Digital Production System

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Abstract: In 1982, Congress endorsed the Office of the Secretary of Defense (OSD) mandate that the Defense Mapping Agency (DMA) should initiate a program to develop an all-digital production system capable of meeting the Armed Forces' critical demands for mapping, charting, and geodesy (MC&G) support.

In response to the OSD decision, DMA undertook the Exploitation Modernization Program, currently known as the Digital Production System (DPS), to redesign and retool its MC&G production systems and processes. The objective of this 10-year conversion program is to develop and implement an improved capability to produce a select set of DMA products from current and advanced imaging systems using softcopy imagery and computer-assisted techniques.

The DPS has two phases. The first phase, MARK 85, is a transitional step which upgrades DMA's current, film-based production system and provides initial digital exploitation capability using new source materials. MARK 85 has been delivered and is already in use. The second phase, MARK 90, provides an all-digital production system and will provide increased throughput, greater product flexibility, and improved responsiveness for the products in the DPS baseline.

DPS OVERVIEW

In 1982, DMA embarked on an ambitious modernization program to renovate the production of its MC&G products and to improve its productivity and management effectiveness. This effort had three main objectives - first, to implement the use of new digital source materials used in the making of MC&G products; second, to improve productivity and reduce production time by 75 percent on key DMA products; and third, to enhance management's flexibility to respond efficiently to new requirements and new technology.

Fulfillment of this modernization program will be realized in the development, delivery, and deployment of the DPS. This 10-year program, now rapidly maturing, is being developed in two phases. The first phase, MARK 85, has already been delivered. The follow-on phase, MARK 90, is scheduled to become fully operational by the mid-1990's. Together, the MARK 85 and MARK 90 programs provide DMA with increasing capability to reach the objectives stated above. MARK 85 improves and enhances hardcopy production methods (i.e., based on mono and stereo photography), improves production management and database management, and provides an initial softcopy production capability. MARK 90 will achieve end-to-end digital softcopy production capability and further improve production management in such key areas as production programming, scheduling, and resource management.

DMA Systems Center (DMASC) guides and oversees the development activities of contractors and subcontractors who are building and delivering the DPS segments.

These segments are keyed to various steps in the production of the defined set of major MC&G products, and will automate, simplify, and/or expedite many cartographic and management tasks formerly requiring manual or other labor-intensive techniques.

The principal function of the DPS is to extract terrain elevation and feature data, primarily from imagery on a multi-product basis, whenever possible; store that data in a global database organized by data type and levels within data type; and use that data to generate a variety of graphic and digital MC&G products. It is a single production system, geographically dispersed to three Production Centers; DMA Reston Center (DMARC), Reston, VA., DMA Hydrographic/Topographic Center (DMAHTC), Brookmont, MD., and DMA Aerospace Center (DMAAC), St. Louis, MO. The Production Management functions will be controlled from Headquarters DMA, Merrifield, VA.

MARK 85 has six segments as follows:
- Data Integration Segment (DI/S)
- Source Acquisition Segment (SA/S)
- Hardcopy Exploitation Segment (HE/S)
- Digital Comparator Segment (DC/S)
- Universal Rectifier Segment (UR/S)
- Feature Extraction Segment (FE/S)

MARK 90, which is being delivered in stages that started in 1990, will have five segments:
- Production Management Segment (PM/S)
- Source Preparation Segment (SP/S)
- Data Extraction Segment (DE/S)
- Data Services Segment (DS/S)

Enhanced versions of the HE/S and SA/S will also be incorporated into the MARK 90 system. The PM/S will build upon the DI/S to achieve total Agency management.

Summary of DPS Operations

The MC&G production process at DMA has many steps. Figure 1 shows an overview of DMA operations, graphically representing the flow of processing steps required to produce an MC&G product. This diagram depicts operational flow as it exists today and as it is likely to remain after the DPS is implemented. Symbols in each box identify areas in the production process supported by the MARK 85, MARK 90, mixed or other systems. Note that not every step is supported by a DPS segment. Separate developments are underway for the processing of geographic names and for the distribution of final products to DMA customers (Box 100). These separate systems are, respectively the Geographic Names Processing System (GNPS) and DMA's Distribution Management System (DDMS). Table 1 summarizes the operations supported by the DPS segments only. The referenced figure and table represent DMA's operational baseline in the 1990's. Each major activity is described.

o **Program Management (Box 10)**

This process encompasses the activities supporting the definition of customer MC&G requirements, translating them into DMA program guidance and development, determining preliminary programs and source material requirements, formulating DMA's Program Objectives Memorandum (POM), DMA's production program, and developing DMA's budget.

o **Production Management (Box 20)**

This process focuses on detailed planning scheduling and allocation of specific DMA resources in preparing monitoring of production status and the supervisory and production mission.
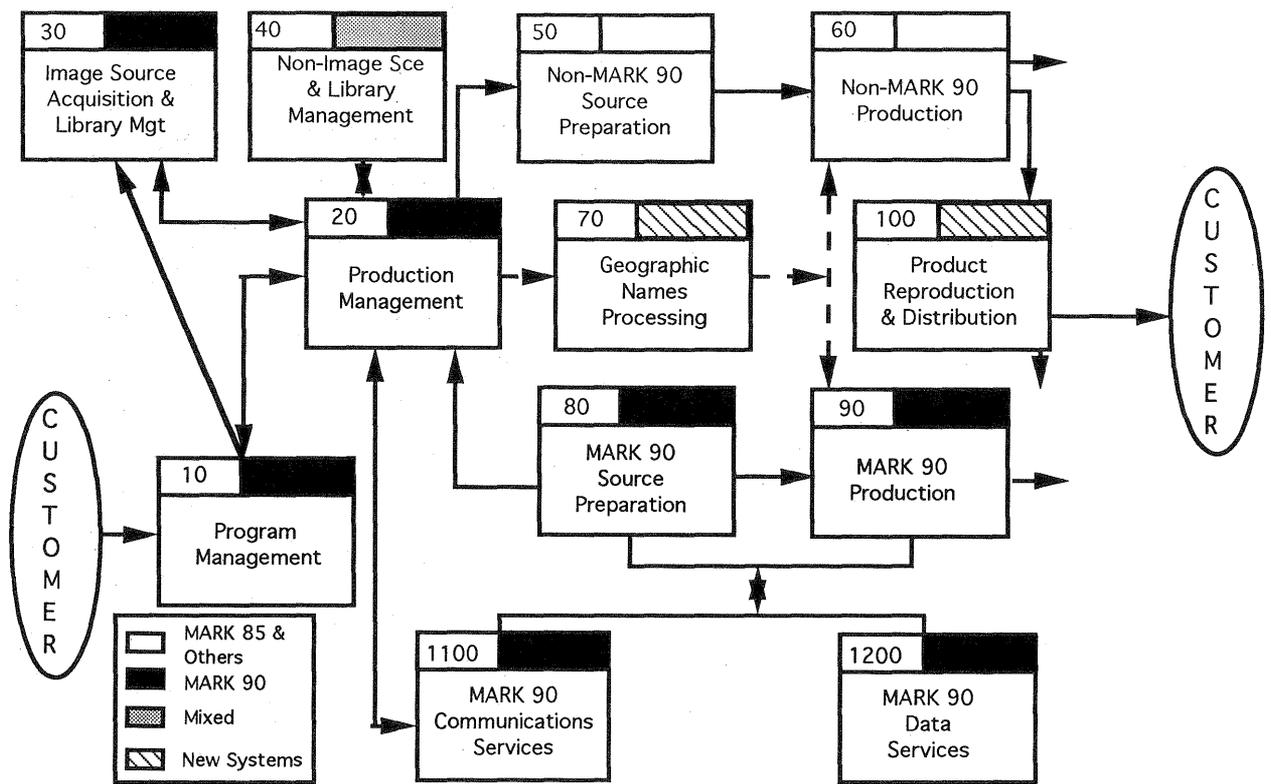
o **Source Acquisition and Library Management (Boxes 30, 40)**

- **Source Acquisition**

This process consists of ensuring the timely acquisition of the source material used to evaluate, produce and support production of DMA products; collecting, validating, correlating, and priori-tizing requests for new source materials; submitting those requests to outside agencies; and monitoring the collection activities in progress.

- **Library Management**

This process consists of providing an information management service supporting the internal access, retrieval, distribution and control of source materials and products; maintaining relevant information for each source item and DMA product, and providing transferral and archival storage for the materials themselves.

Overview of DMA Operations

Figure 1

OPERATION		SEGMENT/ SUPPORT	COMMENTS
NUMBER	TITLE		
10	Program Management	DI/S (MK 85) PM/S (MK 90)	DI/S Integrated Into PM/S
20	Production Management	DI/S (MK 85) PM/S (MK 90)	DIS/S Integrated Into PM/S
30	Image Source Acquisition and Library Management	SA/S MK 85)	SA/S Hosted on PM/S Equipment
40	Non-Image Source Acquisition Library Management	DI/S (MK 85) PM/S (MK 90)	DI/S Integrated Into PM/S
50	Non-MARK 90 Source Preparation	HE/S	
60	Non-MK 90 Production	DC/S FE/S UR/S	
80	MARK 90 Source Preparation	SP/S HE/S	HE/S Modified to Support MK 90 Source Material
90	MARK 90 Production	DE/S PG/S	
100	Product Reproduction and Distribution		PM/S Supports Management of Reproduction Operations. DMA Distribution Management System (DDMS) Being Developed Separately
1100	MARK90 Communications Services	DS/S	Intercenter Communications via Integrated DMA Telecommunications System (IDTS)
1200	MARK 90 Data Services	DS/S	

TABLE 1 DPS Segment Support for DMA Operations

o **Source Preparation (Boxes 50, 80)**

This process consists of the identification, review, evaluation and selection of new and existing multi-media source materials to support a specific production assignment and subsequent generation of a MARK 90 Source Use Package (SUP) or non-MARK 90 Source Package. Databases, libraries, and other DMA inventories are interrogated for the existence of candidate source material (softcopy, MC&G data, books, magazines, map/charts, etc.), and meeting production specific requirements (currency, accuracy, scale, etc.). Candidate source material attributes are evaluated and those best capable of meeting stringent production requirements are selected for production support. Source materials to support non-MARK 90 production are physically retrieved, tailored for production, and compiled into a Source Package. A MARK 90 SUP is a computer file which identifies applicable sources and their physical location (library, database location, inventory/storage, etc.).

o **Production (Boxes 60, 90)**

The production process encompasses data extraction and product finishing. Production requires carrying out a series of operations which yield completed MC&G products. During the production process, various data- bases are populated and maintained.

o **Product Reproduction and Distribution (Box 100)**

This process focuses on printing, duplicating, acquiring, receiving, storing, maintaining, and issuing MC&G products and materials to U.S. combat forces and other authorized users (e.g., other U.S. government agencies, foreign governments, and the public).

o **MARK 90 Communications Services (Box 1100)**

This capability provides for message transfer among all MARK 90 segments. Long-haul, intercenter message routing is supported by the Integrated DMA Telecommunications System (IDTS). Intracenter imagery and master graphics transfers are supported by a wideband communications network. Communications services also provide intracenter network management capabilities via a narrowband network.

o **MARK 90 Data Services (Box 1200)**

Data Services provides the capability to store and retrieve all MARK 90 data, ensure the integrity of the data, and perform database administration functions. Data services maintains current access control lists to ensure users have log-on privileges, determine user authorization to system resources, and that requestors have a valid need-to-know prior to data retrieval.

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MARK 85 Functionality

MARK 85 supports collection tasking and production of point and area products based on imagery and support data. MARK 85 also supports the revision of existing products using imagery source material. This system is installed at HQ DMA, the three production centers and at the DMA Combat Support Center (DMACSC), Brookmont, MD, near DMAHTC, and includes the DI/S terminals at the field offices. The MARK 85 segments are as follows.
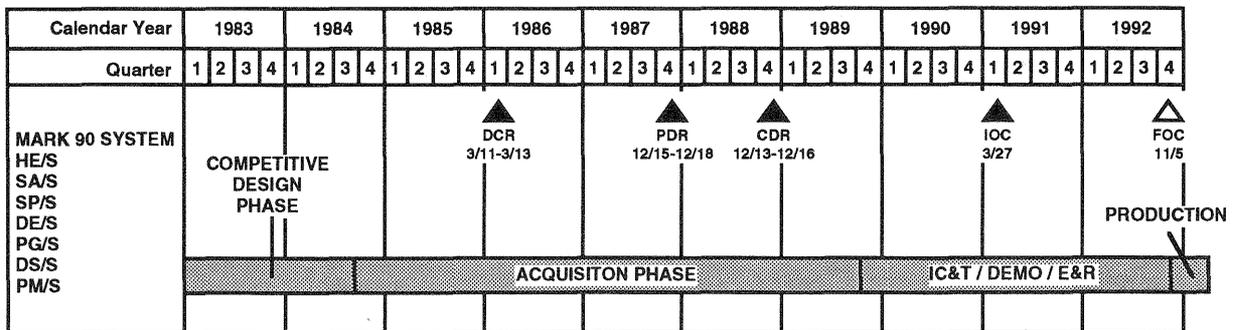
o   Data Integration Segment
    The DI/S provides program management, production management, source collection/acquisition management, and management of various non-imagery source libraries and databases.

o   Source Acquisition Segment
    The SA/S provides tasking for imagery collection and assessment, production feasibility analysis, and image library management.

o   Digital Comparator Segment
    The DC/S provides the capabilities to measure tie points and extract elevation data from softcopy imagery.

o   Hardcopy Exploitation Segment
    The HE/S provides the capabilities to exploit hardcopy imagery for mensuration, triangulation, terrain eleva-tion extraction, point target coordinate derivation, rectification, orthorectification, and Deployable Point Positioning Data Base (PPDB) cartridge generation.

o   Universal Rectifier Segment
    The UR/S provides the capabilities to rectify softcopy imagery and to generate PPDB film chips.

o   Feature Extraction Segment
    The FE/S provides capabilities to perform feature extraction from hardcopy imagery and produces Digital Feature Analysis Data (DFAD), Digital Terrain Analysis Data (DTAD), Vertical Obstruction Data (VOD), elevation extraction, and map and chart data.

MARK 90 Functionality

MARK 90 provides a fully integrated management and all digital production system. The PM/S provides the capability to plan, program, schedule, and manage all DMA products and to support their reproduction and distribution. The MARK 90 production segments (SP/S, DE/S, PG/S) provide the capability to produce a defined set of products listed in Table 2 which currently consume a majority of DMA's production resources. The remaining DMA products are produced using MARK 85 segments and other existing Center resources which are also managed by the PM/S. MARK 90 DS/S provides for the intercenter and intracenter data and message traffic, intracenter flow of digital imagery, and database management installed at all three Production Centers.

o   Production Management Segment
    The PM/S provides a single integrated production management capability for all of DMA. The segment provides the capability to perform Agency level programming and planning; to schedule, manage, and monitor Production Center resources and production assignments; and to monitor and report production progress. The PM/S also accounts for customer requirements.

o   Source Preparation Segment
    The SP/S provides the capabilities to review and evaluate multi-media source materials, measure softcopy imagery to support triangulation, produce point target products, and generate SUPs for use by production.

o   Data Extraction Segment
    The DE/S provides the capabilities to extract terrain elevation and feature data from softcopy imagery, attribute extracted features, edit and merge new to existing extracted data, and perform quality checks to ensure extracted data is in compliance with specifications.

o   Product Generation Segment
    The PG/S provides the capability to extract and attribute feature data from monoscopic imagery and cartographic sources, to extract air facilities and flight information data, to evaluate and process bathymetric data, to edit and merge existing to extracted data, to compile MARK 90 data into hardcopy reproducible masters or digital products, and to perform quality

Calendar Year	1983				1984				1985				1986				1987				1988				1989				1990				1991				1992			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4

MARK 90 SYSTEM
HE/S
SA/S
SP/S
DE/S
PG/S
DS/S
PM/S

COMPETITIVE DESIGN PHASE

▲ DCR 3/11-3/13   ▲ PDR 12/15-12/18   ▲ CDR 12/13-12/16   ▲ IOC 3/27   △ FOC 11/5

PRODUCTION

ACQUISITON PHASE   IC&T / DEMO / E&R

MARK 90 DEVELOPMENT SCHEDULE   Figure 2

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checks to ensure production is in compliance with specifications.

o Data Services Segment
   The DS/S is comprised of two components, a database/data management subsystem and a communications subsystem. The database/data management subsystem provides capabilities to archive and provide access to MARK 90 MC&G data and to protect its integrity. The communica- tions subsystem of the DS/S provides all narrowband communications for each segment's internal communications for intersegment communications within a Center, and for intercomponent communications via within a Center. The communications subsystem also provides wideband communications for imagery to the production segments. The narrowband interconnections and communications services are for message traffic among all MARK 90 segments on an intercomponent basis via IDTS. The communications wideband service provides the capabilities to read compressed softcopy imagery from Digital Tape Cassettes (DTCs) and provide it to MARK 90 production elements, SP/S, DE/S, and PG/S within a Production Center.

Three MARK 85 segments will be enhanced in concert with the development and delivery of MARK 90 segments to support MARK 90 operations. They are:

o The DI/S will be absorbed by the PM/S to form a single DMA management system.

o The SA/S will be used for source acquisition for MARK 90.

o The HE/S will provide triangulation and PPDB support; the Three-stage, Computer assisted Stereo Comparators (TA3/Plls), Pooled Analytical Stereo Plotters (ASllPs) and Universal Automated Map Compilation Equipment (UNAMACEs) will be phased out.

SCHEDULE

The DPS is being phased-in in five major milestones referred to as versions. The first three were associated with MARK 85 development. The last two are associated with the two major MARK 90 capabilities, the IOC and FOC. Figure 3 shows the MARK 90 development schedule. The IOC is defined as the successful installation and test of Version 4.0 at DMARC as demonstrated by successful completion of Demo 909 and predecessor activities. FOC is defined as successful installation and test of full MARK 90 functionality at all DMA Production Centers as demonstrated by successful completion of Demo 911 and predecessor activities and completion of exercises and rehearsals at the three Centers. MARK 90 schedules are formally controlled in the DPS-Program Schedule.

TABLE 2 MARK 90 PRODUCTS

Product Name	Acronym
Tactical Pilotage Chart	TPC
Operational Navigation Chart	ONC
Joint Operations Graphic (Air)	JOG-A
Digital Terrain Elevation Data-Level I	DTED-I
Digital Feature Analysis Data-Level I	DFAD-I
Digital Terrain Elevation Data-Level II	DTED-II
Digital Feature Analysis Data-Level II	DFAD-II
Flight Information Publications	FLIP
Automated Air Facilities Information File	AAFIF
Harbor and Approach Charts	HAC
Coastal Charts	COA
Combat Charts	COM
1:50,000 Topographic Line Maps	TLM
1:50,000 Tactical Terrain Analysis Data Base	TTADB
1:250,000 Planning Terrain Analysis Data Base	PTADB
Joint Operations Graphic (Radar)	JOG-R
Point Positioning Programs	PPP
Deployable Point Positioning Data Base	PPDB
Terrain Contour Map - Landfall Matrix	TERCOM-L
Terrain Contour Map - Enroute/Midcourse Matrix	TERCOM-E
Terrain Contour Map - Terminal Matrix	TERCOM-T