DESIGN AND PRODUCTION CONSIDERATIONS FOR AN INTERNATIONAL CONSERVATION ATLAS

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1. Introduction

An International Ecosystem Conservation Atlas has been proposed by the National Park Service, Natural History Division, in association with their participation in UNESCO Man and the Biosphere Program (Schonewald, August, 1979). The atlas format is proposed in response to two principal needs for environmental analysis and management: First, an atlas could summarize the status of world habitats and internationally recognized environmental priorities, and second, an atlas is to provide a summary of world-wide natural resources, both terrestrial and climatological. Potential and actual biological distributions could be compared along with information about human occupancy and use of the earth. Summaries of previous studies which are not generally available to political decision makers could be presented, but no primary research is to be undertaken.

2. The Purpose of an Atlas

An atlas is a collection of maps centered about a particular theme. Information in an atlas is presented in a consistent manner, usually with maps and graphs of similar scale, spatial extent, projection, use of color, and symbolic representation. Generally, a single editor oversees the entire atlas to insure consistency from one map to another, continuity between maps and accompanying textual descriptions, and among all other elements of the atlas: introduction, explanatory texts, reference maps, subject maps, gazeteers and indices. As for the presentation, an atlas is usually prepared with a book binding, but sometimes, such as with the Atlas Nacional de Espana (Madrid, 1965), atlases have been distributed as portfolios of individual sheets, or even as single, large sheets like Skoda's The Straits of Georgia and Puget Sound Basin, (1974).

The creation of an effective atlas can be a long, difficult and expensive task. Much organization and coordination is required and a particularly skillful choreography of design and production is essential to the assembly of an atlas. Even in cases where this coordination can be effected, some have found that a bound set of maps will not offer maximum communication. Others feel that no alternative data dissemination scheme fully replaces the intrigue and impact of a well-designed and professionally-executed multi-color, bound atlas. Whenever a mapping project seems to call for the creation of an atlas, it is wise to investigate all alternative presentation and dissemination schemes. In terms of information conveyed, an expensive, large, multi-color book may not be as useful or as wise an expenditure as a library, a map series, or a reference bureau might be.

2.1 Data depository

Libraries, depositories, and data banks are one method by which spatial data can be stored and disseminated. Depositories can be organized in manual, microform or automated formats. Manual, library-style depositories require the development of a trained staff familiar with the information. Updated and new data can be included easily in a manual depository and a trained staff can be very helpful in guiding inquiries, but they can respond only to a limited number of inquiries. A microform depository can be made available to a wider audience than a library at a relatively low cost, but updates and additions are difficult. Microforms are small and cheap enough to be sent anywhere and can be easily reproduced. Automated depositories or data banks are very popular means for storing numerical data and tabulations. However, they are considerably more intricate and difficult to create for spatial information. An automated depository has the advantage of providing dynamic access to the information, in which retrievals can be posed on complex sets of logical and spatial criteria. Revisions can be made to the data in a timely manner, but do require the conversion to machine encoded, or machine-readible form. From the standpoint of the maximum distribution of information, a microform presentation has the most advantages. Of maximum utility to the traditional scientist and decision maker is the manual, library-style depository. Only the potential for automatic access recommends the development of an automated spatial information system as a replacement for an atlas. Use of the data in a depository by the general public is usually restricted either because of the lack of information as to how to access the data, or the formidability of institutionalized information.

2.2 Topical map series

Another alternative to a bound atlas is a topical map series, such as the U.S. Bureau of the Census GE-50 series of 1:5,000,000 Alber's Equal Area Maps. A means for timely dissemination of information is provided and the organizational difficulties associated with producing one massive volume are avoided. Furthermore, significant maps and findings can be published as they are completed without waiting several years for the completion of all of the atlas content. A smaller overall personnel organization would be required with such an alternative to an atlas. A series can be presented in portfolio form with annual or biennial publications of a group of related maps and documents. Such a form of dissemination was chosen for two successful national atlases. The Atlas of Australian Resources is a large format, loose leaf atlas which has been published in two periodic series: First Series, 1951-1960, and Second Series, 1961-1977. There have been 13 issues of the Atlas of the Netherlands beginning in 1963, and by 1977, there were over 8000 atlas subscribers, a far greater number than was expected.

A significant drawback to a map series approach is the fact that one-time funding might be available for a single large project rather than a continuing project. From a cartographic standpoint a map series affords refinement and evolution of the best possible graphic representations. New symbolizations can be created and reactions gathered without having to commit an entire publication to one representational schema. In the production of map portfolios, greater size choices are available; and because no consideration needs to be given to binding, much larger layouts can be used.

2.3 Reference bureau

A third alternative is to go beyond the creation of a periodical map series to the establishment of a resource agency. Population Reference Bureau has proven very effective with this solution. An agency could provide a focus for diverse environmental research projects and assist researchers in synthesizing information for public distribution. The PRB's success has shown that there is considerable interest in quality graphics and analysis. A similar response could be generated toward the content of the proposed International Conservation Atlas--awareness of the status of natural habitats and international environmental priorities.

Several alternatives to a bound atlas have been presented which could educate the public and its decision-makers about the status of world habitats and various environmental priorities. The choice of method cannot be dictated from a purely cartographic viewpoint; a fully-developed atlas would be a significant information resource and possibly a major cartographic achievement. A continuing map series or resource agency could allow a number of cartographers a creative opportunity. Depositories and data banks are the least exciting from a cartographic standpoint, but they may be the best possible resource for encouraging new research.

3. Atlas Design

The design of a successful atlas relies on the ability of a designer or group of designers to resolve a variety of geographic, cartographic, and graphic problems. The success of a design is determined by its utility. With an atlas, this means that everyone who reads the atlas, both text and maps, finds information that he or she was looking for without difficulties of any sort. In the extremes, this allows the most frail person to lift the book and position it so that it is read easily, or that the most knowledgeable person is newly informed.

In considering an atlas project, problems of a general cartographic nature are encountered. Additionally, one faces coordination and continuity difficulties in bringing together a variety of diverse subjects into a graphic treatise.

3.1 Data fidelity

Successful atlas design presents the reader with information of consistent quality throughout. Since atlas information is almost always derived from secondary sources, it is especially important that it truly represent the phenomena. Are conclusions based on true variations in the data and not upon artifacts introduced into the data during the various transmutations that it has made from sensed reality to encoded data? In collecting atlas data, specific procedures must be established to insure that the quality of compilation does not vary beyond acceptable bounds. Generally, this means that a knowledgeable cartographic production staff is employed which can spot possible errors and can call in expert advice when it is necessary to assess individual data elements. If variation in the quality of the information is to be allowed, then this is shown either through a reduction in the scale of the worst data, or reliability diagrams are included to show spatially the extent of data quality.

3.2 Data resolution

The term resolution is used in cartography in reference to the ability to portray a geographic phenomenon in respect to its size at a given scale. Typically, the cartographer is faced with the necessity of reducing the amount of information on a map, and resolution is a convenient mechanism to decide which pieces of information can stay and which must go. In general, map compilation guidelines call for elimination of information which when represented at scale would be less than .5mm in size. At the scales required to show the earth's surface in a large atlas format, 1:25,000,000, the spatial extent of a geographic phenomenon has to be 12.5 km (7.63 miles). More practically, a 1.5 mm criterion (i.e., 37.5 km or 22.8 miles) would be reasonable for inclusion of any given individual area.

If the phenomenon to be represented is of sufficient importance, its size can be exaggerated to surpass the minimum representation threshold. Often, this is the case with rivers and other linear features. Isolated incidents may very well be handled by exaggeration, but in congested areas, it may not be possible to perform this exaggeration without cluttering the map. Furthermore, it is the atlas reader's responsibility not to read more spatial accuracy into the graphic than it is capable of providing, nor should the cartographer provide a means to do so.

3.3 Data availability, consistency, and currency

An unfortunate fact is that world-wide data coverage for many simple topics is just not available at suitable resolutions and scales. Particularly, when it is expected that information for the International Conservation Atlas is to be compiled from research reports, the problems of data consistency become tremendous. For some topics, the hoped-for historical trends are not recorded. Just in the field of demographic information, there is such a dirth of data that an accurate, contempory map of population density has not even been attempted at a scale larger than 1:45,000,000. The proposed design of the International Conservation Atlas to include many different maps with comparable data overlays may not be possible.

3.4 Data carrying capapcity

Maps are two-dimensional graphics that have been constructed to show the variation(s) of additional dimensions. Additional dimensions are added by utilizing various classes of symbols: points, lines and areas. On maps consisting chiefly of point and linear phenomena, many separate dimensions can be included, especially if the additional dimensions fall inbetween the symbols of the preceeding dimensions. However, when areal symbolization is used, fewer elements can be superimposed, and various manipulations of the areal symbolization must be performed. These include hue, chroma or brightness changes, and modifications of texture. The limits of acceptable and readible graphic imposition can be very quickly reached. In environmental mapping data carrying capacity is often pushed to the limit and beyond.

3.5 Generalization and classification

The terms of scientific communication, although they are very specific in the physical sciences, are often muddled in the natural sciences. Effective compilation of environmental information of the sort to be used in the International Conservation Atlas requires that a common vocabulary be derived for relating the observed phenomena to their mapped representation. If independent compilers are to collect the information, then specific agreements must be reached on each and every term and class of information that is to be collected.

The need for a single system of classification seems obvious. Unfortunately, it is not so easy to get individual data collectors to come to such agreements. Consider the case of land use mapping. On one hand, apparent land cover can be interpreted in relation to the natural habitat that it provides and the constituent floral and faunal species of that habitat. On the other hand, the same land cover information can be categorized by the degree of human utilization. The problem reduces many times to the difference between a climax coniferous forest and an old-growth Douglas fir stand; the first is a habitat, while the second is timber. Such a distinction may seem extreme, but there are in fact international disagreements on appropriate terminology in soils, climates, land use, etc.

3.6 Graphic credibility

A map is intended to be a graphic summarization of the relationships among sets of spatially-distributed phenomena. The map reader should be able to extract general conclusions about concentrations and voids of the phenomena, as well as the ways in which the phenomena vary with other spatial factors, such as elevation, precipitation, latitude, inter-species competition, etc. Such an overview is the most sophisticated form of map reading and interpretation, and it is the primary reason that the effort of preparing a map is undertaken. However, many researchers are not willing to trust maps to give readers all of the information, especially when investigators have gone to considerable lengths to collect and organize it. Consequently, they will prepare maps which are filled with numbers and labels, just to make sure that the map readers can extract specific information in any given spot. This approach uses the map as a spatial table and detracts from the reader's ability to derive an overall comprehension of the information.

4. Atlas Compilation and Production Schemes

From a review of the collection of over 3,000 atlases held in the Geography Branch of the University of Washington Library, it is clear that five basic production schemes have been used. These different organizations have resulted because of differing levels of cartographic and scientific expertise. Different procedures have resulted in varying degrees of uniformity and internal standardization. However, none of them insure that the final atlas will be well-designed and useful. Overall graphic and book design, which is sometimes applied just prior to the actual publication appears to have brought even the most diversely-created projects into a coherent presentation. A comprehensive design formulated before any data compilation and execution and adhered to throughout an atlas project would be far wiser.

4.1 Individual map compilation, design and execution

Among the University of Washington atlases are 25 to 30 books which are collections of topical map sections each compiled, designed and executed by different individuals or groups. Several of these atlases are prototypes for more ambitious efforts, and very often these have been created by college cartography classes. A prototype for a Washington State Atlas has long been a class project in the advanced cartographic design class at the University of Washington. Loy's Atlas of Oregon (1976) was first conceived, created and published by undergraduate cartography students at the University of Oregon as the Preliminary Atlas of Oregon (1972). Each Student was free to create the best cartographic representation of the subject within the constraints of the 8 1/2 by 11, spiral-bound format.

Such as approach relies on the capability of researchers to be able to select appropriate scales and symbols, organize an effective data collection and encoding scheme, and then, execute their plans in a professional manner. Maintaining a similar style of graphic execution through the atlas could be a particularly difficult problem given the range of graphic arts training.

Styles range from very mechanical-looking engineering drawing to sketchy landscape architectural renderings. Generally, an independent approach would limit cartographic alternatives, such as non-standard map projections or layered tint screens. On the other hand, it does put the task of maintaining data accuracy and fidelity directly with the people most qualified to make judgement about them.

It seems that this approach has been used most often in low-budget efforts, and that it would require a great deal of effort and training on the part of the disciplinary experts. However, there is no reason that it could not succeed if adequate assistance were given from a central supervisory group.

4.2 Guided individual map compilation and execution

An alternative to absolute individual invention of design would be to establish basic cartographic design in consultation with disciplinary experts, and then to provide close guidance for applying this overall design to the creation of the topical map sections. Thus, a cartographic designer and geographic analyst would be available to consult on any problems that the expert might have in creating an effective graphic representation of his or her information. It was in somewhat this manner that the Atlas of the Recovered Territories of Poland(1947) was created. This book contains 35 maps by 10 different authors. Each author created his own symbolisms using 6 standard solid colors which were applied to a common 1:2,000,000 base map with a fixed page layout. Although a diversity of point, line and area symbols were used, the common layout and solid colors provide a unity which prevented the atlas from appearing as an unrelated collection of maps.

As with the first method, this scheme makes data accuracy and fidelity concern of the person best able to resolve any inconsistencies. It comes the closest to making the atlas represent the best considered spatial opinion of the most knowledgeable people.

4.3 Standardized symbolization

Another method that would still rely on disciplinary experts to execute the map is to create a standard cartographic design from which each individual researcher could select the elements that he or she felt were best suited. In this way many of the questions related to graphic and cartographic design are resolved by the people best equipped to handle them, yet those best able to maintain data fidelity are still in charge of final rendering of the information into maps. It was difficult to tell if any of the atlases in the University of Washington collection were prepared in this manner, although such procedures have been employed in the preparation of some planning atlases and reports.

The advantages of this scheme are still those of appropriate division of labor based upon expertise, and the disadvantages rest in expecting non-professionals to execute a professionally created cartographic design.

4.4 Cartographic bureau, agency or laboratory

The majority of bound atlases are made by cartographic production staffs associated with government surveys, national geographical institutes, or universities. Typically, data will be compiled by an outside expert or a consultant working with an internal team devoted to one particular topic. The cartographic and graphic design will be coordinated by a specifically-designated designer responsible for the complete graphic continuity of the atlas. Two very successful recent atlases were prepared in this manner: The Atlas of Israel (1970) produced by the Survey of Israel, and the Economic Atlas of Ontario (1969) prepared at the University of Toronto. In each case, an overall production staff was organized to compile and execute the atlas with topical atlas sections given to particular teams. A complete atlas design can be more effectively carried out if there is a concentration of the production effort, so that conflicts in the design can be resolved as they arise. Furthermore, a team of professional geographers and cartographers are in a better position to make use of more advanced data collection and manipulation techniques, to employ more intricate symbolization, and especially, to utilize more complex graphic arts methods. These aspects can be seen in both atlases. The Ontario Atlas used computer data processing in organization and manipulation of the myriad data shown in the atlas, as well as intricate symbolizations combining shifts in hue, chroma, and brightness with textural pattern changes.

The Israeli Atlas is the product of various scribing materials and photo-etched masking methods which would not generally be available outside a major graphic arts production facility.

The obvious advantage of the professional cartographic production staff is the concentration of expertise and equipment by which the best possible graphic presentation can be created. Distinct disadvantages are the cost of a high-level organization and the fact that it will often require much more time to create the atlas, since all outside data collection will usually have to be completed before atlas compilation and execution can begin.

4.5 Fixed symbolization

The fifth option presents a method of compilation and execution which is the most remote from the actual disciplinary expert and the specifically tailored data representation. The United States Army Corps of Engineers Environmental Atlas of Central Ohio (1976) used a fixed grid system of symbolization. Data gathered in 18 different topical categories were all reduced to 1 km square grid cells for final rendition. Thereby, a uniform treatment of all subject matters was created. This worked well for areal information with extents greater than 1 km, but point and linear phenomena were either over represented or mis-represented by the relatively coarse grid resolution. However, the maps are readily comparable and can be easily adapted to computer storage, access, manipulation and display. A similar method was used in the Twenty American Cities (1964) atlas, and such grid approaches are popular computer-based planning methods, the results of which are often published in planning atlas formats.

5. Automation and Cartographic Execution

If an atlas is conceived as an information resource to be manipulated, studied, and revised, then automated techniques of data encoding, storage, retrieval and execution definitely should be considered. However, solely as a production tool, only cartographic agencies with developed systems are in a position to make cost-effective use of automation. Atlas production is a labor intensive activity which is continually increasing in cost. However, the cost of automation continues to drop in surprising steps. Thus, it would be economical to automate many tedious cartographic tasks to hold costs down. Although this may be true and at some time it may be commonplace, inter-related factors mitigate against cost-effective automated atlas production.

First, cartography is a difficult computational problem. Effective cartographic representation requires access to large amounts of positional data. The geometric problems involved in some forms of cartographic representation provide examples for computer scientists in the theory of incomputability; some cartographic problems just cannot be solved by direct sequential methods. This leads into the problem that tremendously complex procedures must be derived for an automated technique to do some cartographic tasks that are trivial for cartographers; placement of labels on a contour line is just such a task. Furthermore, cartographic symbolism and cartographic production facilities vary so widely that it has not been possible to create a single solution which is anywhere near universally acceptable. The Harvard Laboratory for Computer Graphics and Spatial Analysis has distributed over 30 different computer cartographic programs, and although some of them, such as SYMAP, are used very widely, none produce cartographic work that is acceptable as suitable copy for printed maps, let alone atlases.

Second, cartography is a small field when it comes to computer applications. Even in the area of computer graphics, a field that cartographers helped found, interest in mapping applications is dwarfed by computer -aided design and manufacturing (CAD/CAM) and bio-medical applications. Cartographic problems are not like a slightly more difficult bookkeeping problem. A general accounting and financial management package approach could not be used to create a system that would solve 98 percent of all mapping problems. Admittedly, some mapping tasks are similar to one another and software is being developed and marketed to handle them; land surveying and subdivision, utility line mapping, and general land-use mapping are examples. The remarkable fact is that in examining an atlas collection, it is clear that very few maps are as cartographically simple as the mapping in the three areas just listed. Most atlases use combinations of symbolic variations that would be very difficult for even the most clever programmer to foresee.

Consequently, it does not seem that it is practical to spend the amount of money required for a computer and satisfactory plotter, plus develop the necessary cartographic software, just for one atlas project. However, it is useful for a cartographic production agency to acquire these capabilities and to use them as necessary for particular projects. Indeed, it appears that the most cost-effective approach to automating cartographic production is to effect a synergism of human and computer capabilities, as in interactive cartographic design, wherein the choices that would be difficult to program are solicited from the cartographer.

6. Whither an Atlas?

There are many choices for presenting a spatial message. All options for organization and production should be examined carefully with respect to communication goals. One person's successful design will not necessarily satisfy another person's mapping needs merely through minor revisions. Each new cartographic creation must be designed independently if it is to realize fully the goals set for it.

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