

# ADVANCES IN CARTOGRAPHY

*Edited by*  
**J C MULLER**

*International Institute for Aerospace Survey and Earth  
Sciences, Enschede, The Netherlands*



Published on behalf of the  
**INTERNATIONAL CARTOGRAPHIC ASSOCIATION**  
by  
**ELSEVIER APPLIED SCIENCE**  
LONDON and NEW YORK

ELSEVIER SCIENCE PUBLISHERS LTD  
Crown House, Linton Road, Barking, Essex IG11 8JU, England

*Sole Distributor in the USA and Canada*  
ELSEVIER SCIENCE PUBLISHING CO., INC  
655 Avenue of the Americas, New York, NY 10010, USA

WITH 5 TABLES AND 36 ILLUSTRATIONS  
© 1991 ELSEVIER SCIENCE PUBLISHERS LTD

**British Library Cataloguing in Publication Data**

Advances in cartography.

I. Cartography

I. Müller, J. C. II. International Cartographic  
Association

526

ISBN 1-85166-603-6

**Library of Congress Cataloging-in-Publication Data**

Advances in cartography/edited by J. C. Müller.

p. cm.

Includes bibliographical references and index.

ISBN 1-85166-603-6

I. Cartography. I. Müller, J. C. II. International Cartographic  
Association.

GA108.A32 1991

526-dc20

91-11479  
CIP

No responsibility is assumed by the Publisher for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions or ideas contained in the material herein.

**Special regulations for readers in the USA**

This publication has been registered with the Copyright Clearance Center Inc. (CCC), Salem, Massachusetts. Information can be obtained from the CCC about conditions under which photocopies of parts of this publication may be made in the USA. All other copyright questions, including photocopying outside the USA, should be referred to the publisher.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher.

Printed in Great Britain at the University Press, Cambridge.

# INSTITUTIONAL AND SOCIETAL COMPONENTS OF CARTOGRAPHIC RESEARCH

*Nicholas R. Chrisman*

Geography DP-10, University of Washington, Washington 98195, USA

Just as technological advances are changing the ways cartographers make maps, there is a parallel impact on the institutions for which they work. For many years, cartographic research could be characterized as 'tool development' with an implicit belief in the inevitability and desirability of 'progress'. Cartographic research should not assume that all new tools will be evaluated on some objective scale of efficiency and effectiveness. Despite the best of technology, some tools will succeed or fail based on their institutional ramifications and even on their connections to greater societal goals. This chapter considers the breadth of concerns for institutional constraints and societal outcomes.

## BACKGROUND: RESEARCH IN CARTOGRAPHY

In the 1990s, research in cartography continues the recent emphasis on development of tools for the continued automation of cartography. The previous chapters of this book were written by international experts and emphasize an abstract view of tools with universal application. This chapter takes a different position. While accepting the validity of the preceding chapters as research efforts, it is necessary to add a cautionary note from the perspectives of institutional and social context.

The starting point of this chapter is not an abstract view of cartographic information. Instead, cartographic research should understand who uses cartographic information and why. Most cartography is not carried out in an academic laboratory for individual purposes. Cartographers work inside institutions, some private but many public, and the nature of these

institutions influences the current reality as well as the future of cartography. In turn, these institutions serve, to some degree or another, the general goals of the particular society in which they are embedded. An ardent cartographic technologist might accept that there are institutional and social aspects of cartography, but might fail to appreciate that these concerns are a part of the most pressing research agenda. This chapter attempts to make the argument that research on tool development must be balanced with research on the outcomes in institutions and society. For, our tools are only truly effective if they are actually used.

## NEITHER ART NOR SCIENCE

The commonly accepted definition of cartography begins with the assertion that cartography is at once an art and a science (ICA 1973). This chapter does not seek to redefine cartography, but it must take note of some divergences between the accepted view of cartography and cartography as it is actually practised.

In purest form, an artist is free to express a particular vision or message often by testing the bounds of the chosen medium. Cartographers have long accepted that the constraints of mapping make it hard to act as freely as an artist would expect. Of course, there is some ingredient of art in cartography — an ingredient which must be cherished and nurtured.

The research agenda discussed in the previous chapters provides very little coverage (except perhaps for Chapter 10) of the artistic component of cartography because it emphasizes the scientific component. Proclaiming the scientific in cartography may be an unannounced purpose of publication of a volume on the research agenda at a General Assembly of the International Cartographic Association. Certainly, there have been many advances in cartographic method since the creation of the ICA. Yet, for all of the advances of the computer age, most cartographers do not practise in a purely scientific context. Scientific cartography attempts to study alternative tools, measured on objective grounds of efficiency and effectiveness. To a large extent, these goals are desirable, as long as the measures are appropriate. Scientific cartography fails to be a model for practise first, if the objective measures are not so easily established, and second, if the constraints of societies and institutions are ignored. To the cartographer working in a municipal information system or a national topographic agency, the procedures used may have some connection to scientific research, but they also will be firmly connected to the budget of the organization and its management structure.

Rather than either an art or a science, the practice of cartography should be considered as a form of regulated utility. The distinction is that

practising cartographers do not have very much control over the content of their maps and databases. Each cartographic organization operates under a set of *mandates* which establish the objectives of the organization (Chrisman and Niemann 1985). In many cases, mandates are specified in statute, decree, ordinance, administrative code or some combination of such legal instruments. In cases where cartographic procedures are not clearly established through an external legal process, they may be specified through a set of instructions passed on inside the organization. In any case, it is important to recognize that cartographers frequently operate under a form of public trust.

As with other regulated utilities, the public is not particularly interested in the details of the process. The final product is what the public sees. The experts and technocrats tend to have control over the details, as long as the system seems to function. Thus, much of the research on scientific cartography has concentrated on re-engineering the procedures, assuming that the products are given. This approach certainly applied to the spaghetti era of automated drafting, but it also applies to more recent research. While the products produced under previous technology may have been perfectly adequate, considering the levels of resources available, modern technology may be able to deliver a different product which better serves the ultimate goals. This is the true challenge to cartographers in a technological revolution: to deliver new tools which open up new ways to manage spatial information. This can only be achieved by studying the social and institutional context of cartographic information handling to understand the root causes and ultimate needs.

## TECHNOLOGICAL CHANGE AND CARTOGRAPHY

Cartography has advanced through a dramatic series of technical innovations during this century, so technological transitions are nothing new. In large part, research in the history of cartography involves reconstruction of the technology of an earlier period without a comparative intent. Recent research in the history of cartography (Blakemore and Harley 1980, Harley and Woodward 1987, Harley 1989) shows a substantial broadening of interest and a focus on the meaning of cartography, not just the technology. Monmonier (1985) entitled a book *Technological Transition in Cartography* and *The American Cartographer* (Tomlinson and Petchenik 1988) devoted an issue to personal recollections of the 'revolution', but much more remains to be done. We have to get beyond the classic first sentence which has adorned the cartographic literature for too many years. Perhaps the most pungent form of this sentence was the first sentence of the POLYVRT manual (Laboratory for

Computer Graphics, 1973: 1): 'Recent years have witnessed an upsurge ...' Yes, of course there has been an increase in the use of computers, but why and to what avail?

One direction for research is to consider the economic and social consequences of the shifts in cartographic technology. Monmonier (1985: 14) made this a key point in his treatment of cartographic technology; 'If the fifteenth century saw a revolution in publishing and the nineteenth saw a revolution in design, the late twentieth and early twenty-first centuries must see a revolution in organization and management.'

But what kinds of changes can we expect? There are fundamental differences between most of the technological changes which occurred in the first part of this century and the recent wave of computer systems. Many previous innovations, such as airphotography, had the effect of centralizing the production of maps and promoting efficiency through standardized production in volume. Such technical concentrations are not neutral, they have led to the large national mapping agencies around the world and a concentration of disciplinary skills. The new computerized technology turns the tide from centralized, standardized production towards an emphasis on flexibility. A flexible industry can respond to the actual demands more specifically, differentiating products instead of providing a standardized one-size-fits-all. This development, too, is not neutral. Existing institutions, with their centralist heritage and missions may not appreciate or exploit the full possibilities offered by the technology. A review of recent history can expand on these characterizations.

## CENTRALIZING TENDENCIES: ECONOMIES OF SCALE

The twentieth century has seen a number of technological changes in cartography long before the computer. Acceleration in the rate of change was even noticed over fifty years ago (Raisz 1937). Most of the innovations of the early twentieth century, which included airphotography, photographic duplication, offset printing and other technologies, involved increased productivity through capital investment. The quality of the product could be increased through the new machines, but the final distribution was still in the form of a printed map. In order to gain the full value, this printed map had to serve many map readers. Thus there was a push for standardized products and national conformity to standards. The national topographic surveys (USGS, OS, IGN, etc) are the institutional consequence of this drive for centralized, standard products. To a great extent, such centralized organizations make it easier to develop and implement new technologies, because the new skills need only be

concentrated where actually needed. In addition to the centralization, these organizations involved division of labour. Indeed, these organizations have all the characteristics described as the 'Fordist' model by economic geographers (Scott and Storper 1986). Whatever the terminology, it is important to recognize the linkage between expensive capital equipment, scarce training and uniform, standardized products.

## DECENTRALIZING TENDENCIES: FLEXIBLE PRODUCTION

The computer was treated originally as a similar technology to airphotography. It certainly was difficult to operate and required significant investment just to get it started. The large central organizations were among the few pioneers in automated cartography (see for instance the Proceedings of the International Symposium on Map and Chart Digitizing in 1969). There were thoughts of centralized databanks of national (as in CGIS (Tomlinson 1974)) or at least state scope in the USA.

However, the computer age turned out to be quite different. The idea of centralized databanks was attempted in the USA during the 1970s. Most of the statewide efforts failed (Mead 1981), as much for institutional reasons as technological ones. The technology diffused from its origins to an ever expanding set of users. In the language of the 1980s, the computer was 'empowering' or equalizing. The software encapsulated expert knowledge about map making and map analysis and replicated that knowledge. In the place of the division of labour, the computer age implied a return to the artisanal approach to map making where one person could take a project through all steps from data collection to final production (Bie 1984). In addition, the product need not be a standardized printed map sheet. Each query can create its own graphic, particularly tailored to that message. In short, the rules of the game are altered by the computer, though the players in the game may not catch on as quickly. The computer revolution fits fairly closely to the movement in economic organization known as 'flexible production', seen as a contrast to 'Fordist' organization. Flexible production may substitute small, specialized artisanal firms for the industrial dinosaurs of the assembly line. Of course, both centralization and flexibility are old forms of organization which reappear from time to time in connection with particular technologies.

## HISTORICAL SEQUENCE OF TECHNOLOGICAL CHANGE

From a quick review of recent events, each technology has its particular impact on the people and institutions who implement the technology. In addition, the historical juxtaposition of technologies has an effect as well.

The computer tendency towards flexible production occurs after a period of centralization, so the effect will be different. The discipline of cartography, and particularly the allied disciplines such as photogrammetry, may not recognize the shift in direction.

In third world countries, there are additional twists to the story. Technology does not always recapitulate the phylogeny or sequence which occurred in Europe and North America. Technology tends to arrive for reasons external to the implementing country.

'Such systems, having relatively high capital cost, are invariably a key item in some aid package. Normally, various donor agencies negotiate with separate arms of Government, with the donors committed in advance to 'selling' specific hardware and software products from their own nationals, along with the expertise to operate them. This needless proliferation of systems, none fully maximized, inevitably results in waste and inefficiency'. (Eyre 1989: 367)

Eyre's experience in Jamaica represents experiences in many other countries. Many of the difficulties in transferring GIS technology have institutional roots. Some evoke echoes of colonialist zones of influence within a country's bureaucracy.

## RESEARCH DIRECTIONS

The purpose of this chapter is to discuss the goals of cartography and future research directions. As such, it must speculate rather than presenting specific backing for its assertions. Whatever proof or support will have to arise over time.

The primary plea of this chapter is to balance the interest, evidenced in the rest of this volume, in tool development with the interest in the outcomes of using those tools. The study of outcomes is the study of what happens when a tool is used or not used; it is the study of what societal goals are better fulfilled and which segments of society gain or lose. To conduct this research, cartographers must place their efforts firmly in context of social, economic, political and cultural circumstance.

This plea should not be taken as an attack on scientific research in cartography, but rather as an attempt to conduct that research more effectively. There certainly are components of cartography, such as the axiomatic structure of geometry, which will apply universally. However, as demonstrated in the case of airphotography, technology is not neutral. Cartographers must take responsibility for the directions we take, and attempt to conduct research which serves our ultimate goals. This section reviews two specific tracks for future research in the field of social and institutional context.



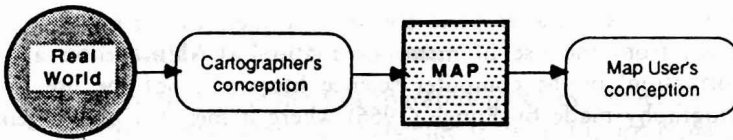


FIGURE 1 Simplified cartographic communication model (Source: Chrisman 1987)

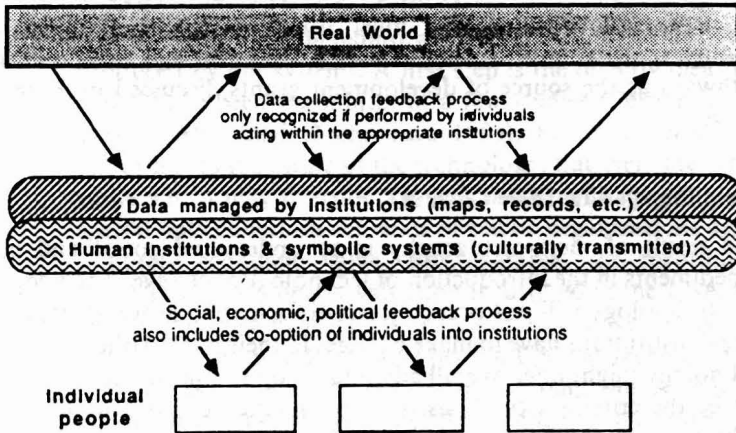


FIGURE 2 Cartographic communication carried out over time with cultural and institutional components (Source: Chrisman 1987)

### Understanding Map Use and Benefits

A major contribution of the 'communication paradigm' in cartographic research was to move the research beyond the technology of making maps to consider the complete communication process. Research in the communication paradigm tended to focus on the individual map reader (Robinson and Petchenik 1976). Figure 1 presents the simplest form of the communication model.

This particular linkage between map maker and map reader is but one link in the full scope of the context of cartography. Studies in this field should expand to consider the use of maps and cartographic databases, not as simple messages transmitted by a map maker, but as a part of a larger social process. Chrisman (1987) portrayed the classical diagram of the communication model with an expansion to show the continuity of the organization over time (see Figure 2).

There have been some beginnings of such research. Muehrcke's (1986) *'Map Use'*, though a text for introductory students, sets a broad stage for considering map use. Monmonier (1985) placed emphasis on the 'management' issues in cartography in the section quoted above. Recently, Nyerges (1991) and Chrisman (1990) have taken different, but complementary approaches on the issue. Taken together, these research efforts

can be seen as an attempt to construct a 'meta-cartography'. This term derives from the use of meta-information as 'information about the information' in the computer science literature, not the use of meta-cartography made by Bunge (1966) where it meant a baldly geometric view of spatial relationships. Meta-cartography might include mapping the distribution of mapping (Szegö 1987), and understanding the social and cultural determinants of the differences so discovered. Research into the organization of mapping must study the diffusion of technology through normal professional channels and through such unexpected pathways as the source of development grants discussed by Eyre (1989) above.

### **Tools Engaged In Their Context**

One result of meta-cartography is to understand social and cultural impediments in the introduction of technological change. The adoption of new technology will not occur on strictly scientific grounds. Real people in real institutions have to make changes in their lives. Although some new technology might offer overall advantages on technical criteria, these may not be the criteria actually used. Bureaucratic decisions to adopt a new technology or to alter the products of long standing may be influenced by many factors from the personal advancement of careers to overall cultural views. For example, just as technologies have life-cycles, the personnel in an agency have life-cycles as well. Most of the topographic mapping organizations required many newly trained photogrammetrists during the period 1935–55. A large number of these entered this discipline due to wartime emphasis on airphoto interpretation. These professionals rose in the ranks, according to normal bureaucratic procedures, so that at the time that the digital mapping technology emerged, the photogrammetrists tended to be in charge. Such events are often accepted as a fact of life, but it may have an influence. As new technology is developed, it should be engaged in the context it must enter.

There are additional limitations which inhibit the research process and the connection between research and software development. The academic base of early research in automated cartography had an effect which still continues (Chrisman 1988). Academic research may not reward the final integration of software to the point where it finally becomes usable by the typical end-user. For the future of the university this might be good or bad, depending on your perspective. The overall societal perspective might lead to different conclusions. A similar division occurs in the public sector, and even in the private sector. The rigours of the competitive market do not always reward strictly on the basis of technical merit.

### **Building Tools That Serve Goals**

The next stage in meta-cartography involves connection from the spatial distributions to the reasons behind them. If Europe is mapped at an order of magnitude greater cost than any other region of the globe, do the citizens actually get something to show for it? Cartographic technologists must be prepared to defend their technology in the arena where resources are allocated. This will require a knowledge of the value of the information produced by our systems. A first step is the directly measurable 'benefits' which have been the subject of a few studies (Bernhardsen and Tveitval 1986, Epstein and Duchesneau 1984). Economic efficiency is certainly important to the future of the technology, but there are other measures of value which may override a pure cost-benefit calculation. Many of the spatial data collection activities of public organizations are not guided by a purely economic value. For example, the recording of property ownership and property valuation is justified in the USA as a measure to ensure equitable taxation. When a country moves away from a tax with some connection to land value (as the UK has recently in adopting a flat rate poll tax), the public interest in mapping will be reduced. Of course, due to bureaucratic inertia, the effects of taxation change may not become apparent immediately. The point is that spatial information may not be collected and processed for its inherent value (as either art or science). These activities which add up to form cartography fit into broader social purposes. Harley (1989) calls for a re-examination of maps in terms of the power relationships in society that the map reflects. Power is one part of the whole equation, but not the only one.

As a result, cartographic technology should advance with an eye on the actual problems posed by practice and by the social purposes for those practices. A new technology must be justified not for its scientific purity or even on its direct economic efficiency as a technology. The ultimate test is satisfying the purpose of having the information.

### **PRACTITIONER'S SUMMARY**

While this paper has concentrated on the generalities, a practising cartographer has always been confronted with the practical politics of working inside some organization. Recent research shows that the research community is increasingly aware of the social and institutional context. It should be clear that technology does not succeed on its own merits. The context in which it is used is equally important. Thus, there is no single, universal formula for a successful implementation of new technology.

Over time, there should be less separation between academic conceptualization of cartography and the cartography actually practised. This development requires flow in both directions. Practitioners should share their findings with the research community through journals and proceedings.

## PROJECTIVE SUMMARY

Cartographers, in developing new technology, will make choices with institutional and societal implications. Some of these choices may be made for seemingly technical reasons without considering the full range of broader implications. The traditional emphasis on the quality of the product and the economic efficiency of production will retain a place, but it should no longer remain the only criterion. Modern society cannot select projects simply on a simple measure such as benefit/cost ratios. There are criteria of balance between sectors of the public interest which are not measured on strictly numerical terms. For instance, many uses of modern spatial information systems involve complex decision-making circumstances where competing interests do not share a common set of values. Cartographers must learn to develop tools to bridge the gap and serve overall societal goals.

## REFERENCES AND BIBLIOGRAPHY

- Ayers E H (1984) Implementation of modern land records systems: Politics and institutional reform. *Proceedings Seminar on the MultiPurpose Cadastre*, IES Report 123. Madison, WI, University of Wisconsin: 289-99
- Bernhardsen T, Tveitdal S (1986) Community benefit of digital spatial information. *Proceedings AUTO-CARTO London 2*: 1-4.
- Bie S (1984) Organizational needs for technological advancement. *Cartographica* 21 (2&3): 44-50
- Blakemore M J, Harley J B (1980) Concepts in the history of cartography. *Cartographica* 17 (4): 1-120
- Bunge W (1966) *Theoretical Geography*. Lund, Sweden, Gleerup
- Chrisman N R (1987) Design of geographic information systems based on social and cultural goals. *Photogrammetric Engineering and Remote Sensing* 53 (10): 1367-70
- Chrisman N R (1988) The risks of software innovation, a case study of the Harvard Lab. *The American Cartographer* 15: 291-300
- Chrisman N R (1990) Building a geography of geographic information: Placing GIS in cultural and historical context. (draft manuscript).

- Chrisman N R, Niemann B J, Jr (1985) Alternative routes to a multipurpose cadastre: merging institutional and technical reasoning. *Proceedings AUTO-CARTO 7*: 84-94
- Dangermond J, Freedman C (1984) Findings regarding a conceptual model of a municipal data base and implications for software design. *Proceedings Seminar on the MultiPurpose Cadastre*, IES Report 123. Madison, WI, University of Wisconsin: 12-49
- Dickinson H J, Calkins H W (1988) The economic evaluation of implementing GIS. *International Journal of GIS 2*: 307-27
- Dickinson H J, Calkins H W (1990) Commenting on 'Concerning 'The economic evaluation of implementing GIS''. *International Journal of GIS 4*: 211-12
- Epstein E F, Duchesneau T D (1984) *The Use and Value of Geodetic Information*. Rockville, MD, Federal Geodetic Control Committee
- Eyre L A (1989) JAMGIS, the first Jamaican Government comprehensive multi-data geographical information system. Achievements and problems. *International Journal of GIS 3*: 363-72
- Harley J B (1989) Deconstructing the map. *Cartographica 26* (2): 1-20
- Harley J B, Woodward D (ed.) (1987) *The History of Cartography*, Vol. 1. Chicago, University of Chicago Press
- International Cartographic Association (1973) *Multilingual Dictionary of Technical Terms in Cartography*. Weisbaden, Franz Steiner Verlag
- Laboratory for Computer Graphics (1973) *POLYVRT User's Manual*. Cambridge, MA, Harvard University
- Mead D (1981) Statewide natural resource information systems: A status report. *Journal of Forestry 79*: 369-90
- Monmonier M S (1985) *Technological Transition in Cartography*. Madison, WI, University of Wisconsin Press
- Muehrcke P C (1986) *Map Use* (2nd edition). Madison, WI, JP Publications
- Nyerges T L (1991) Analytical map use. *Cartography and Geographic Information Systems 18* (1): 11-22
- Portner J, Niemann B J (1984) An overview of social aspects of land records modernization. *Proceedings Seminar on the MultiPurpose Cadastre*, IES Report 123. Madison, WI, University of Wisconsin: 94-108
- Raisz E (1937) Charts of historical cartography. *Imago Mundi 2*: 9-16
- Robinson A H, Petchenik B B (1976) *The Nature of Maps: Essays towards Understanding Maps and Mapping*. Chicago, IL, University of Chicago Press
- Robinette A (1984) Institutional innovations: Moving from academia to serving government needs. *Proceedings Seminar on the MultiPurpose Cadastre*, IES Report 123. Madison, WI, University of Wisconsin: 155-66
- Scott A J, Storper M (ed.) (1986) *Production, Work and Territory: The Geographical Anatomy of Industrial Capitalism*. London, Allen & Unwin
- Szegö J (1987) *Human Cartography*. Stockholm, Council for Building Research
- Tomlinson R F (1974) The application of electronic computing methods and techniques to the storage, compilation and assessment of mapped data. Unpublished PhD thesis, University of London
- Tomlinson R F, Petchenik B B (ed.) (1988) Reflections on the revolution: The transition from analogue to digital representations of space, 1958-1988. *The American Cartographer 15* (3) special issue

- Wilcox D L (1990) Concerning 'The economic evaluation of implementing GIS'. *International Journal of GIS* 4: 203-10
- Wunderlich G, Moyer D D (1984) Economic features of land information systems. *Proceedings Seminar on the MultiPurpose Cadastre*, IES Report 123. Madison, WI, University of Wisconsin: 183-202