

MARK II: THE NEXT STEP IN DIGITAL SYSTEMS DEVELOPMENT
AT THE U.S. GEOLOGICAL SURVEY

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ABSTRACT

The National Mapping Division, U.S. Geological Survey, has begun a major new system development effort called MARK II that has as its goal the implementation of advanced technologies and production procedures that will satisfy projected requirements of the National Mapping Program through the year 2000. At that time, it is planned that the National Digital Cartographic Data Base will be fully operational, with its contents based essentially on digital data. These data will represent the 7.5-minute, 1:24,000-scale map series, as well as other smaller scale series, and will be the central focus of the Division's mapping activities. To accomplish this ambitious goal, a series of development tasks are being implemented to (1) expand and improve mass digitization capabilities, (2) modify data structures to support increased content and access requirements, (3) develop digital revision capability, (4) develop product generation capability for standard, derivative, and digital products, (5) improve quality control, and (6) support advanced analysis and applications. Development of the MARK II system has begun, and implementation over the next few years will lead to full production of 1:24,000-scale digital data in the early 1990's.

INTRODUCTION

Since the mid-1970's, the National Mapping Division, U.S. Geological Survey, has been collecting digital data from the cartographic source materials produced by the Division. The Division has continually been involved in the development and implementation of new and improved systems and procedures to expand and enhance digital data production capabilities. In 1980, the existing production system and its capabilities for digital cartographic and geographic data production underwent a major review, and a series of production improvements and recommendations were made and implemented. Only minor system modifications were allowed, as the system then was considered to be stable and maintainable over the short term although it was recognized to be inadequate to meet the long-term requirements for

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digital data. The opportunity to gain several years of experience, while allowing technology to advance and become more cost effective before launching the next development phase, was judged to be worth these initial investments.

To address these long-range requirements and to continue the development of the Division's digital systems, two studies were conducted in 1985. One addressed the programmatic issues of transforming an ongoing production program from a traditional graphic operation to a digital environment, while coping with an increasing requirement for revision of the basic cartographic series of the country. The second study addressed the technical aspects of this transition. Upon completion of the two studies, an integrated development/production plan was adopted to guide the National Mapping Division through the remainder of the century. This next generation digital production system is called MARK II.

SYSTEM OBJECTIVES

The development plan for MARK II addresses both the programmatic and technical issues involved in the transition of the Division's cartographic operations.

Production Objectives

The production objectives for the Division through the 1990's include the completion of the cartographic coverage of the country and improvements in product quality and in the establishment of more effective map-revision procedures. The long-term development includes a transition from the traditional cartographic production processes to a digital production environment. The near-term objectives involve the completion of approximately 4,600 1:24,000-scale quadrangle maps. In addition, approximately 9,000 existing quadrangles are now judged to be substandard and will be updated to improve positional accuracy. Also, maps with inappropriate contour intervals and those with content deficiencies will be corrected.

The long-term production objectives for MARK II address the development and implementation of specific capabilities and capacities. These goals are divided into three timeframes:

1. By the year 1990

For the 1:100,000-scale data base (approximately 1,800 map sheets)

- Complete digitizing of the major categories.

For the 1:24,000-scale digital data base (approximately 54,000 map sheets)

- Complete digitizing of 50 percent of the Public Land Survey system and boundaries.
 - Complete 50 percent of the digital elevation models.
 - Implement a production capacity of 4,000 quads/year for digital line graphs.
 - Develop contract options for as much as 50 percent of the required production capacity.
 - Implement a digital revision capacity of 2,000 quads/year.
 - Implement an initial capability to produce high-quality cartographic products from digital data.
2. By the year 1995
- Complete digitizing of 100 percent of the Public Land Survey system and boundaries.
 - Complete 50 percent of the other 1:24,000-scale digital line graph categories.
 - Increase production capacity to 5,600 quads/year for digital line graphs.
3. By the year 2000
- Complete digitizing of 100 percent of the 1:24,000-scale digital line graph categories.
 - Increase capacity to revise 5,600 quads/year.
 - Implement capacity to produce 5,600 high-quality maps a year from the National Digital Cartographic Data Base.

Development Strategy

The development strategy proposed for MARK II addresses the major production capabilities to be designed, developed, and implemented to meet the program objectives listed above. These objectives are:

- Development of advanced mass digitization systems, to especially concentrate on the collection of the heavily symbolized 1:24,000-scale source data.

- Development of improved data verification and testing procedures, concentrating on the development of improved automated data checking. This also includes the completion of data standards.
- Development of techniques and processes to produce topographic and thematic graphic products from data contained in the National Digital Cartographic Data Base.
- Provision of digital data suitable for analysis and application by geographic information systems and related technologies.
- Development of an improved production management system to efficiently task and track the multiple production activities of the MARK II system.
- Enhance the National Digital Cartographic Data Base operations and its structure to ensure the data are maintained for optimum utilization by the production system.

MARK II SYSTEM DESIGN

The MARK II effort will result in the implementation of advanced technology and production procedures in the National Mapping Division production centers. To accomplish this and to provide an orderly implementation of newly developed capabilities, the MARK II production system has been divided into four functional components, each under a component manager and designed to address a specific portion of the production process. Each of these components has been further subdivided into a series of development modules, currently numbering 46. Each module then consists of a set of defined and assigned tasks.

MARK II SYSTEM COMPONENTS

Data Production Component

The data production component addresses all phases of data collection, editing, processing, quality control, and revision prior to entry of data into the National Digital Cartographic Data Base. This component is the largest and most complicated portion of the system to be developed. It includes the requirement to develop efficient mass digitization and automatic feature-recognition capabilities for traditional cartographic symbolization and the requirement to develop methods for feature extraction from imagery. Implementation will have to be skillfully managed in introducing new equipment, software, and procedures into an already operational system.

Data Base Component

The data base component is designed to implement improvements in the National Digital Cartographic Data Base to enable a central data repository to support substantially all of the Division's production activities. In order to do this, the development of two levels of data bases are planned: (1) operational data bases located in each production center to support ongoing center production and product generation requirements, and (2) an archival data base to provide a central repository for data to support the operational data bases. These data bases will be linked with high-speed data communication systems to transfer data between data bases and to support the public sale and distribution of products. Additional information about the design and operation of these data bases can be found in "A New Design for the U.S. Geological Survey's National Digital Cartographic Data Base" (Guptill, 1986).

Product Generation Component

The product generation component is designed to provide a capability for producing a variety of standard and derived cartographic products, both graphic and digital.

Production Management Component

The production management component is designed primarily as a two-way interface between the MARK II production system and the National Mapping Program production requirements and authorization systems. This interface will include reporting mechanisms among various systems, establishing production tracking within the data base management system, and ensuring that MARK II activities are appropriately related to the requirements for digital and graphic products.

MANAGEMENT STRATEGY

The implementation of a comprehensive management strategy is critical to the overall success of MARK II. The management of MARK II includes the organization of the development effort, and the establishment of a development cycle.

Management and development of the MARK II effort is being accomplished within the current organizational structure of the Division rather than by establishing a separate organization. The only new position that has been established is the Program Manager for MARK II developments. This position has been placed within the research staff with full responsibility for the overall coordination and management of the development effort. The effort has been divided into components and modules, and component management has been assigned to existing staff offices. Module responsibilities have been assigned throughout the Division, with 60 percent of the work assigned to mapping centers and 40 percent assigned to staff offices.

The cycle established has been divided into two phases -- design and development. The design phase begins with the assignment of component and module tasks and ends with the approval of the component and associated module designs. The development phase begins with the approval of the component designs and ends with the implementation of the developed capacities into the production centers.

The primary review and approval authority for the designs has been assigned to a Division Configuration Control Board. This new senior-level management board was established to review and certify the initial design of the system and control the subsequent configuration of the hardware and software systems developed.

CONCLUSION

The design, development, and implementation of the MARK II system represents a major development activity within the Geological Survey that will exploit state-of-the-art mapping technology resulting in a highly responsive digital cartographic production system. We believe that the timing of this effort is appropriate and necessary to meet requirements, the state of available technology will support the effort, and the future needs of users of these data will be fully met. The development of the MARK II system will assure that the long-term goal will be met, that is, to enable the National Digital Cartographic Data Base to support the product and process requirements of the National Mapping Program. Attainment of this goal will allow the Division to be responsive to national requirements for up-to-date cartographic data and map products that are produced more quickly and efficiently.

REFERENCES

Guptill, S.C., 1986, A New Design for the U.S. Geological Survey's National Digital Cartographic Data Base: Auto Carto London, England, September 1986, Proceedings.