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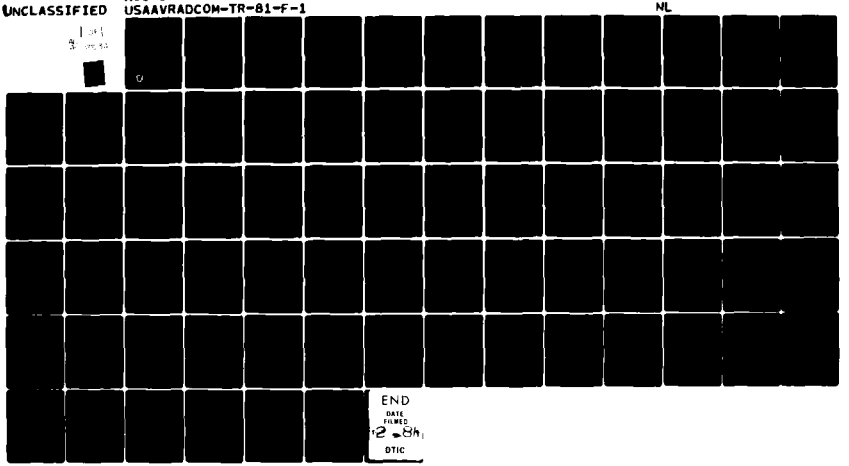

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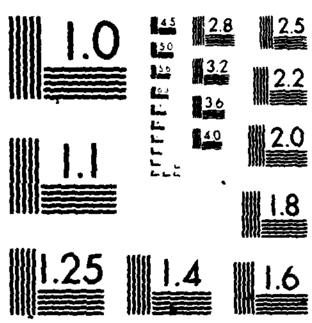

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AVRADCOM

Technical Report TR-81-F-1

INFORMATION RESOURCE MANAGEMENT
AN INTRODUCTION FOR MANAGERS

Shirley J. Smith, DSC

AUGUST, 1980

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Information Resource Management (IRM) is bringing changes -- perhaps even forcing changes -- within large organizations, whether business, industry, or government. The phrase and the concept reflect the growing awareness that information is a resource of an organization -- just as are its personnel, finances, inventory, and physical plant. It is in fact, a resource which is essential to the decision-making process.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

An important component of this new era of information management is the evolving technology of computer software and hardware dedicated to database management.

Sophisticated software packages (Data Base Management Systems) have been available for several years. Their best use requires a high level of analytical expertise of a kind which is not often found within the typical data processing department.

This report serves as an introduction to IRM for managers. It presents the results of a long research study of the published literature which describes the experiences and recommendations of managers, database systems analysts, consultants, and academicians.

Although the report is written specifically for the Army Aviation Research and Development Command, any organization considering information resource management, database administration, or the creation of a corporate database should find it to be useful.

INFORMATION RESOURCE MANAGEMENT

AN INTRODUCTION FOR MANAGERS

AVRADCOM TECHNICAL REPORT

TR-81-F-1

AUGUST 1980

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1 INTRODUCTION

1.1 PURPOSE OF THIS REPORT

The purpose of this report is to present some of the new concepts of information resource management to the Command Group, program managers, and functional managers of the Army Aviation Research and Development Command (AVRADCOM).

In recent years many large companies and government agencies have come to view information as one of an organization's important resources, along with its personnel, finances, physical plant, etc. To reflect this new awareness, the phrase "information resource management" now appears in technical and business journals, in the titles of seminars, and in reports from Federal executive-level study groups.

The set of functions which are within the domain of information resource management is large, is in a state of flux, and is often controversial. What is generally agreed to, however, is that the set of functions should reflect each organization's own corporate-wide understanding of the kind of information needed and how it is to be used in the decision-making process.

Within information resource management, an emerging concept is that of the "corporate database," and one essential function is that of database administration. The most important computing software

tools are known as Data Base Management Systems (DBMS) and Data Dictionary/Directories (DD/D).

From the perspective of information as a corporate resource, data which are essential for management must be shared throughout an organization, must be consistent and accurate, and must be available for rapid response to ad hoc queries. With today's computing software, dedicated to database management, a corporate database and efficient, centralized database administration are technically feasible. With good management, they are possible.

The views presented here are taken directly from the published literature. The body of the report is intended to show a consensus (where one exists) of writers and organizations which have experience in information resource management and/or database administration. Appendix A contains the direct quotations upon which most of the report is based. In general these are succinct and emphasize the fact that the new era of information resource management requires organizations to plan for substantial changes in their management of data.

The actual quotations are more powerful persuaders than a summary could be and, therefore, AVRADCOM managers and other readers are urged to study Appendix A.

The last section of the report presents some steps which need to be taken by top management before beginning a detailed plan for AVRADCOM's information resource management or its database adminis-

tration function.

1.2 BACKGROUND

In May, 1977, the Data Base Management System (DBMS) known as SYSTEM 2000 was installed on the DARCOM Midwest Regional Scientific and Engineering Computer (i.e., the S&E computer) which is supported by "subscribers" and "casual users." The S&E computer is operated by the Directorate for Management Information Systems of the Troop Support and Aviation Readiness Command (TSARCOM/DMIS). It is the computer used for all of AVRADCOM's database applications, and this copy of SYSTEM 2000 is the only true DBMS used by AVRADCOM at this time.

The first training for AVRADCOM users was given in late February, 1978. During that course there were a few clues that database management was, somehow, new; however, the general impression was that SYSTEM 2000 is essentially one more software package now available to individuals or functional elements which have databases they wish to store and query. This is the manner in which the package is still used even though the best use of a DBMS extends far beyond such individual applications.

In May, 1978, the Scientific and Engineering Computing Branch (known then as SECO, the Scientific and Engineering Computational Office) set out to determine what manuals would be required, what additional training would be needed, and what the best use of SYSTEM 2000 would be for all of AVRADCOM. Arrangements were made for AVRADCOM

personnel to attend the three courses given by the Army Management Engineering Training Agency (AMETA). A continuing dialog was established with the system vendor, MRI System Corporation (now a part of INTEL Corporation). AVRADCOM joined the DBMS Users' Group sponsored by US Army Materiel Development and Readiness Command (DARCOM).

A review of the technical and management literature was initiated. It was found that database management is moving into an entirely new era, with new software technology and tools and with new management concepts. In fact, most of the reading is positively startling in its implication that AVRADCOM (and perhaps most of DARCOM) is entering this era without a clear understanding of the potential for database management or of the experiences and recommendations of other organizations.

A typical quotation from the literature (Ref 2, Page 5):

> ... users of database technology have learned... that they should have set up the data administration function even before they installed a data dictionary, and have both installed prior to the installation of the DBMS.

AVRADCOM has not yet established the data administration function. AVRADCOM does not yet have a data dictionary.

1.3 SOURCE MATERIAL

The literature which was used as the basis for this study is

listed in the bibliography, Appendix C. These articles and texts were encountered in the course of a broad search; they were not selected because they support a particular point of view.

The sources include a few text books, traditional computing journals (Datamation, Journal of Systems Management, EDP Analyzer, etc.), and government reports from the General Accounting Office, Bureau of Standards, Department of the Army Headquarters, and other agencies. Those who wish to read a small sample are directed to References 1, 4, 16, 19, and 36.

The quantity of literature being published on this subject is escalating, so that it is not practical to postpone important decisions while trying to read "everything." At the same time, in the references listed, the single discovery which we believe to be of major interest is that there are no significant differences of opinion among government, academic, or business writers concerning what needs to be done or the management difficulties encountered in doing it.

2 INFORMATION AS A CORPORATE RESOURCE

Current writers are generally consistent in emphasizing that data -- and information derived from data -- constitute a corporate resource and should be managed as such.

Most writers now use the phrase "corporate database" to mean that collection of data which is managed by one functional element for the use of the entire organization and, in particular, to aid managers in the decision-making process. Technically, the corporate data may be stored in file cabinets, computers, or whatever; however, the emphasis here is on the management of the corporate data using a Data Base Management System (DBMS). In this report the individual who manages the corporate data is called the Information Resource Manager (IRM). More will be said of other possible titles in Section 5.2.

The concept of data as a corporate resource comes from the fact that the users of data are located throughout the organization, not just in the department (division, directorate, etc.) which is the source for the data. While this is surely not a new situation, the ever-increasing sophistication in the technology of data storage and retrieval has induced a massive increase in the quantity of data which are stored, a massive increase in the number of questions asked about the data, and a general frame of mind (at least wherever a com-

puter is used) that the answers should arrive almost instantly and be based on data which are up-to-date and accurate.

The principal difference between traditional management information systems and the corporate database is one of purpose. Management information systems are, in general, collections of data files which maintain historical records about the organization's other resources (personnel, finances, material, etc.). They are used to produce specific printed reports. Requesting new information from them is slow and cumbersome.

In contrast, the corporate database is designed to help the decision-making process. Since this is a real-time process, data and information must be available for response to ad hoc queries, many of which include projections into the future -- queries from the infinite set of "what-if" questions.

For reasons sketched above, it is becoming intolerable to transmit requests for data down the sequence of line managers to workers who access independent computer files (or file cabinets) maintained in different functional groups and then pass the data back up the line to the requestor. A DBMS and its proper management can replace this slow and unreliable process.

While it is usually agreed that a decision to manage information as a corporate resource infers the creation of a corporate database, there are few well-accepted rules for determining exactly what data elements it should contain. Some advocate a top-down approach: De-

termine directly from top management what information is needed to help the decision-making process and limit the database to those elements which are actually required for this purpose. (More will be said of this in the next chapter.) Some advocate a bottom-up approach: The corporate database should contain every data element which is useful to more than one functional group of the organization or, perhaps, every element which is allowed to be accessed through the organization's DBMS.

Selecting the rules for determining the specific contents of the corporate database is obviously an important step in the planning process.

3 THE INFORMATION REQUIREMENTS OF MANAGEMENT

3.1 LEVELS OF MANAGEMENT

In the June, 1979, issue of EDP ANALYZER (Ref 14), Barbara McNurlin considers methods for finding answers to the question, "What Information Do Managers Need?" As background for discussing two specific methods, she refers to Robert Anthony's well-known book (Ref 33) on planning and control processes.

Anthony identifies three primary internal planning and control processes in organizations: (1) stategic planning, (2) management control, and (3) operational control.

In this model (which is also discussed in Ref 10), decisions concerning strategic planning are made by the top-level general managers; decisions concerning management control are made by middle-level functional managers and the general managers; decisions concerning operational control are made by operational managers and the functional managers.

The "processes" are well-defined in Anthony's book and need not be repeated. Important to this study is the fact that he identifies "information handling" as an independent process and says that it must be carefully distinguished from the others:

> Information handing is the process of collecting, manipulating, and transmitting information, whatever its use is to be.

He shows an information system which operates apart from the

management structure. This system collects data from all management levels and supplies information to all levels.

Although this view is over 15 years old and predates widespread use of a DBMS, the emphasis on managing the information apart from its particular use is only recently gaining general acceptance.

According to McNurlin (Ref 14, Page 4), the typical management information system (MIS) designed during the past 10-15 years attempted to gather and store enormous quantities of data generated at, and for the use of, the level of operational control. It was assumed, then, that the information needed for the two higher levels of management could be generated from summaries of these data. This is the traditional bottom-up approach.

McNurlin states that recent writers on decision-support systems claim that higher levels of management do not use this kind of MIS even when it exists within their organization, but rather that they require a top-down system which can be designed only after investigating what kinds of decisions are actually made and what information is needed as an aid for making these decisions.

3.2 TOP-DOWN ANALYSIS OF INFORMATION REQUIREMENTS

McNurlin (Ref 14) presents a summary and comparison of two specific top-down approaches used to determine the information requirements of management.

One of these approaches is called the CSF method. It is based

on an identification of "critical success factors" and was developed by John Rockart at MIT's Center for Information Systems Research (Ref 24). The second method is called BSP (Business Systems Planning) and was developed by IBM (Ref 25).

It would not be useful to attempt to describe the details of these two approaches; however, it is useful to list some of their similarities and differences:

a. The output of each method is knowledge of the organization's information requirements. With this knowledge, an "information planning team" can construct the plan for providing the desired information and for designing the corporate database.

b. To ensure a high probability of success, both methods require the involvement -- as well as the support -- of the highest level of management.

c. The CSF method finds the "critical success factors" for each individual manager. It assumes the information requirements are functions of the personality and style of these individuals as well as their management duties and, therefore, these requirements change with time as the managers change. The BSP method is directed more at the mission of the different levels of management and concentrates on the two top levels.

d. A CSF study is said to require less time, providing the individual managers are responsive.

e. The BSP method is more structured than the CSF method and provides more detailed information as a starting point for a corporate database.

3.3 EXPERIENCE WITH TOP-DOWN TECHNIQUES

The authors of both methods referred to in the above section state that these methods have been used with success by many organizations. IBM claims (Preface to Ref 25) that "hundreds of studies have been completed successfully using [the BSP] approach." Rockart (Ref 24) presents experiences of five specific cases with CSF.

McNurlin (Ref 14) presents some details from one company's experience with the use of the BSP method and another using CSF. There were several interesting similarities:

a. Both organizations had data processing departments, but both found the information requirements of their mid-level and top-level managers were not being met by the existing MIS.

b. In each organization a high-level manager took an active part in the team which was formed to determine the information requirements.

c. Each organization brought in consultants to help direct the use of the method they chose.

d. Each organization established a new position of "information

planning executive" outside the existing data processing department.

We believe the evidence is clear that any organization, including AVRADCOM, should decide first what level(s) of management are to be served by the corporate database, then what information is needed at these levels, and finally what data are needed for the necessary information. In addition, it must be kept in mind that information requirements are dynamic and that the design of an equally dynamic corporate database is as difficult as it is valuable.

4 COMPUTER SOFTWARE AND NECESSARY TECHNICAL EXPERTISE

4.1 DATA DICTIONARY/DIRECTORY

The data dictionary contains information about data which are stored in the databases. If it is automated, the dictionary itself is a database. Since consistent phraseology would lead from the clear terms of "personnel data," "financial data," "inventory data," etc., to the awkward "data data," the term "metadata" appears in the literature to mean the data which describe the data. The data dictionary, then, is the database which contains metadata.

The most basic data in the data dictionary describe individual data elements which occur in one or more databases. The description of each data element must be accurate, complete, and unambiguous. It must contain enough detail so that database designers and users can distinguish absolutely between similar data elements.

The data directory also identifies all application programs which use each data element. Since more than one user will access an individual database, the directory is essential for determining the effect that a proposed change to a data element will have on the application programs.

There are several commercial software packages which provide a Data Dictionary/Directory (DD/D). In the most desirable situation, the dictionary/directory is independent of any DMBS used for the cor-

porate database. As with all components of database management, the design of a dictionary/directory is sophisticated and evolving.

Within the broad concept of the corporate database, the DD/D is the single most important database. Most writers believe it should be installed and its function fully understood before specific databases are generated.

It is not an easy task to maintain the dictionary/directory; however, it is as essential as a DBMS if the purpose and potential of corporate-wide data and information management are to be realized.

4.2 DATA BASE MANAGEMENT SYSTEMS

It has been pointed out that the Data Base Management System (DBMS) known as SYSTEM 2000 has been available to AVRADCOM users since May, 1977. This is a sophisticated software package developed by the INTEL Corporation. There are several other systems available from commercial sources today, and it is obvious that there will be many more in the near future.

As with all software packages, a DBMS evolves with new enhancements, major revisions, and complete redesigns. Some changes are the result of users' experiences; some are the result of major changes in computer hardware and computer operating systems; some are the result of new understandings of the mathematics which describe the algorithms used for data storage and retrieval.

At this time there are three fairly distinct models used to rep-

resent database organization: network, hierarchical, and relational. Each of today's commercial packages is developed to handle one of these types of data structure. For instance, the major IBM package uses a network model while SYSTEM 2000 uses a hierarchical model. Each model has its supporters and its detractors. Ideally, the choice of which descriptive system (and then which DBMS) to use would come after an understanding of the most probable use of the database. For example, one type of DBMS would be best for a large database which is updated continuously but subject to very few ad hoc queries while a different type would be best for a database which has infrequent updates but is subject to many ad hoc queries.

It is not important for the reader of this report to understand -- or even to know -- the technical differences among the DBMS packages. It is important to appreciate that each DBMS changes with time and that packages in addition to SYSTEM 2000 will be used eventually by AVRADCOM. It is important to recognize that efficient use of any DBMS requires specific technical expertise and careful and continuous management in order to minimize the disruption of the users as the systems evolve.

4.3 OTHER SOFTWARE

Although the Data Dictionary/Directory (DD/D) and Data Base Management Systems (DBMS) are the software packages which have the highest visibility and are the subject of the most conversation and even

controversy, they are not the only packages which are essential in the database environment.

If the DD/D is not an integral part of the DBMS, software is required to connect the two. If the DD/D is an integral part of a DBMS and if more than one DBMS is used, software is required to communicate between the DBMSs.

If the technology continues to move towards real independence between application programs and the corporate database, software will be required as an interface between the applications and the DBMS.

Report generators will become more important as the database becomes more useful for decision-support. Graphics packages will be used with ad hoc queries.

As the DBMS becomes even more sophisticated, it is anticipated that using it efficiently will require considerable understanding of the computers' operating systems and user protocols.

In considering the evolution of the computer software which both drives and supports the evolution of information resource management, it is more important to accept the fact that there are many complex components to the collection of software packages than to attempt now to understand the specific functions of those components.

4.4 TECHNICAL EXPERTISE

The right kind and quality of technical expertise must be avail-

able in order for the corporate database to be useful as a decision-support tool. Martin (Ref 36, page 267) identifies three types of analysts on the database administration staff: (1) Data Definition Analyst, (2) Database Design Analyst, (3) Data Operations Supervisor. In addition, he identifies a separate security officer.

The list of functions performed by each is sufficiently detailed that it should be studied carefully at the time the mission and functions are determined for the staff of the Information Resource Manager (IRM). It is, in fact, too detailed to be considered item-by-item in this report; however, some comments are important:

1. It is impossible to over-emphasize the necessity for accurate definitions of data elements and the relationships between them. The person responsible for the definitions must be committed to translating local jargon into lucid English. He/she must have all the attributes of a dedicated technical writer.
2. In-depth technical knowledge of some fields of computer science, software engineering, mathematics, and systems analysis will be needed by the IRM staff. Since the hardware, software, and the database(s) will evolve continuously, the real-time function of decision-support cannot be maintained by relying solely on contractors and consultants for this kind of knowledge.
3. The techniques used for determining and describing the re-

quirements, specifications, and design of the database(s) must be rigorous, well-structured, and well-documented.

4. The technical staff must be -- and remain -- fully professional. Each member must stay in touch with the state-of-the-art by having easy access to current journals, texts, classes, short courses, conferences, and meetings of users, designers, and administrators.

Of course a particular organization may choose to assign responsibility for the functions listed by Martin in some way other than that which he recommends. Nevertheless, most of the functions listed are so basic that they will be performed -- if not by the most appropriate person according to a well thought-out plan, then by the most desperate user or application programmer according to the needs of a crisis!

5 THE FUNCTION OF INFORMATION RESOURCE MANAGEMENT

5.1 FEDERAL POLICY

In very recent years there have been at least two high-level projects concerned specifically with the federal government's problems with information management. One is the Commission on Federal Paperwork (Ref 17, Page 59, and Ref 110). The other is the Federal Data Processing Reorganization Project (Ref 11, Ref 43, and Ref 46). Both have submitted reports to the Office of Management and Budget (OMB).

The major concern of both projects is the enormous burden placed on business, industry, and private citizens to provide information to the government and, in turn, the government's own burden of providing information to the public. Although these concerns are not identical with those of AVRADCOM and other subordinate commands of DARCOM, many of the recommendations from the two projects will have an effect on the policies of information management within most government agencies. Some of the recommendations are incorporated in legislation which has been introduced to the House of Representatives as H.R.6410 (Ref 42).

Among the requirements which should eventually effect all DARCOM agencies (if the legislation passes) are: (1) establish an Office of Federal Information Policy within OMB, (2) designate within each agency (including, presumably, Department of Defense (DOD) and De-

partment of the Army (DA)) "a senior official who reports directly to such agency head" to perform specific functions relative to information management, (3) establish a Federal Information Locator System, and (4) define more clearly the obligations of OMB, the Department of Commerce, and the General Services Administration (GSA) in the Brooks Act (Ref 39).

The vocabulary used in H.R.6410 and the description of the Federal Information Locator System (Ref 17, Page 97) should lead all agencies to a common terminology for the functions of information management and for database design as well as a general acceptance of "information as a resource."

In addition to the proposed legislation, the Commission on Federal Paperwork has sponsored the creation of a new job series, Information Manager, with grades GS-9 through GS-15. The proposed qualification standard (Ref 44, sent to the Office of Personnel Management in April 1979) identifies the Information Manager as a "resource manager." In general terms, the responsibilities of this new manager can include all of those which appear in the literature (discussed in the following section) as relevant to managing a corporate database and many more, such as libraries, information centers, word processing centers, etc.

From the level of AVRADCOM on up the hierarchy of federal agencies, those who are involved in the acquisition of computing hardware are aware that the Brooks Act has a direct effect on their procure-

ment procedures. This act also assigned responsibility for scientific and technical "advisory services" and data processing standards to the Department of Commerce which then delegated the requirement to its National Bureau of Standards (NBS). Each NBS report included in Appendix C mentions that fact. Within NBS, the Institute for Computer Sciences and Technology publishes the results of its own studies and the formal Federal Information Processing Standards (FIPS).

Congressional hearings (Ref 40 and Ref 41) in June-Oct, 1976, attempted to assess the success/failure of the Brooks Act. Although the major concern was hardware procurement, the role of NBS in generating standards received considerable attention. In addition to the involvement of OMB, GSA, and NBS, the ubiquitous General Accounting Office (GAO) has published several reports (Ref 23 and Ref 45) which are critical of the management of software development and acquisition (including database systems) by all levels of federal agencies.

In the course of this study, we have not yet encountered current references to the concept of a corporate database or the database administrator's functions from the DOD; however, there were DOD representatives on the two projects noted above.

At Department of the Army Headquarters (DA HQS), the Office of the Assistant Chief of Staff for Automation and Communications (ACSAC), with the aid of a consulting firm, has completed a large study of its own requirements for information management. Reference

16, "An Information Management Study for Headquarters, Department of the Army," is the executive summary of their findings and recommendations. The terminology used (e.g., information resource management, information locator, decision support) is consistent with the other federal studies mentioned above and with the general literature.

Any organization -- including AVRADCOM -- which attempts to find an answer to the question, "What information do managers need?," could profit from a thorough look at the procedure used by DA HQS to find its own answer to that question.

The Air Force has several published reports on database administration, including Reference 6, "The Data Administrator's Handbook," from the Air Force Academy.

As this report is being written, DARCOM/DMIS is looking at information management and database administration from within the DMBS Users' Group, the DMIS Chiefs' organization, the Scientific and Engineering Computer Steering Committee, and the Scientific and Engineering Computing Council.

Although the DARCOM "ADP Blueprint for the 80's" (Ref 21) does not include information resource management as one of the seven major "thrusts," it does emphasize the future use of Data Base Management Systems and the database administrator's role in maintaining data element definitions, data integrity, and data security.

We have sketchy information from several other DA commands and subordinate commands which appear to be in different stages of inves-

tigating and/or implementing information resource management. Although many aspects of this particular field of management science are in a state of flux, it is at least clear that all federal agencies are moving toward a new seriousness about data/information management as well as toward new technical and organizational approaches.

5.2 THE INFORMATION RESOURCE MANAGER

The literature is replete with suggestions for titles for all aspects of the new database environment. Among those offered for the person who has the highest direct responsibility for management of the corporate database are: Information Resource Manager, Information Manager, Information Planning Executive, Information Services Executive, Data Base Administrator, Data Base Manager, Data Base Project Manager, Data Administrator, Global Data Administrator, Enterprise Administrator, Application System Administrator, and Data Locator. No doubt there are more.

Those authors who claim to be presenting views based on actual experience make a point of selecting a title which they hope will emphasize the fact that the corporate database and its management should not be viewed as just another assignment for the department which has traditionally performed the data processing or maintained the management information systems. Appendix A contains a sampling of these views.

In this report, it is assumed that the title of Information Resource Manager (IRM) is the most accurate. As the references show, this title appears more and more in the current literature and current government studies. It also appears in new product information from vendors.

The specific functions which are a part of managing the corporate database are listed in the following section; however, the IRM's most important function is to establish policies relative to the corporation's information. This is stated and explained in different ways by various authors. From Martin (Ref 36, Page 261):

> The Corporate data administrator [i.e., the information resource manager] has a policy-oriented job concerned with corporate strategy and planning. He should be high enough to know the corporate policies and politics, and have strong powers to see that his strategies are implemented.

The same author (Ref 36, Page 233) points to the technical knowledge required:

> The first event [in "going database"] should be the appointment of a data administrator with enough knowledge and at a high enough level to develop the data-base strategy and select an organization-wide data description language and data dictionary.

It is clear in the text that the author's use of "select" in the sentence above infers in-depth technical knowledge of the important analytical and management functions rather than just the authority to approve a recommendation made by a lower-level technical expert.

Throughout much of the literature, it is emphasized that the in-

formation resource manager must have a combination of technical expertise and corporate-level decision-making power. The NBS survey of federal database administrators found (in real cases) that usually this person did not have enough decision-making power and did not have enough enforcement power. In addition, the survey found that problems arose because the "decision-making management [was] not knowledgeable in [the] technological state-of-the-art."

5.3 FUNCTIONS PERFORMED TO MAINTAIN THE CORPORATE DATABASE

In order for the corporate database to be a significant improvement over a collection of computer files and typical management information systems, its design and management must be such that the technical advantages of the DBMS software and the organizational advantages of centralized control can be realized. These advantages include the ability to:

a. Maximize data independence.

b. Minimize data redundance.

c. Ensure data integrity.

d. Ensure data reliability.

e. Ensure data security.

Data independence means that the application programs are not affected by changes in the design or structure of the database, or vise versa. Complete data independence is not yet a reality. It waits for even more sophisticated software; however, good design of

the database(s) and understanding of the DBMS by application programmers will minimize adverse effects of changes.

Redundant data implies that the same data element is stored in more than one database or in more than one part of a single database. The technical experts who design the database will always be faced with the traditional tradeoff problem of choosing to save computer storage (i.e., reducing redundancy) or choosing to save computing time (i.e., storing data automatically in more than one way for faster access). This source of redundancy is not the major concern. Redundancy of serious concern occurs when the same data element is entered in more than one database, usually by workers in different parts of the organization, each one unaware that someone else is entering the same data. If the database design and management permit this, it is inevitable that some data will be inconsistent -- as will be the information derived from that data.

Data integrity means that data remain correct even if there are software or hardware failures. Experienced DBMS users have said that failure recovery is the problem which requires the most in-depth technical expertise.

Data reliability means that the value stored in a data element is the value which is supposed to be stored there.

Security means protection against unauthorized access to the database for any reason, intentional or accidental.

Since data elements within the corporate database are made

available for all approved application programs and ad hoc queries, the IRM's staff must maintain all essential information about the description of the data elements and where they are used.

In order to be the central source of knowledge about the database and to take full advantage of a sophisticated DBMS, the IRM's staff must perform many administrative and technical functions. Several authors provide their version of a list of essential functions. There are differences of course, but most writers agree that the IRM's staff should:

a. Approve the definition of data elements -- requiring completeness and accuracy.

b. Provide training in the use of the DBMS and the Data Dictionary/Directory.

c. Develop and publish all policies and procedures having to do with the corporate database.

d. Maintain the Data Dictionary/Directory.

e. Monitor the use of the database in order to make design improvements.

f. Acquire software and hardware.

g. Determine the priority for developing application programs when there are competing requests for the help of the IRM's staff.

h. Approve access to the database for application programs.

i. Assist application programmers who need to access the database.

j. Approve the content of the database -- including requests to add or delete data items.

k. Maintain the record of who is responsible for entering values in the database and arbitrate disputes about this responsibility.

l. Establish and enforce procedures to minimize accidental damage to the database.

m. Establish and maintain procedures for reconstructing a damaged database.

n. Develop procedures for assigning responsibility for the accuracy of data values.

o. Assign all passwords and arbitrate disputes about access to the data.

p. Select and enforce the use of a standard data description language.

As the corporate database evolves and as designers, users, and managers gain experience, the functions of the IRM and his/her staff will be refined. In fact, Martin (Ref 36, Pages 267-269) lists 41 distinct functions divided among three types of analysts (c.f. Section 4.4) and a security officer.

Since the corporate database will be a resource for the entire organization, the policies and procedures developed by the IRM must

be adhered to by all functional elements. Some authors believe that the IRM's authority to enforce procedures will be maintained only on the basis of a clear, written charter which is agreed to and actively supported by the highest level of top management.

5.4 MANAGEMENT PROBLEMS

As most authors state, the technical problems which are encountered in using a Data Base Management System, and in designing and implementing a corporate database can be solved by a competent technical staff which has access to good software, hardware, and training. The problems are not trivial, but they are not more difficult than those encountered by a typical engineering design group working with a new and evolving technology.

The success or failure of information resource management (or the corporate database) is said to depend primarily on management itself -- specifically the commitment and support given to the IRM by top-level management (c.f., particularly, Page 31 of Ref 19, Ref 2, Ref 8, Ref 10, and Ref 36).

It is well-known that the supply of trained computer scientists and computer systems analysts has not kept pace with the introduction of new and sophisticated hardware and software. The design of database software is one of the computing technologies evolving at a very fast rate. In addition to advantages listed previously, then, there will be an overall savings in high-level technical personnel if

the database is managed by an IRM with the expertise concentrated in a single functional element. The number of experts required is considerably less than the number needed if each large functional division attempts its own database design and maintenance with its own staff of database experts.

The difficulties which will arise initially with central design and control are not unique to the business of information management. They exist whenever one functional element is the primary source (or sole source) of a service or product needed by other functional elements. Since these kinds of problems are "old stuff" to large organizations, their solutions are well known (even though it cannot be taken for granted that they are working well at any particular moment).

As all management texts and seminars stress, success in providing a resource across functional lines requires the usual combination of authority, responsibility, competence, cooperation, communication, and adequate personnel resources.

The characteristics of information resource management which will make the early phases of implementation more difficult than, say, inventory management are (1) the newness of the concept and (2) the lack of technical experience (with large computer software systems) of those managers outside the IRM's staff who will be asked to rely on the services.

It is reported in the literature (and amply illustrated in Ap-

pendix A) that the Information Resource Manager (or Database Administrator) encounters considerable difficulty with management-level differences of opinion. Martin (Ref 36, Page 266) is direct:

> Too often the conceptual clarity of shared databases becomes clouded by political warfare. To resolve the bitter arguements that ensue the data-base administrator must have considerable diplomacy and authority.

But what is there, really, to disagree about? A short list of reported controversies includes:

a. Differences of opinion among managers about the desired contents of the corporate database.

b. Differences of opinion among managers about who "owns" particular data values.

c. Differences of opinion among managers about who should be allowed to read particular data values.

d. Differences of opinion among managers about who should load and update particular data elements.

e. Differences of opinion among managers about whose application program has highest priority for the help of the IRM staff.

f. Differences of opinion between the IRM and other managers about the quality of documentation required by the IRM's staff or provided by the IRM's staff.

Resolution of these and other conflicts requires considerable

diplomatic skill from the IRM and his/her staff. Still, there remains the potential for the effective destruction of the IRM's function since it is often human nature for the manager who perceives that he/she has "lost" one of the above arguements to decide, "I'll do it myself, my own way, in my own shop!" It is at this time that top management must re-confirm its commitment and prevent the fragmentation of the corporate database into the old system of individual, disjoint, inconsistent, and redundant computer files.

Martin has summed up his views on causes of success and failure in his EPILOGUE: HOW TO SUCCEED. This is included as Appendix B.

6 INITIAL ACTION REQUIRED BY TOP MANAGEMENT

Once the corporation has made the decision to enter the era of information resource management -- infering, of course, the creation and maintenance of a corporate database which is designed as a decision-support tool -- there are three steps which should be taken by the top management:

a. ESTABLISH THE IRM. A distinct functional element should be created for information resource management. A specific person should be designated as the Information Resource Manager. A core staff of at least four or five analysts should be assigned at the outset to take part in the requirements study (see below) and to begin to build the staff's technical excellence. Additional technical people will be needed as the detailed plans evolve.

b. DETERMINE THE HIGHEST MANAGEMENT LEVEL TO BE SUPPORTED BY THE CORPORATE DATABASE. As discussed in Section 3, a fundamental decision must be made about the highest level of management which the corporate database will be designed to support:

    1. Top-level general managers (i.e., the Commander, Deputy Commander, Technical Director, Chief of Staff).
    2. Functional managers (i.e., Directors, Deputy Directors, Office Chiefs).

3. Operational managers (Division and Branch Chiefs).

Based on our reading of the literature cited and the reality that much of the information generated within AVRADCOM is needed in order to respond to requests from higher "corporations," particularly DARCOM and DA, we recommend that the corporate database be designed as a decision-support system for the top-level general managers.

c. ESTABLISH A TEAM TO DETERMINE THE INFORMATION REQUIREMENTS OF MANAGEMENT. As discussed so often in the literature and reviewed in Section 3 of this report, the important answers to the question, "What information do managers need?," must be found before the detailed specifications of the corporate database are generated. A "requirements team" should be designated to pursue this question. It should follow the direction of a consultant who has had first-hand experience. The in-house members of the team should include at least:

1. One of the top-level general managers.
2. The Information Resource Manager.
3. Two analysts from the staff of the IRM.

The need for participation of a top-level manager as an active member of this team is clearly stated by Martin (Ref 36), McNurlin (Ref 14), and other writers who discuss the reasons why typical management information systems have not succeeded

as aids to decision-making. They warn of the many probable pitfalls in entering the era of information resource management without top-management involvement and support.

At the operational level, there are many other tasks and plans to be undertaken by the IRM (c.f., Sections 5.2 and 5.3) in structuring work assignments, developing training plans, establishing policies and procedures for data access, retrieval, query, etc. These do not require the active involvement of top management until they are ready for review as corporate policy.

Since the IRM's staff will be the source of in-depth technical knowledge of Data Base Management Systems for the whole corporation (c.f., Section 4.4), it should begin with the design and implementation of the Data Dictionary/Directory (Section 4.1) and one or more relatively small database projects in order to develop the necessary technical experience. These seed projects do not require the active involvement of top management except, of course, for the commitment of personnel to the staff.

The amount of ground work which can be done while the requirements team is working depends on the speed with which the IRM's staff can be recruited.

The scope, complexity, and the specifications of the corporate database itself cannot be reasonably anticipated until the requirements study is complete. At that time the IRM should present a clear set of

functional requirements for a top-level management review and decision. Following an agreement (by all accounts, no trivial matter!) about the intended functions of the corporate database, the "master plan" should be developed. This will include specifications and a timetable based on expectations for the staff's growth and training. It is reasonable to assume we will follow the overall recommendations of others to "plan big," for the long term, but to implement carefully with a series of small, well-designed projects.

APPENDIX A

QUOTATIONS FROM THE LITERATURE

APPENDIX A

1. An information control system is not a large, complex, super-sophisticated information filing system. It is a tool for making decisions in the highly complex, probabilistic business environment (Ref 1, page 85).

2. Application systems are not control systems; they are filing systems (Ref 1, page 85).

3. One thing is for sure; the most dynamic need in business is the need for information (Ref 1, page 86).

4. The alternative to the applications systems approach is the data base approach (Ref 1, page 86).

5. [The data base approach] requires a complete psychological reorientation to computerization, not just for management, but for data processing folks as well (Ref 1, page 86).

6. ..."data base" does not refer to the physical structure of computer files (Ref 1, page 87).

7. Data bases do not store information as information. They store data which can be used to generate information (Ref 1, page 87).

8. ...the ground rules [for data base management] require that the concept of individual computer applications, each with its own input, storage and output, be abandoned (Ref 1, page 87).

9. [DBMSs]...have as their primary purpose the maintenance of data quality and integrity. They are not concerned with the ultimate use of the data (Ref 1, page 87).

10. Management's information needs rest on only 400-800 elements of data (Ref 1, page 87).

11. Data base development is performed in a data base management environment organized around three basic control systems: 1) a data base input control system, 2) a data base output control system, and 3) a data base storage and processing control system (Ref 1, page 87).

12. The processing and control system is an independent data base management system with built-in capabilities for controlling backup, recovery, data availability, security, computer efficiency, and so on. It

is generally controlled by an individual called a Data Base Administrator (Ref 1, page 87).

13. A conventional data processing department performs a basically clerical role in spport of many individual computer applications while under the [data base] environment it must have a company-wide responsibility for managing data base input, data base output, and data base storage and processing activities...Rarely will the technologies involved be the same, nor will there be compatibility in the overall skills or internal controls required within the departments (Ref 1, page 90).

14. [A management information] department functioning in a data base systems environment must play an active, supportive role in determing how a company can be most productively managed. Regular data processing departments are rarely staffed to perform this role, nor are they looked to for management guidance...[They] cannot function effectively in the environment which data base management creates, nor can they be called upon by management to develop that environment. The skills and basic understanding just do not exist (Ref 1, page 90).

15. The political, economic, business, management and computer skills needed to successfully and properly construct a data base rarely exist in a conventional data processing department (Ref 1, page 92).

16. ...management must back up its intent [to utilize data base management] by establishing the authority and responsibility, both functional and financial, needed by the [new] department to establish and manage a data base systems environment (Ref 1, page 92).

17. A company which intends to develop an efficient and cost-effective data base environment must be prepared to adopt and implement the following general guidelines (Ref 1, page 92):

    1. The data base must be built for the whole company, not for individual managers.

    2. Data base development must follow a logical, well orchestrated plan, not the path of least resistance.

    3. Data processing must be intended to improve overall productivity by supplying accurate information based on management needs, not justified through cost reductions based on personnel replacement.

    4. Management must concentrate primarily on identifying the information it needs to manage.

5. MIS must control what is stored on the computer and how.

6. Company input responsibilities should be established and funded separate from output needs.

7. MIS must be given increased responsibility for input control and data integrity and accordingly, authority for defining and obtaining required input.

8. Investments in hardware, software and personnel must be based on the needs of the data base control systems, not on requirements for specific applications.

18. Data base is the future. Any company which intends to grow and prosper must, sometime during the next 5-10 years, move away from application systems toward data base systems. To do so it will have to commit itself financially and functionally to a path of migration to data base. This will be a major commitment, not to be taken lightly. It will require a whole new philosophy about what role computers, systems, and data processing personnel really play in company management. But more than anything else, it will require a positive and aggressive program to change attitudes and ideas in both functional and data processing management (Ref 1, page 92).

19. There are hardly any technical problems involved with installing a DBMS, only people problems and managerial ones (Ref 2, page 3).

20. ...the company selected a systems programmer who "could be spared"...Not only was this choice of the key person poor but so was the choice of the first application...This experience convinced user departments...that a DBMS was inefficient and just another programming fad (Ref 2, page 3).

21. Don't start the wrong way [to shift to a DBMS] or it could take you ten years or an organizational crisis to change and do it right (Ref 2, page 4).

22. ...a DBMS will cause important shifts in responsibilities (Ref 2, page 4).

23. First, a reasonably high level of top management acceptance and support is needed...Second, use competent managers, to provide good management control of the DBMS project. Third, assign competent technicians, including a data administration staff, with proper tools. And finally get competent auditors to monitor content, security, and privacy of the entire data base system (Ref 2, page 4).

24. [The chairman of the CODASYL Systems Committee] recommended that a data dictionary be installed before the first data base application is fully operational (Ref 2, page 4).

25. Some...organizations have a percentage of their applications running under one or more DBMS, but with little or no sharing of data among the applications. "Data bases" in these organizations are much the same as application files, and the DBMS is used as just a fancy new access method (Ref 2, page 4).

26. Here are the elements that make up the total data base environment (Ref 2, page 5):

    Data definitions.

    Data files.

    DBMS.

    Computer programs.

    Data dictionary.

    Query and report writing facilities.

    Data administrator function.

    Security and integrity functions.

27. Many users of data base technology have come to realize that they should have installed a mechanized data dictionary, to get their data definitions under control, before they installed a DBMS (Ref 2, page 5).

28. ...users of data base technology have learned...that they should have set up the data administration function even before they installed a data dictionary, and have both installed prior to the installation of the DBMS (Ref 2, page 5).

29. ...converting to data base technology is no simple matter (Ref 2, page 5).

30. The broad question of data management lies at the very center of the organization management process...So in dealing with the data of the organization, one deals with the heart and soul of management (Ref 2, page 6).

31. It is essential that management establish DBMS objectives (Ref 2, page 6).

32. An unequivocal statement of responsibility and a proper structure must be provided for the data management function...The new organization should include strong, central, total authority over data definitions and related DBMS functions (Ref 2, page 6).

33. Insufficient training for computer professionals seems to center on the areas of decision theory, systems, and man-machine dialog...But the greatest need is for management training in information systems in general and data base management systems in particular (Ref 2, page 7).

34. [Converting to a DBMS] is primarily a management problem, for both executive management and data processing management (Ref 2, page 7).

35. Management should recognize that the problem of converting to data base technology is not one that will just "go away" if it is ignored long enough. It is a question of when, not whether (Ref 2, page 7).

36. The first DBMS that an organization installs will be just that -- the first of many (Ref 2, page 8).

37. The [Data Base Directions Panel] strongly urged that the good practice be followed of installing a data dictionary and getting the data definitions under control before installing a DBMS (Ref 2, page 11).

38. Companies that use data base systems have in essence recognized that data represent a major corporate resource. Thus they have taken three steps in order to standardize the processng of data throughout the coporation (Ref 3, page 131):

    1. Establish a data base administrative function...[over] all corporate data.

    2. Develop structured data bases to replace the individual files.

    3. Install the set of computer programs required to create and manipulate the data bases.

39. One of the most important elements in planning for a data base system is an analysis at the outset of potential costs and benefits...It becomes a focal point for management involvement at all levels, which is indispensable to any data base development efforts...(Ref 3, page 132).

40. Possibly the greatest payoff could come in this area [of general management] (Ref 3, page 135).

41. With a data base...a high degree of independence is possible between application programs and the data base...The productivity of analysts and programmers often doubles, or even triples, once they become thoroughly familiar with the DBMS (Ref 3, page 137).

42. Tomorrow's information services executive will have at least four roles, some of them quite new. He or she will be the architect and information services planner, the information broker, the auditor who measures the quality of the service delivered and assures the integrity of the information system, and finally, the operator of those systems that continue to be centralized...The information services executive will become much more a corporate staff member...His or her decision at this level will affect the way an organization can be structured and the efficiency with which it can operate (Ref 5, page 146).

43. ...there will arise an information services executive of power and stature similar to that of the comptroller. The rank will be that of vice president and the information he or she controls will be viewed as one of the organization's most valuable resouces...The current MIS practioner may or may not be that person. Success will come to the one who starts now to conceptualize tomorrow's role for information processing and its manager (Ref 5, page 151).

44. ...the Data Administrator's function requires...characteristics which are not all readily found in any one individual (Ref 6, page 7 (quoting the EDP Analyzer of November 1972)):

    1. Two to five years experience as a systems designer and programmer with some of this exprience in large-scale integrated systems.

    2. Experience in large data base design.

    3. Ability to lead, organize, and control.

    4. Knowledge of user requirements.

    5. General technical and communicative skills.

    6. Diplomat extraordinare.

45. The Data Administrator is defined as that individual or group responsible for the design, creation, integrity, efficiency, and administra-

tive functions of a multi-user data base [i.e. updates from more than one functional area]...If a multi-user data base is used or is contemplated,...a Data Administrator is a necessity and not just a luxury (Ref 6, page 10).

46. The data base design function is involved with data elements, data use identifiers [DE/DUI], data dictionary/directory [DD/D], and data and storage structures (Ref 6, page 11).

47. The Data Administrator is responsible for acquiring or building this DD/D and for deciding what information about the DE/DUIs should be included (Ref 6, page 11).

48. The Data Administrator has sole responsibility for this function [of data base creation] (Ref 6, page 12).

49. The efficiency of the data base is the sole responsibility of the Data Administrator (Ref 6, page 14).

50. Data base design is perhaps the most critical Data Administration function...[His] ability to translate user requirements into an effective DD/D, data structure, and storage structure will be the final measure of how well he performs this design function (Ref 6, page 23).

51. The DD/D is maintained by the Data Administrator...(Ref 6, page 24).

52. ...many organizations that have tried to do without the position [of data base administrator] have found they could ill afford to continue without it (Ref 7, page 123).

53. The major areas of responsibility in data base administration are (1) data base description; (2) control of data access; (3) system support, protection, and tuning; and (4) information enhancement (Ref 7, page 123).

54. Control of the data dictionary is in all cases the responsibility of the [data base administrator] (Ref 7, page 128).

55. This role [of data base administration] requires familiarity with several levels of organizational activity: (1) management planning, policies, and goals; (2) application design and development; and (3) inter-area use of system resources...[the] position of DBA is centralized, with sufficient authority to obtain that information and compliance necessary for designing and supporting an effective data base system. The DBA should not, however, be a member of a central systems support group (Ref 7, page 130).

56. Concentration of DBMS knowledge within a central DBA group produces the best results in terms of the...proficiency that can be achieved and eliminates wasteful redundancy...In short, a central DBA team is the best solution for in-house DBMS support (Ref 7, page 131).

57. Organizations using DBMS find themselves in one of three situations: transition, expansion, or corporate (Ref 7, page 132).

58. A fully empowered data base administration team becomes necessary for most organizations [which integrate data into corporate data bases]. This team not only oversees data base activities but coordinates and controls much of the information flow within the organization (Ref 7, page 132).

59. ...an initial period of adjustment and trial and error is important for the eventual success of the data base support project. A transition period allows a relatively painless shaping of data base administration tasks to occur (Ref 7, page 134).

60. The ideal time for establishing a DBA position is during the transition stage, well before data base systems become critical to organizational production (Ref 7, page 134).

61. The ideal candidate [for the data base administrator] is a person equally comfortable with the roles of technician, administrator, and diplomat. The selection of a qualified DBA is in fact one of the most crucial steps in establishing successful data base projects (Ref 7, page 135).

62. Without strong senior management support and Database Administration, the Database effort will result in only minimum benefits to the organization (Ref 8, page 42).

63. ...two separate positions (offices) may be required with two different functional requirements. One might be called the Data Administrator and the other the Data Base Administrator. The Data Administrator manages the Database Administration section, is on the corporate staff, and is responsible for coordinating data collection, storage, and dissemination efforts throughtout the company...A Data Base Administration group should also be established, reporting to the Director of Data Processing. [This group is] managed by a Data Base Administrator responsible for managing the Data Bases and the use of the DBMS...He/she is also responsible for implementing the directives and policies of the Data Administrator...(Ref 8. page 42).

64. Each set of data is stored as a data base...under the control of one person or Local Data Administrator (LDA)...The concept is to delegate

and decentralize data administration among LDAs...while concurrently maintaining overall data administration...by a Global Data Administrator (GDA)...Its overall concept is to place data management capabilities directly into the hands of the user of data (Ref 9, page 6).

65. Before a Data Administration function can be established, certain conditions must exist:
(a) Top management must be willing to take a long-range view of the cost structure.
(b) DP and line management must be prepared for the data base approach with the associated protocols, standards, etc; and
(c) The entire line management must view data as a resource similar to raw materials, equipment, etc. (Ref 10, page 43).

66. ...a formal structure [for data administration] is needed which may or may not be within the data processing organization (Ref 10, page 43).

67. Information needs to be treated as an organizational resource (Ref 11, page 69).

68. Serving as the principal advisor to top and middle federal managers, the so-called information manager, according to the draft proposal, would provide technical expertise and counsel on such matters as information plans, budgets, and security measures...acting as a bridge between increasingly costly, complex and diversified information handling technologies on the one hand, and larger and larger numbers of managers and users unfamiliar with the technologies, their applications, their costs, and their values...(Ref 11, page 70).

69. [The commissioner of GSA's] Automated Data & Telecommunications Service feels strongly that expertise in the computer and telecommunications fields would be a qualifying must for the proposed information manager position (Ref 11, page 73).

70. The data base is forcing more awareness of data as a corporate resource. Because data in a data base is used by all authorized departments, it has become clear that the definition of the data cannot be left to individual departments (Ref 13, page 6).

71. ...the function of the data administrator (or data base administrator) has emerged to exert control over data and data definitions (Ref 13, page 6).

72. The overall function of data administration was divided into three components by the [ANSI/SPARC data base] study group, primarily to support data independence. The "enterprise administrator" is a business-oriented individual, perhaps on the staff of the executive

vice president...The "application system administrator" ...develops...the data definitions and relationship definitions as seen by the application programmers...[The] "data base administrator" creates the "internal data base plan" defining the way data is stored in the data base to achieve performance and economy objectives (Ref 13, page 9).

73. ...both of the companies [studied by the writers of Ref 14]...found it necessary to create new management positions following their [determination of the information needs of their managers]. These new information planning executives have the job of aligning their company's information systems with the management information needs...In both cases the position was set up outside of the data processing department, either just above it or along side of it organizationally (Ref 14, page 11).

74. Information Resource Management is responsible for...defining and planning all new uses of data within the organization and for ensuring that these uses correspond to the corporate information perspective (Ref 15, page 13).

75. Information must be classified and managed as a corporate resource in spite of the fact that it is inherently intangible (Ref 15, page 17).

76. The role and the responsibilities of Information Resource Management must be clear and placed high enough within the organization to affect change (Ref 15, page 17).

77. Data Base Administration is an integral part of the organization's commitment to meet its information needs by the data base approach and to use its DBMS effectively (Ref 15, page 20).

78. Establishing Data Base Administration requires extensive knowledge of the organization and insight into its objectives and functioning. Another important ingredient is the ability to stand back and objectively appraise the organization's procedures and personnel (Ref 15, page 27).

79. Data Base Administration is an agent of change. This charter for change requires detailed planning, careful preparation, and considerable resourcefulness. Teamwork and cooperation are more than important -- they are essential (Ref 15, page 27).

80. Information Resouce Management helps to determine an organization's information needs. Data Base Administration facilitates the production of information the organizaton uses...(Ref 15, page 28).

81. Information resource management is concerned with the knowledge and management of the composition, description, acquisition, dissemination, and flow of data or information where the information is held to be a resource of the entire organization (Ref 16, page 7).

82. There is no single source of information policy in HQDA, today (Ref 16, page 8).

83. Data Base Administration (DBA) is concerned with the technical design and maintenance of data bases used in information systems. Data Base Administration is a highly technical area which requires significant technical training (Ref 16, page 9).

84. ...we conceive the management of the data resource to be parallel to the management of the manpower, money, machinery and material resources. It is a staff activity, apart from such support services as records operations or data processing (Ref 17, page 140).

85. Among the key requirements for effective database administration are: strong management commitment and support; technically competent staff; team participation in the database environment by DBA's, management, technical staff, and users; and a well-defined Database Master Plan (Ref 19, page 3).

86. It is [the DBA's] responsibility to maintain and update database definitions and databse documentation, and to maintain and update the [Data Element Dictionary/Directory] and other database support software. The DBA should interpert and administer high level management policies related to the database, and define rules of use and access constraints for the database (Ref 19, page 5).

87. The consensus among data resource technologists is that the DBA function should be placed very high organizationally in order to ensure its success (Ref 19, page 7).

88. Three examples of organizational placement are presented below (Ref 19, page 7):

> ...the DBA is located in the director's office...[where he] should have access to the organizational data resources and can exact cooperation from the line organizations.
>
> ...the DBA [is located] as a staff position in the Comptroller's Office...[where] the "purse string" can be used as a lever in assuring compliance to database rules and regulations.
>
> ...the DBA [is located] as a sub-unit of the data processing

shop. This represents the lower end of the spectrum in organizational placement. [Here] the DBA usually would have less authority organization-wide...and can expect less cooperation from the rest of the organization.

89. The date of creation of the [database administration] function frequently was preceded by extensive unofficial initiation activities, ranging from 12 to 18 months (Ref 19, page 15).

90. [Of the twelve federal agencies surveyed by the NBS, those which have an operational database administration activity state that it] is usually located within the data processing/information management area of an organization; it is most often separate from, but on a par with, the computer operations activity. Sometimes, there is a tie to the comptroller's office, or to the office of the director for administration (Ref 19, page 16).

91. [The NBS survey of federal database administrators] identified several specific [non-technical] problems (Ref 19, page 25):

    1. Lack of commitment to database administration concepts at different management levels;

    2. Management hesitant to commit manpower and money to internally-oriented, non-visible projects;

    3. Unreasonable management demands;

    4. Lack of decision-making power for the DBA;

    5. Lack of enforcement power for the DBA;

    6. Unresolved jurisdictional problems, especially when different groups perform database administration tasks;

    7. Unclear definition of responsibilities of DBA's, analysts, users, and management;

    8. Frequent reorganization causing instability in control of data;

    9. Undefined ownership and control of data, especially between users and DBA;

    10. DBA concepts conflict with service center concepts;

    11. Failure to establish effective communication lines between DBA's, technical staff, and management;

12. Insufficient communication between DBA's and users with respect to data errors and availability of help;

13. Decision-making management not knowledgeable in technological state-of-the-art;

14. Lack of training and understanding of database concepts and DBMS by users and technical staff;

15. Lack of experience in database technology;

16. Skepticism with respect to the success of database administration practices;

17. Resistance of analysts and programmers to DBA interference;

18. Excessive procurement constraints on purchase of hardware, software, and services;

19. Inadequate cost-benefit analyses regarding implementing DBMS vs. conventional programming, and in evaluating in-house vs. commercial software;

20. High cost of hardware, software, services, technical staff, training, and vendor support.

92. The following advice was offered by the practicing DBA's to those about to establish this function. ...[It] should be helpful to future DBA's since it is based on actual experience (Ref 19, page 27):

1. Get complete management support, and get it early;

2. Establish a strong organization, with good lines of communication;

3. Have a good Database Master Plan;

4. Be flexible, and adaptable to change;

5. Develop credibility;

6. Be a combination of a good technician and a good politician;

7. Involve the users in planning;

8. Hire staff with strong database technology background, and system software experience.

9. Develop strong training program for staff, users and management;

10. Agree on standards first before designing a system;

11. Design a total system, but implement it in segments;

12. Experiment with different approaches;

13. Implement a DED/D early;

14. Consider the usage of a DBMS early;

15. Do benchmarks when possible;

16. Don't try to do too much at once;

17. Be patient. It may be a long time before you see results.

93. The MIS role will be increasingly one of "data base administrator," maintaining definitions of standard data elements and getting users to agree on who is responsible for maintaining which data elements (Ref 21, para E2c).

94. The implementation of a DBMS can be complex, time consuming, and costly, and it can affect every information handling aspect of an organization...[Successful] implementation requires careful planning (Ref 23, page 10).

95. [The method developed by MIT to determine the informaton needs of managers] takes into consideration the fact that information needs will vary from manager to manager and that these needs will change with time for a particular manager (Ref 24, page 85).

96. There are significant benefits of taking the necessary time to think through -- and to record -- the critical success factors for each general manager in an organization...The informaton system [designed around the manager's critical success factors] should be in constant flux...to accomodate changes...Rather than changes in an information system being looked on as an indication of "inadequate design," they must be viewed as an inevitable and productive part of information systems development (Ref 24, page 88).

97. In these areas [of expertise required for use of data base technology], skills of the highest possible caliber are absolutely essential for a successful data base system project (Ref 27, page 8).

98. DBMS is a new technology and even people whom you think are superior technologists will have to be retrained (Ref 28, page S/13).

99. "Data base administrator" (DBA) is not a fancy name for a systems programmer. The DBA is a unique specialty which requires more DP management and user application skills than systems programming know-how. The DBA must be fully indoctrinated into the concepts of data resource management (Ref 28, page S/13).

100. [The Standards Working Panel at a recent NBS and ACM workshop] called for the establishment of a group dedicated to the management of an organization's data...[The panel] felt data should be managed as a corporate resource...(Ref 29, page S/14).

101. The data base administrator was regarded [by the panel] as one job description in the data management function. ...[The] data base administrator should have "primary responsibility for the overall accuracy, timeliness and availability of the corporate data through direct control over the data dictionary/directory system" (Ref 29, page S/14).

102. Executive management must take an active role in the evaluation and implementaton of a Data Base Management System (DBMS)...It is a decision that cannot be made casually or by lower levels of management (Ref 32, page S/3).

103. If set up properly, a data base can become the hub of an executive decison-support system by readily answering the what-if questions and facilitating ad hoc reporting (Ref 32, page S/3).

104. The appointment of a DBA is essential because a DBMS requires the complete attention of one individual or group. It is essential that careful control of the analysis, planning and implementaton of a data base be handled on a day-to-day basis under one roof (Ref 32, page S/12).

105. The information specialist does need to have a good understanding of the uses that will be made of the information that flows through [the] system (Ref 33, page 95).

106. The information specialist has to resist the temptation to alter the specifications of the information so as to facilitate data processing or to make them fit his own conception of what data should be supplied to management (Ref 33, page 96).

107. ...it is not [the responsibility of the information specialist] to decide what information the manager should have, it is his responsi-

bility to show the manager what information he can have (Ref 33, page 97).

108. The DBA is responsible for the creation and maintenance of the Data Base Directory (Ref 34, page 8).

109. An important function of the DBA is the recording of procedures, standards, guidelines, and data base descriptions necessary for the proper, efficient, and continuing utilization of the data base (Ref 34, page 23).

110. If the DBA is unable to gain management's support and approval of his goals and objectives in managing the DBMS, then he will not be able to fully exploit the corporate data resource. Similarly, the DBA must be kept apprised of management's policies, goals, and objectives (Ref 34, page 45).

111. First, a data base, or data-base management system, does not imply a "management information system." There is no direct relationship between the terms (Ref 36, page 231).

112. A second delusion is that a data-base system is sometimes described as containing all the data items in a corporation or a division... Any attempt to implement so grand a notion is doomed to disaster before it begins (Ref 36, page 231).

113. [Another] delusion is the notion that an organization will have one data base. In reality it is likely to have many databases...[M]ost corporations should not talk about a corporate-wide data base but rather a corporate-wide organizing principle which forms the structure for data-base development (Ref 36, page 232).

114. The first [data-base] project attempted by an organization should be regarded as a seed project, deliberately planned and used to train a nucleus of data-base staff who will lead the way on other projects (Ref 36, page 233).

115. The first event should be the appointment of a data administrator with enough knowledge and at a high enough level to develop the data-base strategy and select an organization-wide data description language and data dictionary (Ref 36, page 233).

116. ...the corporate data administrator has a policy-oriented job concerned with corporate strategy and planning. He should be high enough to know the corporate policies and politics, and have strong powers to see that his strategies are implemented (Ref 36, page 261).

117. Too often the conceptual clarity of shared data bases becomes clouded by political warfare. To resolve the bitter arguments that ensue the data-base administrator must have considerable diplomacy and authority (Ref 36, page 266).

118. Great care must be devoted to (1) establishing expectations that can have a reasonable probability of attainment, (2) determining the degree of commitment by which management is willing to bind itself, and (3) formulating implementation guidelines that match the expectations and commitment (Ref 38, page 13).

119. The payback from the Data Resource Management investment will not be immediate; two to five years for the start-up investment is a reasonable expectation (Ref 38, page 14).

120. Do put some high-level focus upon Data Resource Management, other than the issuance of policies, directives, instructions or regulations. A high-level executive or staff officer should be publicly designated as the person who will either be held accountable for Data Resource Management implementation, or who will at least review and report upon compliance and upon the benefits realized (Ref 38, page 17).

121. Don't place primary responsibility for the Data Resource Management function under the top "data processing" officer [unless all of the following conditions are met]: (a) he has demonstrated an ability to formulate sound organization-wide policies and procedures, (b) he is well removed from the operational management of major computer centers, (c) he has a solid grasp of program missions and activities, and (d) he has a keen interest in paperwork management in addition to data processing management, and understands and appreciates the nature and role of manual (non-automated) information systems (ref 38, page 18).

122. The federal government needs to upgrade the training and career development required for functional managers, reclassify personnel skilled in the management or use of information technology, and establish appropriate career paths for such persons (Ref 43, page 14).

123. Firms preparing to meet the challenges of the 1980s will need a capable and sophisticated manager of corporate information. An organization's success in the coming decade will be dependent in large part on successfully managing its information resources. Executives responsible for corporate information management will require skills far beyond those of the traditional data processing manager (Ref 47, page 114).

APPENDIX B
"HOW TO SUCCEED"

The lists which follow are excerpts from Chapter 26 of Reference 36: James Martin, PRINCIPLES OF DATA-BASE MANAGEMENT,

James Martin is the author of over twenty books on different aspects of computing and computers, including database design and administration. He was with the IBM System Research Institute for ten years. At this time he is an independent consultant and the Chairman of the board of two private companies, one concerned with teleprocessing and communications, the other with corporate planning, information management, and database technology (Database Design, Inc. (DDI)).

Martin and DDI have been consultants to several large corporations, helping them construct a management-level plan for the development of those "subject databases" which make up the corporate database.

Reasons for Long-Term Data-Base Successes and Failures

Reasons for Success	Reasons for Failure or Disappointment
• Top management understanding and support of the objectives, and determination to make the data bases a valuable corporate resource.	• Dissenting political factions who prevent the integration which can maximize the value of data.
• Concentration on well-specified, profitable uses of the data bases.	• Overselling "Management Information Systems" (especially MIS for top Management).
• Development of data bases which relate to corporate subjects, rather than computer applications.	
• A planned step-by-step buildup of applications of the subject data bases, with each step being suitably small and easy.	• Plans for the installation of a grandiose all-embracing system.
• Corporate-wide planning by a high-level competent data administrator.	• Fragmented plans by noncommunicating groups.
• Conversion planning that permits the old non-data-base programs to coexist with the new. This requires well-tested conversion programs which create the data files required by the old programs.	• Inadequate attention to coexistence of the old and new; attempts to rewrite too many old programs.
• All persons are thoroughly educated at a level appropriate to their function.	• Lack of understanding of data-base principles or implementation requirements.
• Tight Technical control by the data-base administrators.	• Inadequate CPU power or main memory. Failure to estimate response times or maximum throughput. Failure to monitor usage and performance.

Reasons for Success	Reasons for Failure or Disappointment
	Failure to select appropriate physical data structures.
• Adoption of a corporate-wide data description language. (The software will change while the schema data descriptions remain the same.)	• Use of multiple separate incompatible data-base management systems.
• Adoption of proven state-of-the-art software with both logical and physical data independence.	• Writing your own data-base management facilities or modifying existing software. (In the long run this is usally a disaster.)
• Through end-user involvement in the data-base design.	• Ill-defined user requirements.
• Employment by end users of a powerful easy-to-use data-base interrogation language.	
• Recognition of the vital nature of a data dictionary and system --Naming standards --Update control --Version Synchronization	• Casual approach to library control.
• Program specifications containing full details of types and sequences of date-base accesses, thoroughly reviewed with structured "walk-throughs" with the data-base administrator present.	
	• Lack of a comprehensive system testing plan including the testing of compatibility with the surviving old applications.
	• Inadequate controls on data accuracy or quality.

Reasons for Success	Reasons for Failure or Disappointment
	• Inadequate security or embezzlement controls.
• "Keep it simple."	• Excessive complexity. Confused thinking.
• Careful selection of the first data-base project. The first project should be chosen to maximize the chances of success, and to act as a seed project used to develop expertise (see next table).	
• An appropriate mix of centralized standardization and guidance, and decentralized implementation.	• Lack of centralized guidance leading to a proliferation of incompatible systems.
• Technical management has a business orientation.	• Excessive centralized control by a group out of touch with the reality of local operations and problems.

The First Project is Critical to the Acceptance of the Data-Base Route and Needs to be Seen to Succeed

Reasons for Success on the First Project	Reasons for Failure or Disappointment
. A worthwhile profitable new project with its own "bottom-line" payoff. Project visibility.	. Replacement of an existing system without adding new function. (All this will prove is that data-base systems are more expensive.)
. A relatively simple project.	. A complex or grandiose beginning.
. Management commitment to future data-base use.	. The project is approached in a skeptical "evaluation" mode.
. A strong technically competent project lader who is respected above and below.	
. Proven bug-free software likely to be of lasting importance.	. The latest software wonder.
. Very thorough education of the individuals involved.	
. A project without a critical deadline.	. Inadequate manpower or too short a schedule.
. Less than 12 hours on-line per day.	. On-line 24 hours per day.
. Thorough assessment of the hardware requirements.	. Inadequate CPU power, main memory, or access speed.
. Data bases with a high potential for sharing with other applications in the future.	

Reasons for Success on the First Project	Reasons for Failure or Disappointment
• Careful design and thorough testing of conversion aids.	• A high degree of interation with other current applications.
• Thorough attention to detail.	• The solving of problems put off for later.
• Very thorough system testing and training of user groups.	

APPENDIX C

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APPENDIX D

ABBREVIATIONS FOR FEDERAL AGENCIES

ACSAC	Assistant Chief of Staff for Automation and Communications (directs a major functional element within DA HQS)
AMETA	Army Management Engineering Training Agency
AVRADCOM	Aviation Research and Development Command (a major subordinate command of DARCOM)
DA	Department of the Army
DARCOM	Development and Readiness Command (a major command of DA)
DMIS	Directorate for Management Information Systems (a functional element within many DARCOM subordinate commands)
DOD	Department of Defense
GAO	General Accounting Ofice
GSA	General Services Administration
NBS	National Bureau of Standards
OMB	Office of Management and Budget
SECO	Scientific and Engineering Computing Office (now the Scientific and Engineering Computing Branch, a functional element of AVRADCOM)
TSARCOM	Troop Support and Aviation Readiness Command (a major subordinate command of DARCOM)

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