

## Outside the Bubble: Real-world Mapmaking Advice for Students

The student maps that I see are generally impressive. Compared to my student maps made back in the dark (room) ages, your maps are technically competent, more ambitious in scope, and innovative. Clearly the technology has improved to a level that student mapping is now less of a production slog and more about design and experimentation, as it should be. However, because you are still a student, your maps are not without problems, often the same mistakes I once made. What follows can help you address these problems.

Some of my advice is specific—nuts and bolts stuff, such as map generalization and text legibility. Other advice is general. Maps made from inside the bubble of a university class differ markedly from those made by careerists in terms of purpose and design. I will discuss what these differences are, why they exist, and the changes students can expect when transitioning to the professional ranks. Map design also gets a lot of ink because it is my passion. As the digital mapmaking craft matures with many of us employing the same software and data, it is design that will most differentiate the maps we create.

In a field as broad and subjective as cartography, we tend to view the world through the lens of our personal experiences. My main focus has been terrain presentation, tourist maps, and print production. I now work for a government agency. Filter what I say accordingly.

### To map is to err

I will begin with a delicate topic—misspellings, poor grammar, and typographical errors. These are all too common on maps, but student maps are among the worst offenders. The consequences of these mistakes are not trivial. One misspelled word casts doubt on all of the map's information despite your careful research. In a map design competition, disqualification will result. Worse, a prospective employer reviewing your portfolio may not hire you. Then there is the embarrassment factor. We all delight in discovering text blunders by *others*—as you just noticed. The more authoritative the document, the more smug we become about its errors. Your map, which many people instinctively regard as an authoritative document, is not immune.

Maps are probably more prone to textual errors than other types of publications. Books, magazines, and newspapers—highly text-centric media—more likely receive proof reading as a matter of course. In contrast, a map's mostly graphical elements may not get close editorial scrutiny. Mapmaking is largely a visual undertaking, and mapmakers may or may not have a bent for the written word. While engrossed in mapmaking, we tend to treat labels as graphical elements, relying on pattern recognition for identification—for example, Vienna and Vlnna have similar forms. Compounding this problem, technical and design issues demand our attention for the greater part of a project. Only at the project's end do labels appear on the map—just when time is running short.

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To minimize text errors, get in the habit of always proofreading your map. Remember: mistakes on a draft map, if caught, you soon forget. If published, they will haunt you forever. On a student map I once misspelled Everett, Washington, as Everet, a transgression that my professor, Dr. Everett Wingert, still reminds me of. And always use spell checkers. If your mapping software has no spell checking, copy and paste the text into software that does. Then ask an erudite, detail-oriented person to read your map. Spell checking alone will not catch the wrong word if properly spelled—for example, on a map of the Wasatch Range, Utah, I once labeled a peak as a peek.

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Focus your map proofreading in the most obvious of places. Titles, legends, large labels, and familiar place names are especially vulnerable to errors. Be on the lookout for labels that you duplicated, dragged aside, and forgot to re-name while placing type on your map. Errors of omission are the trickiest of all to catch. Discovering an inadvertently deleted label is like finding a needle in a haystack—a needle that you can’t see. Other checklist items: make sure that metric/imperial number conversions are accurate, bar scales display the correct length, and legend text matches the symbol it identifies.

### Brief encounters

Perhaps you have experienced something similar to this: You are visiting home from university and proudly unveil the map project you worked on for a gazillion hours, only to have your family give it perfunctory attention. Smarting from the “That’s a very nice map, dear” brush-off, you first might think that you come from a family of incurious dullards. What you in fact experienced is the 500-to-1 rule of mapmaking: for every five hundred units of time you spend making a map, readers will spend one unit looking at it, maybe two if they are loved ones.

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In our busy, media-saturated lives, attention spans have decreased. At Zion National Park, a study of hikers about to set off on a two-hour hike found that slightly less than 50 percent bothered to read the large trail-head map. Those that did look at it did so for an average of 44 seconds (Schobesberger and Patterson, 2008). Attracting reader “eyeballs” challenges all visual media, not just maps: we surf the web, peruse newspapers, flip through magazines, scan TV channels, and “do” the Smithsonian Air and Space Museum in an afternoon. On the positive side, research suggests that maps attract more attention than other media. A study at Yosemite National Park (Hall et. al., 2001), for example, found that a significant factor in whether a pedestrian read an outdoor sign was the presence of a map. (Signs warning of big, dangerous animals were the most popular.) Maps are included in news magazines as visual speed bumps, hoping we will pause long enough to read the accompanying article.

So what should a cartographer do? The trick in such a competitive environment is to give readers reason to slow down and read your map—catch their eye, pique their curiosity, and then draw them in—without resorting to dumbed-down content and cheesy graphics. Even maps on highly specialized topics targeted at small audiences should cater to educated lay audiences, the so-called public television demographic. Human interest is a powerful attractor that you should harness judiciously. For example, knowing what I do today, I would re-title my undergraduate student map “Household income by census tracts in Oneonta, NY, 1978” as “Oneonta 1978—Where we live, what we earn.” Peruse the *Economist* magazine for excellent examples of punchy titling; its editors masterfully hook general audiences to read serious news stories.

Presenting map information with visual hierarchies is a hallmark of good map design, as you have no doubt heard in class. Give the most emphasis to the information that you want someone to remember long after they put down your map. A reader should be able to tell what your map is about instantly and understand its major point within seconds. The finer details will follow if you designed your map properly. These principles also apply to other visual communications. In this article I use subtitles, short paragraphs, and a preference for plain English to entice you to read on—if you got this far, perhaps the technique has merit. Readers should also have the option to cherry-pick information: reading your map should not be an all-or-nothing exercise.

A pleasing color palette is crucial to attract and retain readers. The colors on your map are highly personal, more so than any other design element, providing you with a way to connect with the reader. People respond to colors at an emotional level. If you select the right palette—there is an element of luck involved—they say they “love” your map colors. It’s like a first date: Colors are the pheromones of map design.

A problem we all face when selecting colors is the almost infinite variety in the spectrum. As you experiment with map colors, note the tendency to make each new version of your map more colorful than the last, eventually leading to gaudiness. Avoid using primary colors in their pure form (even the venerable 20 percent cyan water tint benefits from having a little magenta or yellow added to it). If your color sense is not finely honed, find maps with colors that people like and mimic them—sampling colors on raster maps with the eyedropper tool in Photoshop is easy. To obtain good color schemes for choropleth maps, visit the ColorBrewer2.org Web site.

If the above advice seems unseemly or manipulative to you, consider the alternative: no readers at all.

### Stand-up cartography

I see student maps mostly when I am on my feet, either at cartographic conference poster sessions or as a judge of the Cartography and Geographic Information Science Society (CaGIS) Map Design Competition. There is nothing wrong with reading maps while standing up. The problem is that people are sitting down when they design these maps and presume that the readers will be, too.

Cases in point are the *National Geographic* magazine insert maps that feature a collage of text, photographs, and illustrations—a widely admired style now *de rigueur* for student final projects. You see these beautiful maps tacked to walls everywhere—but rarely read. Why? Because the complex information and small type sizes are intended for close-up reading, not for reading by people standing several feet away. When designing your map for a design contest or poster session, consider the possibility that your audience will be upright.

A Darwinian aspect applies to map design contests. You can do things to help judging audiences take notice of your map—and perhaps have it voted best student map<sup>2</sup>. Large size is advantageous—up to a point, because very small maps are easy to overlook amidst the goliaths. People subconsciously expect a winning map to show evidence of considerable work, so the judges look to size as a crude gauge of your sweat-equity labor. For similar reasons maps with sparse information fare less well than maps with dense information—so long as your map isn’t impenetrably complex, cluttered, and illegible. A common pitfall with *National Geographic*-style maps made by students is too little map and too much

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non-map content. This emphasis makes judges look askance. In the color department, brighter, richer hues stand out better in the often poorly lit venues where your map is displayed. Eye-catching colors also help if your map is on exhibit in a public place where people socialize. Conference goers, a group prone to information overload, too little sleep, and too much alcohol, are an especially challenging audience to engage.

Legible labels and text are critical to the success of any map on public display. To make sure your map is readable, print out a draft and view it from some distance away. Limit text on your map to essential information. Lengthy discourses on common data types and software used to create the map fall under the category of “too much information.” Do you really care what word processor I used on this article? Let your map speak for itself.

Avoid “text brick,” long uninterrupted columns of text as impenetrable to readers as brick walls are to pedestrians. Break up your prose into bite-sized chunks. Ridiculously wide lines of text are my pet peeve. Tip: if, when you read a text, your head moves horizontally, you know there’s a problem. Other text advice: Eschew exotic fonts (use sparingly, and only then in titles), use ample leading between lines (a bit more than what you see here), and, most important, set the text in a point size large enough to be read from a comfortable distance.

### Maps for everyone

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The above harangue about text legibility has probably led you to conclude, correctly, that I am middle-aged wearer of eyeglasses. With a significant part of the population in industrialized countries getting on in years, you must make maps that cater to our special needs—and yours, too, eventually.

Are you seeking a job and new avenues for mapping research? Accessibility is a hot topic. The idea of universal design is central to accessibility. At the National Park Service, where the average age of park visitors is older than the national average, the labels on our maps are now a point size or two larger than in decades past. Tactile interaction with maps is encouraged. Solid terrain models of the parks are now touchable by millions of visitors—who I hope regularly wash their hands.

When appropriate and economically feasible, your maps should reach out to the widest possible audience. For example, designing maps with a palette distinguishable by the many people with red-green colorblindness is usually achievable without detracting significantly from the majority experience. And when it is not, the inclusion of symbols, patterns, and other visual cues besides color can help this viewing population (Jenny and Kelso, 2007). Contrary to what my generation was told in map design class, redundancy has its benefits. We all interact with maps differently.

Universal design is not universally applicable to all maps, however. For instance, creating a mountaineering map of K2 with contour lines removed because they are too technical and hard to see would jeopardize the safety of the climbers who rely on them. If you are asked to create specialized maps fundamentally at odds with goals of universal design, the best approach is dual product lines.

Technology in the form of interactive mapping is key to this effort. First, the relatively small size and low resolution of digital displays forces the cartographer to design cleaner and simpler maps. This solution benefits everyone. (Those seeking in-depth information can get it simply by clicking deeper.) Zooming to larger scales solves the problem of legibility. And audio content and text readers improve the map-using experience for people with severely limited vision. It is not too far-fetched to imagine

that location-aware mobile devices soon will direct the sight-impaired and give warnings for site navigation.

### Getting organized

Transitioning from university to a career comes with benefits—most notably getting paid—and the trade-off of having your identity subsumed by an organization. This is not necessarily a bad thing. I am inspired working for the National Park Service, an outfit associated with the likes of John Muir, Theodore Roosevelt, and Stephen Mather<sup>3</sup>. The longer you work for an organization, the more you are identified with it. One personal decision that many of you will face is whether to remain a cartographer or to pursue opportunities within the organization in an unrelated area, often in management. If you cross this Rubicon, you never go back. With fast-paced technology changes, your mapmaking skills soon become rusty. Three people come immediately to mind who used to attend NACIS meetings and who have now moved on to other pursuits in their organizations and are doing well, thank you very much.

As a cartographer in an organization, you will be making maps using new procedures, and the end result will have a stylistic imprimatur not of your own devising. This can be trying if your new employer is using antiquated technology to create maps that are less sophisticated than your student projects. As the cub cartographer, you can often do little to change this situation in the short term: employees with more seniority have staked out their turf, map standards are in place, and production processes have been set. Because most cartographic institutions are inherently conservative, direct challenges to the *status quo* are almost always counter-productive. Change happens one retirement at a time.

A long-term strategy is, first, to gain acceptance as a loyal team player. Depending on where you work, this can take months or even years. Then suggest small changes of a non-threatening nature in collaboration with your boss and colleagues, building on these successes in a gradually more significant way over time. Concurrent to this “sleeper cell” approach, be prepared to spring to action if organizational chaos ensues. Disruptive technologies, reorganizations, and business downturns open the door for overdue change that you can contribute to in meaningful ways.

Compared to your university studies, largely based on the “every person for him/herself” model, working as a cartographer in an organization is highly collaborative. Think Vladimir Ilyich Lenin instead of Ayn Rand. You work with colleagues on teams and have clients to please, consultants to query, and bosses to answer to. Working collaboratively makes it harder to pour your heart and soul into a project. On the other hand, you benefit from the expertise of others. As cartography becomes increasingly interactive and technologically complex, making maps becomes dependent on the specialized talents of more than one person. Outsourcing will become a part of your cartographic life.

### Cartographic triage

Not all maps can receive the full benefit of your flowering cartographic talent. The reasons are many. Too little time and too little money obviously impede cartographic excellence. Poor or unavailable data diminish quality. Without a herculean effort on your part, a map of the Ruwenzori Mountains, where data is scarce, for example, can never have the same polish as a map of Mt. Rainier, where data is plentiful. Geographic reality versus graphic reality is another limiting factor, as any Chilean cartographer who

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has struggled with a landscape-format page can tell you. And sometimes unreasonable client demands come into play.

Accept these mapping limitations and do the best job possible, within reason. A heretical thought: suggest to your clients that they not make a map in favor of text, a chart, photograph, or some other means to convey the information. Some overly ambitious assignments given to cartography students would never fly in the professional world—editors wouldn't allow it. As a cartographic pro you occasionally just need to say no.

An exception to the above: it is not acceptable to make a deliberately inferior map for an obnoxious client. Swallow your pride, do your best work, vent your frustrations privately, and raise your rates if they come back.

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### Be smooth

Those of us with one foot planted in the manual era and the other in the digital era have noticed that today's maps are not as generalized as they once were. In a complete change of emphasis, automated cartographers have replaced the preternaturally smooth lines of manual cartography with those laden with detail (Wingert 2007). Creating small-scale maps from large-scale data is at the root of this problem. An extreme example would be to have microscopic Manhattan Island appear on a page-size world map. The explanation for the past and present generalization deficiencies hinges on two words: extra work. Adding detail to a manual map (not counting hand jitters) requires painstaking tracing at close visual range, hence the overly generalized maps of yesteryear. Removing information from map databases is not quite as onerous but does take extra effort—thus explaining the busy maps that we see today. Both professional and student maps suffer from an excess of detail, as do some of mine.

Another rationalization for not generalizing maps, I suspect, is hesitancy to alter data made by others—who are we to mess with what the scientists at USGS have created? “Best leave things alone,” we tell ourselves. Poor geographic knowledge of the area you are mapping can exacerbate this “hands off” tendency.

Generalizing raster data is relatively easy. For example, shaded relief that when rendered from a Digital Elevation Model (DEM) with too high of a resolution looks like a dense texture instead of recognizable mountains. On small-scale maps, rendering shaded relief from a downsampled DEM fixes this problem. The rule of thumb is for the DEM to be 40- to 50-percent as wide (measured in pixels) as the rendered shaded relief at final size. Generalizing vectors—coastlines, drainages, roads, etc.—is not as easy. The workhorse Douglas-Peucker algorithm developed in 1973 produces spiky, angular lines that are arguably worse than the original detailed data. Line simplification in Adobe Illustrator works well only when applied very lightly. The Web site Mapshaper.org is a better option for vector generalization because it offers the more advanced Visvalingam-Whyatt algorithm (Bloch and Harrower 2006). To get good results usually involves experimenting and using more than one of these tools.

No matter which method or combination of methods you use for generalization, the likelihood of needing manual touchups exists. The broader message here is that you must do what it takes to create a good map by whatever means. If working manually gives you pause, consider this: surgeons using high-tech equipment operate on thousands of patients every day. They are highly trained, consummate professionals. They have no compunction about working with their hands. They improve people's

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lives. Couldn't your automated map with its blemishes benefit from a little cosmetic surgery?

### In pursuit of elegance

An item to put on the list of life's changes you will experience in the next few years is the prospect of becoming a cartographic creature of habit. Like following the same route to work every day or ordering the same item from the menu of your favorite restaurant, all of your maps will carry a distinctive mark. At my office, for example, where there are four cartographers making maps according to general standards—the same fonts, recreational symbols, north arrows, scale bars, etc.—each of us can tell at a glance who made which map. Sometimes the identifying trait is as subtle as a type positioning preference. Outside of an institutional setting, and left to your own inclinations, your maps will become highly personalized, more so as the years go by. Established freelance cartographers known for their unique style of mapping are a prime example. I mention all of this to you because in the next few years the habits you develop will become more or less set. Now is the time to decide the mapping style you wish to exhibit.

I recommend elegance as an ideal to guide your map design. According to Wikipedia:

Elegance is the attribute of being unusually effective and simple. It is frequently used as a standard of tastefulness, particularly in the areas of visual design and decoration. Elegant things exhibit refined grace and dignified propriety.

Elegance is a portable ideal. It can change as your ideas about maps change. Also, it applies to paper maps as much as to map interface design and to map software development. Even those few iconoclasts in the geospatial community who profess disdain for attractive maps (you can identify them by their use of "pretty" and "picture" as pejorative terms) can hardly take issue with the goal of map elegance. Or so I would hope.

Mapping software is both the friend and enemy of elegant map design. GIS software—as we all know—is still a bit rough in its graphics capabilities but improving. And graphical software has its own issues, most notably gimmicks to tempt you. Drop shadows, reflections, glows, transparency, fades, and the like are wonderful when used with restraint. They are abominable when they are not. I would change the former Adobe advertising slogan from "If you can dream it, you can do it" to "If you can dream it, should you do it?"

As you discover new design features in your favorite software, think twice about using them on your next mapping project. In our enthusiasm for a new technique, misapplication is all too easy. One of my least successful maps (the list is long) was a panorama of Dinosaur National Monument created with new 3D software for a landscape best viewed conventionally from directly above. Be patient and file a new technique away in your bag of tricks for use when just the right situation arises<sup>4</sup>.

Part of my job involves art-directing illustrators. Their mockups often show a simplistic elegance not evident in the highly rendered final piece. Knowing how far to push a map's aesthetic bounds is a judgment call—with additional work, your map should become more refined, not less. But graphically overwrought maps are all too common now. Most extreme are those lavishly rendered maps lacking useful information or a message,

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whose sole purpose is to provide viewing pleasure. I call this carto-porn. Although precisely defining this genre is difficult, most of us “know it when we see it.”

While you strive for elegance, you should also work toward creating fault-tolerant map designs. With repurposing of maps now the norm, try to select colors that can withstand shifts in color mode (CMYK, RGB, etc.) and that will display satisfactorily on a range of different media, from paper to iPhones. Think about how legible your map will be when viewed at different scales and display resolutions. Some maps have a superior fault-tolerant design, for reasons I can’t explain. Nonetheless, it is a factor for you to consider.

### Continuing education

Having sermonized at you, I will end by telling you where you can hear other viewpoints on mapping. Attend cartography conferences. The NACIS annual meeting will expose you to a wide range of map topics and map people in a friendly setting. On the other side of the Atlantic in the U.K., the Society of Cartographers conference attracts like-minded participants. For an on-line map community with members from around the world, the Cartotalk.com discussion forum is the place to go, as are excellent mapping blogs too numerous (and sometimes ephemeral) to mention. The ESRI Mapping Center ([mappingcenter.esri.com](http://mappingcenter.esri.com)) offers a wealth of map design and production advice aimed primarily at ArcGIS users.

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Professional journals generally are not a good source of practical mapping information—present publication excepted, of course—for want of relevant articles. Those who make maps don’t much write about them. And those who write, mostly academics, have tenure review committees to think about that do not look kindly on right-brained pursuits, such as map design. A related concern is the many articles containing poorly designed maps and illustrations. This lack of “cartographic cred” sends practical mapmakers the mixed message: do as you read, not as you see. (How to interpret map articles with no maps, such as this one, is for you to decide.) An encouraging sign is the focus that *Cartographic Perspectives* now gives to map techniques and to delivering issues in a more timely fashion, including a free online issue. I encourage you to share your ideas by writing articles, which need not have earth-shattering significance. Short, direct, and helpful will do just fine.

In an on-line survey, mapmakers ranked work experience as the most influential factor in learning map design (Patterson et. al 2007). To capitalize on this, consider taking part in one or more mapping internships to broaden your exposure to new mapping methods. To avoid the trap of working in a self-imposed cartographic ghetto, interact with those in related fields. At the National Park Service, working with GIS specialists, writers, and graphic designers especially has brought tangible benefits to the maps that I make. So, too, has working with outside software developers to improve mapping tools.

In the nature versus nurture debate over what it takes to be a good mapmaker, I am convinced that our craft is learnable. My student maps were lackluster. Although natural talent is obviously advantageous, a motivated person with persistence can excel at making maps—and have lots of fun.

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## Endnotes

<sup>1</sup>The opinions in this article are my own and not those of the U.S. National Park Service, nor do examples necessarily relate to the National Park Service. I borrow examples and tips liberally from the mapping community—my thanks to all of you. Attempts at humor are mine alone.

<sup>2</sup>My advice pertains to traditional paper maps. The CaGIS Map Design Competition has seen an uptick in interactive entries in recent years, some of which have won. This trend will only continue.

<sup>3</sup>Stephen Tyng Mather (1867–1930) was the founding director of the National Park Service, shaping the agency’s modern form.

<sup>4</sup>In counterpoint, risk-averse mapmaking is not good either. Breakthrough map designs will happen only if you stretch your abilities and try new techniques, accepting a few inevitable failures.