information.*

Wright, J. K. *et al.* 1938. *Notes on Statistical Mapping, with Special Reference to the Mapping of Population Phenomena*.

Wright, J. K. 1944. "A Proposed Atlas of Diseases, Appendix I, Cartographic Considerations." *Geographical Review* 34, 649-652.

The Atlas of North American English: Phonetics, Phonology and Sound Change. A Multimedia Reference Tool
By William Labov, Sharon Ash and Charles Boborg
Berlin and New York: Mouton de Gruyter, 2006.
Xv, 318 pp., maps, illustrations, index. $749.00
book and multimedia CD-ROM, ISBN 3-11-016746

Reviewed by Russell S. Kirby
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Book reviewers draw on a limited set of clichés and expressions that are commonly used to place a work in its proper perspective. We speak of books that are perfect coffee table conversation pieces or are monumental works of scholarship; of texts that provide definition to fields of intellectual endeavor or of monographs that will become the standard reference for decades to come. The newly published *Atlas of North American English*, or *ANAE* as its authors charmingly refer to it, may be all of these things, but there is one thing it is not. While it is called an atlas, it meets the conventional definition only in the sense that it contains a series of maps interspersed throughout the text.

In this volume, with its accompanying CD-ROM and materials accessible through the publisher's website, the authors bring to fruition a project of which linguists and cultural geographers have dreamt for decades. Indeed, the author William Labov has labored in this field since the early 1960s, thus making this volume the result of almost a half century of research and study. It is unique, too, in its continental scale, as previous projects examining 'dialect geography' in the United States have focused on regions (generally several states).

Several cultural geographers contributed to earlier works, but the *ANAE* differs markedly from work by Kurath, Zelinksy and others in that the focus here derives from the scientific discipline of linguistics rather than on the mapping of usage of specific terms or 'word geography'. For this reason, the details presented in *ANAE* may seem pedantic or overly academic to cartographers or cultural geographers – but a careful reading of the entire text demonstrates the care with which the authors have researched spatial variation in phonetics, phonology, and other aspects of linguistics as they painstakingly analyzed hundreds of lengthy audio taped interviews based on a complex, highly structured questionnaire.

The text of the *ANAE* is structured in six parts. In the introduction and methods, the authors outline the scope of their intellectual undertaking, basic principles of dialect analysis, methods applied to sampling and field research, techniques of acoustic analysis and measurement, and their approach to mapping isoglosses that demarcate boundaries between linguistic features of English in use on the North American Continent. The next two parts focus on more specific aspects of spatial patterns of linguistics, including mergers of regional phonological variants and some mergers currently in progress. These parts are followed by two lengthy sections providing an overview of North American regional dialects and more detailed sections focusing on each of the specific regions identified in the broader analysis. These regional dialects include the North, Canada, New England, the Middle Atlantic States and New York City, the South, the Midland, and the West. The concluding part addresses three additional topics: lexical and grammatical maps, spatial aspects of American English usage by African-Americans, and a critical assessment of the *ANAE* along with some future directions for research in the geographical analysis of linguistics.

In the *ANAE*, the authors have conducted a comprehensive analysis of regional patterns of English usage based on detailed study of extensive interviews from carefully sampled respondents across North America. From the perspective of spatial statistics, however, many may share this reviewer's concern that the sample of 762 survey participants is too small to draw sweeping conclusions across the entire continent. From a linguistic perspective this sample may indeed be adequate, but determination of isoglosses for specific usages or broad dialect regions almost certainly requires a larger sample. Given the spatial and sociocultural complexity of two nations with a total population approaching 350,000,000 persons it seems unlikely that a sample of fewer than 1000 individuals would be sufficient for this undertaking, no matter how much greater the process of collecting and analyzing data from a larger group of study participants may have been. One major casualty of this approach is its inability to detect highly localized dialects. For example, natives born and raised in the city of New Orleans exhibit a speech pattern quite different from those of rural Louisiana or other Gulf coast cities, but this local pattern is not identified as a sub-dialect within the broad southern regional dialect. Other aspects of rural linguistic patterns may be similarly masked, but perhaps this issue will be of greater interest to future linguistic historians as the rural population continues to diminish in virtually all regions of North America.

While the *ANAE* is called an atlas, the monograph is structured as a detailed academic treatise with maps as a primary focus for presentation of study results. However, libraries or researchers who purchase the book will also gain access to the accompanying website, permitting users to query the research database and to generate specific maps of linguistic usage patterns and summary dialect regions. However, while this feature facilitates greater exploration of phonetic and phonological patterns, and permits examination of very specific linguistic questions, the maps generated are similar in structure to those in the monograph.. Researchers in linguistics may find this more interesting than most geographers or cartographers.

The authors of the *ANAE* are to be commended for completion of a monumental undertaking in scholarship. Cultural geographers will undoubtedly use selected dialect maps in their teaching and research, and linguistic researchers will return to the *ANAE* time after time as a core reference for the foreseeable future. Larger geography and map libraries and research institutions should consider acquisition of this volume, but the list price will deter most individual geographers and cartographers from adding it to their working libraries. Meanwhile, if you haven't seen it, seek it out; you'll be intrigued.

Chicago: A Geography of the City and Its Region
By John C. Hudson
Chicago, IL: University of Chicago Press (co-published with the Center for American Places), 2006.
xvii, 260 pp., maps, tables, photography portfolio with 84 plates, $45.00. Hardbound, ISBN: 0-226-35806-2.

Reviewed by Russell S. Kirby
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For much of the twentieth century, Chicago served as a laboratory for sociological and urban geographical research. Focused on, but by no means exclusively based on, theoretical models and empirical research conducted by University of Chicago sociologists during the first half of the century, patterns of urban morphology and social processes of assimilation and social mobility observed in the Chicago region formed the basis for analysis and interpretation of cities across North America. Later in the century, economic geographers under the tutelage of Brian J.L. Berry at the University of Chicago during the 1960s and 1970s utilized the regional economy and social structure of Chicago to develop quantitative models that have formed the theoretical basis for urban economic geography for several decades. All this research has made Chicago one of the best known and studied cities in the world and spawned several monographs focused on the city and its region These include publications by Irving Cutler (*Chicago: Metropolis of the Mid-Continent*, first published in 1973) and Brian J.L. Berry (*Chicago: Transformations of an Urban System*, 1976). Surprisingly, although the region has continued to interest historical geographers (most notably Michael P. Conzen and William Cronon), until the publication of this new monograph by John C. Hudson, the city of Chicago and its region has not received a comprehensive contemporary treatment in several decades.

Hudson notes in his initial chapter that a monograph on a major city and its region might take one of many organizational forms. The one he chose organizes the chapter material first by a series of topics in five chapters that build a comprehensive physical and social geographic platform, followed by an examination, in twelve chapters, of the spatial evolution of Chicago and its region since the earliest European settlement. A concluding chapter re-evaluates the contemporary social geography of the region within the context of the models of urban structure based on Chicago in the first half of the twentieth century.

Hudson sets the stage by reviewing each of the series of urban models developed successively by Park and Burgess, Hoyt, and Harris and Ullman and known so well by most students in courses on introductory urban geography. A discussion of Chicago's neighborhoods, spatial patterns related to the climate of the region, the geography of the physical landscape, and patterns of surface water drainage follows. In each of these introductory chapters, events in which humans transformed the physical landscape are placed in a broad environmental context.

The chapters which follow trace the development of the modern city of Chicago and its region from the beginning of European exploration and settlement through the early years of the 21st Century. In engaging prose, Hudson describes the role of key events in the continually changing socio-economic geography and spatial configuration of the emerging city. These events include, among others, the 1871 Chicago fire, the 1893 World's Fair, the work of landscape architects and urban planners including Olmsted, Vaux and Burnham, commuter rail lines and the 'El', the later development of freeways, toll roads, and airports, and the opportunities for reconfiguration of economic space in the wake of declining as well as of emerging industries.

Hudson then devotes much text and many more maps to an analysis and discussion of Chicago's changing social geography. While Chicago has always been a city of neighborhoods, demographic and social data are not conveniently arrayed in a manner conducive to neighborhood-level analysis. Hudson instead uses a deft interpretation of census-tract level data to examine changes in population density and distribution of racial and ethnic groups from the 19th Century through the year 2000. Patterns of housing and occupations are examined as well. Those who take the time to study these maps and the accompanying text will gain a working understanding not only of the social fabric of Chicago today, but also a sense of how it is only a snapshot in time as the Chicago region continues to evolve. Coincidently, those readers interested in photographic snapshots will find many poignant images in the last section of the book. Titled a "Chicago

Portfolio: Where Geography and Photography Meet", it contains 84 plates in both color and black and white.

This monograph joins a relatively small group of publications that successfully capture the sense of history and place of a metropolitan region in a manner accessible to a general audience while providing sufficient detail to satisfy the needs of most academic readers. While it is customary for reviewers to point out limitations and weaknesses as well as strengths; here it is the strengths that are much more evident. It might have been helpful for ease of comparison, however, had more of the statistical maps been drawn on the same base map and had those maps displaying data measured across other spatial units also been at the same scale. Insets might also have been included for maps displaying patterns both within the city of Chicago and its metropolitan region, to better show detail in more densely populated areas. While the text references many important historical and contemporary resources and studies, the list of references and selected readings is just that; a list, requiring real effort on the part of the truly engaged reader wishing to delve more deeply into the historical and contemporary geography of this great city. These are, nonetheless, but passing concerns regarding what is otherwise an outstanding work of scholarship and literature. In *Chicago: A Geography of the City and Its Region*, John C. Hudson has set an example to which we all might aspire; integrating visual images, maps, history, physical, social and economic geography into a tapestry that at once helps the reader understand where things are, where they may be going, and where they have been.

Permissions, A Survival Guide: Blunt Talk about Art as Intellectual Property
By Susan Bielstein
Chicago: The University of Chicago Press, 2006.
177 pp., black and white illustrations, $30.00 (US).
Hardcover, ISBN 0-226-04637-0

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www.rve.com

Susan M. Bielstein is Executive Editor for Art, Architecture, Classical Studies, and Film at the University of Chicago Press. She is also a trustee of the Graham Foundation for Advanced Studies in the Fine Arts. Even without an awareness of these impressive credentials, the reader has the sense from the outset that the author has a thorough and "inside" understanding of the subject she is presenting.

Permissions deals largely with "art books;" the sort of book with lavish illustrations and scholarly subject matter that could be used as reference or proudly displayed on one's coffee table. The illustrations in these volumes, which often consist of reproduced artwork, photographs of artwork, or photographs in general, are becoming increasingly difficult to obtain for commercial use. The fees associated with licenses, usage and reproduction are simply too costly for publications that may have limited interest and print runs.

As the author herself states, this book is not intended as a complete explanation of copyright law. The main focus of the book is to define what a copyright is, and how the existence or non-existence of a copyright can influence your use of an image or photograph. There are guidelines presented for determining whether or not a work is copyrighted, what constitutes "fair use" of an image, and how to acquire an image in publishable or otherwise usable format suited to a particular project.

Although the examples provided in *Permissions* are related to the publication of art books, they can also be applied to the use of copyrighted images in any type of publication. Copyright law is important to cartographers as well, since maps are highly sought after for inclusion in a wide variety of visual media.

Copyright laws vary from country to country, so it is important to understand the origin of an image being considered for publication. In the United States, the following key points roughly define existing copyright laws:

- Anything created since 1978 is currently protected under copyright law.
- Unpublished artwork created before 1978 is protected under copyright law for the life of the artist plus an additional seventy years.
- Unpublished artwork created by an artist who died before 1932 entered the public domain no later than 2002, and is therefore usable without permission.
- Anything published before 1923 is considered in the public domain and therefore usable without permission.
- Many works published between 1923 and the present are still protected by copyright law.

This sounds relatively straightforward, but there are a number of interesting twists and turns that make judging the need for permission to use an image in the first place, and ultimately acquiring that permission, very complicated. For example, does a photograph of an existing artwork that is already in the public domain constitute a separate work of art in itself? If so, would that photograph be subject to copyright protection even if the artwork it represented was not?

If a photograph is taken of a three-dimensional work, such as a sculpture or statue, it often involves creative lighting and the careful consideration of which angle would be best for photographic effect. A photograph made in this manner is considered an interpretative image and is therefore subject to copyright protection, even if the subject of the photograph is already in the public domain. However, if a photograph is made of a two-dimensional work, such as a painting or map, and was simply made to document the existence of an artwork in the public domain, it is considered a slavish copy and is not subject to copyright protection.

What about photographs taken of people, or with people appearing in them even if the people themselves are not the subject? It is understood that permission to publish a photograph of a person is generally not necessary if the person in the photograph is not recognizable to others. This might include people well in the distance, or camouflaged somehow by light or shadow. If a person in the photograph is recognizable to others, then permission from that person would be required before the image could be printed.

There are additional issues concerning where and how a photograph of a person or event was taken. Does it center around a public place or public gathering? Or does it represent uninvited intrusion and documentation of a private location or event? These issues often come into play when celebrities are photographed. A celebrity is considered fair game for photographers in public, but not in private surroundings. After all, a celebrity is a celebrity in the first place by virtue of capitalizing on his or her own public appeal. Part of being a celebrity is accepting, or perhaps even inviting, a certain amount of publicity. However, a photographer crosses the line when photographing a celebrity in private surroundings or during a private event without obtaining permission to do so. Even the biggest celebrity is entitled to some amount of privacy.

Another issue involves unsolicited photographs that will ultimately interfere with or lessen the value of previously solicited photographs. For example, when celebrities have babies, the rights to publish the first photographs of the babies are often highly coveted and exorbitantly expensive, but the publisher hopes to recoup these costs many times over once the photographs are published. Therefore, if another photographer manages to take an unsolicited photograph of the baby and has it published prior to the solicited work, it can damage the commercial value of the solicited work. What may initially seem like quite a coup for the unsolicited photographer will most likely result in a lawsuit and punitive damages once the deed has been made public.

When photographing a private individual, even in a public setting, permission must be gained if the person is recognizable in the photograph, since non-celebrities do not capitalize on their public appeal and do not necessarily want to see their images splashed all over the printed or visual media. When a photographer is requesting permission to use a photograph of a private individual, it should be expressly stated that complete rights to the image are being solicited. Any compensation being offered to the subject in return for those rights should be clearly spelled out in the permission paperwork.

"Fair use" is a concept related to copyright law, but is not a law itself. Fair use involves using someone else's copyrighted work for a particular purpose, while recognizing that the work's original ownership remains unchanged. There are several important factors that define fair use:

- The purpose and character of the intended use should not transform the original work.
- If the nature of the original copyrighted work is factual, the facts themselves are not subject to copyright protection, but the way the facts are presented in the original work are subject to copyright protection.
- Only a small percentage of the original copyrighted work can be used or quoted in relation to the original copyrighted work as a whole.
- The new work incorporating fair use cannot infringe upon the potential market value of the original copyrighted work, nor can it otherwise compete with the original work.

For educational purposes, it is considered acceptable to use a slide or digital file of a copyrighted work as a teaching resource, for research purposes, or within a thesis. However, you cannot subsequently publish these new works without permission. It is also considered acceptable to get an idea from a copyrighted work and then incorporate the idea itself into a new work, but it is not acceptable to simply copy an existing work in another medium.

Style is another commodity that cannot be copyrighted. Looking at maps, for example, it would be acceptable to produce an entirely new map in the overall style of another without infringing on the original's copyright.

If the intended use of an original does not fall under the concept of fair use, it will be necessary to gain permission before the original can be incorporated into a new work. When requesting permission to use any image, it is important to explain exactly how the work will be used, including who will publish it, what type of media it will be in, where it will appear in a book (inside or on the cover), whether the image will be reproduced in color or black and white, and how many copies are expected to be printed. It may also be necessary to describe any caption or associated text that will be devoted to the image.

It may take some research to determine exactly what individual, group or organization holds the rights to a particular work. In addition to the artist or artist's estate, there are image warehouses, museums, libraries and artists rights organizations. *Permissions* provides contact information for image banks, search engines and artists' representatives that may help in this quest. Potential publishers will generally require that appropriate rights be obtained before a book is published. The author is generally responsible for the costs and documentation involved.

Acceptable formats for images destined for publication are transparency/slide, high resolution digital files, or photographic prints. Transparencies are preferred, since they are the closest to the original work. Suppliers of transparencies will generally license their use for a limited period, rather than selling them outright, so it is important to establish an acceptable timeframe and/or gain an extension so that the work will be available throughout the publication process. A good transparency includes a color bar to help printers reproduce the image as faithfully to the original as possible.

When submitting digital images for publication, it is important to use the format and resolution guidelines outlined by a potential publisher. Images should be submitted on CD or DVD rather than attached to an e-mail. The current industry standard for digital image resolution is 300 pixels per inch (ppi). *Permissions* offers examples of illustrations that were reproduced at the appropriate resolution, at a lesser resolution, and even at a lesser resolution that was enhanced with image software. The comparisons demonstrate the importance of meeting the 300 ppi standard.

Many works in the public domain can be downloaded directly from the United States Library of Congress. Other works are available only for research or educational use. Always check the fine print for any usage restrictions.

Permissions provides the source of each illustration within its covers, as well as a complete account of copyright fees and related use fees. The total fee required to obtain and use the black and white illustrations included in the book was $1,511.18. Additional examples are provided from other authors that involve even greater costs. No wonder Bielstein expresses her concern about the future of art books.

Bielstein offers some creative suggestions for negotiating better usage rates, including the substitution of a percentage of the author's royalty fees for an actual licensing or reprographic fee. The percentage paid would be based on what percentage of the overall book will be taken up by the image involved. For example, a full-page image in a 200-page book would involve 1/200 of the author's royalty.

Sample form letters for obtaining copyright or use permissions are included in the back of the book. These provide important insight and guidance for those wishing to publish copyrighted artwork. Bielstein also recommends that copyrighted artwork only be used when absolutely necessary in order to conserve costs and avoid lengthy negotiations. There may be equally usable works in the public domain, or a particular image may not complement the text enough to make the extra costs and wrangling worthwhile.

Since copyright law has long been associated with books and illustrations available in traditional "hard-copy" formats, the easy accessibility and sheer volume of data increasingly available online must be testing the concept of "fair use" in ways that could never have been foreseen when copyright law was last revised in 1978. I had hoped that Bielstein's book would explore this timely subject in greater detail, and that at least one chapter might be devoted to the obvious issues involved when publishing or using material online. However, Bielstein provides limited guidance on electronic media, and instead refers readers to other authors and books that might offer a more thorough understanding of this topic.

In spite of this one drawback, I found *Permissions* to be a very comprehensive book that is entirely true to its stated purpose. I would highly recommend it to anyone considering compiling and publishing a book or article that will rely heavily on artwork, images or even maps created by others. *Permissions* provides important insight into the forms, contacts and fees associated with finding and using copyrighted illustrations. The book is informative without being boring, and the complicated subject matter is presented in a light and understandable fashion. *Permissions* is aimed at the layperson and not at the legal profession.

For readers who are not compiling a heavily illustrated art publication, this book is useful from a different perspective. Many people, particularly in the academic world, will ultimately want to publish articles, papers or similar works of their own creation, with or without incorporating the illustrations of others. Cartographers may be asked to provide maps for publication in books, periodicals or atlases being compiled by other sources. *Permissions* provides a valuable source of reference for the author, artist or cartographer wondering about the intricate elements of copyright protection as applied to his or her own creative work. It is important for anyone involved in the arts, whether literary or cartographic, to understand the level of control that can or cannot be exerted once a work has been published or otherwise publicly displayed. The concept of "fair use," although not open-ended, is one that must continue to work both ways in order to survive and prosper.

Mapping: Methods & Tips

The Cartographic Apprentice: By the End of This Assignment, Someone Will be Fired

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Abstract

The encouragement for group work and collaborative learning is supported in education. Simulations, role playing, and games are common techniques to engage students in actively participating in the learning process. Creating the rules and organizing the groups are some of the challenges facing instructors, especially in mapping courses where students vary greatly in both content knowledge and technical skill development. Surprisingly, successful tactics were adopted from the growing fascination of reality tv. The Cartographic Apprentice simulated Donald Trump's business tactics to engage students, create competition, and mediate group dynamics. The semester-long game had students working in groups to create posters that were evaluated by faculty and students. Winning teams were rewarded by maintaining their successful group, while losing teams had to meet in the cartographic board room and critically evaluate their projects, which eventually led to someone being fired.

Introduction

As an instructor, developing course exercises and activities can be a monumental task. Trying to reflect on exercises I used during my formal training does not work, as much of my schooling took place in the "pen and ink" and "early computer program" eras. Today, information, technology and employer expectations have drastically changed. Students need to have conceptual understanding of content material, the ability to utilize computer software, and ideally acquire strong communication and personal skills. A combination of small individual projects along with group work can assist in achieving desirable student outcomes. However, like many in the teaching profession I have struggled with group dynamics. As someone who watches very little television, and primarily sporting events at that, I was quite surprised to find creative teaching strategies develop from the current popular trends of questionable network programming.

Group Projects and Gaming in the Classroom to Enhance Student Learning

A growing literature exists encouraging group work and collaborative learning in education. Davis (1993) reports that regardless of subject matter, students who worked in small groups tended to learn more and retain information longer than those who learned individually, which in turn resulted in students reporting to be more satisfied with their courses (Collier, 1980). Livingston and Lynch (2002) who tested two approaches to group work in a GIS curriculum discuss how a country's workforce can be enhanced by group projects to develop cognitive and interpersonal skills that extend well beyond the student's disciplinary content or material.

Simulations and games are a common teaching technique used to encourage group projects and collaborative learning in education. Simulations or case studies actively engage students in "real-world" roll playing scenarios, such as the study by Churchill and Liebowitz (1990) who used the hypothetical situation of locating a noxious facility to explore spatial conflict at local and regional scales. Warbuton and Madge (1994) found gaming as a motivating factor for students regardless of content material, and gaming in geography has been found to encourage small group interaction that ensure all members of the class participate (Greenblat, 2001). Edgington and Hyman (2005) consider the use of games, such as lessons learned from baseball, ideally suited to making the foundations of geography relevant to students and help them engage in their learning.

The literature addresses many of the limitations or problems associated with group work. The design, implementation, and assessment of groups can be a challenge. Healey and Matthews (1996) discuss the unequal contributions from team members, unfair distribution of grades, the ability for non-productive students to slide through, the inability for all group members to meet, and personality clashes. Thus, the development or design of group work is an important key to success. Davis (1993) outlines important guidelines that include (1) creating groups that require some independent activities and hence allowing for a fair division of labor, (2) making the objectives relevant,

(3) increasing difficulty of assignments as students skills and abilities increase, and (4) setting up competition between the groups. Surprisingly, I found these strategies being successfully employed as I was channel surfing.

Reality Television

It is hard to ignore the popularity and fascination television networks and the public have placed on reality tv over the past several years. The content and the "reality" of these programs is disputable, but the pervasiveness of them is undeniable. In hindsight, many people may classify early programs such as the 1948 *Candid Camera* and the 1950's *Truth or Consequences* series as the beginnings of Reality TV. These programs caught people in unexpected circumstances, where as in 1992, MTV's *The Real World* began staging environments in which groups of people interacted. It was in 2000 that CBS's *Survivor* combined this "reality" with the "game show" strategy where team members competed for one million dollars. Today, the major networks and cable stations run a series of reality tv programs, and winners (and some losers) of these shows are becoming household names (Turner, 2006).

The underlying premise for many of these reality shows is questionable, the underlying morals may be low, and the participants may be exploited. Reiss and Wiltz (2004) claim that reality tv programs appeal to basic human instincts, while O'Fallen (2004) argues that important lessons can be learned. The premise behind *Candid Camera* showed the importance of resisting unjust or ridiculous authority, and current filming of a British reality show is recreating important psychological experiments (Shouse, 2001). The challenges of group dynamics are evident in the business tasks presented by Donald Trump in *The Apprentice*.

In January of 2004, Donald Trump, Mark Burnett, and NBC produced the television reality show, *The Apprentice*. It has since continued with additional seasons. The show involves a group of interns who are competing for a position in Donald Trump's organization. Each week, he splits the candidates into two teams who are given a business task that requires intelligence, creativity, motivation, and often luck. The team's progress is assessed by Donald Trump, two other senior employees, and then an additional outside observer, general public, or total sales. At the end of each task, one team wins and one team loses. The losing team meets Mr. Trump in the board room to discuss what went wrong and who was accountable for specific assignments. The show ends when one person hears those famous words, "You're Fired!"

The Cartographic Apprentice

The Cartographic Apprentice was a teaching strategy that successfully achieved group work and collaboration throughout the semester of a 300-level cartography course. The course contained many traditional techniques such as lectures, short exercises, homework assignments, quizzes and exams. However, carried throughout the semester were six group assignments that required larger poster-size maps that could be hung in hallways. Students in the class were assigned to groups of 4-5 people. The class was given a specific topic along with an overall agenda. Each group had to decide on the specific area, gather data, design a poster, and submit a written report. The posters were displayed for faculty and students to give input. Geo-Environmental faculty were asked to give their expert advice, while students in a general education course gave a public opinion. Winning posters were announced and the losing teams had to meet me in the Cartography Board Room and yes-someone was fired!

The Theme Song

To start the premise of this semester off, I designed an interactive multimedia video that highlighted topics of the course. The video utilized the same theme song and the beginning format as *The Apprentice* television show. A rotating compass rose would stop every ninety degrees and highlight topics covered during the semester, such as the history of mapping, data collection, scales, projections, symbology, typology, and overall design layout. In between these topics, and similar to the show, I would fade images of Donald Trump and the New York skyline and superimpose my own face on our campus (I even drew Trump's signature pink tie on one of my photos at the end). Several screen shots faded away by a helicopter going across the screen, and transitional slides were used with text such as "It is not personal, it's just cartography." This became the theme song of the class and it seemed to get students motivated, excited, and into the competitive nature of the assignment, while it displayed course objectives in a manner that showcased cartographic techniques.

Apprentice Rules

As in other gaming techniques, the game had a set of rules by which students followed. At the beginning of each assignment I reminded students about the rules.

✓ Tasks are given at the beginning of each assignment.

✓ Time limits will be exact and NOTHING will be accepted past the deadline.

✓ Printed maps should have the group's logo only. NO individual names should appear on the final poster.

✓ Posters will be hung for faculty and students to evaluate.

✓ You are NOT allowed to ask faculty for help-that includes ideas, data gathering, information, or design.

✓ A written summary, with inserted graphics must accompany each poster. I would expect it to be several (2-3) pages in length and include the main topic headings: Introduction to topic, method or sources of data, classification, selection, and interpretation method, overall design, and a conclusion.

✓ Since there will be more than two teams (as on *The Apprentice* show) the choice of which team competes against which team will be randomly selected and announced at the end of the evaluation period.

✓ Everyone in the group will receive the same grade for that given project.

✓ The losing group (groups) will meet me in the boardroom.

✓ Someone WILL BE FIRED!

✓ Fired person must still complete all remaining assignments; however, without a group there will be much more work to do on their own.

✓ Fired persons can make a new group (up to 5 people).

Apprentice Assignments

The challenge of assigning group projects was understanding the student's cartographic knowledge at that point of the semester. For example, the first activity of the semester had to consider the fact that the students had limited knowledge. As a class we had only covered an introduction and the history of cartography, along with its relationship to other mapping sciences. We had covered a short discussion on the basic constraints of the Earth's shape, coordinates, projections, and scale, and had only a basic introduction to map design and layout. The students had begun to use ArcGIS and CorelDRAW and learned how to import and export between these programs and Microsoft Word.

The Assignment therefore could not require students to gather a great deal of data and make proper symbology choices. Thus the result was the following first assignment:

- Your job is to design a map of a fictional place.
- The place can be entirely from your imagination, from a book, movie, song, or other medium.
- As a group you should decide on that place and agree upon its characteristics.
- By next week your group should hand in the title of your place, a brief description, and a general idea of the overall design (this will then be further developed for your final written summary).
- Your map should be NO larger than 24 x 36 inches.
- You may want to include photos, diagrams, charts, or additional text describing your place. If suitable you may want to put a scale bar, graticule lines, north area, etc. But only if it makes sense!
- Make sure you properly reference and cite any source from which you get information.
- Your overall design should represent the "Feel" of the place. For example, a map of Middle Earth would probably be dark and spooky, while a map of Sesame Street would be more kid-colorful.
- The best map will be based upon ability for readers to get the right feel of the fictional place, understand the basic spatial features represented on the map, and overall creative aspects.
- You must hand-in a digital copy of the final map by the beginning of class, along with a written summary.

Each of the six assignments targeted specific tasks, computer skills, and cartographic content. A few class periods were devoted to the assignments, or a few minutes at the end of the period allowed for group members to meet, however, the assignments were given with multiple parts. Specific students within each group could chose roles. For example, one student may be in charge of the supporting text, one the data collection, one design the diagrams, and the overall layout. This allowed for them to work on their own time, but collectively contribute to the group. It was also designed to be a pivotal point when discussing cartographic flaws in the board room.

Evaluation and Assessment

The assessment of the assignments was similar to the show. As the instructor, I oversaw all activities and production, and of course, had the final say. Fourteen faculty members in the Department of Geography and Earth Science were asked to give their expert opinion, and eighty students in two sections of a general education course gave their public opinion. The benefits of having this many people evaluate the maps motivated the cartography students, increased the fun, competitive nature of the game, show cased some very impressive posters, and introduced general education students to technique-based courses in the department.

The faculty evaluations listed a series of questions, the title of each poster entered, and a ranking from 1 to 5 that they could circle. Space was allotted for any additional comments, but the form was intended to be filled out quickly (I hardly wanted to increase the paperwork for my fellow colleagues). The following is an example of the questions from the first assignment:

Please Circle the value for each map, for each description: 1 is the lowest score, or poorest job, and 5 is the highest or best job of each category.

Ability to get a feel or sense of the fictitious place from the map

Sweet Valley Map	1	2	3	4	5
Plato's Lost City of Atlantis	1	2	3	4	5
Oz	1	2	3	4	5
The Restaurant at the End of the Universe	1	2	3	4	5

The remaining six questions were in a similar 1-5 format but targeted…

1. Ability to understand the fictitious place
2. Use of map components, such as border, neat line, scale, legend, author (group logo), date, and source.
3. Overall map clarity-easily distinguish between map features and overall design components
4. Visual Hierarchy (important items should be seen first, followed by less important items)
5. Appropriate use of space/visual balance
6. Overall Map

The evaluation instrument given to the undergraduate students in the general education course followed a similar format, however the questions included:

(1) Makes the topic interesting, (2) The mapped items are easily understood, (3) I get a good sense of the place, (4) It is easy to read, and (5) Overall map.

Holding Students Accountable: The Cartographic Board Room

At the end of the evaluation period groups were randomly selected out of a hat to compete with each other. After the posters had been on display for a week, the students generally knew which were the better posters before they received feedback from the faculty and general education students. By randomly selecting the competing teams, an element of chance was added to the game.

The losing teams had to meet with me and discuss why their poster did not win. The group was asked to evaluate their poster. This critique forced the students to really consider the components of their project in light of the cartographic concepts they had learned. Quite often the posters had a major flaw or two, such as not enough data to make the poster interesting, poor font sizes, styles, and placement, illogical symbol choice, or overall disorganized display. Specific students usually confessed that the crippling component was their responsibility, and yes, they were fired!

The cartographic board room was intended to have the students engage in self evaluation and critique their own maps. In addition, it effectively managed many of the problems associated with group work. In one instance one student freely admitted that he was busy, had not contributed to the group, and deserved to be fired. In another group, two of the students did all the work and asked to both be fired so they could do the next project on their own.

The board room did not solve all problems. In one group, serious personality clashes arose. Unfortunately a non traditional student who seriously struggled with the computer portion of the class was not appreciated by her fellow team mates for her conceptual knowledge. This specific student freely admitted that working with the software would bring her to tears, yet she was devoted to learning the material, study diligently, and was excellent at evaluating the group's work. In large part due to this student's input, the group would consistently create a high quality project and win, and thus the group remained in tact.

Conclusion

The Cartographic Apprentice was a semester-long teaching strategy that attempted to get students in a cartography class to actively participate in group activities. Taken from the reality tv series where interns competed to work for Donald Trump, the Cartographic Apprentice combined gaming and competition to encourage group participation and collaborative learning. Students learned to work together to produce a final output that was evaluated by the instructor, trained faculty, and undergraduate students. The display of the group projects provided an outlet for the cartography students to present their efforts and work, increased the stakes and professionalism expected from the projects, and it was a way of introducing mapping courses to general education students. The losing teams met in the boardroom to critique their loss and evaluate their errors. Those that did not contribute adequately to the group were fired and thus had an increased work load for the next assignment they had to complete without the help of a group.

Reports from the students were overwhelmingly positive. Most students reported a satisfaction of group participation and learning. As in any class the range of student output varied greatly and it is hard to compare the maps produced in this strategy to those in previous semesters, however it did force students to evaluate and critically analyze their maps and the work of their peers. As the professor, I have to admit this strategy was a lot of fun. Usually as a professor, I try to be nice, encouraging, and sensitive. It was rather refreshing to take on Donald Trump's role, pull aside a student who you know had not been engaged in the course as much as they should have and say "You're Fired!"

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NACIS Map Design Survey—Looking at the Results

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Download the survey data at: www.nacis.org/map_design

The results of the NACIS Map Design Survey are a snapshot of the opinions held by the mapping community on map design—a subject that means many things to many people. Each of us has distinct ideas about what constitutes good design, where the state of map design currently stands, and how to go about designing maps. Design is an integral part of mapmaking; as an example of this, NACIS meetings devote considerable time to map design. Despite this attention, little concrete information exists on the opinions of our diverse community on this varied subject. The survey we conducted, sponsored by NACIS, is a step toward filling this gap.

The questions asked in the survey are intentionally general in nature. You will find that the responses do not divulge how to design better maps per se. Instead, they provide broad insights on how map designers think and the work processes they employ—good map design is very much a state of mind. In composing the survey, we sought to cover a wide variety of topics within the field of map design and to satisfy our own curiosity.

The initial questions (numbers one through five) in the survey establish the characteristics of the respondents. Where are they from? What background do they have in cartography, mapmaking, or geospatial science? How long have they been involved in the field? Questions 6 through 14 address general ideas about map design quality, the nature of map design, and its current and future status. These questions were answerable by anyone with an interest in maps.

Question 15, which asks, "Do you make maps?" was a pivotal question. Answering "no" to this question would exit the respondent from the survey. Answering "yes" would bring the respondent to a final set of questions (16 through 27) designed specifically for practicing mapmakers. These questions delve deeper into the creation process and the practice of map design in the working world.

We created the survey at SurveyMonkey.com, a firm that provides affordable and easy-to-use services for creating, conducting, and analyzing surveys online. The survey was open for two months from February 6 to April 6, 2007. Before launching it, we asked two survey specialists to review the questions for possible bias. A non-native English speaker reviewed the questions for clarity. NACIS board members then beta tested the survey online and gave additional suggestions for improvement. Once launched, we announced the availability of the survey on several online mapping and GIS forums. Open to all comers, the survey attracted 322 respondents from 24 countries, the large majority of whom lived in the United States.

While monitoring responses during the open survey period, we found that after approximately 100 respondents the percentages of answers to each of the questions began to stabilize. Additional respondents failed to move the results more than a few percentage points. Adam Engst (2007) in the online newsletter Tidbits (http://db.tidbits.com/article/8894) noted how a small survey could predict a pattern of results similar to that of a survey with a much larger response. His observations drew on his experience with online surveys and summarized the work of Jon Krosnick at Stanford University. According to Krosnick (2007), computer surveys tend to be more accurate than phone surveys—in part because people can take the time to think about the question and do not suffer from awkward silences in the interview. He goes on to say that computer surveys are better than written surveys because people will tend to fill responses very quickly on a paper survey, working to just get it done instead of thoughtfully responding. Krosnick points out an important limitation of Internet surveys: they suffer from lack of random response. In our case we felt the prerequisite of an interest in map design and an awareness of our survey were key to the collection of a useful set of responses.

Our report on the survey contains no analysis—the responses largely speak for themselves and we encourage readers to draw their own conclusions. Readers wishing to dig deeper into the data can download the survey results in html, pdf, and spreadsheet format at www.nacis.org/map_design. Here you will also find the results filtered by demographic category. You can learn, for example, whether respondents over the age of 50 from Canada share the same views on map design as those under the age of 30 from Croatia. Your NACIS membership dues paid for the survey. We invite you to use these data for research projects or simply peruse the graphs presented on the following pages for enjoyment.

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1. Which country do you live in?			
		Response Percent	Response Count
United States		**72.7%**	234
Croatia		5.0%	16
Canada		3.4%	11
United Kingdom		3.4%	11
Switzerland		2.5%	8
Slovenia		1.9%	6
Australia		1.9%	6
Austria		1.2%	4
Germany		1.2%	4
Netherlands		1.2%	4
New Zealand		0.9%	3
Poland		0.6%	2
United States Virgin Islands		0.6%	2
Bulgaria		0.3%	1
Hong Kong		0.3%	1
Hungary		0.3%	1
Italy		0.3%	1
Japan		0.3%	1
Norway		0.3%	1
Portugal		0.3%	1
Romania		0.3%	1
Saudi Arabia		0.3%	1
Spain		0.3%	1
Turkey		0.3%	1
		Answered question	**322**
		Skipped question	**1**

2. Gender:		
	Response Percent	Response Count
Female	27.9%	90
Male	**72.1%**	233
Answered question		**323**
Skipped question		**0**

3. Age:		
	Response Percent	Response Count
Under 19	0.9%	3
20 to 29	26.3%	84
30 to 39	**33.5%**	107
40 to 49	22.9%	73
50 to 59	11.9%	38
60 to 69	4.1%	13
Over 70	0.3%	1
Answered question		**319**
Skipped question		**4**

4. What is your primary involvement with maps?	Response Percent	Response Count
Cartographer	**35.1%**	113
GIS specialist	28.0%	90
Software developer	2.8%	9
Data developer	1.2%	4
Professor	4.7%	15
Educator	4.7%	15
Researcher	4.7%	15
Student	10.3%	33
Map librarian	1.6%	5
Map collector	1.2%	4
Map dealer	0.3%	1
Map enthusiast	1.6%	5
Other	4.0%	13
Not applicable	0.0%	0
	Answered question	**322**
	Skipped question	**1**

5. For how many years have you been professionally involved with maps?	Response Percent	Response Count
0 to 4	22.1%	71
5 to 9	25.2%	81
10 to 19	**30.4%**	98
20 to 29	14.0%	45
More than 30	6.2%	20
Not applicable	2.2%	7
	Answered question	**322**
	Skipped question	**1**

6. In general, how do you rate the design of maps made today?	Response Percent	Response Count
Very bad	0.3%	1
Bad	14.0%	41
Adequate	**46.1%**	135
Good	36.5%	107
Very Good	3.1%	9
	Answered question	**293**
	Skipped question	**30**

7. Compared to manual maps made twenty or thirty years ago, how do you rate the design of digital maps today?	Response Percent	Response Count
Much worse	3.8%	11
Worse	32.2%	94
About the same	19.2%	56
Better	**33.2%**	97
Much better	11.6%	34
	Answered question	**292**
	Skipped question	**31**

8. Do you think map design will generally get worse or better in the next 10 to 20 years?	Response Percent	Response Count
Get worse	13.7%	40
Stay the same	20.6%	60
Get better	**65.8%**	192
	Answered question	**292**
	Skipped question	**31**

9. For much of the twentieth century, maps designed in North America and Europe often looked different from each other. Is this still the case today?	Response Percent	Response Count
Yes	28.0%	77
Yes, but not so much	**63.6%**	175
No	8.4%	23
Answered question		**275**
Skipped question		**48**

10. According to a popular definition, cartography is a discipline that combines art and science. Looking broadly at the profession today, how would you rate this balance?	Response Percent	Response Count
Entirely art	0.0%	0
More art	14.4%	42
Equal art and science	29.1%	85
More science	**55.5%**	162
Entirely science	1.0%	3
Answered question		**292**
Skipped question		**31**

11. In your experience, how unusual is it for a cartographer to have both design and technical ability?	Response Percent	Response Count
Very rare	5.5%	16
Rare	24.7%	72
Sometimes	**36.4%**	106
Common	27.8%	81
Very common	5.5%	16
Answered question		**291**
Skipped question		**32**

12. *Nature vs. nurture:* both natural aptitude and education are factors determining whether a person is good at map design. Which do you consider most important?

	Response Percent	Response Count
Entirely aptitude	0.0%	0
More aptitude	**37.2%**	109
Equal aptitude and education	35.2%	103
More education	26.6%	78
Entirely education	1.0%	3
Answered question		**293**
Skipped question		**30**

13. If you *HAD* to hire someone to design custom maps for a magazine like *National Geographic* and the choice was between a GIS specialist with no graphical experience and a graphic designer with no GIS experience, whom would you choose?

	Response Percent	Response Count
GIS specialist	27.8%	81
Graphic designer	**72.2%**	210
Answered question		**291**
Skipped question		**32**

14. Is map design a mature field with little room for innovation or do new design techniques still await discovery? Rate the likelihood for future map design innovation:

	Response Percent	Response Count
Very unlikely	1.4%	4
Unlikely	6.8%	20
Likely	**57.3%**	168
Very likely	34.5%	101
Answered question		**293**
Skipped question		**30**

15. Do you make maps?		
	Response Percent	Response Count
Yes	**93.9%**	275
No	6.1%	18
	Answered question	**293**
	Skipped question	**30**

16. How do you rate yourself as a map designer?		
	Response Percent	Response Count
Bad	0.4%	1
Not so good	2.8%	7
Average	33.5%	84
Pretty good	**53.8%**	135
Excellent	9.6%	24
	Answered question	**251**
	Skipped question	**72**

17. What has influenced your development as a map designer?					
	Not important	Somewhat important	Important	Rating Average	Response Count
Cartography classes	12.5% (33)	28.3% (75)	**59.2% (157)**	2.47	265
GIS classes	27.7% (73)	**41.7% (110)**	30.7% (81)	2.03	264
Art/Design classes	31.2% (81)	**38.1% (99)**	30.8% (80)	2.00	260
Self taught	3.7% (10)	33.3% (89)	**62.9% (168)**	2.59	267
Internship/apprenticeship	28.8% (74)	**36.2% (93)**	35.0% (90)	2.06	257
A mentor	24.0% (63)	32.4% (85)	**43.5% (114)**	2.19	262
Work experience	3.4% (9)	15.0% (40)	**81.6% (218)**	2.78	267
Professional outreach (conferences, online forums, etc.)	14.8% (39)	**50.4% (133)**	34.8% (92)	2.20	264
				Answered question	**269**
				Skipped question	**54**

18. Do you seek advice from others when designing maps?		Response Percent	Response Count
Never		0.7%	2
Not often		14.9%	40
Sometimes		**40.2%**	108
Very often		34.2%	92
Always		10.0%	27
		Answered question	**269**
		Skipped question	**54**

19. Have you ever submitted a map to a design contest?		Response Percent	Response Count
No		**63.7%**	170
Yes		13.9%	37
Yes, and won an award		22.5%	60
		Answered question	**267**
		Skipped question	**56**

20. Looking beyond maps, how do you rate your ability in the broader field of graphic design?		Response Percent	Response Count
Bad		0.4%	1
Not so good		9.7%	26
Average		41.6%	112
Pretty good		**44.2%**	119
Excellent		4.1%	11
		Answered question	**269**
		Skipped question	**54**

21. When making a map, how closely does your initial concept (minds-eye view) match the final design?	Response Percent	Response Count
Never	0.8%	2
Not often	8.3%	22
Sometimes	32.7%	87
Very often	**55.3%**	147
Always	3.0%	8
	Answered question	**266**
	Skipped question	**57**

22. On a typical map project, about what percentage of the total project time do you devote to map design?	Response Percent	Response Count
Little or none	0.0%	0
5 percent	3.0%	8
10 percent	8.7%	23
20 percent	18.1%	48
30 percent	**19.2%**	51
40 percent	9.8%	26
50 percent	13.5%	36
60 percent	7.9%	21
70 percent	10.5%	28
80 percent	6.8%	18
90 percent	1.9%	5
100 percent	0.8%	2
	Answered question	**266**
	Skipped question	**57**

23. When making a map, to what extent do you integrate design with other mapping tasks such as research, compilation, and production?

	Response Percent	Response Count
Completely integrated	18.4%	49
Mostly integrated	**39.7%**	106
Sometimes integrated, sometimes separate	32.2%	86
Mostly separate	9.7%	26
Completely separate	0.0%	0
	Answered question	**267**
	Skipped question	**56**

24. Looking at one of your typical map projects from start to finish, when does most design effort occur?

	Response Percent	Response Count
Beginning	11.3%	30
Middle	5.6%	15
End	15.4%	41
Beginning and end	19.9%	53
Throughout the project	**47.7%**	127
	Answered question	**266**
	Skipped question	**57**

25. Of the maps you make, how many are custom designed versus made to already existing design standards or from default software settings?

	Response Percent	Response Count
Entirely custom	22.4%	60
Mostly custom	32.5%	87
Both custom and standardized	**33.2%**	89
Mostly standardized	11.2%	30
Entirely standardized	0.8%	2
	Answered question	**268**
	Skipped question	**55**

26. Does software influence map design?		
	Response Percent	Response Count
Not often	9.3%	25
Sometimes	41.4%	111
Very much	**49.3%**	132
	Answered question	**268**
	Skipped question	**55**

27. Not every map can be a design masterpiece. What factors *LIMIT* the quality of maps you design?					
	Infrequent	Sometimes	Frequent	Rating Average	Response Count
Not enough time	3.4% (9)	42.5% (114)	**54.1% (145)**	2.51	268
Not enough funding	25.0% (67)	**38.4% (103)**	36.6% (98)	2.12	268
Pre-existing map design standards	31.1% (83)	**52.4% (140)**	16.5% (44)	1.85	267
Strict supervisor or client control	**45.7% (121)**	37.7% (100)	16.6% (44)	1.71	265
Lack of manual/artistic skill	**51.7% (138)**	38.6% (103)	9.7% (26)	1.58	267
Inadequate software	**43.7% (117)**	39.6% (106)	16.8% (45)	1.73	268
Data problems	20.9% (56)	**50.7% (136)**	28.4% (76)	2.07	268
Just feeling lazy	**62.3% (167)**	32.8% (88)	4.9% (13)	1.43	268
				Answered question	**269**
				Skipped question	**54**

Visual Fields

Atlas of Yellowstone – Preliminary Work

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The Atlas of Yellowstone represents a collaboration among the University of Oregon, Yellowstone National Park, and many researchers of the Greater Yellowstone Area (GYA) to produce the first comprehensive atlas of a national park for the first national park in the world.

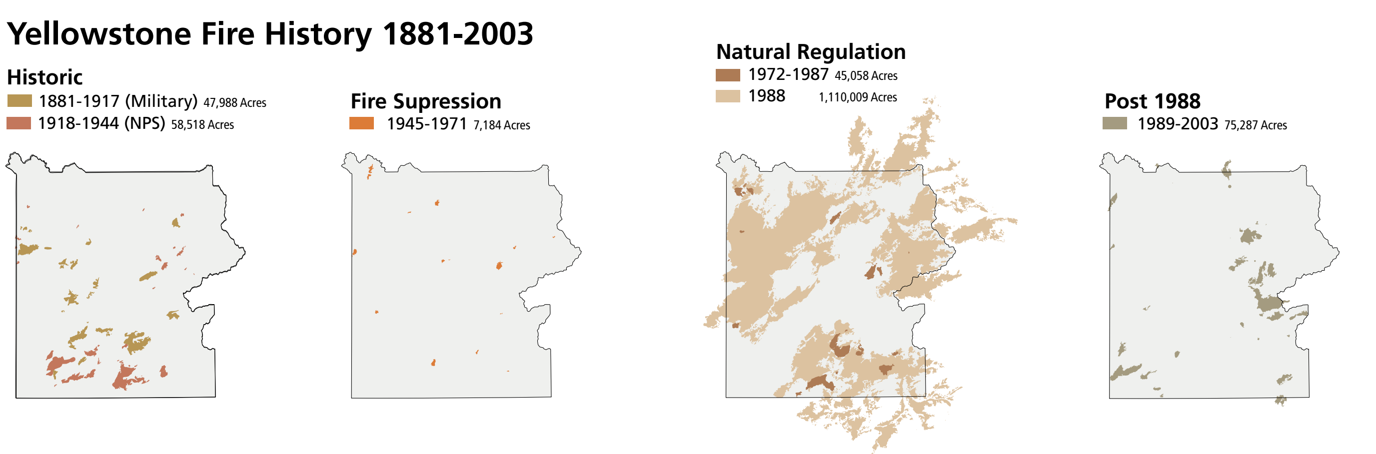
The atlas will contain approximately 300 pages that describe and explain the human and natural setting of Yellowstone National Park and the GYA. Topics such as wolf ecology and fire history will be depicted in thematic page pairs that provide maps, graphics, tables and text specific to the topic. Reference maps will depict topography, and other key natural and human features.

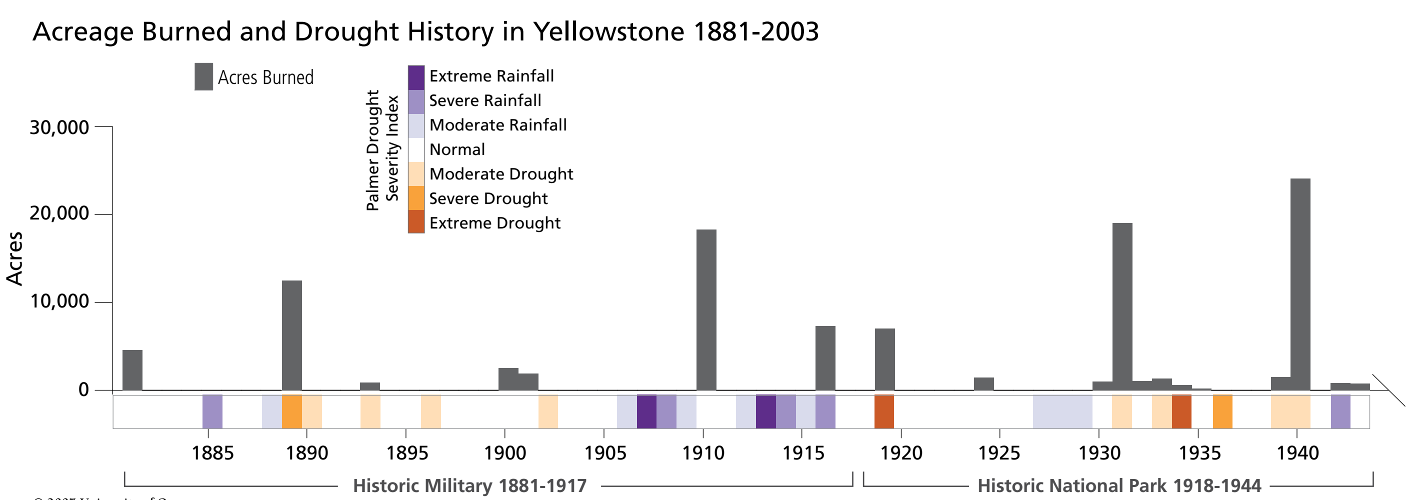
The overarching content goal of the Atlas of Yellowstone is to give readers an enriched understanding of and appreciation for Yellowstone's natural and cultural landscapes. In order to accomplish this overarching goal, content within the Atlas of Yellowstone will focus on four interconnected themes.

Yellowstone is extraordinary. In the context of the Atlas of Yellowstone, this "sense of place" theme will emphasize how Yellowstone is extraordinary relative to other places. Maps, text and tables related to bison, for example, will identify the critical role of Yellowstone National Park in preserving this species and its genetic integrity.

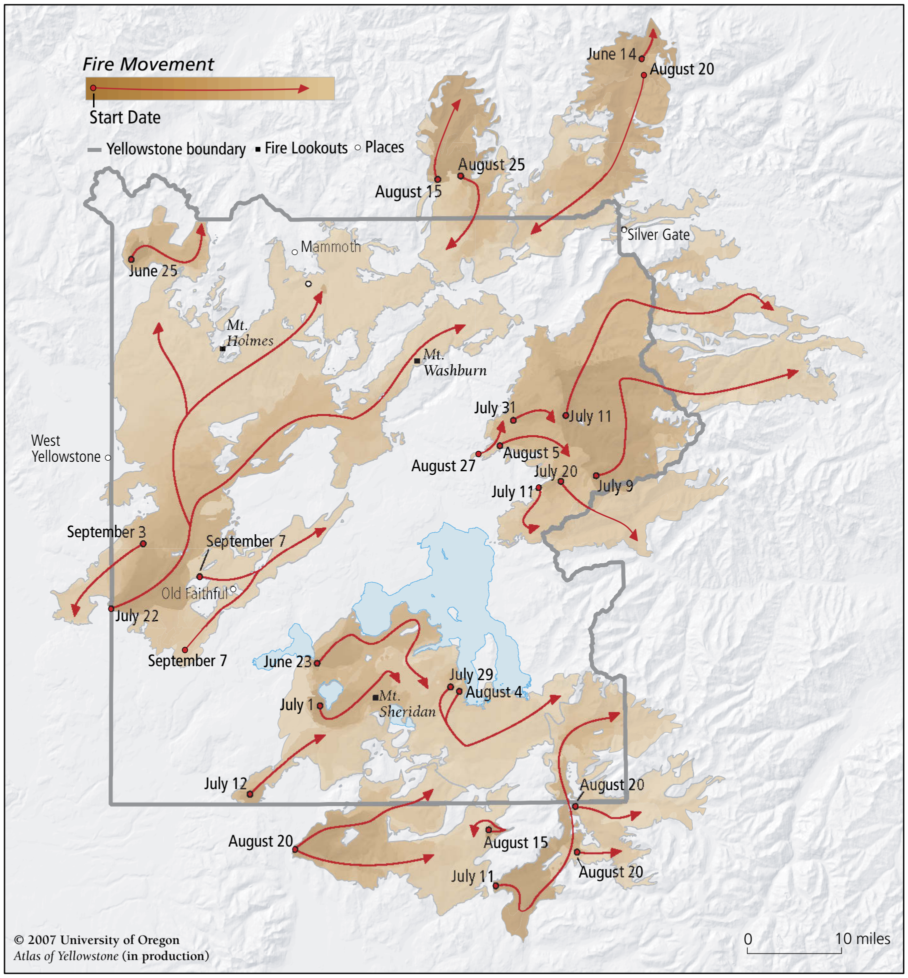
Yellowstone is connected. Yellowstone does not exist in isolation. Story lines built around the "connections" theme will demonstrate the complex interactions of organisms and habitats within and outside Yellowstone. A range of topics such as wildlife migration, seismic activity, and the local economy will demonstrate how Yellowstone is situated in a broader spatial and environmental context.

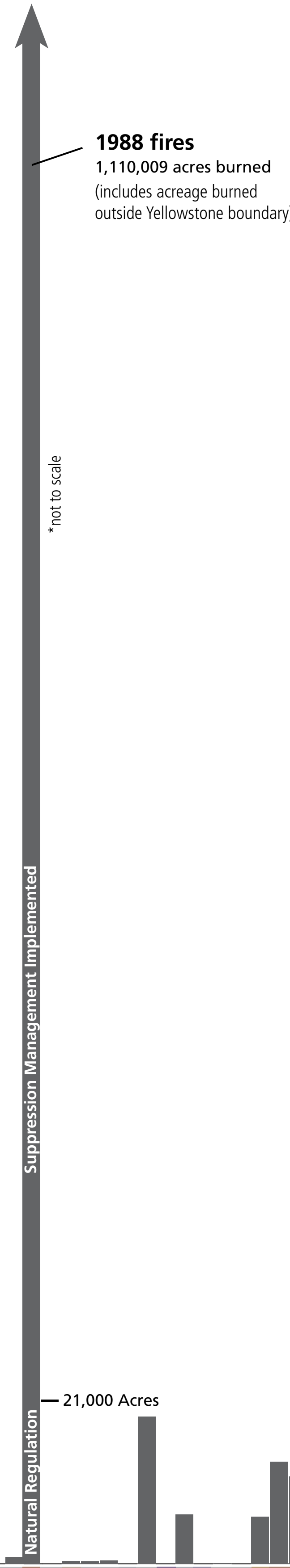
Yellowstone is temporally dynamic. The environment of Yellowstone is constantly changing over a wide span of time scales ranging from geologic time to the almost instantaneous. For example, the "Fire History" and "1988 Fires" topic pages document changes





1988 Fire Progression in Yellowstone





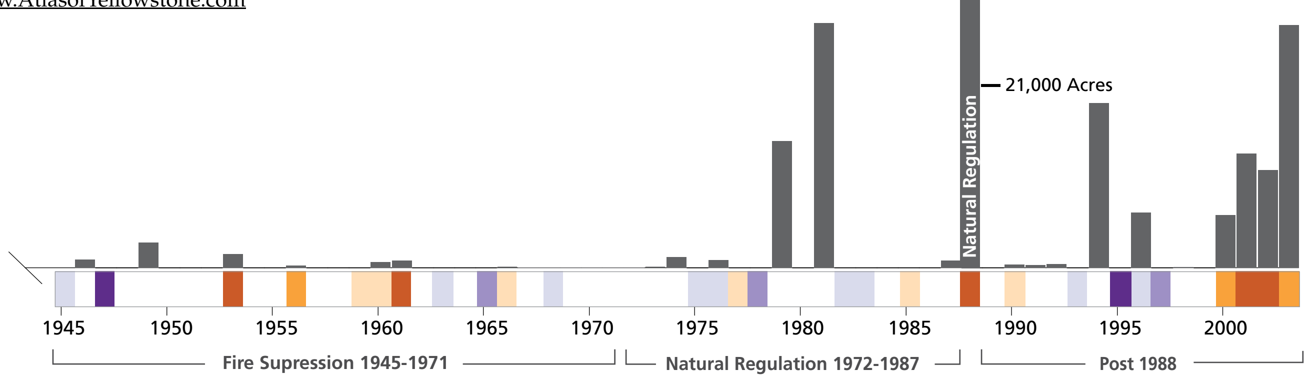
in fire frequency and controls over long periods (from 12,000 years) to monthly and daily for the dramatic 1988 fire season. The maps and graph displayed here in "Visual Fields" are excerpts from the two "Fire" topic pages.

Humans are part of Yellowstone landscapes. Humans have interacted with Yellowstone and the surrounding region since prehistoric times. The "human imprint" theme will demonstrate the complex interplay of the human and natural processes in and around the region and will illustrate how human actions have altered these landscapes.

These four themes provide a general framework that helps editors, experts and cartographers develop story lines and cartographic layouts.

Acknowledgements:
Don Despain, Roy Rankin, and Erik Strandhagen.

www.AtlasofYellowstone.com



Color Figures

Introducing Plan Oblique Relief
Bernhard Jenny and Tom Patterson

Figure 1. Southeastern Oahu, Hawaii, rendered as conventional shaded relief (left), *plan oblique relief* (center), *and as a 3D perspective view* (right).

Figure 2. Xaver Imfeld's "Reliefkarte der Centralschweiz."

Figure 3. A sample from Erwin Raisz's 1957 "Landforms of the United States" (left) *and Heinrich Berann's 1968 "Atlantic Ocean Floor," published by National Geographic Society* (right). *Note that Raisz uses lower left illumination and Berann lower right illumination.*

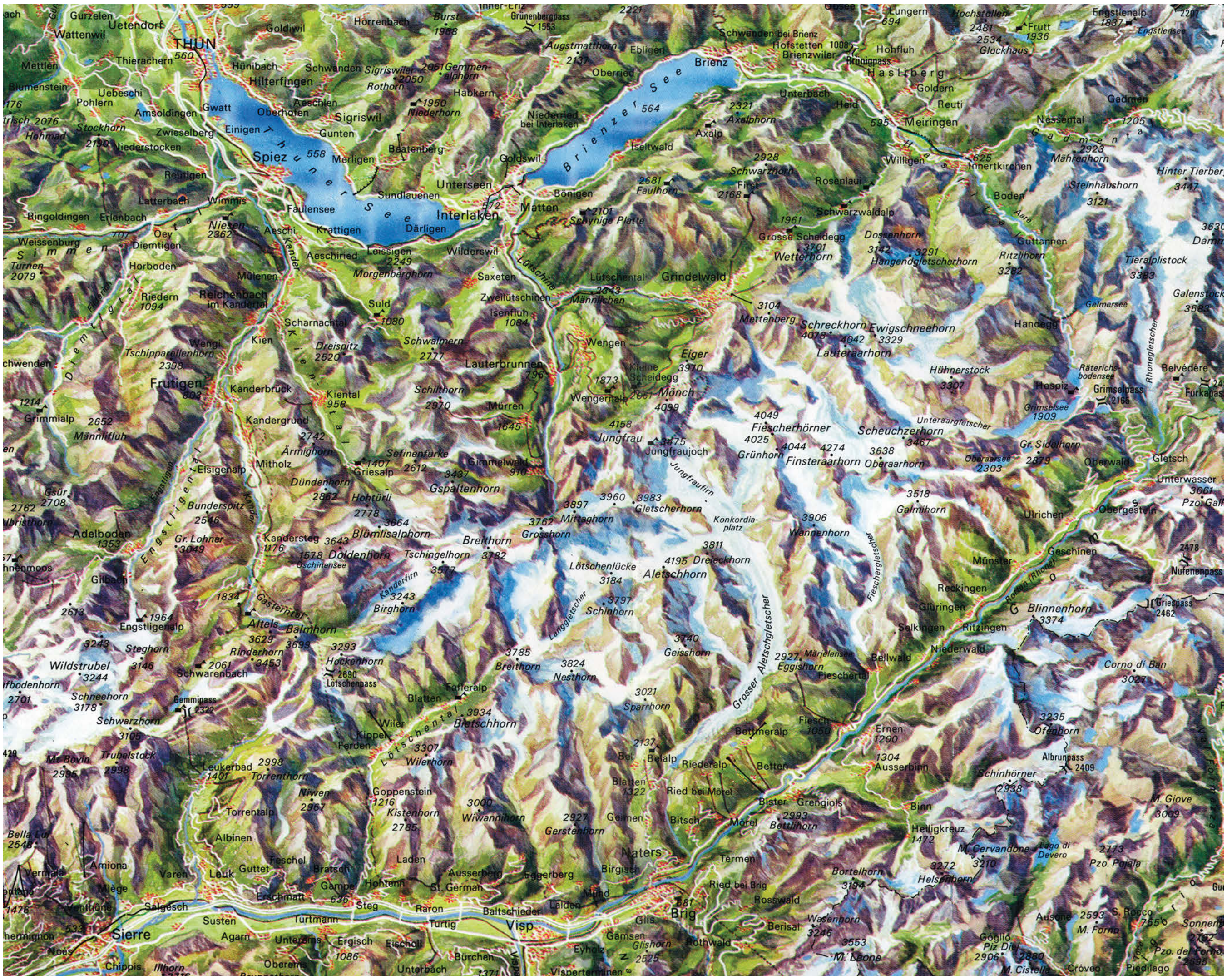


Figure 4. "A Bird's Eye View of Switzerland" by Bruno Kersten.

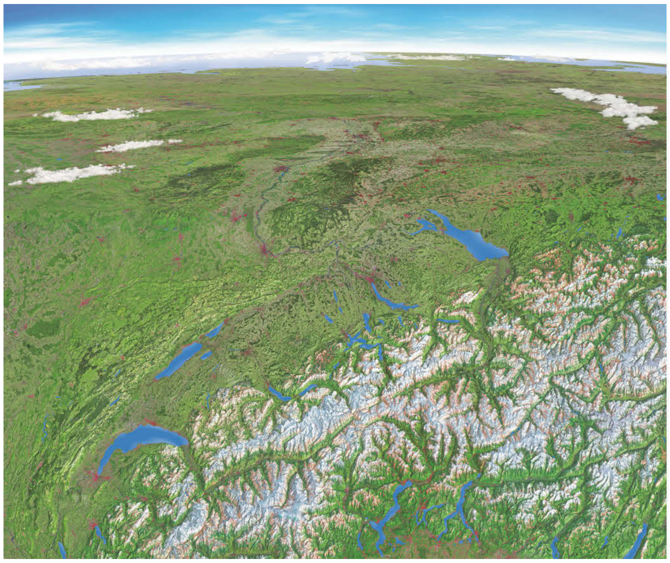


Figure 10. Panorama of Switzerland looking north (left) *and an excerpt from the "Physical Map of the Coterminous United States"* (right).

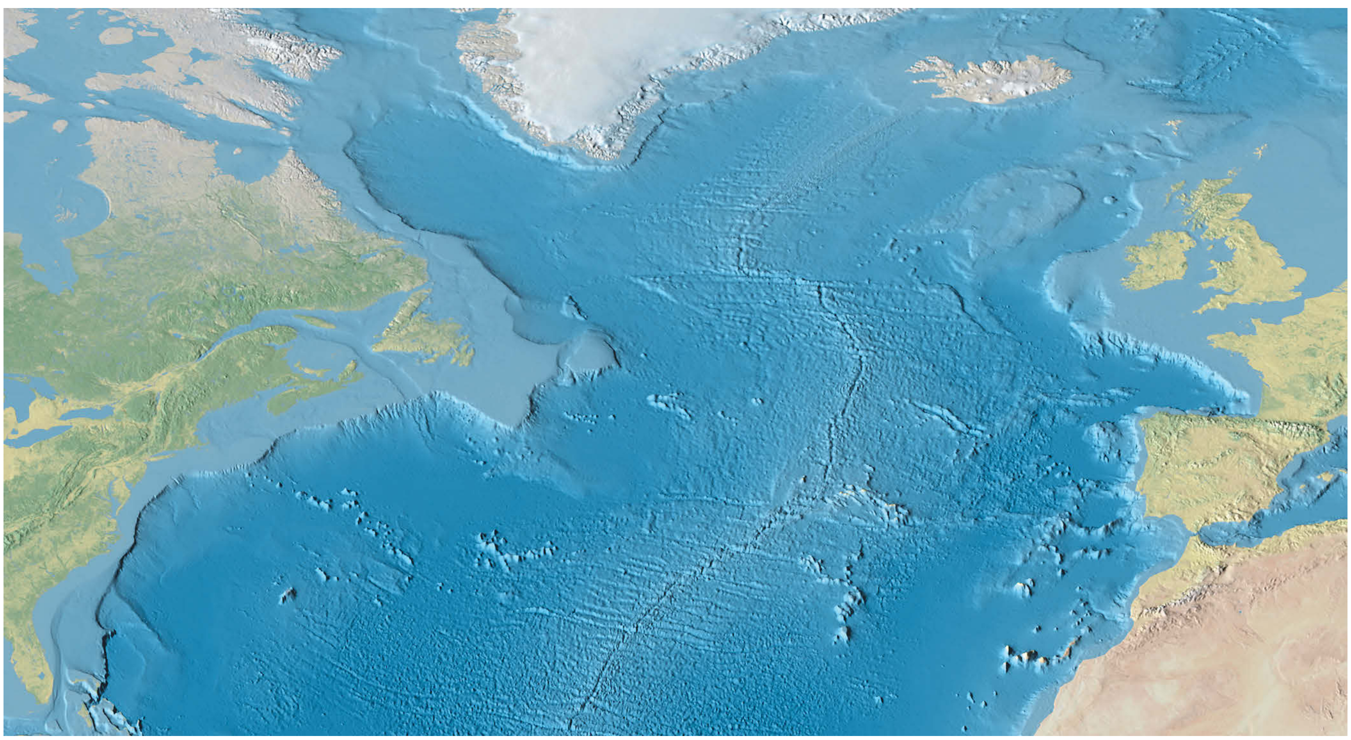


Figure 11. The North Atlantic rendered as a plan oblique relief. For a comparison with Heinrich Berann's work, see Figure 3, right.