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CIM in Space: Corporate Information Management (CIM) Implications for Space-Based Information Systems

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ABSTRACT

This paper describes the DoD Corporate Information Management (CIM) initiative, space forces, and space-based information systems used by the DoD. It then describes implications of CIM in the space industry. CIM is defined as a philosophy which has management and technical components. The CIM management philosophy includes concepts for standardization, system engineering, and the use of commercial systems and technology. The technical component uses the information engineering discipline to improve business processes. The paper provides examples of the CIM management philosophy in operation as well as opportunities for CIM application. Information engineering is described as it applies to space-based information systems. The appendix includes an illustrative example of the Integrated Definition (IDEF) methodology applied to the Tactical Warning/Attack Assessment mission.

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TABLE OF CONTENTS

LIST OF FIGURES

I. INTRODUCTION

"...the future war will be an information war. You actually win before you start shooting. It's an intelligence war, a C3I war, a deployment war, it's a command and control war. We have to start rethinking the information resource mission as a war prevention, war inhibiting, and ultimately war winning engine."

---- Mr. Paul Strassmann
Former Director of
Defense Information

"The center of gravity of space is information."

---- Dr. John Kohout
Strategic Geographer

The first quote acknowledges the increasing importance of information as a strategic military resource. The second quote speaks of a different battlefield, one that Carl Von Clausewitz wasn't aware of when he introduced the concept of center of gravity as "the hub of all power and movement, on which everything else depends. That is the point against which all our energies should be directed." (15:595)

Future conflicts must increasingly consider the importance of space as a conduit for information. Military strategists refer to Desert Storm as the first information war. The proliferation of information systems has changed the nature of warfare, not only for the military but for the public as well -- witness the impact of the media during the Gulf War and its influence in our involvement in Somalia.

The relationship between information and space led me to research the implications of the Department of Defense Corporate Information Management (CIM) initiative for military space-based information systems. The objectives of this paper are threefold:

1. Define Corporate Information Management
2. Describe military space-based information systems
3. Describe relationships between them

Because this subject may be controversial, I remind the reader that the implications of this paper are purely the conjecture of the author and are not to be taken as any type of policy recommendation. This paper is simply an examination of both areas with observations made on relationships.

II. CORPORATE INFORMATION MANAGEMENT

Background

The Department of Defense (DoD) is arguably the largest consumer of information in this country and perhaps the world. The DoD employs millions of uniformed and civilian personnel stationed around the world. Organized by Service (branch), geographically and functionally, DoD requires mountains of information transfer across millions of miles to perform its mission.

"To err is human, to really foul things up takes a computer", reads the caption beneath a cartoon character ready to bash his computer with a huge hammer. How True! In DoD information management appeared to be progressing smoothly, albeit slowly and tediously, until the introduction of the computer. Each Service, Command, and functional activity then began to develop its own information systems to perform its assigned mission independently. We refer to these systems as "stovepipes" because of their vertical, independent orientation. The lack of interconnection of these stovepipes causes much redundancy in information systems and data storage. This problem was not the fault of automation, but rather resulted from how automation was misapplied -- i.e., the lack of effective information management.

So how does one manage all these systems and all this information? Without some type of structured approach, the problem soon exceeds the zone of indifference of even the most capable management. The system is not broken; however, there are opportunities for enormous improvements in efficiency. The DoD developed the Corporate Information Management (CIM) initiative to deal with this complexity.

Corporate Information Management Defined

Corporate Information Management is not a program, a philosophy consistent with the principles of total quality management (TQM). The Air Force defines TQM as a "customer-oriented operating philosophy committed to excellence in products and services, through total participation of all employees in the constant improvement of all processes." (1) One way to view CIM is that it applies TQM to information management.

The objective of CIM is to increase military effectiveness while meeting cost reduction targets and deploying information technology in support of functional improvement measures. To achieve this objective, CIM has stated three guiding principles. (2:1-4)

1. The customer defines requirements, manages implementation, and measures results.

2. Business processes must be simplified before applying technology. Technology is then applied where required on a fee-for-service basis. Changing the way people work increases efficiency and reduces cost.

3. Evolutionary migration provides the fastest progress with the lowest risk.

The idea is not automation for automation's sake, but getting the process right -- then automating it. CIM aims to change the way DoD works by business process re-engineering and delegating cost saving responsibilities to the lowest level.

Rather than separate the military Services and their functions, CIM views DoD as a joint enterprise. Figure 1 is a structured view of the relationships and information flows within the missions of the DoD. Viewed from the bottom, the information management infrastructure supports business operations which ultimately support national defense doctrine and policy. (6:17-18)

Figure 2 is a graphical description of CIM which is explained below.

DOD ENTERPRISE MODEL

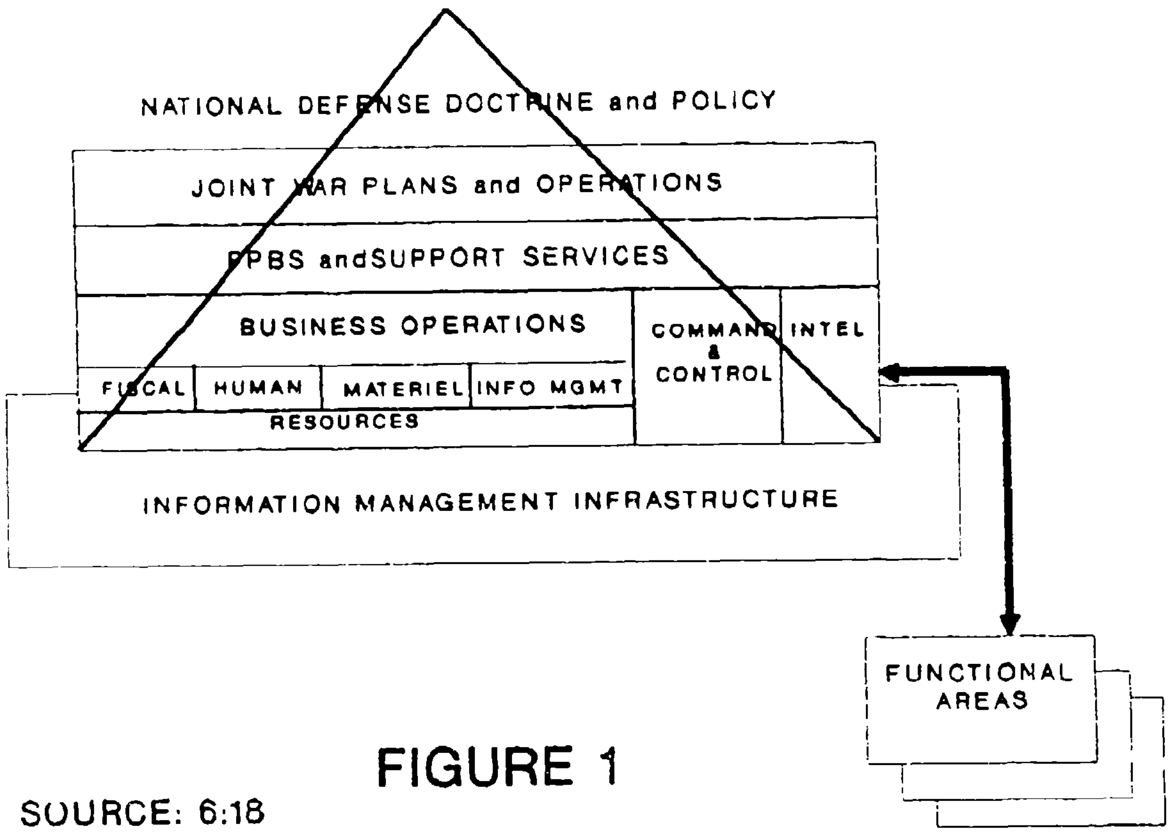

FIGURE 1

SOURCE: 6:18

ELEMENTS OF THE CIM PROGRAM

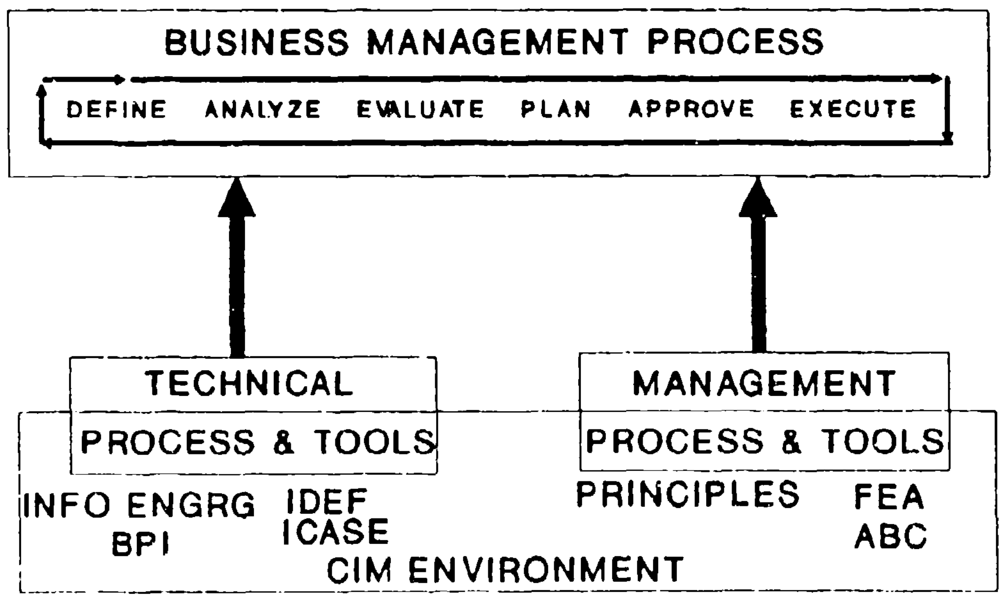

FIGURE 2

CIM Technical Processes and Tools

CIM uses a structured analysis approach combined with automated tools to achieve its objectives. CIM embraces the information engineering principles of James Martin. Mr. Paul Strassmann, the former Director of Defense Information, enhanced this process by incorporating activity based costing (ABC) with integrated definition (IDEF) modeling techniques to ascertain the cost and value added by each process. (2:1-5)

Information Engineering

"Information engineering (IE) is defined as the application of an interlocking set of formal techniques for the planning, analysis, design, and construction of information systems on an enterprise-wide basis or across a major section of the enterprise." (10:1) IE progresses in a top-down manner beginning with enterprise strategic planning, then information planning, business area analysis, system design, implementation and cutover. IE emphasizes data storage and inputs rather than processes and outputs. Enterprise knowledge is stored in an evolving encyclopedia which creates a framework for system development. IE requires the end-user to become more involved because the demand for system development exceeds the production capacity.

Management develops a comprehensive systems plan which results in an enterprise-wide data model. Systems analysts define business processes which modify the data and develop procedures which are programmed to work with the database. End-users then design and implement programs using powerful fourth generation language (4GL) report generators. 4GLs use English-like statements in lieu of cryptic code to simplify programming. (16:264)

Business Process Analysis

Business process analysis is a structured way to examine the methods used to perform the mission. This analysis uses graphic tools to avoid any ambiguity in describing the process. The technique involves modeling the business process as-is and then posing changes (to-be) to optimize the system. (2:1-5)

Integrated Definition

Integrated Definition (IDEF) is the modeling tool used to perform business process analysis. IDEF uses graphic representations to display semantic characteristics of business activities and rules associated with data structures. These models support business process improvement, management of data as a resource, integration of information systems, and the creation of computer databases. (2:1-5)

Integrated Computer Assisted Software Engineering

Integrated Computer Assisted Software Engineering (ICASE) provides a workbench with integrated tools to perform information engineering. The ICASE toolkit supports enterprise-wide planning, data modeling, and process modeling to create a framework into which many process life cycles fit. ICASE tools include graphic representations, code generators/ optimizers, and documentation generators. (10:54)

CIM Management Principles and Tools

In espousing the CIM philosophy, Mr. Strassmann refers to high level management principles which must be adhered to and introduces management tools to assist in implementation.

Executive Level Principles

Mr. Strassmann's vision is comprehensive. These are some of his ideas which have implications for space:

- Simplify business processes before design
- Apply economic analysis to functional business methods
- Provide a shared communications and computing infrastructure
- Require process and data models for all systems
- Use off-the-shelf hardware and software
- Lengthen technology by continuously upgrading
- Establish technical systems integration capabilities as a core Defense capability
- Benchmark transaction costs against commercial services (14:13,70,46)

Functional Management Process

To cite a recently published DoD manual: "The Defense IM program, and the corporate IM initiative that implements it, provide the policy and procedural framework to guide the improvement of functional processes, data resources, and supporting information systems for all areas of DoD missions and operations." The functional management process uses a life-cycle development model which defines objectives, analyzes alternatives, evaluates them based on preliminary functional economic analysis, plans the systems implementation, solicits and receives approval, and finally executes the program in an evolutionary fashion. The underlying technical environment guides this process using methods and tools to assist. These programs provide cost-effective, automated information services. (6:13-15)

Functional Economic Analysis

Functional economic analysis (FEA) is a tool used to assist management in evaluating alternative solutions. Activity based costing (ABC) assigns costs to each activity within a process. FEA uses this information to perform a cost-benefit analysis for alternative functional solutions. Managers use a risk-adjusted, net present value of different alternatives to decide.

CIM Implementation

In order to implement CIM the DoD created a substantial organization within the former Defense Communications Agency (DCA). To emphasize the new mission of DCA, the name was changed to Defense Information System Agency (DISA). In April 1991, Mr. Paul Strassman was selected from outside the federal government as the first Director, Defense Information (DDI). The DDI reports directly to the Assistant Secretary of Defense (ASD) for Command, Control, Communications and Intelligence (C3I). The DDI can task DISA resources through ASD (C3I). [Mr. Strassmann resigned at the end of the Bush administration and the position was vacant at the time of publication.]

The CIM process works through Defense Management Report Decisions (DMRDs) and DoD directives. DMRDs are products of the Defense Management Review (DMR) process which evaluate courses of action for cost savings. "CIM succeeds only in so far as it supports DMR initiatives." (13:23) Once the DMRD is approved by the Secretary of Defense it becomes a mandate. Similarly, DoD directives are used to implement changes with emphasis on policy rather than cost savings. The following DMRDs are applicable:

DMRD 925, Develop Standard ADP Systems, created the CIM initiative on 10 November 1989. This directive cited the problems of redundancy and lack of standardization and directed the formation of the CIM organization for more effective use of information systems. DMRD 925 slashed the DoD automated data processing (ADP) budget by 631 million dollars in fiscal year (FY) 92, and more than 900 million dollars in FYs 93, 94, and 95! All of this money is not pure savings -- 220 million dollars in FY92 and more than 300 million dollars a year in the outyears are allocated to finance CIM.

DMRD 971, DoD Financial Systems, was signed on the 2nd of February 1991 to realign costs with outputs. This is better known throughout DoD as Fee-for-Service. DMRD 971 also established the Defense Business Operating Fund (DBOF) as a military industrial fund to administer the fee-for-service concept.

DMRD 918, Defense Information Infrastructure (DII), signed on 15 September 1992, called for a new paradigm to "enable operational and functional staffs to access, share, and exchange information worldwide with minimum knowledge of communications and computing technologies." The DMRD assigned DISA as central manager of the DII which estimated initial savings of $12 billion for FY 93-99. This directive could contain the most far-reaching implications for all information systems.

CIM Status

Initially CIM concentrated more on the administrative systems with the most progress in the financial functional area. The Defense Finance and Accounting System (DFAS) target architecture provides a migration path to condense seventy-one existing financial systems into just nine by the end of 1995. The report also contains evidence of significant progress by other functional areas such as Human Resources, Medical, and Materiel & Logistics.

The status report mentions expanding CIM efforts into other functional areas, including "command and control and intelligence." Specifically for space, the report mentions a two part project under the title "Space and Warning System Center" that requires an IDEF system engineering model to define interfaces for the Cheyenne Mountain Complex. The second part of the project requires the use of information engineering techniques to develop specifications for the databases required for the Space Mission. (13:45)

III. MILITARY SPACE-BASED FORCES AND INFORMATION SYSTEMS

Overview

This section will describe the military space force organization and the information systems used to perform or support assigned functions.

Space Force Components

The DoD created the United States Space Command (USSPACECOM) on 23 September 1985 in order to perform military space functions effectively. Located at Peterson AFB, Colorado, USSPACECOM employs military space-related forces and ensures operational support to other combatant commands. The Air Force component, AFSPACECOM, is the major Service component and is divided into four wings and one group, see figure 3. One wing is assigned to operate each of the eastern and western launch ranges to provide spacelift. A third wing is charged with providing early warning of a missile attack using assigned radars and other assets around the world. The fourth wing operates satellite constellations for communications, navigation, meteorology, and surveillance through mission control complexes and automated remote tracking stations. The lone group provides command & control for aerospace defense and our space order of battle. This group operates the nerve center of space information, the Cheyenne Mountain Complex, and other ground based surveillance units. (9:36-40)

UNITED STATES SPACE COMMAND

Peterson AFB, Colorado

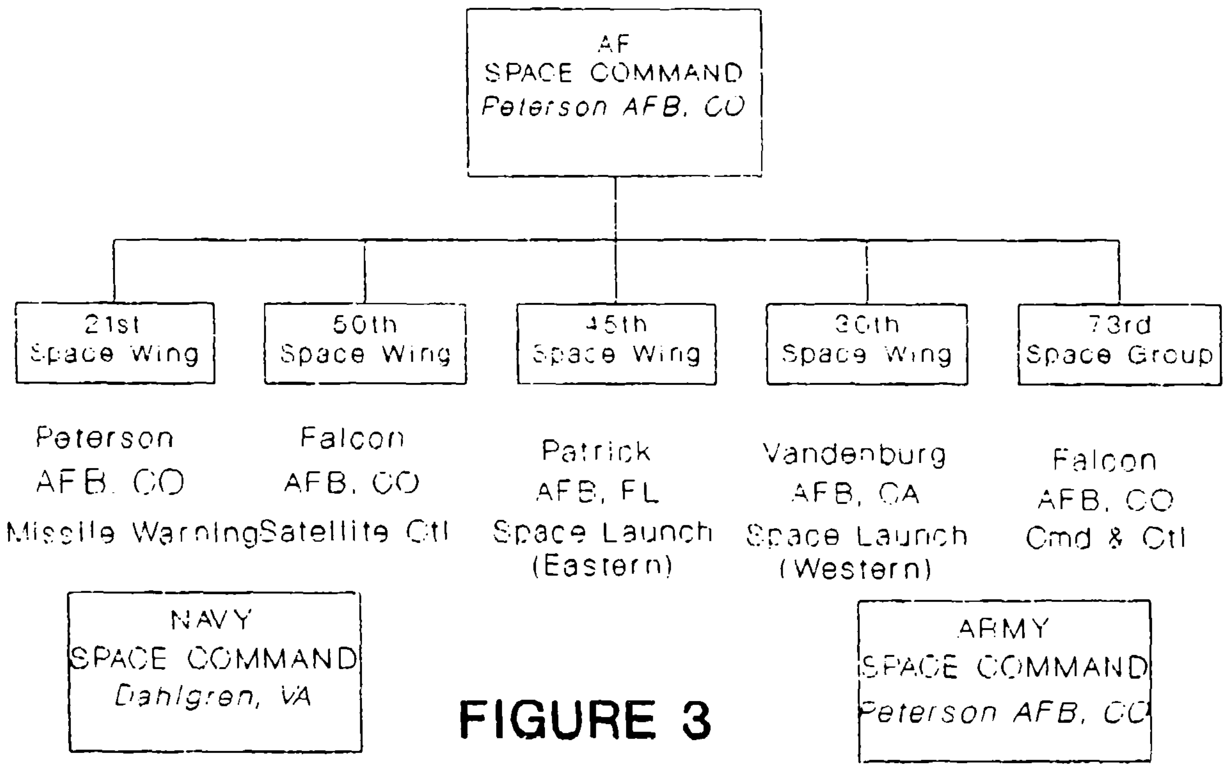

FIGURE 3

Army Space Command (USARSPACE) assures access to and use of space capabilities to enhance Army missions. USARSPACE operates the DSCS ground centers and manages the use of DSCS satellites by tactical ground units. USARSPACE would be charged with operation of anti-satellite and ballistic missile defense systems if the United States should develop these systems. Naval Space Command (NAVSPACECOM), headquartered in Dahlgren, Virginia, commands naval space forces and operates space systems to provide support to naval forces. The Naval Space Surveillance Center (NAVSPASUR) tracks objects in space out to an effective range of 1,725 miles and provides this information to USSPACECOM.

Space Force Functions

JCS Pub 0-1, Basic National Defense Doctrine, assigns the following functions to space forces:

Space Control -- requires undeniable use of space and space systems for our forces, including combat against enemy forces in space and their infrastructure.

Force Application -- combat against enemy land, sea, and missile forces, including command, control, and communication capabilities.

Force Enhancement -- support for friendly forces which includes warning, communications, navigation, meteorology, and surveillance.

Space Support -- launch capability.

Space-Based Information Systems

JCS Pub 0-1 states that, "The United States depends on space systems for support such as communications, terrestrial surveillance, navigation and positioning, meteorology, oceanography, mapping, and search and rescue." USSPACECOM uses a variety of different satellites in various orbits to provide this support. The following is a summary of existing and planned systems. (8:44-52)

Communications

The primary satellite communications system is the Defense Satellite Communications System (DSCS). The DSCS is a high-capacity, super-high-frequency (SHF) subsystem of the Defense Communications System that provides worldwide, wideband, secure voice and data communications. USSPACECOM provides operational control while DISA provides network management.

In the ultra-high-frequency (UHF) band, the Air Force uses AFSATCOM to provide command & control of forces. The Navy uses FLTSATCOM to provide ship-to-shore or ship-to-ship communications. UHF systems provide limited bandwidth capability. The planned replacement system is dubbed UHF Follow-On (UFO).

In the extremely-high-frequency (EHF) band, the Air Force is planning to deploy Military Strategic and Tactical Relay (MILSTAR). MILSTAR uses advanced signal processing and space-based relays to provide survivable low and medium data rate communications for command & control.

Navigation and Positioning

Navigation information is essential for military operations. The NAVSTAR Global Positioning System (GPS) is a space-based, radio navigation and time distribution satellite system. GPS provides highly accurate information to receivers on ships, airplanes, vehicles, and even personnel. GPS information is also valuable for commercial and perhaps enemy use. In order to maintain our advantage selective accuracy control denies the most detailed information to those not equipped.

Surveillance

The Defense Support Program (DSP) provides space-based assets for early warning of missile launch and nuclear detonation (NUDET) detection. NUDET capability is hosted on the GPS. The planned replacement for DSP is the Follow-on Early Warning System (FEWS).

Meteorology

The view from space allows unique weather observation capabilities. The Defense Meteorological Satellite Program (DMSP) provides worldwide weather information, both visual and infrared, to support military operations. Information from commercial weather satellites is used to augment DMSP.

IV. IMPLICATIONS OF CIM ON SPACE FORCES

Overview

The purpose of the previous sections was to give the reader an understanding of CIM and an overview of space forces and information systems. I will now relate the two.

Does CIM Apply?

Since the CIM mandate excludes embedded information systems, the first issue to address is applicability. Embedded information systems are those integral to a major system, like the radar tracking system on a missile. Space-based information systems have embedded systems which are used to support the operation of the satellite; e.g., maintain its orbit. Since the satellites mentioned in the previous section serve as sensor inputs or relays to larger systems, I do not consider them as embedded systems. However, I maintain that systems used by the operator of the satellite for "housekeeping" are embedded and should be excluded.

This assertion is supported by the fact that after initial success in administrative functional areas, there is now a growing trend for CIM to address command and control systems. The CIM status report indicated CIM will spread to other functional areas including space. (13.45) Additional support is contained in a report from the Joint Staff written after the Gulf War. Although the main theme of C4I for the

Warrior is resolving the fixed-to-tactical interoperability problem, the report makes no distinction between administrative and command and control systems. C4I for the Warrior also endorses the use of commercial satellite communication systems and integration of Service stovepipe systems. (5)

Complicating this matter further is the increasingly blurry line between what constitutes command and control and administrative systems. Most strategists would agree that logistic information systems are as important as command and control systems. The Gulf War experience showed that as the duration of the conflict increased, more and more of what were considered administrative systems, such as military pay and health care, became increasingly important and appeared in theater as mobile systems. The problem became one of containing information flow requirements because of the limited connectivity to the region. (4)

Information Engineering

The CIM Status Report directs analysis of the Space Mission using information engineering techniques. In order to perform this task, we must first define space business processes. These are the processes which support the space force functions mentioned earlier: space control, force application, force enhancement, and space support. IDEF modeling of each process must then be performed on each process for the as-is process. Once the process is [illegible] down, functional economic analysis using activity-based costing can be used to calculate the cost of this process.

The next steps are to develop alternative processes (to-be) and to calculate costs in a similar manner. This information must then be assembled into a cost-benefit analysis for a management decision to change the process.

My research did not reveal any progress by USSPACECOM in this area. For illustrative purposes Appendix A is a preliminary IDEF model of the tactical warning/attack assessment process.

Organization

The DoD enterprise model in Figure 1 should be examined against the USSPACECOM organization shown in Figure 3. On the surface there appears to be some opportunity for streamlining this structure. The recent report by the Chairman of the Joint Chiefs of Staff recommends a review of this structure and the possible reassignment of the space mission to U.S. Strategic Command. When performing this review, one must keep in mind the binational agreements with Canada in the North American Air Defense Command (NORAD).

War Fighting Roles

The role of defense against [illegible] warfare is challenged by the redefinition of war fighting roles [illegible]

Title 10 of the United States Code, sections 164 and 193, directs unified commands to fight wars and limits the role of defense agencies to support. DMRD 918 suggests that DISA assumes operational responsibility for the MILSATCOM portion of the Defense Integrated System Network. Does this mean DISA usurps the space control function assigned to USSPACECOM? If so, some legal changes are required.

Another related issue is the definition of the term "combat". The Gulf War was the first information war, we have yet to witness a conflict where our space-based assets are held at risk. Space warfare is an abstract type of combat which does not require the physical stamina of the front line. It is impersonal combat waged by "keyboard commandos" at long distance where strategy and intelligence are paramount. In light of this fact, the military must reexamine the definition of combat relative to special pay and physical demands.

<u>Use of Commercial Systems</u>

The information systems that the military requires to "kill people and break things" are not that much different from those of the commercial sector, whose mission is significantly different. Military systems are designed to military specifications which are becoming outmoded as the threat changes. Commercial companies such as IntelSat, an international consortium of satellite communications service providers, supplied [illegible] services. During the Gulf War ninety percent of U.S. military communications [illegible] satellites; almost a quarter of this traffic was carried by commercial providers. (12) Commercial weather systems like the Geostationary Operational Environment Satellite (GOES) provide similar services to DMSP. Likewise imagery can be provided by U.S. LANDSAT or from systems provided by international firms, such as the French SPOT system.

The Assistant Secretary of the Air Force for satellite system acquisition estimated that ninety percent of all military communications traffic could be carried by commercial satellite systems. (12) DoD recognized this fact and commissioned several contractors to study this option. Results were not available at the time this paper was written, but are anticipated to be in favor of the increased use of commercial systems for military purposes. (4)

Technology Trends

The CIM philosophy includes a technology doctrine which emphasizes the use of off-the-shelf hardware and software and lengthening technology life by continuous upgrading. (16:48) Previously the military led industry in research and development and spun off technology to commercial industry. For example, the commercial space launch industry is based on the Inter-Continental Ballistic Missile (ICBM) developed for the military. Now the tables have turned and there are many opportunities for the military to spin on commercial technology trends.

Very Small Aperture Antenna Terminal (VSAT) satellite communications are used to provide dedicated, medium-capacity, point-to-point communications. Formerly inaccessible locations can be quickly connected provided frequencies and real estate are available. Presently this technology is in limited use; however, as quick reaction and worldwide responsibilities increase, so should the use of VSAT.

Other implications from trends in commercial satellite technology could prove useful to the military as they evolve. The exploding trend for the use of cellular telephone technology led to a concept for worldwide cellular telephone coverage -- Iridium, a concept of Motorola [named for the element having the atomic number of its 77 satellite constellation]. As the military threat changes to a more uncertain geographic area, American forces will be sent to areas where the existing communications infrastructure is unlikely to serve their needs (e.g., Somalia). When the Iridium technology is developed and fielded, forces would only need to carry cellular phones to stay in touch.

Space-based information systems from the entertainment industry could provide dual-use capabilities for the military. Digital Broadcast Satellite (DBS) allows the reception of video through an 18-inch dish antenna, which will greatly increase portability. Video on demand for households could become battlefield imagery for battalions. Digital Audio Broadcast (DAB) technology provides audio radio broadcast from satellites with potential worldwide coverage. DBS technology could augment national security for emergency broadcast services as well as provide entertainment for our dispersed forces. Since our military forces travel frequently by air, inflight telecommunications via satellite could be useful. Such a system will provide connectivity from the aircraft into the public switched telecommunications network, allowing calls from airborne passengers to anywhere a telephone can reach.

The above examples considered the adoption of commercial systems by the military (spin on). The commercialization of military systems (spin off) can work the other way for mutual benefit. In the case of the Global Positioning System, the military developed a system with great commercial promise. The transportation industry expressed great interest in GPS information to track vehicles. The increased demand for receivers increased production which greatly reduced costs for both sectors. Other such dual-use technology efforts must be uncovered and pursued.

A word of caution is in order on the use of commercial systems. Since the above technologies are targeted for commercial use, the design included no provisions for security. If any of these systems are to be considered for clandestine military use, some type of cryptographic security is required.

Standardization

Standardization in the design of launch vehicles, satellites, and earth terminals is another example of application of CIM management philosophy to space-based information systems.

Although the major benefits from standardization are realized in a high-volume market, the limited inventory of U.S. launch vehicles effectively provides a standard for satellite design. Depending on the physical size and weight of the satellite, anything from an air-launched Pegasus to the Space Shuttle can be used. International competition from several countries now complicates standardization in this area. The use of foreign launchers is a controversial subject. From a standardization view, only U.S. launchers should be considered.

Although the design of each satellite is unique because of its mission, the incorporation of a standard design within a series pays manufacturing benefits. The satellite bus refers to the sustaining portion of the spacecraft to which different sensors or electronics can be mated. Several satellite manufacturers have developed a standard bus which they can easily modify for different functions. The trade-off in the weight of a standard bus versus the manufacturing costs must be made by the customer. Another area where standards come into play is in the function of the satellite. For example in a communications satellite, the use of commercially recognized standards like the T1 data rate (1.544 Mbs) allows compatibility with terrestrial systems.

The most benefit from standardization is found in the design of earth terminals. Communication terminals use commercial standards for multiplex schemes. Designers follow local area network (LAN) standards for interconnection. All military computer system acquisitions must specify the government open system interconnection profile (GOSIP) to provide future interoperability.

A word of caution on the security risks associated with standardization is in order. There is a classic struggle in the defense community on the benefits of open systems versus the need for security. Management must be ever mindful of this consideration when designing new systems.

Systems Engineering

A prime example of the CIM management principle of system engineering is the effort to integrate space-based information systems at Cheyenne Mountain. The Cheyenne Mountain Complex (CMC) contains the many systems necessary to perform tactical warning/attack assessment. The primary mission of the CMC is to scan the earth for signs of a missile launch and, when detected, to estimate the targeted area and to alert the National Command Authority, civil defense, and retaliatory forces. Major components in this system are the Space Defense Operations Center (SPADOC) and the Communications System

Segment Replacement (CSSR). The USAF undertook this integration effort with a program called Granite Sentry.

The Navy addresses space-based information system integration in its Copernicus Architecture. Copernicus consists of four pillars: global and tactical information exchange systems, and Commander-in-Chief and tactical command centers. The Navy developed a new doctrine of Space and Electronic Warfare (SEW) which poses a surveillance grid to collect information, a communications grid to transport it to the CINC, and a tactical grid to get it to the battlefield.

Fee-for-Service

DMRD 971 directs DoD to align costs of services with their outputs. The rationale behind this initiative is to make users aware of the costs and force trade-offs in their operating budgets. Dubbed "fee-for-service" this initiative is somewhat easy to implement when costs and services are readily trackable. For software design services, users state their requirement and all costs associated with satisfying that requirement are directly attributed to it.

Space-based information systems are different. In the case of GPS, where information is broadcast freely, the only way to regulate usage is by charging a premium on purchase of the receivers. Weather satellites could use a similar scheme. Communications services have many users and the cost of implementing a usage-based billing scheme might cost more than the amount that would be collected. However, launch services may be easier to track to user communities and should be investigated for use on a reimbursable basis.

If fee-for-service is difficult to apply to space, how can you enforce user discipline? The Air Force is attempting to solve this problem up-front in the requirements definition stage. Since the Air Force is the lead military department for satellite communication systems, the Air Force budget includes all funding. In order to discourage "gold-plated" options, the Chief of Staff of the Air Force, General McPeak, initiated a fee-for-requirement scheme. After a thorough scrub of requirements, if a Service feels they strongly require a certain capability, they must provide additional funding. (7)

V. SUMMARY

CIM-Space Implications

The above implications are mainly examples of how CIM management principles are being used in the military today. The CIM philosophy will take time to be ingrained in the corporate culture. My research found little evidence of CIM technical processes and tools currently in use. If the military is to realize operating efficiencies and cost savings, more effort is required in business process improvement.

The military must maintain close contact with commercial space technology to develop potential spin-on systems. Military development efforts should be aimed at dual-use technology to capitalize on decreased production costs.

Importance of Space

With the stability of the space portion of the defense budget compared to the overall decline, one can say that the relative importance of space is increasing. This indicates that leadership is cognizant of the benefits available from space-based information systems and is trying to leverage these benefits as a strategic advantage.

The military uses the term "lines of communication (LOCs)" to refer to logistical support routes. When planning military campaigns, strategists are keenly aware of the importance of the LOCs and provide appropriate protection. There is a parallel with space and information. Now that information support is becoming as important as logistics, the military must consider the "lines of information" as a strategic asset and protect it accordingly.

Battlefields of the Future

Dale Brown gives us a vision of future information warfare in his latest book Sky Masters. In it the United States Air Force takes on the Chinese Navy in the South China Sea. Because of the timing and location of the crisis, the U.S. has only limited intelligence. The author introduces the concept of "Need It Right This Second Satellites (NIRTSats)" which are a series of lightweight communications, intelligence and surveillance satellites which are air launched to provide instant information from any trouble spot. He also develops a "souped-up" B-2 that is able to receive and process this information. This capability provides sensor to shooter information allowing realtime mission planning which results in an overwhelming U.S. victory. (3)

The application of CIM to space-based information systems is a step in this direction. However it is important to remember that technology alone does not win the war, THE USE OF TECHNOLOGY BY THE COMMANDER DOES.

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APPENDIX A

TACTICAL WARNING/ ATTACK ASSESSMENT

INFORMATION ENGINEERING MODEL (AS-IS)

CIM7

PURPOSE

The purpose of this appendix is to illustrate how information engineering principles can be applied to a space-related business process. IDEF modeling techniques were derived from the Integrated Computer Aided Manufacturing (ICAM) program sponsored by the U.S. Air Force. The acronym IDEF comes from ICAM Definition Language. IDEF0 is used to model activities or processes. IDEF1X is used to model rules or data. IDEF0 and IDEF1X modeling techniques will be applied to the tactical warning / attack assessment mission of USSPACECOM.

The DoD Corporate Information Management (CIM) Initiative requires this process to be performed for all DoD functional areas. Since my research did not uncover any efforts in this area, I will attempt to start it off. The reader should be aware that this is a very detailed process and this appendix barely scratches the surface.

CONTEXT DIAGRAM

IDEF0 uses an hierarchical approach to simplify systems. The context diagram models the highest level of activity and represents the entire subject being modeled. IDEF uses the ICOM convention, Inputs (from the left), Controls (from the top), Outputs (to the right), and Mechanisms (from the

TW/AA IDEF MODEL
CONTEXT DIAGRAM

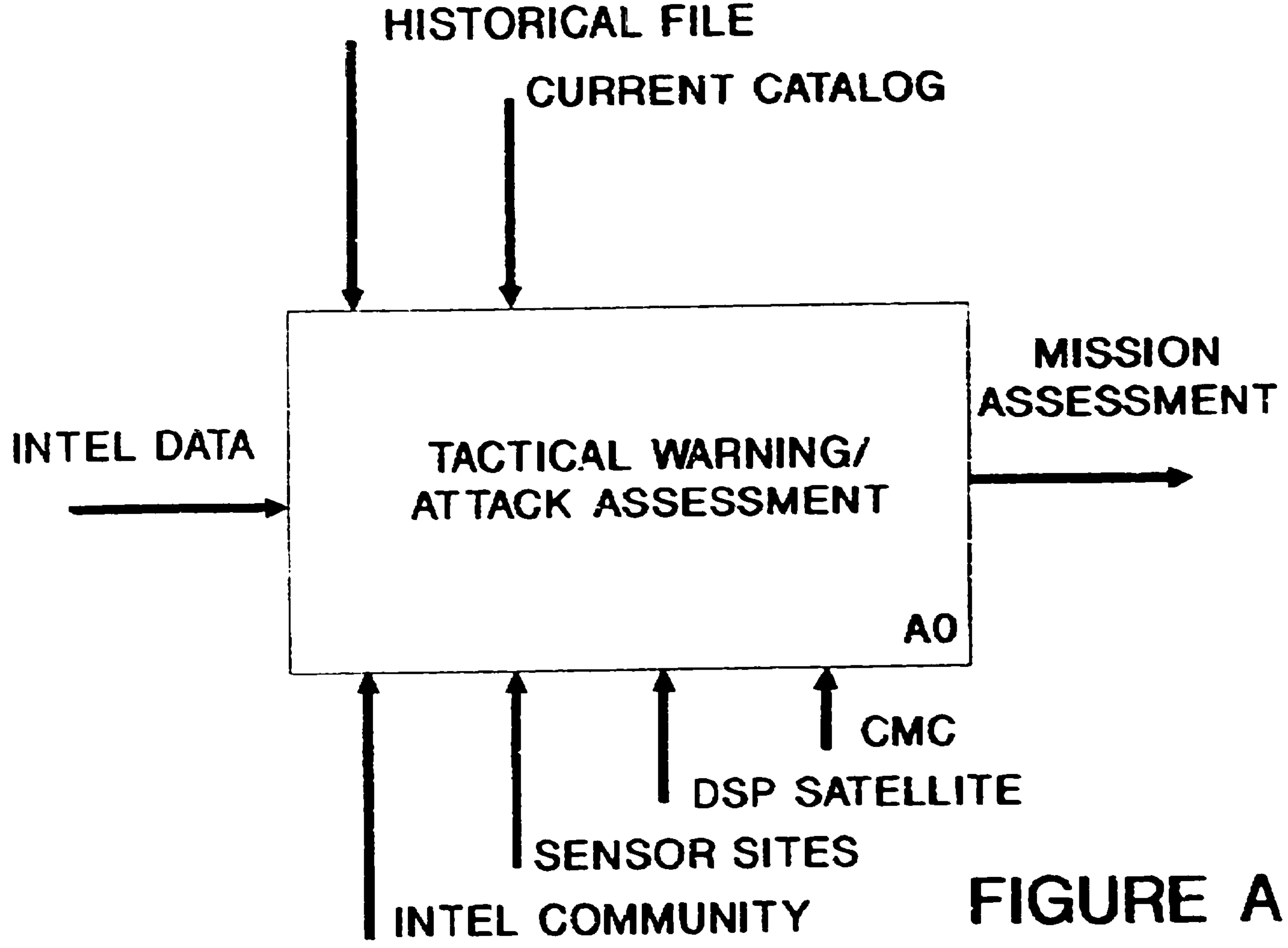

FIGURE A-1

CIM4

bottom). Controls are information or material that constrain an activity and regulate the transformation of inputs to outputs. Mechanisms are resources that provide energy to the activity, like people or machines. (2:3-3) The TW/AA process with associated ICOMs is shown in Figure A-1.

DECOMPOSITION DIAGRAM

The decomposition diagram in Figure A-2 shows the next level of detail. The A0 process is broken down to four subordinate processes. In process A1, the intelligence community and the Cheyenne Mountain Complex (CMC) receive intelligence data concerning an impending launch. This information is compared against the Current Catalog which keeps an inventory of orbiting objects and the Historical File which tracks what type of satellite is usually launched from which location in which general direction. The CMC prepares an alert message to DSP satellite controllers and sensor sites advising them to be prepared to obtain launch data.

In process A2, the DSP satellite and sensor sites obtain launch data which is provided to the CMC for processing. In process A3, this information is first analyzed for any immediate threat to the United States. Within two minutes CMC must provide an assessment to the National Command Authorities. If not an immediate threat, the space object is continually tracked and monitored during its lifetime for future developments.

TW/AA IDEF MODEL
DECOMPOSITION DIAGRAM

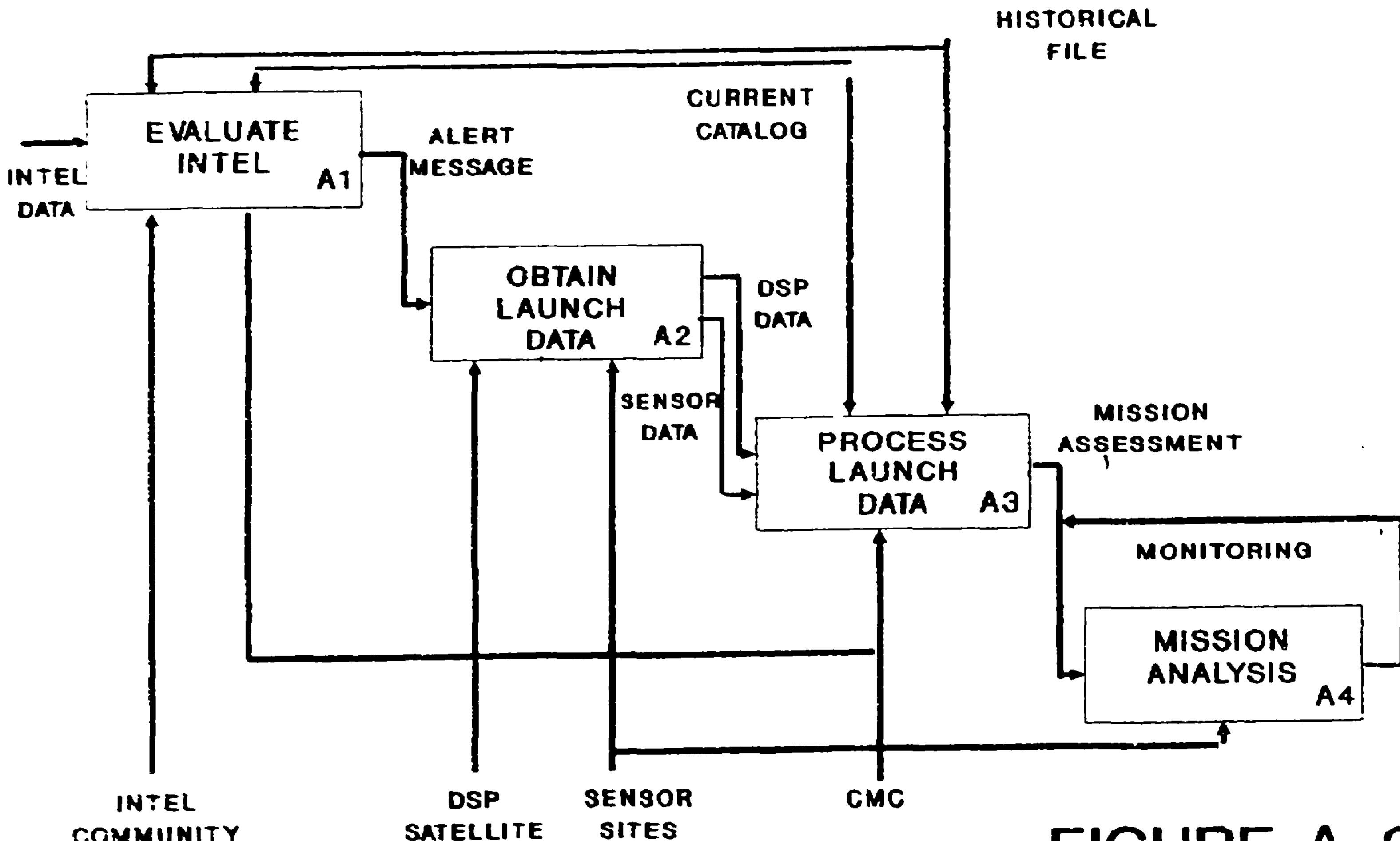

FIGURE A-2

CIM5

The next step in this process is to take each of the above processes and continually break them down into subprocesses until this can be done no further. At this point we have identified the relevant activities. Activity-based costing (ABC) is then performed to assign a cost to each activity so that the cost of subprocesses and processes can be determined. This completes the IDEF0 modeling.

Alternative processes can be developed and costed in a similar manner so that management has detailed, objective data on which to base decisions.

DATA MODEL

Database design requires different modeling techniques to efficiently store data. This technique can be used to understand and define the business rules of an organization. The elements of this techniques are: entities (things), attributes which describe entities, and relationships between entities. The IDEF1X technique uses three refinement levels to describe a process: entity-relationship, key-based, and fully attributed. Each level builds on the previous. A fully attributed model of the TW/AA process is shown in Figure A-3.

At a macro level, each launch receives one mission assessment. The launch number is the key attribute for the launch. TEAR data (time, elevation, azimuth, range, and range rate) is used to perform the mission assessment.

TW/AA IDEF MODEL

DATA MODEL

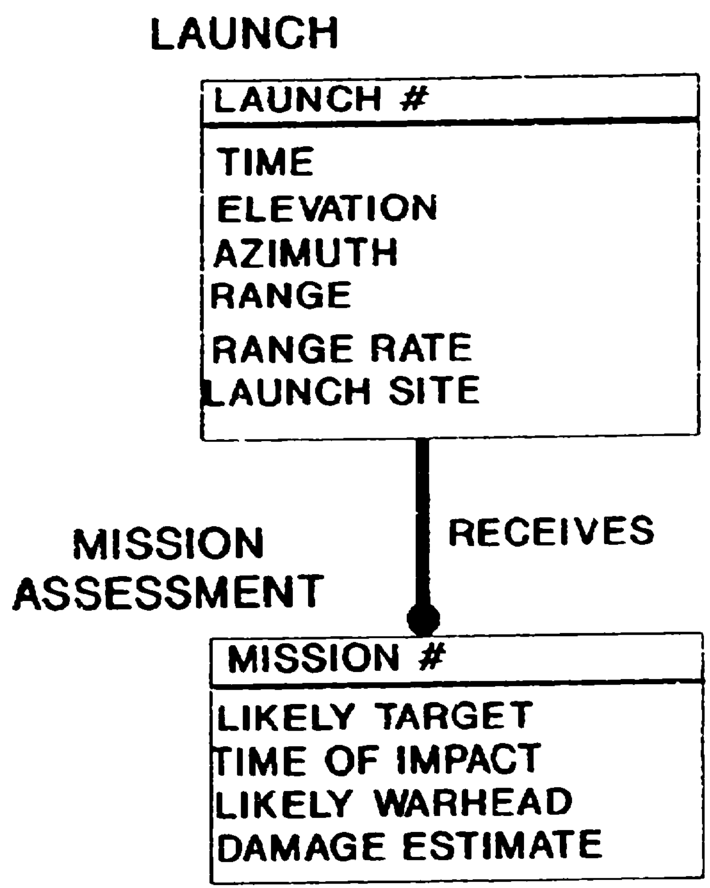

FIGURE A-3

CIM6

CONCLUSIONS

This has been a very cursory examination of a complex process. Many other considerations need to be taken into account; i.e., security and physical hardware limitations.

The overarching purpose of this exercise is to reach agreement among those involved in the process, which is easier said than done. Often basic misunderstandings are uncovered during this process.

As I worked through this exercise, it seemed there was duplication between data contained in the historical file and the current catalog. I would consider adding fields to one the databases and eliminating the other. Security and hardware limitations must be considered. As a novice, I cannot take this exercise any farther. I hope this example illustrates the benefits of information engineering.