









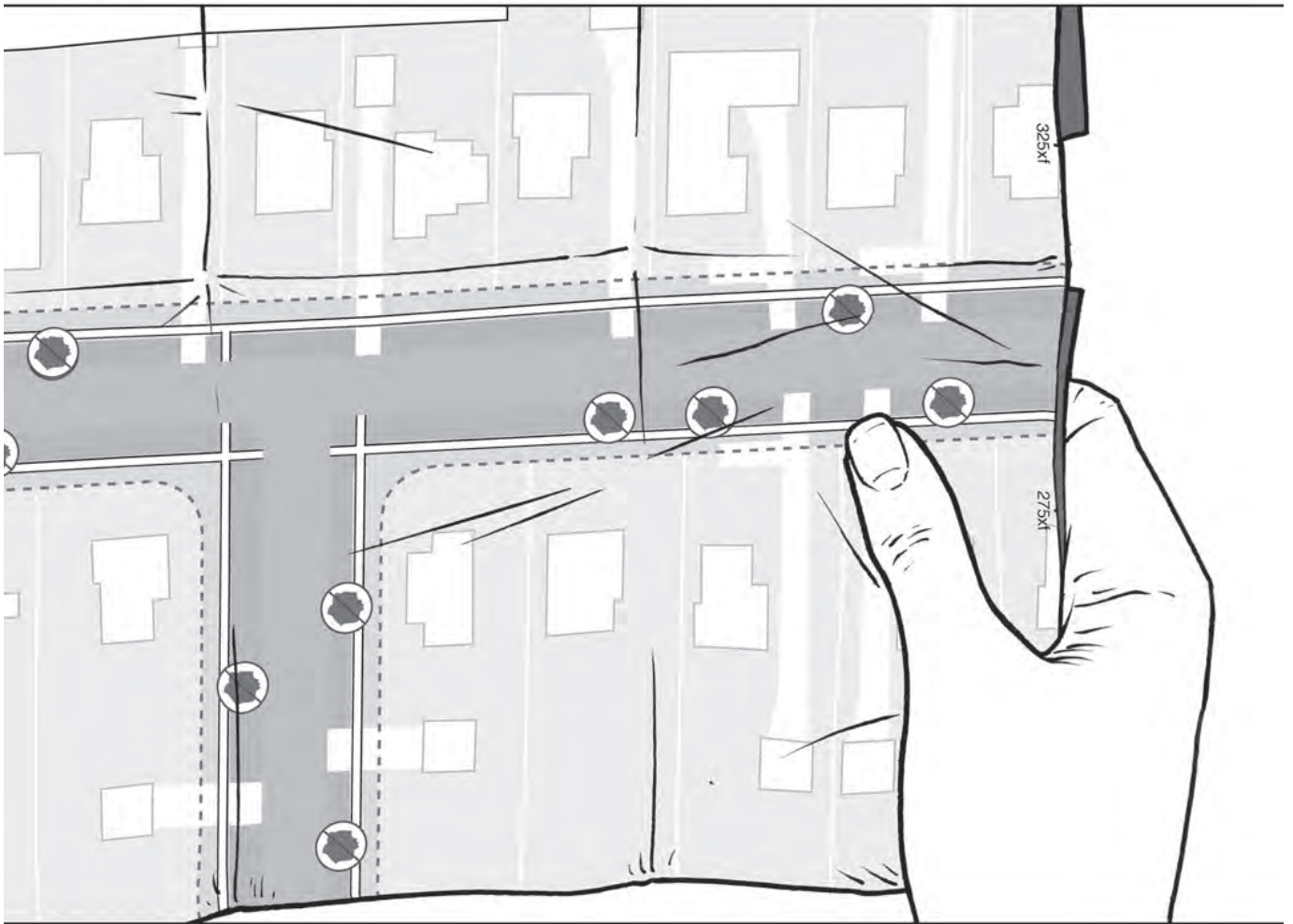




They want to widen  
Crestview to four lanes!!!







Susan, calm down. It's just a proposal.  
No one's ever going to do that.





325x1

Jaki, what are you talking about!?  
It's on this map I downloaded from  
the city's website. It goes *right*  
*through my yard!!*

275x1





It's just a proposal, Susan. We'll come up with our own and make a map for the City Council just as official-looking as the planning department's. They'll have to listen to us. It's all in this book I just picked up at the bookstore, *Making Maps*.

Third Edition

# *Making* **MAPS**

A Visual Guide to Map Design for GIS



**JOHN KRYGIER** and **DENIS WOOD**



THE GUILFORD PRESS  
New York London





Copyright © 2016 The Guilford Press  
A Division of Guilford Publications, Inc.  
370 Seventh Avenue, Suite 1200, New York, NY 10001  
[www.guilford.com](http://www.guilford.com)

All rights reserved

No part of this book may be reproduced, translated, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, microfilming, recording, or otherwise, without written permission from the publisher.

Printed in the United States of America.

This book is printed on acid-free paper.

Last digit is print number:

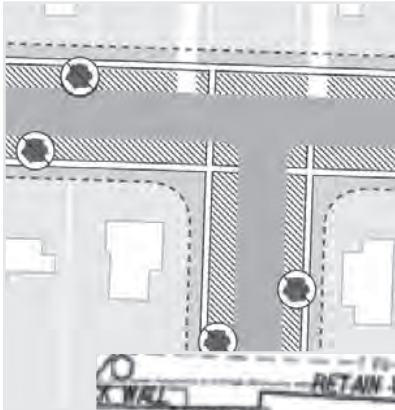
9 8 7 6 5 4 3 2 1

Library of Congress Cataloging-in-Publication Data  
is on p. 293

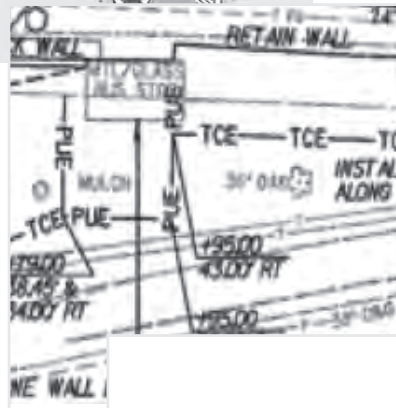
# It's Time to Make Maps...

People communicate about their places with maps. Less common than talk or writing, maps are made when called for by social circumstances. Jaki and Susan are making maps to protect their neighborhood. Why a map? Because the city used a map. The map unambiguously expresses the city's intentions to widen Crestview Road, drawing from the maps, talk, and text of city planners. If the plan is realized, the city will also use maps to communicate its intentions to surveyors, engineers, contractors, utility companies, and others.

The maps are all of Crestview Road – all of the same place – and the maps are all different. Yet they are all equally good. Different goals call for different maps: the quality of a map is frequently a matter of perspective rather than design. Think of a map as a *kind of statement locating facts*. People will select the facts that make their case. That’s what the map is for: to make their case.



The city's case is that Crestview Road needs to be widened. They present their plan as "a new vision," an enhancement, different and better.



The city communicates to construction firms and utilities with detailed maps, making the case that the planners and engineers have done their work.

Jaki and Susan's case is that widening Crestview Road would be a terrible mistake. Time to make a map!

## Making maps, making your case...

## Different Goals Call for Different Maps

Jaki and Susan soon realize the plan to widen Crestview is but a piece of a larger plan to redevelop the northern and western suburbs of the city. The key feature of the plan is a connector (in solid black, below) proposed to link two major roads. Different groups create equally effective maps to articulate their different perspectives on the proposed road. Though the maps may seem polemical, isolating the facts each presents is useful in focusing debate.

**Goal: keeping costs low.** A city map shows that its plan is the shortest and least costly route for the connector. The city's map focuses on moving traffic at the least cost to taxpayers.



Property Values    ■ high    ■ med.    ■ low

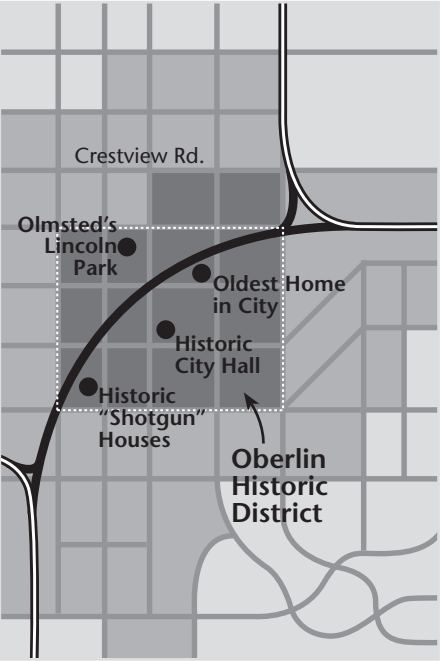
**Goal: defending neighborhood integrity.** An African American community map shows how the connector rubs salt in the wound sustained by the earlier imposition of the arterial highway. The focus of their map is the further destruction of their neighborhood by the proposed connector.



% African American    ■ high    ■ med.    ■ low



**Goal: maintaining historic continuity.**  
The Society for Historic Preservation’s map shows how the connector will affect significant properties in an existing historic district. Their map focuses on the adverse effect on significant properties and on the integrity of the historic district.

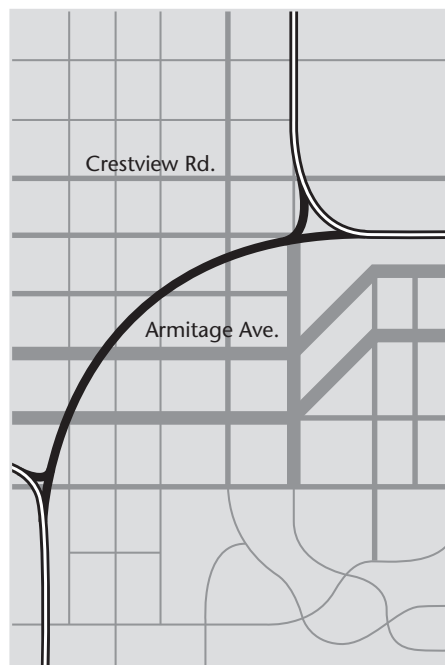


% Historic Buildings    high    med.    low

**Goal: protecting endangered wetlands.**  
An environmental group shows that the connector will violate the city’s policy of avoiding road construction in floodplains. The Oberlin Creek watershed, already greatly impacted by over 100 years of urban growth, cannot withstand a further onslaught of development.

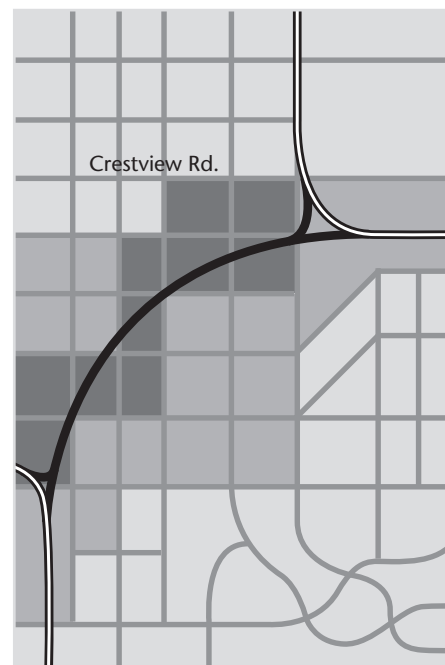


**Goal: defending their street.** Jaki and Susan's first map scales roads to show existing traffic counts. It suggests how much more effective it would be to widen Armitage Avenue, a street already tied into the downtown grid. Their aim is to divert attention from Crestview Road.



Daily Traffic Counts  
 ■ high ■ med. ■ low

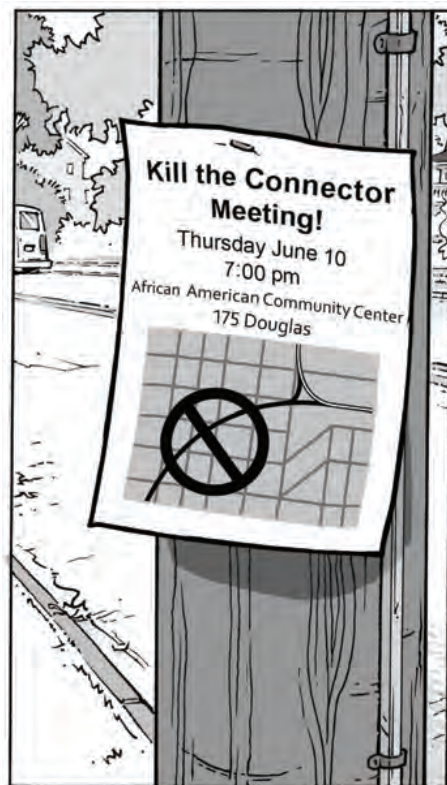
**Goal: defeating the connector.** Aware of the connector's key role in motivating the widening of Crestview, and informed by the maps produced by other groups, Jaki and Susan realize it's less that Crestview needs defending and more that the connector needs defeating: low property values correlate with historic discrimination against African Americans, with older housing, and the floodplain. The connector exploits this nexus: their new map focuses on social and environmental justice. Jaki and Susan work out a "Social and Environmental Justice Sensitivity" metric, taking into account race, history, and environmental factors.



Social and Environmental Justice Sensitivity  
 ■ high ■ med. ■ low

**Goal: defeating the connector.** When they moved from defending Crestview to defeating the connector, Jaki and Susan realized they'd shifted their attention from their neighborhood to the larger community. At first this alarmed them – maybe they were overreaching – but once they realized they could find allies in the African American community, among the historic preservationists, and in the environmental group concerned with the floodplain, they got excited.

All the groups concerned with the city's plan got together at the African American Community Center. Jaki and Susan's Social and Environmental Justice map helped everyone see they shared a common problem. Everyone's map making had made a difference!





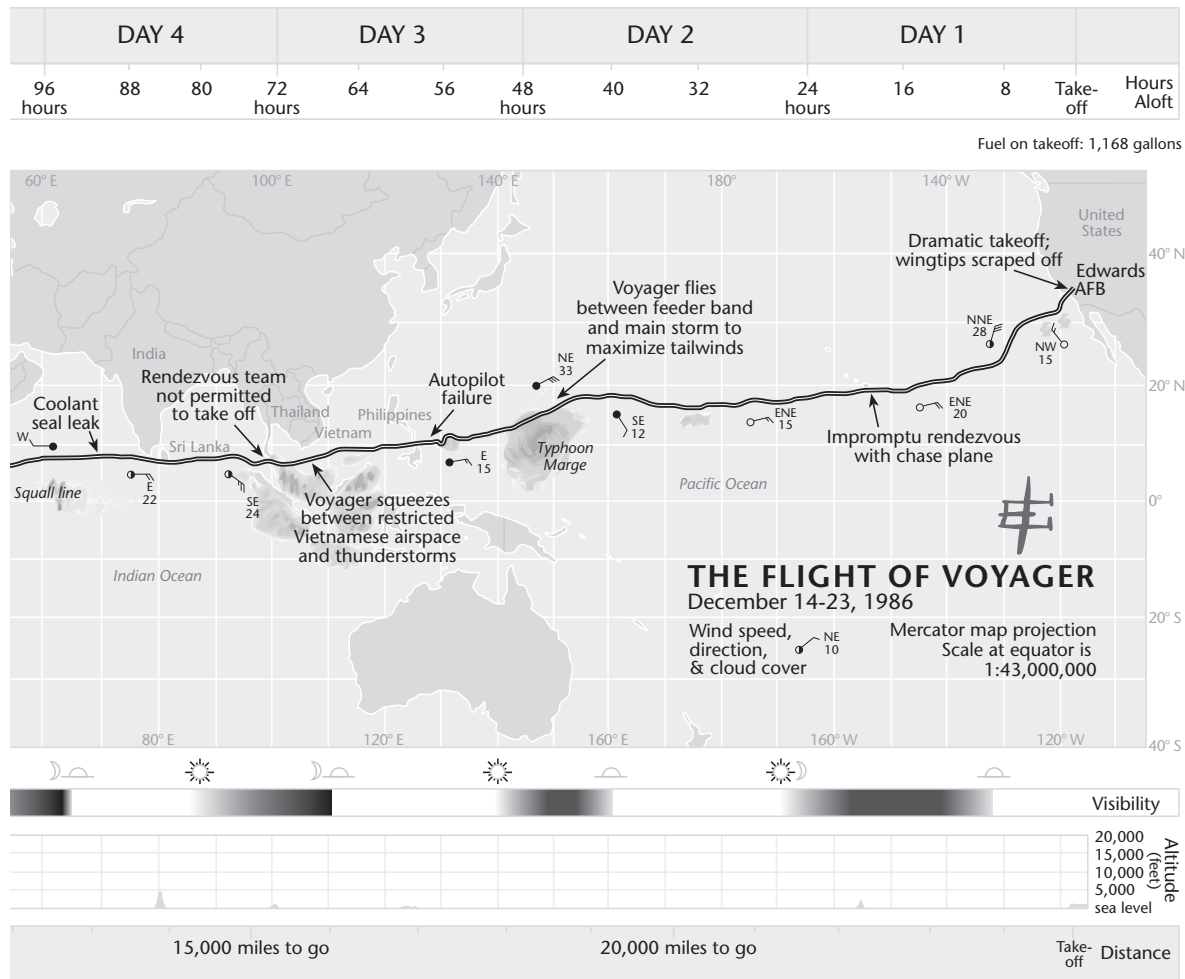


## Contents

1	How to Make a Map	20
2	What's Your Map For?	32
3	Mappable Data	56
4	Map Making Tools	82
5	Geographic Framework	94
6	The Big Picture of Map Design	122
7	The Inner Workings of Map Design	140
8	Map Generalization and Classification	160
9	Map Symbolization	184
10	Map Symbol Abstraction	202
11	Words on Maps	232
12	Color on Maps	252
	A Note to the Users of <i>Making Maps</i>	283
	Acknowledgments / About the Authors	284
	Index	285

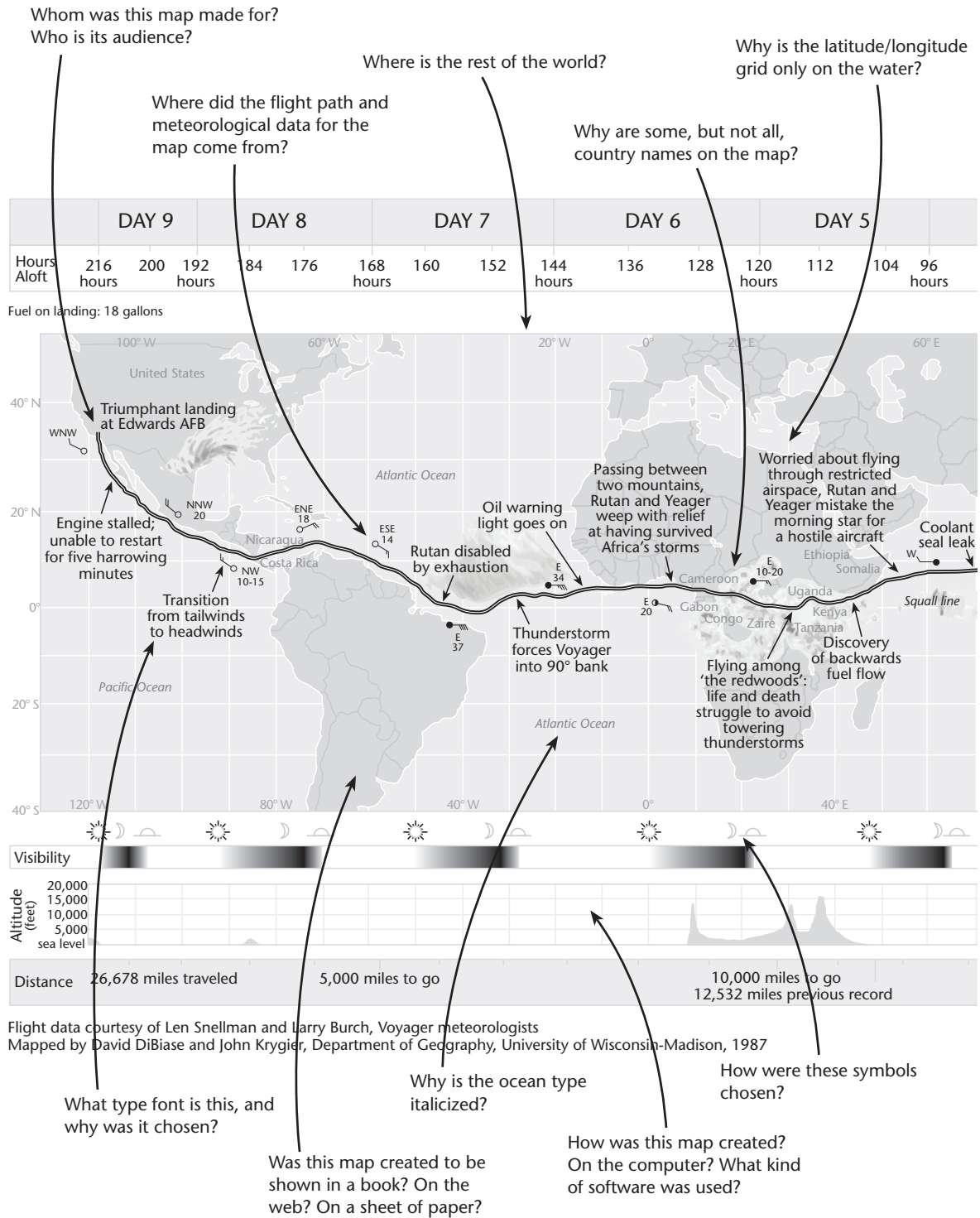


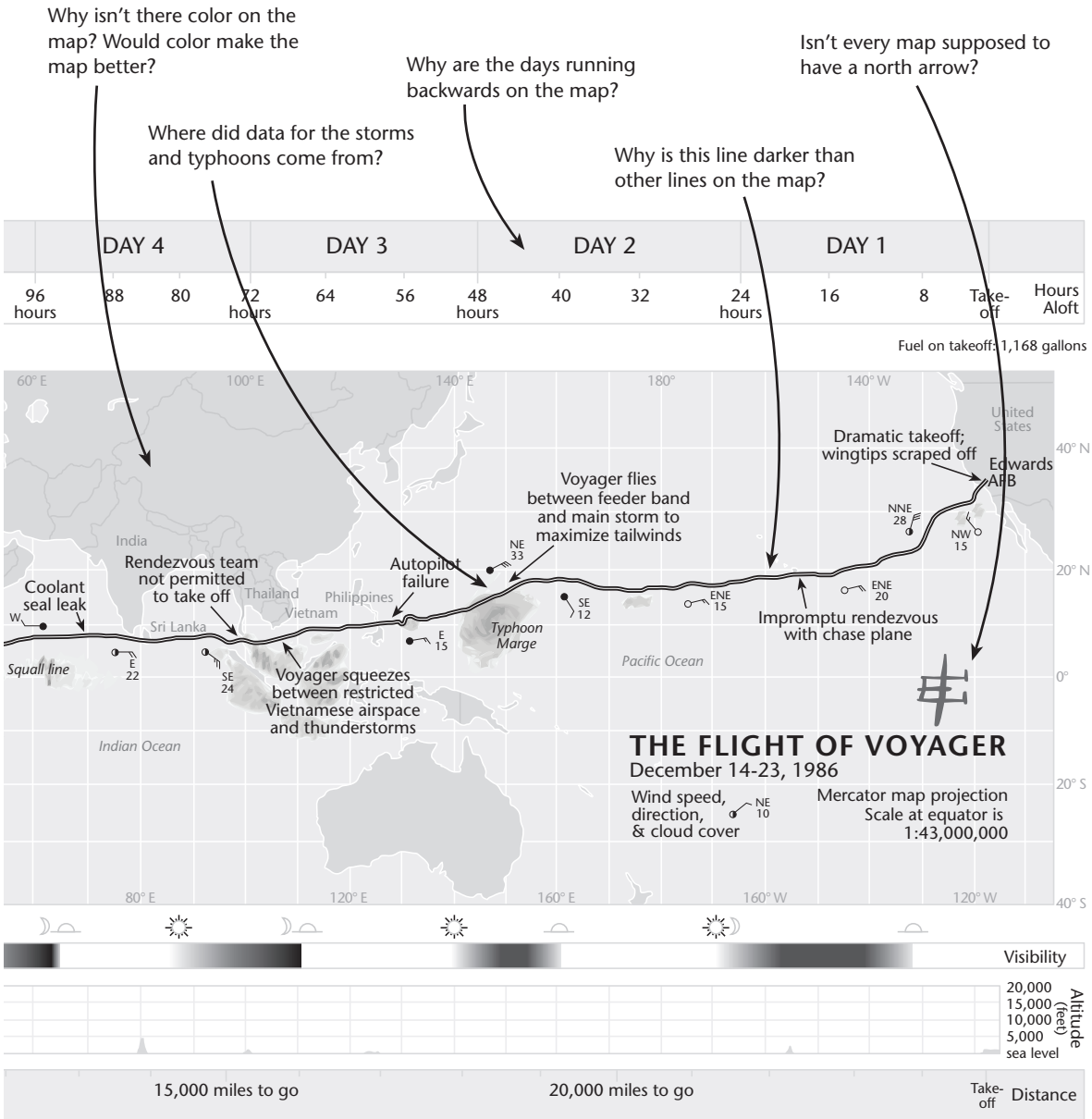




Voyager pilots: Dick Rutan and Jeana Yeager  
Voyager designer: Burt Rutan

What do you need to know to make this map?





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

## CHAPTER 1 How to Make a Map

Start by looking; what do you see? Looking at maps is easy. Not really. You can glance at the Mona Lisa in a second. But to *get* the Mona Lisa you have to look more carefully. What do you see on the Voyager map? Words, lines, continents, a grid. A story, some information with the story. What do you notice first? Black lines, gray lines, white lines ... why are they different? Making maps requires that you answer such questions, and many more. Throughout this book, in nearly every chapter, we annotate *The Flight of Voyager*. By the end of the book, you will understand how to really see – and make – a map.

# Making Maps Is Hard

The bewildering array of considerations to be taken into account when making maps, shown on these two pages, should be overwhelming – at least initially. All shall be explained in subsequent chapters, in general and in relation to a series of annotated *Flight of Voyager* maps. 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 once 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 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 map's goals?

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?

## The Map's Framework

What are the characteristics of the map's projection, and is it appropriate for the data and map goals? What is distorted?

Is the coordinate system appropriate and noted on the map?



## The Design of the Map

Does the title indicate what, when, and where?

Is the scale of the map appropriate for the data and the map goals? Is the scale indicated?

Does textual explanation or discussion on the map enhance its effectiveness?

Does the legend include symbols that are not self-explanatory?

If the orientation of the map is not obvious, is a directional indicator included?

Are authorship and date of map indicated?

Are inset and locator maps appropriate?

Is the goal of the map promoted by its visual arrangement, engaging path, visual center, balance, symmetry, sight-lines, and the grid?

Has the map been thoroughly edited?

Does the map contain non data ink?

Has detail been added to clarify?

Do the data merit a map?

Do variations in design reflect variations in the data?

Is the context of the map and its data clear?

Are there additional variables of data that would clarify the goals of the map?

Do visual differences on the map reflect data differences?

Do important data stand out as figure, and the less important as ground, on the map? Are there consequences of data not included on the map?

Have visual difference, detail, edges, texture, layering, shape and size, closure, proximity, simplicity, direction, familiarity, and color been used to reflect figure-ground relationships appropriate to the map's goals?

Are the level of generalization and the data classification appropriate, given the map's goals?

Do map symbols work by resemblance, relationship, convention, difference, standardization, or unconvention? Are the choices optimal for the map's goals?

How do the map symbols relate to the concepts they stand for? Is the relationship meaningful?

Have the map symbols been chosen to reflect the guidelines suggested by the visual variables?

If symbolizing data aggregated in areas, is the most appropriate method used? How will the choice affect the interpretation of the map?

What do the words on your map mean? How do they shape the meaning of the map?

Has the chosen typeface (font) and its size, weight, and form effectively shaped the overall impression of the map as well as helping to symbolize variations in the data?

Does the arrangement of type on the map clarify, as much as possible, the data and the goals of the map?

Do color choice and variation reflect data choice and variation on the map?

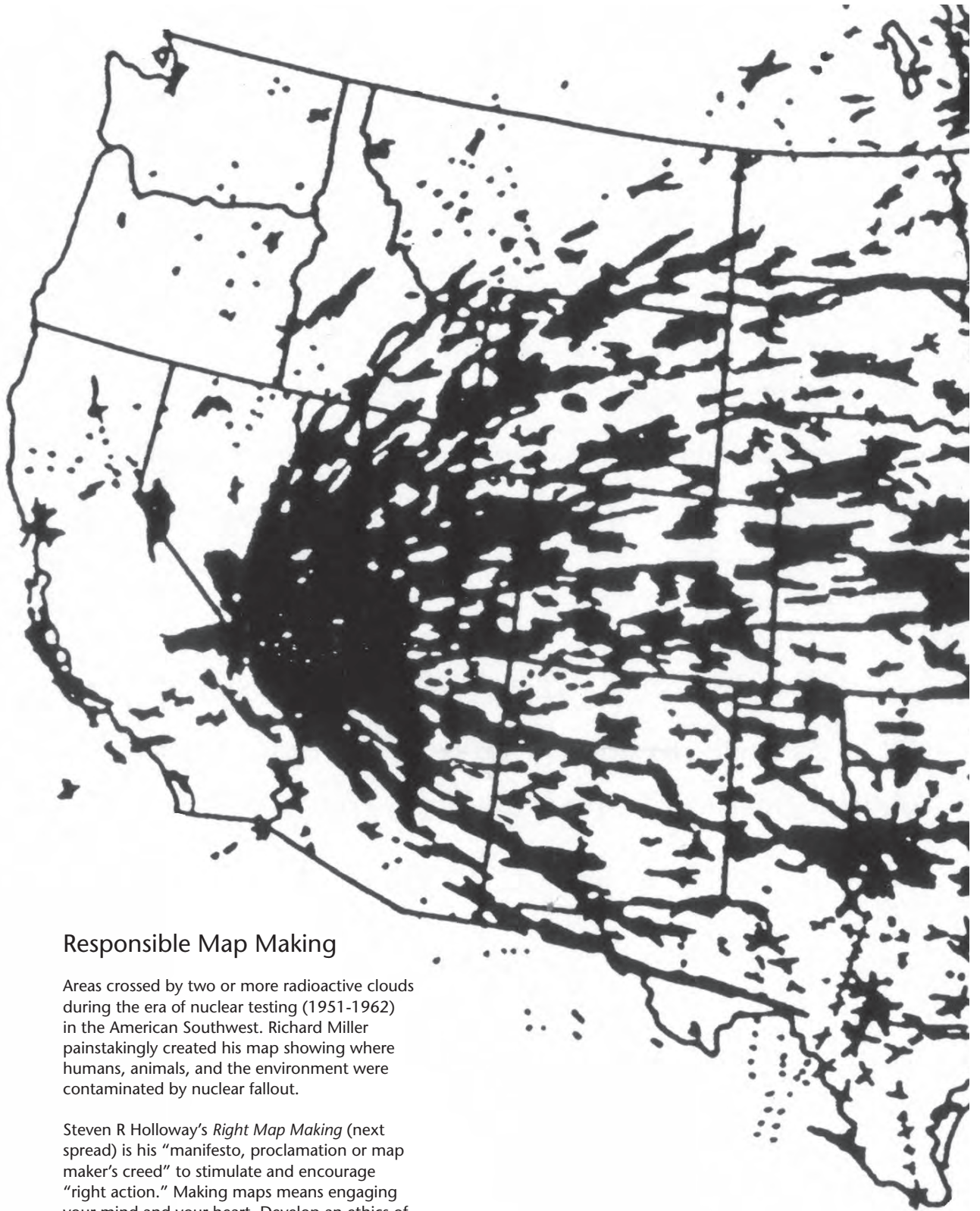
Is color necessary for the map to be successful? Does color add anything besides decoration?

Do color choices grab viewer's attention while being appropriate for your data?

Does the map's design reflect the conditions under which it will be viewed?

Are color interactions and perceptual differences among your audience accounted for?

Have symbolic and cultural color conventions been taken into account and used to enhance the goals of the map?



## Responsible Map Making

Areas crossed by two or more radioactive clouds during the era of nuclear testing (1951-1962) in the American Southwest. Richard Miller painstakingly created his map showing where humans, animals, and the environment were contaminated by nuclear fallout.

Steven R Holloway's *Right Map Making* (next spread) is his "manifesto, proclamation or map maker's creed" to stimulate and encourage "right action." Making maps means engaging your mind and your heart. Develop an ethics of map making, however you may define it. The maps you make make a difference.





# RIGHT MAP Making

*"The most obvious characteristic of our age is its destructiveness."* TH. MERTON  
THE PROBLEM for the maker of maps being that our maps are, in part, engaged in the active and wanton destruction of the world.

*Thus AWAKENED, we VOW to take right effort & Engage in cartographic disobedience, map making "for a future to be possible."* T. N. HANH *Unacceptable it is not to ACJ.*

## Five Ways to MAKE MAPS for a Future to be Possible

### REVERENCE; the first precept of right map making

From the awareness that our maps are, in part, responsible for the great and unnecessary destruction of life taking place in the world today. We vow to map and comment on spatial relationships in a manner non-harming, with reverence and with respect, and to reflect and reveal the beauty of life in a manner non-objectified, where the economic, the non-economic, and the unseen elements are given voice. We vow to recognize and incorporate story with the arguments on our maps. In agreement with M. Gandhi, "first... non-cooperation with everything humiliating," we vow to refrain from economicism, the objectification of sentient beings, and cartographic pornography. Such mapping and maps reflect agreement with the first principle of right action: REVERENCE.



## THE PRACTICE OF GENEROSITY; the *second precept*

From the awareness that our maps are, too often, in our self-interest, greedy consumptions of endless desire, human biased and nationalistic. We vow to engage in a mapping of that which desires to be mapped and shared, not taking that into map form that which does not belong to us; desiring to remain unmapped. We vow to be generous to all sentient beings on our maps and in our mapping. Where generosity is also the courage to leave blank on the page that which does not belong to us, not mapping to take what is not ours, and honoring the sanctity of the commons. Leviticus: "*fields are not to be reaped to the border.*" Such mapping and maps show agreement with the second principle of right action: GENEROSITY.

## COMMITMENT TO THE RELATIONSHIP WITH THE PLACE; the *third precept*

From the awareness that our maps are, in part, reflective of a lack of relationship and commitment to the place in which we reside and map. We vow to resist the temptation to map places with which we have no intimate or committed relation. We seek to remember and honor our relationship to the place; mapping with an honesty of lines, colours and shapes, the naming of places, the unnamable as well, without gossip or intent to harm, or to divide, but rather with a clarity of intent to all sentient beings with whom we are committed to with & in the relationship. Such mapping and maps show agreement with the third principle of right action:

COMMITMENT TO THE RELATIONSHIP WITH THE PLACE.

## DEEP LISTENING THROUGH DIRECT ~ CONTACT & STOPPING; the *fourth precept*

From the awareness that our maps are, in part, a failure to deeply listen and have been made without stopping to directly contact and listen to the place we are mapping. We vow to refrain from mapping what we do not know to be the truth, to first stop to experience the interconnected, ever-changing and interwoven space we are privileged to map. These maps acknowledge the intimate Other, the desire for the awakened heart and mind with & in direct contact with the place itself. Such mapping and maps show agreement with the fourth principle of right speech: DEEP LISTENING THROUGH DIRECT-CONTACT AND STOPPING.



## ON BELONGING TO ONE BODY; the *fifth precept for a future to be possible*

From the awareness that our maps are, in part, disconnected from the body of the earth. How can this be? Kabir says, "*Whose Body is it anyway?*" We vow to make our maps about the body living, our own body, the body in motion, ever-changing and interconnected, the body free from addiction and enslavement to the toxicity of drugs: ownership, objectification, disconnection, greed, capitalism, all the *isms*. We vow to map that delight in the body that serves to reduce suffering and misery. Maps, and the making of maps that respect all sentient beings: the living breathing air, the changing clouds, and the wind and the tides in motion, the soils, the interwoven rocks, the waterways and the water bodies entwined & circling, mountains rising & falling, compost building. Maps respecting and awakened to belonging to the OneBody without separation. Such mapping and maps show agreement with the fifth principle, oikos as the ecologic, economic and ecumenical whole of right livelihood: BELONGING TO ONE BODY.

My soule, saith he, is but a mappe of shoes. No substance, but a shadow for to please.

Thomas Middleton, *Wisdom of Solomon Paraphrased* (1597)

Who died and made you the map police?

Jill, *Home Improvement* (1991)

For the execution of the voyage to the Indies, I did not make use of intelligence, mathematics or maps.

Christopher Columbus, *Book of Prophecies* (15th century)

I presume you have reference to a map I had in my room with some X's on it. I have no automobile. I have no means of conveyance. I have to walk from where I am going most of the time. I had my applications with the Texas Employment Commission. They furnished me names and addresses of places that had openings like I might fill, and neighborhood people had furnished me information on jobs I might get.... I was seeking a job, and I would put these markings on this map so I could plan my itinerary around with less walking. Each one of these X's represented a place where I went and interviewed for a job.... You can check each one of them out if you want to.... The X on the intersection of Elm and Houston is the location of the Texas School Book Depository. I did go there and interview for a job. In fact, I got the job there. That is all the map amounts to.

Lee Harvey Oswald, *Interrogation after the John F. Kennedy assassination* (November 24, 1963)

## More...

Makingmaps.net contains a collection of materials on maps and mapping, serving as an extension of this book. Cartotalk.com is a great discussion forum about maps and map design.

Engage your thinking about maps: Jeremy Crampton, *Mapping: A Critical Introduction to Cartography and GIS* (Wiley-Blackwell, 2010); Martin Dodge, Rob Kitchin, and Chris Perkins, eds., *Rethinking Maps: New Frontiers in Cartographic Theory* (Routledge, 2009); Martin Dodge, Rob Kitchin, and Chris Perkins, eds., *The Map Reader: Theories of Mapping Practice and Cartographic Representation* (Wiley-Blackwell, 2011); Brian Harley, *The New Nature of Maps* (Johns Hopkins University Press, 2002); Alan MacEachren, *How Maps Work* (Guilford Press, 2004); Mark Monmonier, *How to Lie with Maps* (University of Chicago Press, 1996); Les Roberts, ed., *Mapping Cultures: Place, Practice, Performance* (Palgrave Macmillan, 2012); and Denis Wood, *Rethinking the Power of Maps* (Guilford Press, 2010). For a terrific overview of the diversity of maps throughout history, see Brian Harley and David Woodward's multi-volume *History of Cartography* (1987-date, University of Chicago Press) series: volumes 1, 2 and 3 are freely available at the University of Chicago Press website ([www.press.uchicago.edu/books/HOC](http://www.press.uchicago.edu/books/HOC)). Tony Campbell's website ([www.maphistory.info](http://www.maphistory.info)) is a tremendous resource for the history of mapping.

This book, like all books, draws from numerous other texts, old and new, that can be consulted for more information than you'll ever want or need: R.W. Anson and F.J. Ormeling, eds., *Basic Cartography* (International Cartographic Association, 1984); Borden Dent, Jeff Torguson, and Thomas Hodler, *Cartography: Thematic Map Design* (McGraw-Hill, 2008); J.S. Keates, *Cartographic Design and Production* (Wiley, 1973); Menno-Jan Kraak and F.J. Ormeling, *Cartography: Visualization of Spatial Data* (Routledge, 2009); Paul Longley, Michael Goodchild, David Maguire, and David W. Rhind, *Geographic Information Science and Systems* (4th ed., Wiley, 2015); Juliana Muehrcke, A. Jon Kimerling, Aileen Buckley, and Phillip Muehrcke, *Map Use: Reading and Analysis* (ESRI Press, 2011); Gretchen N. Peterson, *GIS Cartography: A Guide to Effective Map Design* (2nd ed., CRC Press, 2014); Arthur Robinson, Joel Morrison, Phillip Muehrcke, and A. Jon Kimerling, *Elements of Cartography* (Wiley, 1995); Erwin Raisz, *General Cartography* (McGraw-Hill, 1938) and *Principles of Cartography* (McGraw-Hill, 1962); Terry Slocum, Robert McMaster, Fritz Kessler, and Hugh Howard, *Thematic Cartography and Geovisualization* (Prentice Hall, 2008); and Judith Tyner, *Principles of Map Design* (Guilford Press, 2010). These nice folks are the "map police."

Scholarly articles and practical insights can be found in *Cartographic Perspectives* and the North American Cartographic Information Society ([nacis.org](http://nacis.org)), the journal *Cartographica* and the Canadian Cartographic Association ([cca-acc.org](http://cca-acc.org)), the *Cartographic Journal* and the British Cartographic Society ([www.cartography.org.uk](http://www.cartography.org.uk)), and the International Cartographic Association ([icaci.org](http://icaci.org)).

Sources: Richard Miller, "Areas crossed by two or more radioactive clouds during the era of nuclear testing in the American Southwest, 1951-62" in *Under the Cloud: The Decades of Nuclear Testing* (Two-Sixty Press, 1999). "Right MAP Making" copyright 2007 by Steven R Holloway. Designed and produced by toMake.com Press. "Right MAP Making" is intended to articulate the fundamental principles of ethical conduct in mapping and maps and to stimulate "right action." Forty letterpress prints are signed and numbered by the author. A PDF version of the poster is available free of charge at: [www.tomake.com/work/rightmapmaking.html](http://www.tomake.com/work/rightmapmaking.html).