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DIGITAL DATA SUPPORT FOR NEW WEAPON SYSTEMS(U) DEFENSE
MAPPING AGENCY WASHINGTON DC K I DAUGHERTY ET AL.
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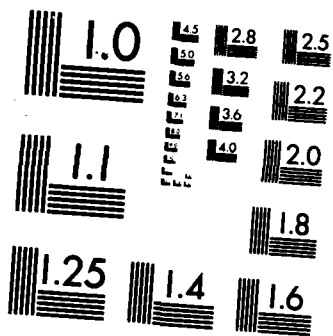
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<p>A host of new weapon systems are being developed which will require some form of digital mapping, charting, and geodetic (MC&G) data for operation. Along with these new weapon systems are a diverse spectrum of combat support systems such as weapon system trainers, battle management systems, and intelligence analysis systems which will likewise need digital MC&G data. In some cases these systems are being designed to operate with data which the Defense Mapping Agency (DMA) does not currently produce or plan to produce in the future. Also some of these digital MC&G data requirements are simply beyond the current technological capabilities of DMA to produce within the required time frame.</p> <p>The answer to this untenable situation is communication. It is essential that military system developers and DMA customers alike understand the nature of this situation. System developers are encouraged to design their systems to operate with data currently being produced. When this is not feasible, early communication with DMA is necessary because</p> <p>(OVER)</p>			
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19. ABSTRACT (Continued)

DMA requires the same lead time as any other developer to generate new production capabilities.

This paper is part of the effort being made by DMA to establish the necessary communication links. Included in this paper are a brief overview of DMA's mission and products, a description of our digital data products, a discussion of the production challenges and schedules, a listing of current developing systems that we know about, and a summary of the DMA research and development efforts aimed at meeting future digital data requirements.

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DIGITAL DATA SUPPORT
FOR NEW WEAPON SYSTEMS

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INTRODUCTION

A host of new weapon systems are being developed which will require some form of digital mapping, charting, and geodetic (MC&G) data for operation. Along with these new weapon systems are a diverse spectrum of combat support systems such as weapon system trainers, battle management systems, and intelligence analysis systems which will likewise need digital MC&G data. In some cases these systems are being designed to operate with data which the Defense Mapping Agency (DMA) does not currently produce or plan to produce in the future. Also some of these digital MC&G data requirements are simply beyond the current technological capabilities of DMA to produce within the required time frame.

The answer to this untenable situation is communication. It is essential that military system developers and DMA customers alike understand the nature of this situation. System developers are encouraged to design their systems to operate with data currently being produced. When this is not feasible, early communication with DMA is necessary because DMA requires the same lead time as any other developer to generate new production capabilities.

This paper is part of the effort being made by DMA to establish the necessary communication links. Included in this paper are a brief overview of DMA's mission and products, a description of our digital data products, a discussion of the production challenges and schedules, a listing of current developing systems that we know about, and a summary of the DMA research and development efforts aimed at meeting future digital data requirements.

DMA MISSION AND PRODUCTS

DMA has become an important part of the national deterrence equation because our products are vital to the nation's

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front line war-fighting capability. DMA supports the national command authority as well as the unified and specified commanders and military departments of the entire Defense establishment. As the DoD manager for mapping, charting, and geodesy, DMA produces a large spectrum of products starting with the traditional paper products but also including film products, safety of navigation publications, geodetic data, and digital products. These products are critical to the national command, control, communications, and intelligence assets as well as the full range of military forces. However, it is the Unified and Specified Commands who generate the high priority requirements for data and drive DMA's production goals.

Digital data, the focus of this paper, accounts for approximately 65% of DMA's work effort. In FY 86, DMA will produce digital MC&G data over greater than 10% of the earth's land surface area. This digital data is required to support a large number of systems such as radar and visual simulators, the Pershing II missile system, cruise missiles, and the Firefinder system.

DIGITAL DATA DESCRIPTION

There are two major data bases of primary digital data: digital terrain elevation data (DTED) and digital feature analysis data (DFAD). The earth's surface is defined by DTED which consists of latitude, longitude, and height above mean sea level for a series of evenly spaced points or posts referenced to the World Geodetic System. The features, both natural and manmade, which populate the earth's surface are then measured and defined by a series of codes. For example, there are 13 surface material codes and 269 feature identification codes.

The specifications for these digital data bases are somewhat complicated and reflect the fact that requirements have changed over the years. Digital terrain elevation data (DTED) is produced in Level 1 and Level 2 specifications. Digital feature analysis data (DFAD), on the other hand, has been produced at Level 1 in both first and second edition specs, Level 2, and Level 1-C. Also some prototype data sets of DFAD have been built at Level V and Level X.

DMA's primary digital data production for broad area coverage of the world is produced to Level 1 specifications. Level 1 data is produced in one degree cells, an area approximately 60 nautical miles on a side.

Level 1 DTED is defined by measuring an elevation post every three arc seconds apart, a distance of approximately 100 meters. This means that a one degree cell of Level 1 data contains over 1.44 million DTED posts. Level 1 DFAD contains the feature content equivalent to that of a 1:250,000 scale map.

Level 2 data is produced only in small area patches of particularly high interest. In Level 2 DTED the elevation post spacing is decreased to one post every one arc second, a distance of approximately 30 meters. The feature content is Level 2 DFAD is equivalent to that of a 1:50,000 scale map.

The difference between Level 1 DFAD first edition and second edition reflects a change in the requirement. The initial requirement for DFAD in the 1970s was for support of radar simulators so the features were extracted based on radar reflectivity alone. By 1983 other uses were being made of the data, and the specification was changed. The major change which constitutes Level 1 DFAD second edition is the addition of roads, railroads, and surface drainage (rivers and streams).

DFAD Level 1-C represents an innovative approach to greatly speeding up data production. The "C" stands for cartographic source, and the data is extracted primarily from existing 1:250,000 scale maps without any photo analysis. The areas selected were mainly tundra and barren areas. Level 1-C does include roads, railroads, rivers, and country boundaries. To aid in production, Level 1-C was targeted for contracting to private companies to the extent possible.

Two levels of prototype high resolution feature analysis data bases have been produced by DMA. DMA produced a set of Level V DFAD at the 1:200,000 scale for visual simulators. It was determined that the value of Level V over Level 1 was insufficient to warrant further production. However, recent improvements in computer technology have made it possible to manipulate very large volumes of data. This led to the request for DMA to produce some very high density sets of digital feature analysis data known as Level X. Initially DMA produced prototype DFAD sets in both the 1:10,000 scale and the 1:25,000 scale. Enthusiasm for the 1:10,000 scale DFAD has made this generally accepted as the definition of Level X data. With Level X, radar reflectivity is no longer the criterion for data extraction; with Level X virtually every feature is identified.

PRODUCTION CHALLENGES AND SCHEDULES

The major trend in the development of new military weapons is toward high technology, high accuracy "smart" weapons. These smart weapons are needed to counter the threat of the great masses of Soviet and Warsaw Pact weapons and maintain deterrence. The development of smart weapons is presenting DMA with requirements for and a challenge to produce data with greater accuracy and increased information content. This is indeed a challenge because DMA is struggling to meet its current data production requirements.

DMA is concentrating a major effort on meeting its total area requirements for Level 1 digital data. As of 1 May 1986, the DMA digital data holdings consisted of 61.6% of the total area requirements for Level 1 DTED and 26.6% of the total area requirements for Level 1 DFAD. Furthermore, approximately half of the current DMA data holdings are considered of limited use because of currency and accuracy. If current production methods, rates, and schedules are maintained for five years, DMA will be able to produce data over only about half of the areas for which there is no coverage today.

The increased effort and manhours required to produce higher resolution data only compound the problem at a time when DMA is striving to meet its Level 1 digital data requirements. Level 2 DTED takes twice as many workhours to produce as Level 1 DTED over comparable areas. The problem is considerably more acute in the production of feature analysis data. The relative cost in workhours of Level 2 DFAD is about 100 times that of Level 1 DFAD, and Level X DFAD is about 244 times that of Level 1 DFAD.

The DMA Modernization Program will help but will not solve this problem. In the first place, the Modernization Program is required for DMA to cope with a programmed change in its primary data source. Modernization will, however, give DMA an end-to-end digital production capability essential for handling evolving technologies which may solve production shortfalls. Current Modernization Program goals call for a 75% reduction in the calendar time required for data production. With the Modernization Program completed and the digital production capability fully operational, it will still require 80 times more manhours to produce Level X DFAD than it will take to produce Level 1 DFAD.

CURRENT DEVELOPING SYSTEMS

The development of new systems which will require digital MC&G data presents DMA with one of its most vexing problems. Just knowing about their development is difficult let alone understanding their potential impact on DMA. DMA needs early knowledge of these developing systems and communication with their developers. The requirement for early communication is two-fold: first, if possible, the system should be engineered to operate with data which DMA currently produces, and second, if that is not possible, DMA needs sufficient lead time to generate production of new data. The problem lies in the fact that there are so many military agencies and contractors developing new systems, and the lines of communication are not clearly established. Many system developers do not even recognize the need for this early communication with DMA. Often, DMA first learns about a new system when a prototype has been built and a MC&G data set is requested for test and evaluation. Following are some examples of developing systems which will impact DMA.

There are a number of new Air Force systems which will require DMA support. The B1-B aircraft weapon system trainer was developed to use high resolution digital data in its radar simulator. The request for this data is overwhelming to the current DMA production capability. To support development of the Advanced Technology Bomber, SAC has requested gravity data which is beyond DMA's current technical capability to produce. The Joint Surveillance Target Attack Radar System (JSTARS) is a joint Air Force and Army program designed to detect and track enemy targets and provide precise locations in real time. DMA has provided 8 cells of test data of increased accuracy Level 1 second edition DFAD; the operational requirements for this system are unknown.

For the most part, the Army is developing its new systems to operate with a single DMA product, the Tactical Terrain Analysis Data Base. The problem lies in the fact that DMA is only in the prototype data set development stage at this time (see paper on Tactical Terrain Analysis Data Base by Major Foster). Army systems which fit into this category are the light helicopter (LHX), the All Source Analysis System (ASAS), the Maneuver Control System (MCS), the Battle Management System (BMS), and the Digital Topographic Support System (DTSS). The Army Training Battle Simulation System (ARTBASS) is a system which has already been fielded. The

Army is producing its own data to support the ARTBASS until DMA's Tactical Terrain Analysis Data Base is in production.

Because the Navy is a multimission force, they require a broad range of DMA data for current and developing weapon systems. The Tomahawk Land Attack Missile alone will require six different types of DMA data for mission planning and operation. The AV-8B aircraft moving map display system will require DMA to produce its digital data on an optical disk. The Trident II submarine requires geophysical data which is still being collected. A whole family of electronic nautical charts are in development for which DMA does not know the MC&G data requirements.

Identifying developing systems with MC&G requirements is more difficult than it may appear. A careful review of the Military Department Program Objective Memorandums is not revealing because MC&G requirements are not specified. This section concludes with an appeal that readers help identify pertinent developing systems to DMA.

DMA R&D PROGRAM

The DMA R&D program is a broad based program, but it is aimed directly at satisfying user needs. The program is currently defined by seven R&D goals which are paraphrased below:

1. Improve acquisition of geodetic data.
2. Improve acquisition of hydrographic data.
3. Automate terrain analysis production.
4. Digital crisis response support.
5. Protray earth information from a minimum data set.
6. Optimize user satisfaction through emerging technologies.
7. Exploit multispectral data.

The customer is obvious in some of these goals. Goal #1, the improved acquisition of geodetic data, is designed to support strategic weapon systems. The Navy's need for hydrographic data far outstrips current technology for data collection; hence, Goal #2. The automation of terrain analysis production, Goal #3, is designed to satisfy not only the Army's data needs, but also those agencies studying the strategic relocatable target problem. Goal #7, exploitation of multispectral data, on the other hand, is designed to benefit all customers by improving data

production across the board. Each one of the DMA R&D goals warrants a paper by itself, but that is not our purpose here.

Goal #5 is the one aimed at the digital data problem. The goal is to develop techniques, systems, and expertise to portray earth information required by planners, operators, and weapons from a minimum MC&G information set. The main objective under this goal is to satisfy customer's needs for high resolution data for aircraft synthetic aperture radar simulators, automated terrain analysis exploitation systems, and future electronic chart systems. The key phrase here is minimum MC&G information; the data must be sufficient for system operation but within DMA's capability to produce in a timely manner.

The plan of approach is four fold. First, the requirements must be identified. Second, short term alternatives must be developed using currently available DMA data and techniques. Next, longer term solutions must be sought using innovative approaches. And finally, communication with system developers and users must be established to ensure customer satisfaction.

There are several strategies included in Goal #5 which conform to the plan of approach. The most promising short term approach is called synthetic breakup. A longer term but highly promising approach is the direct transformation of synthetic aperture radar data collected from an overhead platform for simulator use. The Deployable Digital Data Base Technology is a somewhat mid-term approach which will be discussed in detail below. The use of EOSAT data for automated material classification is being pursued under the multispectral goal but would directly benefit the production of high resolution data.

Synthetic breakup is a technique to make Level 2 DFAD look like Level X DFAD in a simulator without the work effort required for the extraction of Level X data. This technique primarily applies to urban residential and industrial areas. For example, in Level 2 DFAD a residential area is simply outlined and defined by a set of codes. Level X DFAD requires that that same residential area be defined by extracting every street and every house. On a radar simulator the Level 2 data makes that residential area look like a boxed area of uniform brightness whereas Level X makes the area look textured. A single code added to Level 2 data can artificially add texture to the residential

area making it look very similar to Level X data. Let us emphasize that this synthetically enhanced data is for use in trainers only and not for navigational or weapon system guidance use.

The Deployable Digital Data Base (D3B) Technology is a revolutionary concept for DMA. It involves providing the customer a set of digital data files on a transportable medium along with software tools necessary for the customer to enhance the basic data file to meet his own needs. Each of the users would need a digital graphic workstation and a high capacity processor to exploit the D3B data. The DMA R&D program includes the development of this workstation and processor as well as the transportable software tools mentioned above. It is anticipated that the set of digital data files prepared by DMA would include processed elevation data (Level 1), a feature file (Level 1), symbolized graphics data, a names file, and a digital point positioning data base (see paper on Digital PPDB by Dr. Waxman). The software tools would include auxiliary elevation extraction software, interactive geographic information software, and perspective scene view software. As an example of the use of D3B, a user could take the basic Level 1 DTED and upgrade it to Level 2 DTED over areas of particular interest to him using imagery and the extraction software provided in the D3B. A user could also update his file of feature information based on current intelligence such as reconnaissance photographs.

CONCLUSIONS

There are a couple of recent policy decisions in the Office of the Secretary of Defense of which users of MC&G data must be aware. These decisions affect the transformation of DMA data for specific applications and the production of new and unique MC&G data.

The Assistant Secretary of Defense for Command, Control, Communications, and Intelligence signed a policy letter on transformations on 15 May 1985. This policy letter stated that DMA would continue to perform the transformations on data for systems deployed at that time, but DMA would not be responsible for transforming data for new systems. Notable by its absence from the list of grandfathered systems is the F-15E aircraft. The transformation of data to support the F-15E weapon system trainer will, therefore, be the responsibility of the Air Force.

A policy decision of even greater potential impact was the Program Decision Memorandum (PDM) signed by the Deputy Secretary of Defense in August 1985. This PDM stated that beginning in FY 88 the military departments must program funding to pay for the production of new and unique MC&G data required to support their new weapon systems. A DoD instruction detailing implementation of the PDM has been written and signed.

These policy decisions as well as DMA's physical and technological limitations make the following actions essential. Identify to DMA the development of new systems which will require MC&G data as early as possible. Engineer new systems to use currently available or programmed DMA products whenever possible. Be aware of the DMA digital data coverage. Beware of proposals from contractors for systems which may require MC&G data not available from DMA. Establishment of a vigorous dialog between system developers, system users, and the Defense Mapping Agency is the key to deploying new weapon systems fully supported by pertinent, accurate, and timely MC&G digital data in the future.

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