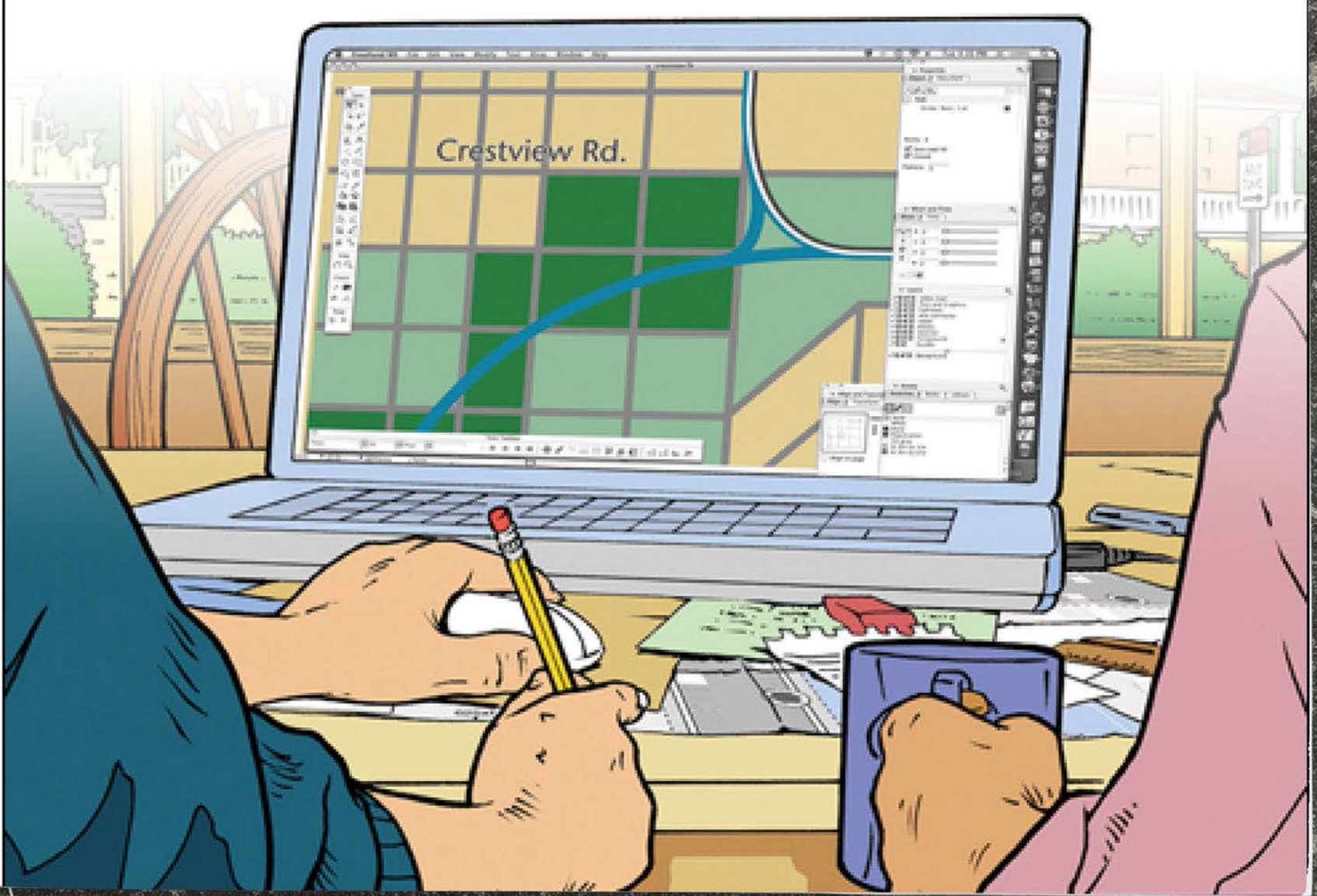
Making MAPS

A Visual Guide to Map Design for GIS

JOHN KRYGIER and DENIS WOOD



Making Maps is Hard

Whether looking at or making maps, there is a lot to see, think about and do. Throughout this book, myriad subjects are considered in general and in relation to The Flight of Voyager map. A systematic critique of an existing map or the successful making of your own map is accomplished by considering the following issues. When making maps, think about everything before starting; Then, when your map is complete, reconsider them all again.

The Whole Map

Write out exactly what the map is supposed to accomplish: Does the map meet its goals?

Are you sure a map is necessary?

Is the map suitable for the intended audience?

Will the audience be confused, bored, interested or informed?

Look at the map in its final medium: Does it work? Has the potential of a black-and-white or color design been reached?

Is the map, its authors, its data and any other relevant information documented and accessible to the map reader?

Look at the map and assess what you see; is it:

- confusing or clear
- interesting or boring
- lopsided or balanced
- amorphous or structured
- light or dark
- neat or sloppy
- fragmented or coherent
- constrained or lavish
- crude or elegant
- random or ordered
- modern or traditional
- hard or soft
- crowded or empty
- bold or timid
- tentative or finished
- free or bounded
- subtle or blatant
- flexible or rigid
- high-contrast or low-contrast
- authoritative or unauthoritative
- complex or simple
- appropriate or inappropriate

Given the goals of the map, are any of these impressions inappropriate?

The Map's Data

Do the data serve the goals of the map?

Is the relationship between the data and the phenomena they are based on clear?

Does the map symbolization reflect the character of the phenomena or the character of the data?

Does the origin of the data – primary, secondary, tertiary – have any implications?

Are the data too generalized or too complex, given the goals of the map?

Is the map maker's interpretation of the data sound?

Are qualitative and quantitative characteristics of the data effectively symbolized?

Have the data been properly derived?

Has the temporal character of the data been properly understood and symbolized?

Is the scale of the map (and inset) adequate, given the goals of the map?

What about the accuracy of the data? Are the facts complete? Are things where they should be? Does detail vary? When were the data collected? Are they from a trustworthy source?

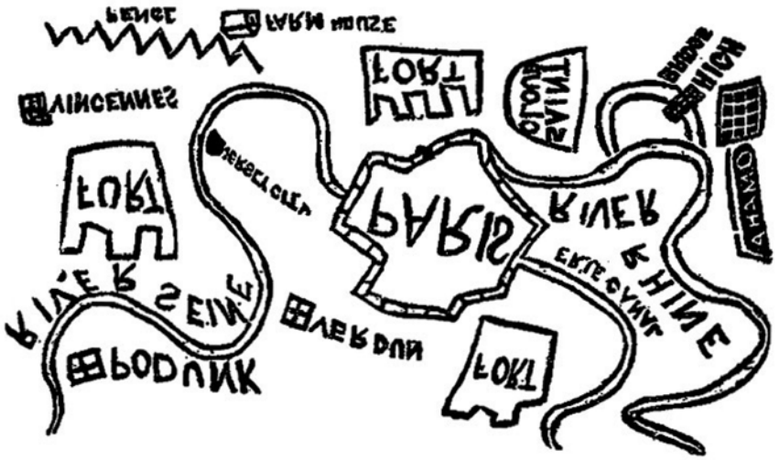
Have you consulted metadata (data about data)?

Does the map maker document copyright issues related to the data?

Is the map copyright or copyleft licensed?

What's Your Map For?

What was Twain's map of Paris for? To make us laugh. But first it was to make Twain laugh. It was a dark time for Twain. "He swung between deep melancholy and half-insane tempests and cyclones of humor." In one of the latter moments, "he got a board and with a jackknife carved a 'crude and absurd' map of Paris under siege." The map was a parody of those found in the newspapers of the time and was wildly popular. Who's your map for? How will you show it? How will you document, evaluate and review it? Your answers will profoundly shape your map.

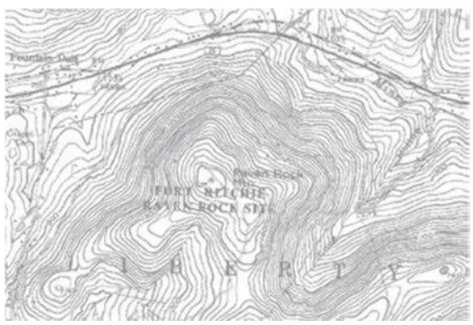


But Do You Really Need a Map?

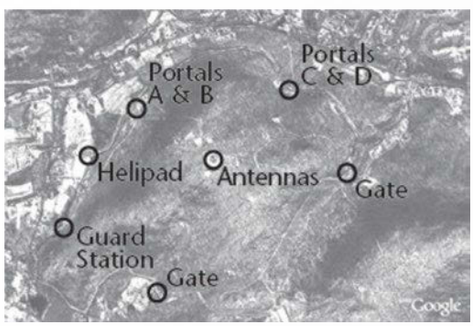
The first thing you need to decide is whether you need a map. You may not. There are secrets that don't want to be mapped. There are circumstances where maps are inappropriate. And sometimes there are more effective ways of making your point: a graph, a drawing, a photo.

The Secret

Sometimes it's better not to map stuff you could easily map. Military sites, sacred indigenous locations and archaeological sites are often left off of maps.



The U.S. Geological Survey topographic map of Raven Rock Mountain in Pennsylvania (above) doesn't show the extensive infrastructure of "Site R" – the bunker where U.S. Vice President Dick Cheney hunkered down after 9/11. Architect John Young tracked down the missing data and mapped it as part of his cryptome.org Eyeballing project (below).



The Silly

"How surprised are you that Chicago has been eliminated from the potential host cities for the 2016 Olympics?"

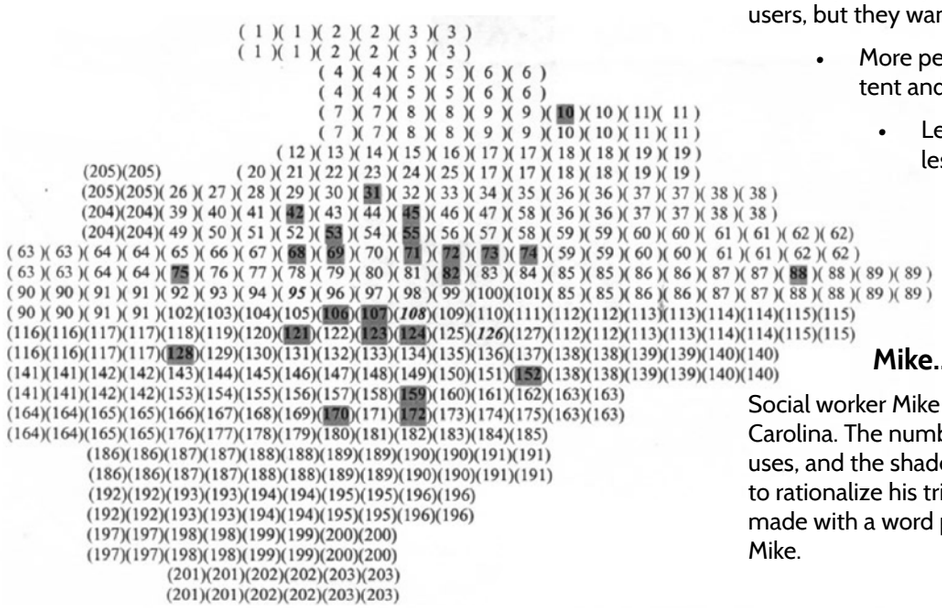
The Not Mappable

Typically land claims by native peoples are accompanied by maps. This is so obviously the place for a map that it seems perverse to question it, but increasingly Indigenous peoples have been arguing that maps can't capture their relationship to the land.

In 1987 the Gitxsan and the Wet'suwet'en in British Columbia entered the Gitxsan adaawk (a collection of sacred oral traditions about their ancestors, histories and territories) and the Wet'suwet'en kungax (a spiritual song or dance or performance tying them to the land) as evidence in their suit seeking title to their ancestral lands. In 1997 the Canadian Supreme Court found that forms of evidence like these had to be accepted in Canadian courts.

Who's Your Map For?

Knowing the intended audience for your map will help you design it. Your audience may or may not be familiar with the area being mapped, an expert on the mapped topic or a novice, an eight-year-old or a college student. In each case, consider how your map can function better for the people who will actually use it.



Experts

Experts know a lot about the subject of the map. Experts are highly motivated and very interested in the facts the map presents. They expect more substance and expect to engage a complex map.

- Less peripheral information on map explaining content and symbols
- More information, more variables of information, more detail
- Follow conventions of experts: consider using a spectral (rainbow) color scheme for ordered data if the user is accustomed to using such colors to show ordered data (such schemes are usually not good for other users)

Novices

Novices know less about the map subject and may not be familiar with the way maps are symbolized. They need a map that is more explanatory. Novices may be less motivated than expert users, but they want the map to help them learn something.

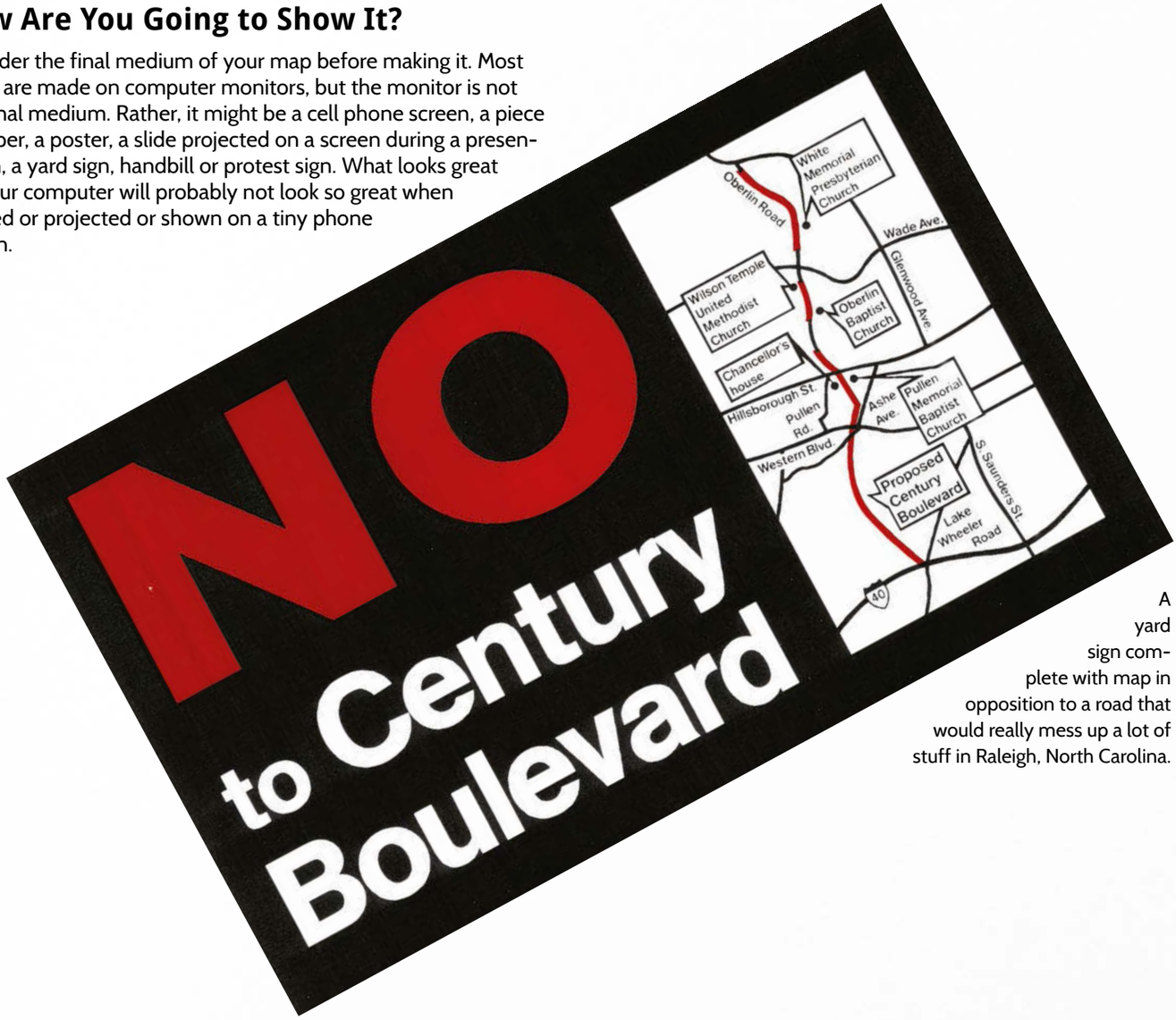
- More peripheral information on map explaining content and symbols
- Less information, fewer variables of information, less detail
- Follow map design conventions, which enhance comprehension of the map

Mike...

Social worker Mike Rakouskas's map of Wake County, North Carolina. The numbers refer to pages in the county street atlas he uses, and the shaded numbers are client sites. He uses this map to rationalize his trip planning and as an index to the atlas. It was made with a word processor. Peculiar! Clever! And perfect for Mike.

How Are You Going to Show It?

Consider the final medium of your map before making it. Most maps are made on computer monitors, but the monitor is not the final medium. Rather, it might be a cell phone screen, a piece of paper, a poster, a slide projected on a screen during a presentation, a yard sign, handbill or protest sign. What looks great on your computer will probably not look so great when printed or projected or shown on a tiny phone screen.



A yard sign complete with map in opposition to a road that would really mess up a lot of stuff in Raleigh, North Carolina.

Black and White, on Paper

Most maps are created on computer monitors, with less resolution and area than is possible on a piece of paper. When paper is your final medium, design for the paper and not for the monitor. Always check design decisions by printing the map (or having your printer create a proof if your map is to be professionally printed). While all computers offer color, final printing with color is not always an option. Don't despair! Much can be done with black and white.

Map size should match final paper size, with appropriate margins.

10-point type works well on a printed map, but you may have to zoom in to see it on the computer monitor.

Point and line symbols can be smaller and finer on a printed map than on the computer.

More subtle patterns can be used than on a computer monitor map.

More data and more complex data can be included on a printed map.

Substitute a range of grays and black and white for color. Remember that printers cannot always display as many grays as you can create on a monitor; subtle variations in grays may not print clearly.

Black will be more intense than white; use white to designate no information or the background, dark to designate more important information.

Monochrome copiers sometimes reproduce gray tones poorly.

Very light gray tones may not print.

Color, on Paper

Color on a computer monitor is created in a different manner than color on desktop printers or on professionally printed maps. Select colors on the computer, then print and evaluate (or ask for a proof). Always design for the final medium: Adjust the colors on the monitor so they look best for the final output. The same colors will vary from printer to printer. Reproducing color is often more expensive than black and white. Finally, keep in mind that users may reproduce your color map in black and white. Will it still work?

Map size should match final paper size, with appropriate margins.

10-point type works well on a printed map but you may have to zoom to see it on the computer monitor.

Point and line symbols can be smaller and finer on a printed map.

More subtle patterns can be used than on a computer monitor map.

More data and more complex data can be included on a printed map.

Use color value (e.g., light red vs. dark red) to show differences in amount or importance. Use color hue (blue vs. red) to show differences in kind. Desktop printers cannot display as many colors as you can create on a monitor; subtle variations in colors may not print.

Dark colors are more intense than light; use light colors to designate less important information and background, and dark to designate more important information.

Never print a color map in black and white; redesign it for black and white.

Computer Monitors

Designing maps for final display on a computer must take screen resolution and space limits into account. Desk or laptop computer monitor resolution is typically 72 dots per inch (dpi), compared to 1200 or more for many printers. Computer monitors also have limited area, typically 7 by 9 inches, or less if the map is displayed in a web browser window. Design a map so that all type and symbols are visible without magnification. Also avoid maps that require the viewer to scroll around to see the entire map. Use more than one map if you need more detail, or consider web tools that allow you to zoom and pan over a map.

The entire map should fit on the screen without scrolling (if pan/zoom is not possible).

Increase type size: 14 point type is the smallest you should use on a monitor.

Make point and line symbols 15% larger than those on a paper map.

Use more distinct patterns: avoid pattern variations that are too fine or detailed.

You may have to limit the amount and complexity of data on your map compared to a print map.

Use color but remember that some monitors cannot display billions of colors; subtle color variations may not be visible on every monitor.

White is more intense than black. Take care when using white to designate the lack of information or as background color, it may stand out too much.

Save static maps for the internet at 72-150 dpi. Size the map to fit in a browser window.

Design your map so it works on different monitors (RGB, LCD, portables).

Interactive maps require attention to additional issues, such as pan, zoom, interactivity, etc.

Portable Monitors

Maps on smart phones, PDAs, GPS units, and other portable devices pose the same design challenges as on desktop monitors, with the further limitation of screen size. Typical portable monitor sizes are shown on this spread. Many portable monitors are touch-sensitive, allowing users to pan and zoom, thus overcoming some of the limitations of the small monitor size.

Static maps on portable devices can follow desktop monitor design guidelines, taking into account 'the limited display size into acount.

Interactive maps should use appropriate interface metaphors: Zooming in is "up" on a slider bar, or two fingers diverging outward. Pan is touch and slide in the appropriate direction.

Interactive maps should vary map design specifications with scale.

Generalize more as the user zooms out on the map: For example, local roads and road names disappear when zoomed out.

Generalize less as the user zooms in on the map: Local roads and their names appear when zoomed in.

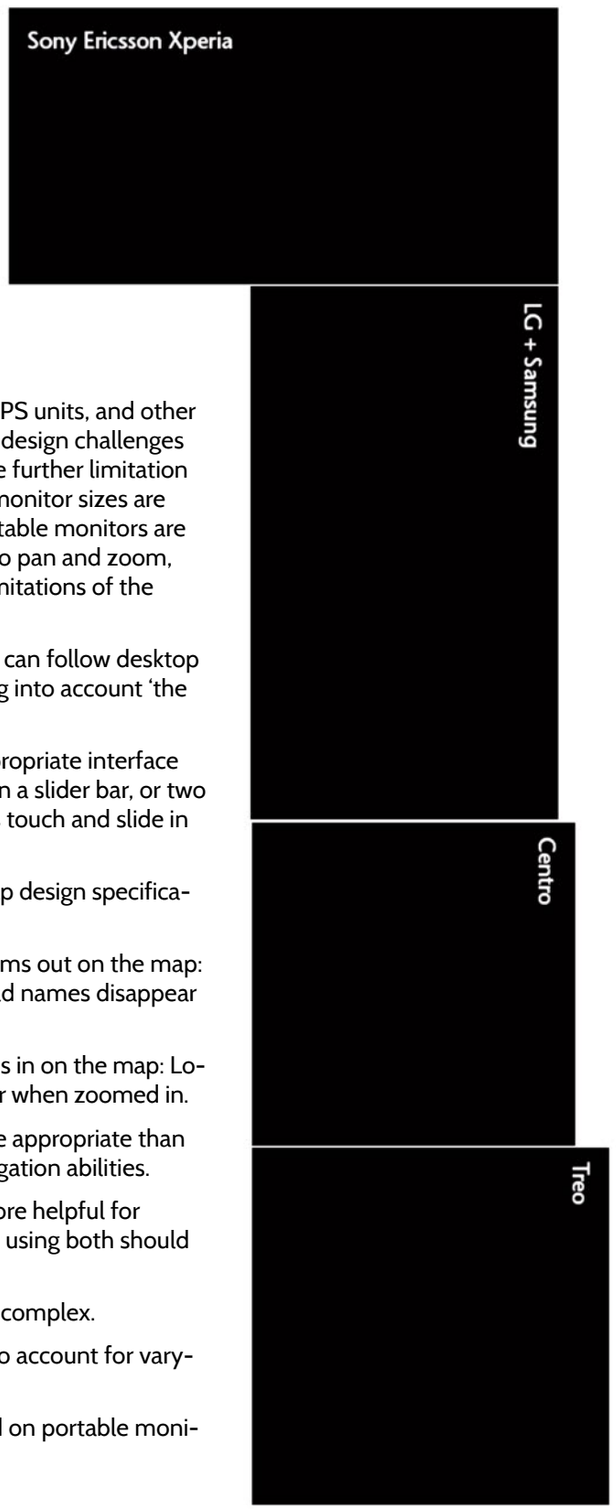
Aerial photographs may be more appropriate than maps for users with limited navigation abilities.

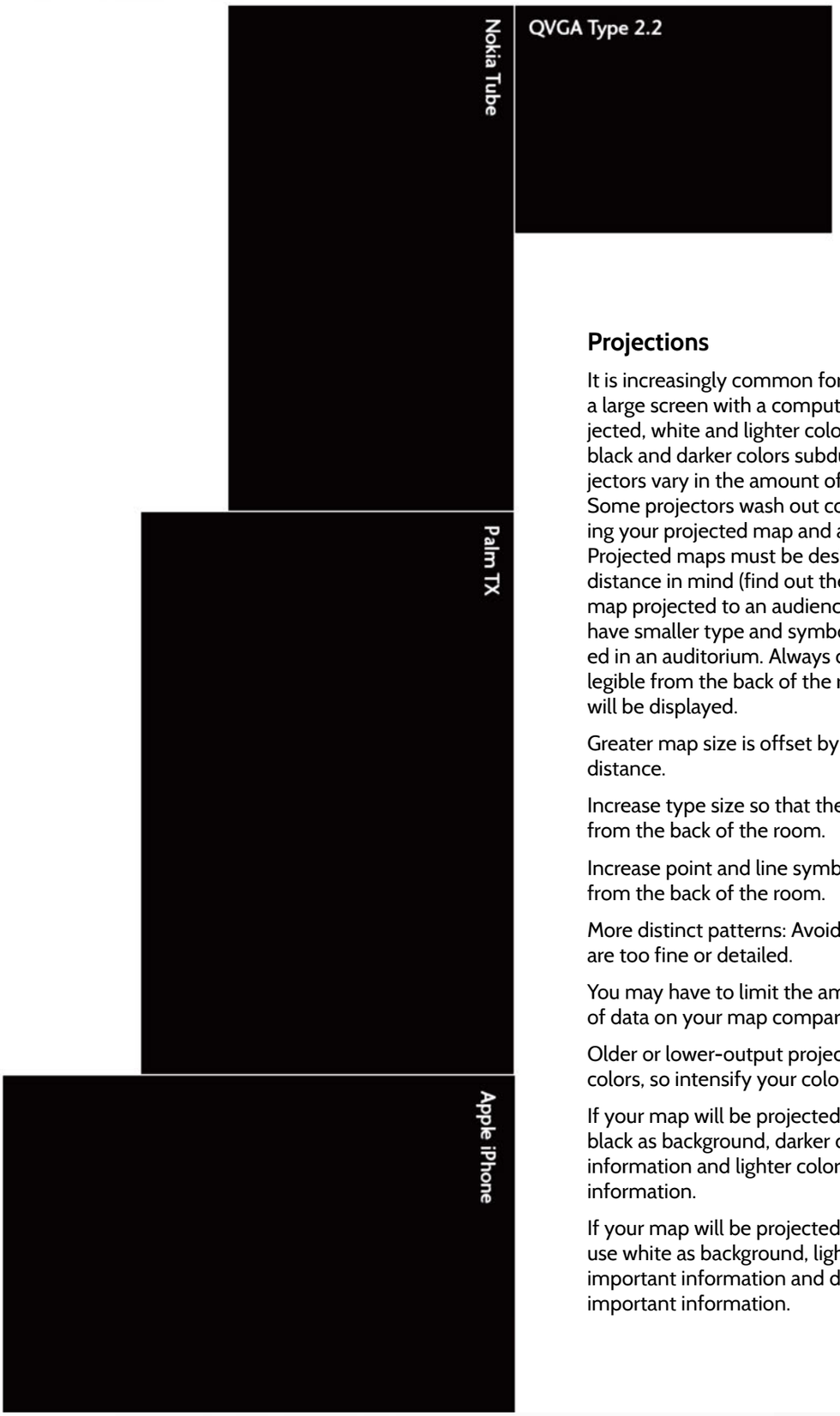
Ground-view images may be more helpful for navigation than maps alone, but using both should increase navigation success.

Map symbols should not be too complex.

Colors should be more intense to account for varying lighting conditions.

Serif fonts may be easier to read on portable monitors than sans serif.





Projections

It is increasingly common for maps to be shown on a large screen with a computer projector. When projected, white and lighter colors will be more intense, black and darker colors subdued. Computer projectors vary in the amount of light they can project. Some projectors wash out colors. Consider previewing your projected map and adjusting the projector. Projected maps must be designed with the viewing distance in mind (find out the size of the room). A map projected to an audience in a small room can have smaller type and symbols than a map projected in an auditorium. Always check that the map is legible from the back of the room in which the map will be displayed.

Greater map size is offset by the increased viewing distance.

Increase type size so that the smallest type is legible from the back of the room.

Increase point and line symbol size to be legible from the back of the room.

More distinct patterns: Avoid pattern variations that are too fine or detailed.

You may have to limit the amount and complexity of data on your map compared to print maps.

Older or lower-output projectors may wash out colors, so intensify your colors for projection.

If your map will be projected in a dark room, use black as background, darker colors for less important information and lighter colors for more important information.

If your map will be projected in a well-lighted room, use white as background, lighter colors for less important information and darker colors for more important information.

Posters

Posters are similar to projected maps, although usually viewed in well-lighted conditions. Viewers should be able to see key components of the map (such as the title) from afar, then walk up to the map and get more detail. Design the poster so information can be seen both close and at a distance. The size of poster maps is limited by the largest printer you can use; always check color and resolution of the printer used to reproduce your poster. You may want to request a test print of the colors you plan to use to evaluate your color choices.

Design map title and mapped area so they are legible from across the room.

The majority of type, point and line symbols should be slightly larger than on a typical printed map but not as large as on a monitor or projected map. Design this part of the map so it is legible at arm's length.

More complex information can be included on a poster map than on a computer monitor or projected map.

Follow color conventions for color-printed maps. Most posters are viewed in a well-lighted room, so use white as background, lighter colors for less important information and darker colors for more important information.

Left: A portion of the poster-sized map Guide Psychogeographique OWU, made by a group of middle-school students and John Krygier during a summer class, Mapping Weird Stuff, at Ohio Wesleyan University, June 2009.

Document, Evaluate, Review

Constantly cast a critical eye on your work. Document what you do and continually evaluate whether the map is serving its intended goal, meeting the needs of its intended audience and working well in its final medium.

NASA's Bob Craddock set about revising a 1986 map of Mars with new imagery from the Viking Orbiter. Craddock transferred details from the 1986 map while referencing his new data, drawing lines and labeling what he thought he saw, evaluating the data as he worked. Craddock used the old interpretations when the new data supported them and modified features clarified by the new data.

When complete, the new map was sent to other experts for review and evaluation. The reviewers annotated the map wherever they disagreed with Craddock's interpretations or saw alternatives. Craddock, in turn, revised his map with the reviewers' comments, not necessarily agreeing with all of them but, in the end, producing a map of the geology of Mars that was better because of the expert evaluation and review.

Documentation

What were those six great shades of red I used on that map I made last month? What font did I use on the last poster map I made? How big was the title type? How long did it take me to make that map for the annual report last year? Where did we get that great data set? Was it licensed? Who printed that large format map for us last year? How much did it cost to print and fold those color maps?

Documentation of the details involved in making a map may seem tedious but can save time and effort in future map making, both for yourself and others who may need to make similar maps. Working toward a few general styles that are effective for specific types of commonly produced maps is useful. Documentation of mapped data is vital if the map is to be published.

Documenting General Issues

Document your goal for the map and

...the intended audience and what you know about them

...the final medium and details about the medium that will affect map design and reproduction

...the amount of time it takes to create the map, and any major problems and how you solved them

Keep copies of the map as well as information on where it was published or presented

Documenting Data

Document the source of the data, including contact information and copyright information

...the age, quality, and any limitations of the data

...how the data were processed into a form appropriate for mapping

...map projection and coordinate system information

Documenting Design

Document specifics of map size, scale, and sketches of layouts

...a list of information on the map, arranged in terms of importance, and associated symbols

...data classification and generalization information

...sources and details of map symbols

...details of type size, font, etc.

...color specifications for all colors used

...design problems encountered and solutions

...software problems encountered and solutions

Formative Evaluation

Ongoing formative evaluation is as simple as asking yourself whether the map is achieving its goals throughout the process of making the map. Formative evaluation implies that you will "re-form" the map so it works better or maybe even dump it! It is never too late to bail out if the map is not serving your needs. It is a good idea to ask others to evaluate your map as well: What do you think of those colors? Can you read that type from the back of the room? Does what is most important on the map actually stand out? What is the boss going to think? Simply engaging your mind as you make your map, and being open to critique and change, will lead to a better map.

Ask yourself...

Is this map doing what I want it to do?

Will this map make sense to the audience I envision for it?

How does the map look when printed, projected, or viewed in the final medium, and what changes will make it better?

Are the chosen scale, coordinate system and map projection appropriate?

Do the layout of the map and the map legend look good? Could it be adjusted to help make the map look better and easier to interpret?

Does the most important information on the map stand out visually? Does less important information fall into the background?

Are data on the map too generalized or too detailed, given the intent of the map?

Does the way I classified my facts help to make sense of them? Would a different classification change the patterns much?

Do chosen symbols make sense, and are they legible?

Is the type appropriate, legible, and is its size appropriate, given the final medium?

Is color use logical (e.g., value for ordered data, hue for qualitative data) and appropriate, and will the chosen colors work in the final medium?

Do I want a series of simpler maps, or one more complicated one?

Is a handout map needed, if presenting a map on a poster or projected?

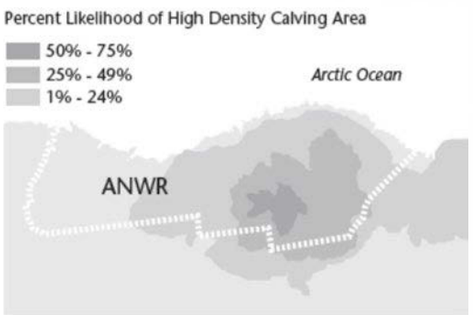
...then re-*form* your map.

Impact Evaluation

Impact evaluation is a range of informal and formal methods for evaluating the finished map. It may be your boss or a publisher reviewing the map, or it may be public feedback on the efficacy. You should begin any map making with a clear sense of who may have the final say on the acceptability of your map, and factor in their wants, needs, and requirements at the beginning of the process.

Caribou Calving Areas

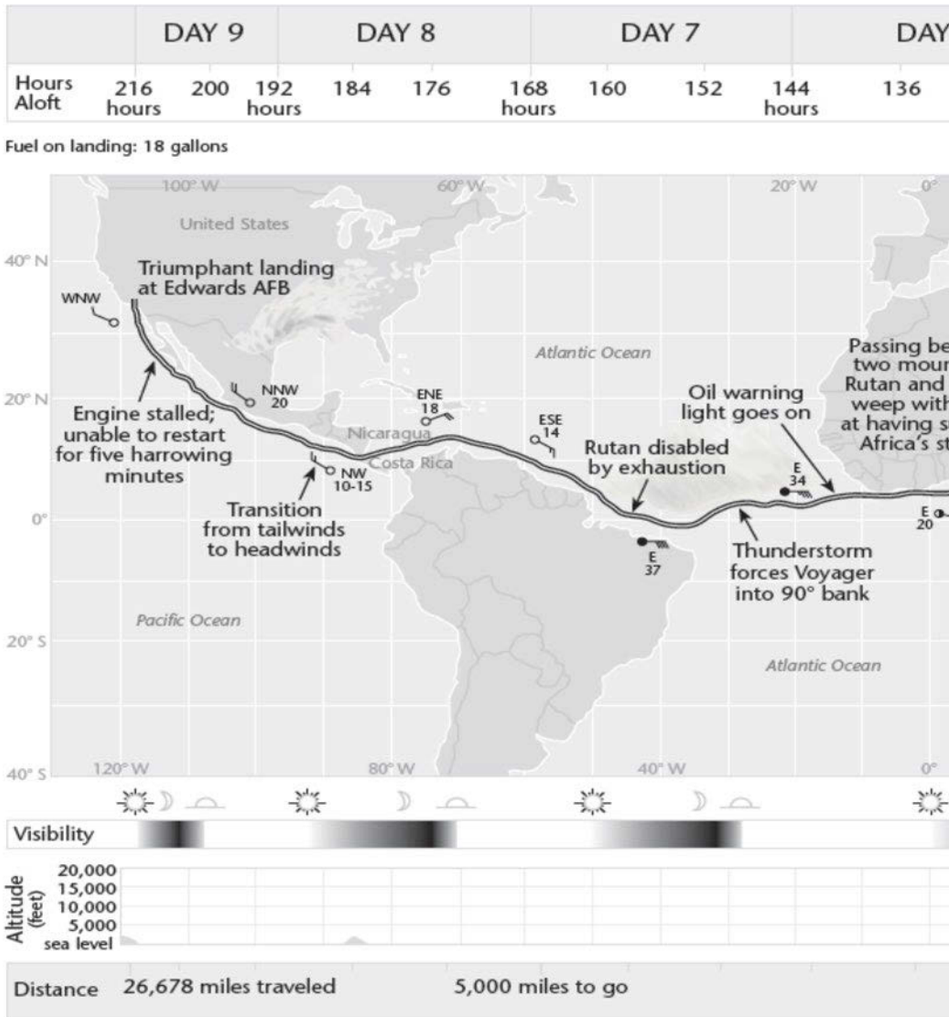
Arctic National Wildlife Refuge (ANWR)



Ian Thomas, a contractor for the U.S. Geological Survey, was fired, allegedly for making maps of caribou calving areas in the ecologically and politically sensitive Arctic National Wildlife Refuge. Thomas argues he was fired for publicizing facts that would undermine the push for oil exploration in the refuge. Others claim the maps were of out-of-date information beyond Thomas's area of expertise and had nothing to do with his being fired. In either case, it is obvious that making maps can piss off your boss.

An old Japanese map from the David Rumsey digital map collection was added to Google Earth in early 2009. A label on the map described a village as populated by "eta," the untouchable caste of burakumin (translation, "filthy mass"). Because some idiots in Japan discriminate against the burakumin, it is common practice to remove such references. Rumsey initially decided not to censor the map, but after an uproar the offending nomenclature was removed.

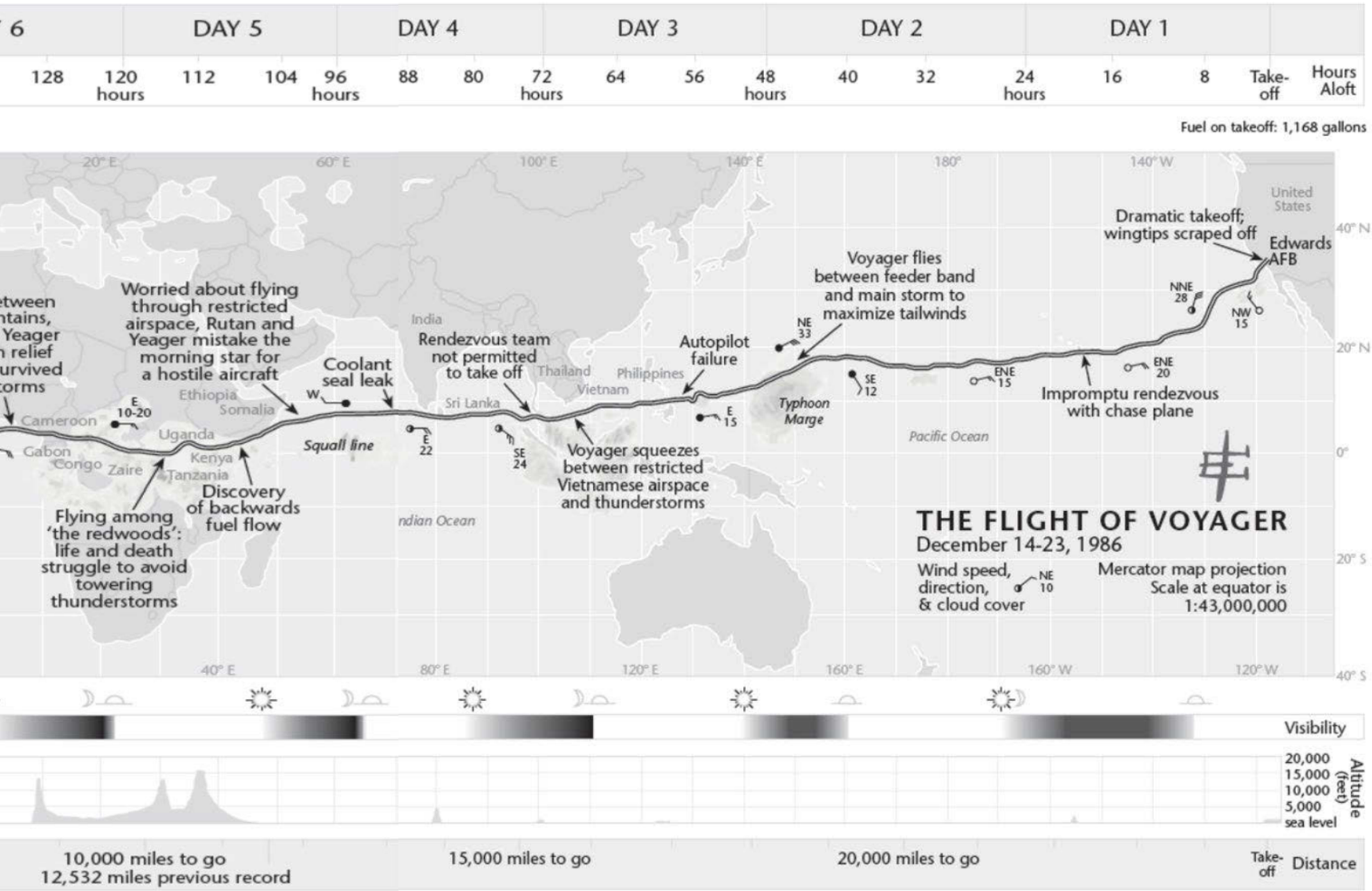
The Flight Of Voyager map was published in 1987 in the book *Voyager* by Jeana Yeager, Dick Rutan and Phil Patton.



David DiBiase and John Krygier designed and made a map to tell the story of Voyager and its pilots. The map was created for a map design course at the University of Wisconsin-Madison taught by David Woodward.

The map was split between the front and back book end-papers, half in the front and half in the back. Each endpaper was 9" high and 12" wide.

The map was designed to be viewed at arm's length.



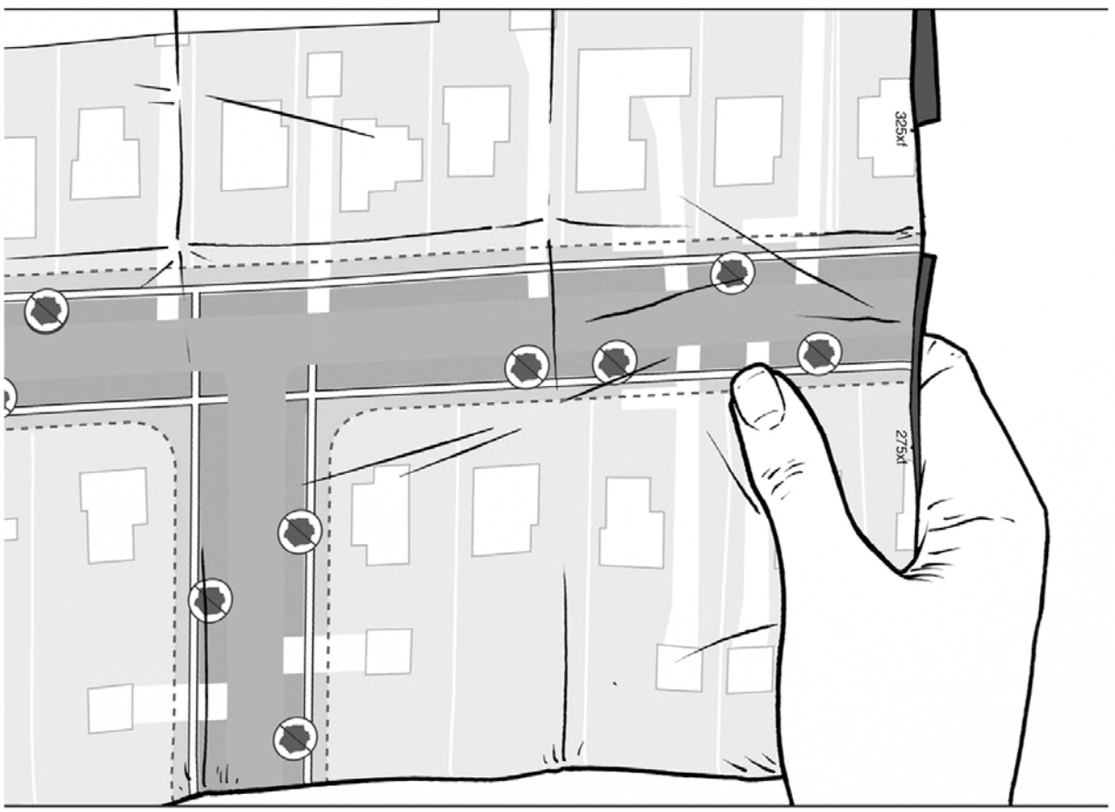
-Madison, 1987

Voyager pilots: Dick Rutan and Jeana Yeager
Voyager designer: Burt Rutan

The map was made for readers of the book *Voyager* (1987) with its general, educated audience, including those with a specialist interest in flight and aerospace. Given the audience, the map was designed to contain a significant amount of information, including detailed data, sure to resonate with pilots.

The publisher of Voyager, Knopf, allowed us black and one color for the map. We chose deep red for the most important information (such as the flight path and related text). The map was redesigned in monochrome for Making Maps, 2nd Ed. The map still works!

Details of the design of the map – line weights, type size, percent gray of different areas on the map, etc. – were documented, as we were taught in David Woodward's course and at the University of Wisconsin-Madison Cartographic Lab. Formative evaluation was ongoing throughout the process, and the editors at Knopf provided the final edit and evaluation of the map.



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