

AN INTERNATIONAL PERSPECTIVE ON THE DEVELOPMENT OF  
NATIONAL DIGITAL CARTOGRAPHIC STANDARDS

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ABSTRACT

Increased activity in digital cartography and geographic information systems has clarified the need for standards and has sharply increased the demand for them. Nations are looking at the standards question in different ways and with different urgencies, based on their progress in digital cartography and geographic and (or) land information systems, identification of responsible agencies for development and promulgation of standards and the diversity of perceptions about the need for standards. This paper comments on the standards development experience in the U.S.A. and in several other countries.

WHY ARE STANDARDS NEEDED?

If we are to understand the importance of digital cartographic standards, we must examine the fundamental differences between conventional printed graphics (maps) and digital representations of spatial data. With the former, spatial relationships and cartographic features are drawn directly and symbolized for relatively easy visual perception by the map reader, while in the digital domain, there is need to be specific and unambiguous in coding the spatial relationships among various data elements that constitute the surficial and deep structure of the cartographic model. Further, this must be done in accordance with acceptable ADP practice.

In digital cartography, problems arise when an individual or an organization attempt to use data from a data base compiled by another individual or organization. The areas of difficulty are many (Moellering, 1985), and are listed below.

1. Inherent nature of the data being captured is different

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Publication authorized by the Director, U.S. Geological Survey.

2. Data structure, model(s), and organization are different
3. Quality of the data is variable or unknown
4. Definitions for features are conflicting
5. Terms and definitions used are not consistent

As agencies begin to pursue active programs involving spatial data handling, they search for standards and if there are none, they must proceed without them. This involves making decisions in all the areas listed above and can lead to data bases that are unique and more importantly, when multiplied by the work of several agencies leads to mounting inability to exchange data among important data bases. This condition is serious enough for digital cartography tasks of all kinds but if analysis and manipulation are the desired goals, the inability to interchange data is crucial. As geographic information systems come more and more into use, therefore, the ability for interchange of data becomes more and more essential.

#### SOME NATIONAL STANDARDS PERSPECTIVES

The development of digital cartography standards in the various countries varies widely as to approach and urgency based on the breadth and status of digital cartographic activities in the country, relationship among agencies in and out of government, responsibility for development and promulgation of standards and the pressures that affect the producing and using communities.

In these sessions we will hear some detailed accounts of standards development from Canada, Finland, United Kingdom, and U.S.A. There are common threads among the standards development activities of various countries as well as some differences. Without telling the entirety of their stories, even if I could, I will draw your attention to some aspects of those national experiences that will help describe the nature of the standards development problem. Because I am most familiar with USA developments I will say most about that.

#### United States of America

The fundamental support for digital cartographic activities in the U.S.A. is very broad. In 1973, the Federal Mapping Task Force recommended increased coordination of cartographic activities in the Federal government, and recommended that attention be given to establishing a national digital cartographic data base (Federal Mapping Task Force, 1973). Several National Research Council

panels made strong supportive statements about the need for national attention to multipurpose cadastres, specifications and standards for integrated national information systems, and the geodetic and cartographic data bases to support them (National Research Council, 1980, 1981, 1983).

In 1980, the National Bureau of Standards (NBS) signed a Memorandum of Understanding (MOU) with the U.S. Geological Survey (USGS) that provided for USGS to serve as lead agency in the development of digital data standards for earth science information systems. Since 1982, functioning under the mandate of this MOU, working under the sponsorship of the American Congress on Surveying and Mapping and funded by a grant from USGS, Professor Harold Moellering of Ohio State University has been leading a well-documented effort called the National Committee for Digital Cartography Data Standards (NCDCDS) (Moellering, 1982). This committee consists of membership from government, private industry and academia and furnishes a forum for a wide spectrum of interested parties to "express their opinions, assessments, and proposals concerning digital cartographic standards." NCDCDS now consists of a Steering Committee and three working groups--Data Organization, Data Set Quality and Cartographic Features. Professor Moellering will address you later on the work and considerable progress of NCDCDS.

In 1982, the General Accounting Office (GAO) called attention to the overlap in Federal digital cartography activities and recommended that the Office of Management and Budget (OMB) direct the interagency coordination of computer mapping and create a rulemaking body to establish uniform standards for Federal Computer Mapping (General Accounting Office, 1983). In April, 1983, the OMB issued a memorandum calling for a coordinating committee for the Federal digital cartographic program. Chairmanship of that coordinating committee was to be provided by the U.S. Geological Survey. Accordingly, the Federal Interagency Coordinating Committee on Digital Cartography (FICCDC) was formed, consisting of an 11-agency steering committee and 5 working groups (Southard and others, 1984). I was the first chairman of FICCDC and since my retirement early in 1986, the chairman has been your session leader, Mr. Lowell Starr.

Since the inception of FICCDC, careful attention has been paid to coordination of the work of NCDCDS and the standards effort of FICCDC. To this end, Professor Moellering has briefed FICCDC on his progress several times and FICCDC members attend NCDCDS meetings regularly.

Standards activities at USGS have been conducted both in parallel and in coordination with FICCDC and NCDCDS. In 1982, USGS decided that a set of draft standards was needed for the purpose of conducting the digital cartographic

business of the National Mapping Program. Accordingly, such draft standards were published and made widely available to the community in the U.S.A. and abroad. These digital cartographic standards were published in 1983-84 as several volumes of USGS Circular 895 as follows:

- USGS Circular 895-A Overview and USGS Activities
- 895-B Digital Elevation Models (DEM)
- 895-C Digital Line Graphs (DLG) from 1:24,000-Scale Maps
- 895-D Digital Line Graphs (DLG) from 1:2,000,000-Scale Maps
- 895-E Land Use and Land Cover Digital Data
- 895-F Geographic Names Information System
- 895-G Digital Line Graph (DLG) Attribute Coding Standards

Several of these standards, namely 895-B through G, are replaced by USGS Data Users Guides, and other volumes have been added, such as "Digital Line Graphs from 1:100,000-Scale Maps." Content changes have been made based on experience and feedback from users of the data and the draft standards. The USGS standards are being looked at by both NCDCCDS and FICCCDC for consideration of their impact on ultimate national standards.

The FICCCDC mandate is nominally for activity affecting Federal agencies only, while the effect of NCDCCDS work will be industry- and profession-wide. This difference must be taken into account when reviewing the work of the two groups although the difference may not be as great as first perceived. Even though FICCCDC standards affect Federal agencies only, the data bases these agencies deal with are often so large and national in scope, that standards promulgated for them are bound to have an influence on industry-wide standards. Currently the FICCCDC Working Group on Standards, chaired by Mr. Gale TeSelle, Soil Conservation Service, Department of Agriculture, has proposed a Federal Geographic Exchange Format (FGEF) to facilitate the exchange of data among several Federal data bases. Mr. TeSelle will tell you more about this important work.

The Moellering Committee (NCDCCDS) has issued Interim Proposed Standards for Cartographic Data Exchange, Data Set Quality and Cartographic Features. Testing has been conducted and assessment and public opinion are being

received. All the standards discussed above will be reviewed, coordinated, tested, enhanced, and evaluated before being developed as proposed Federal Information Processing Standard (FIPS) for promulgation by the National Bureau of Standards (NBS).

### Australia

In 1982, The Standards Association of Australia issued a standard for the interchange of feature-coded digital mapping data. The work to produce this standard was done by a committee of the Association called the Committee on Computers and Information Processing working with twenty governmental scientific and industrial organizations. In the standard, coding methods and data structures were specified for features on maps and charts (Standards Association of Australia, 1981).

Since the issuance of the original AS 2482 Standard, work and discussion have continued, with particular attention given to defining the preferred usage of the standard. Some minor changes were made to the standard in 1984, resulting in a new standard, AS-2482-84. The changes included additional feature codes and some changes in essential information fields to accommodate exchange requirements in cadastral mapping.

The National Mapping Council (NMC) assigned a technical committee to evaluate the use and effectiveness of AS 2482. The study revealed concerns that the standard may be: overly-complex, especially for applications such as digital elevation models; and not sufficiently sophisticated for applications such as topological structures.

Based on the work of their technical committee, NMC has prepared a series of recommendations that would clarify the usage of AS 2482 for small and medium scale vector, unstructured topographic mapping data and develop additional standards as needed for other types of data.

### Canada

Concerns in Canada about the lack of standardization in the handling of digital cartographic data began to surface in the 1970's. The Task Force on National Surveying and Mapping perceived these concerns, and in their final report recommended that mechanisms should be created for the formulation of standards for digital mapping, including the storage and retrieval of digital map data involving federal, provincial and municipal governments, the universities, and the private sector.

The Canadian Council on Surveying and Mapping (CCSM) resolved to carry out the Task Force recommendation. Under leadership of the Director, Topographical Survey, Survey and Mapping Branch; Energy, Mines and Resources, Canada, planning meetings were held including members of CCSM and the Canadian Association of Aerial Surveyors (CAAS). Technical Committees were appointed to address the following:

- I. - Standards for the classification of topographic features
- II. - Standards for the quality evaluation of digital topographic data
- III.- EDP standards applied to digital topographic data

The Committees produced a three-volume draft report in 1982. Volume I set forth a standard for feature coding and classification and definition of topographic features. Volume II included the procedures for evaluating digital topographic data, descriptive conditions to be communicated along with the data, lineage of data acquisition and accuracy standards. Volume III contained the EDP file format. These volumes were sent to several hundred locations for review, and replies were reviewed by the appropriate Technical Committees (Canadian Council on Surveying and Mapping, 1982).

In July 1984, a revised draft version was published with contents as follows:

- Volume I: Standards for data classification, quality evaluation standards, and an EDP file format for digital topographic data exchange
- Volume II: Topographic feature codes and a dictionary of feature definitions

After a proposal for a revised interchange format made by the Ontario Ministry of Natural Resources, in November 1984 a subcommittee of CCRS with broad national representation recommended the following:

1. There should be a clear information model for digital topographic data which contains at least topography, attributes, text, and topology.
2. The Federal Surveys and Mapping Branch should examine the CCSM EDP data exchange format and extend it to include topology and attributes to allow for bulk, batch-mode data transfer.

3. The Ontario Surveys and Mapping Branch should develop their proposal involving the use of structured codes to handle topographic and land related data to optimize on-line data transfer over computer methods.

Regarding Recommendation 1, a working group consisting of members from the Federal Surveys and Mapping Branch, Statistics Canada and the Canadian Center for Remote Sensing (CCRS) have produced a draft of "Proposed Standards for a Digital Topographic Information Model (DTIM)". A revised draft was circulated in November, 1985.

Work on Recommendation 2 is still under way by the same working group described above.

The Ontario Surveys and Mapping Branch was assigned responsibility for Recommendation 3 and has produced a report titled "Map Data Interchange Format" (MDIF). That concept will be discussed in detail by Mr. Zui Jiwani, from the Ontario Surveys and Mapping Branch.

#### United Kingdom

In 1983, the House of Lords Select Committee on Science and Technology conducted a thorough study of remote sensing and digital mapping, and in connection with that study, investigated the views of a large body of witnesses regarding the need for standards in digital cartography. The Committee thought it perceived a clear case for standardization of format and accuracy to facilitate access to digitized data. Many witnesses felt the need for standards is urgent while some felt that digital cartography is still too young for the adoption of standards which might be based more on traditional practices than on changing views based on the new technology (House of Lords, 1983).

The Ordnance Survey (OS) feels strongly about the need for digital cartographic standards, and has discussed the need and best approach with the Royal Society. The Royal Society has an OS Scientific Committee with a Digital Data subcommittee, chaired by Dr. David Rhind, which has studied the issues involved in defining standards for digital mapping. After the recommendation made by the House of Lords Select Committee and in discussion with several other agencies, it was decided that OS should head a group that would work to develop a national digital data transfer standard. Other agencies involved are the Military Survey, the Hydrographic Department and the National Environment Research Council (NERC). Considerable effort has been applied to resolve difficulties and differences of opinion. The standard will be made public at Auto Carto London and

an open forum will be held in November. It is hoped the transfer standard can be implemented by late January 1987, in cooperation with the British Standards Institute.

In this session, Sam Sowton and Peter Haywood will describe the UK experience for you in considerably more detail.

#### WHAT LESSONS CAN BE LEARNED?

It is not intended to stamp any of the efforts described here as successes or failures. The development of digital cartographic standards is evolutionary and if we are to influence the evolution to our advantage, we should look for the presence of factors that promise success. Some of these factors are identifiable in the case histories I have recounted for you. These are:

1. It is necessary to identify and evaluate issues involved with the handling of digital cartographic data. This study should be conducted by the most knowledgeable people available.
2. It is important to study these issues both from the standpoint of data production and data use to assure realistic standards.
3. It is probably best not to rush the development of official national standards, particularly when working standards can serve during the early phases of the educational process.
4. Government cartographic agencies should be involved in standards development and administration of the standards.
5. A balance should be achieved involving input by government agencies, private firms, academic resources, professional societies and users. Too much influence by any group will make the final product less effective.
6. Agencies furnishing funding and personnel resources for standards development should be made to understand that the effort will be extensive and may need to be continuous as sophistication of data collection and data use is developed.
7. Effective mechanisms should be developed for the treatment of differences of opinion. Those differences should not come as surprises but should be anticipated.

8. Better, more responsive methods of international reporting on standards development need to be developed. Meetings like Auto Carto are excellent means for doing this and sessions like this one will do the job, if they are conducted frequently enough.

## CONCLUSION

The fast-changing, almost explosively developing field of digital cartography and the related field of geographic information systems demand a means for accurate and responsive exchange of digital data. Experience over the last 10 years and particularly in the last 3-4 years show us that the organization of standards development activities must be given a high priority and must be understood to be a complex, demanding task requiring the best talent available in the country. The process requires education in the intricacies of spatial data handling but it also furnishes education, so that those involved, themselves, become important parts of the evolutionary process of digital cartography. Accordingly, the process of standards development can be considered as important as the final product of the standard itself.

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