Managing The Data Resource: A Contingency Perspective

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Abstract

Today, corporations are placing increasing emphasis on the management of data. To learn more about effective approaches to "managing the data resource," case studies of 31 data management efforts in 20 diverse firms have been conducted. The major finding is that there is no single, dominant approach to improving the management of data. Rather, firms have adopted multiple approaches that appear to be very diverse in (1) business objective, (2) organizational scope, (3) planning method, and (4) "product," i.e., deliverable produced. The dominant business objective for successful action is improved managerial information; most data management efforts are "targeted" without a formal data planning process; and the dominant product was "information databases." In addition, several key organizational issues must be addressed when undertaking any data management effort.

Keywords: Data administration, data management, information resource management, information systems management, strategic data planning

ACM Categories: H.2.7, J.1, K.6.0, K.6.1

Introduction

Although the literature presents both conceptual justifications for managing data as a resource (Diebold, 1979; Edelman, 1981; Horton, 1985) and approaches/methods that describe how to do so (IBM, 1981; Martin, 1982, Ross, 1981), it unfortunately contains little discussion of actual business problems caused by poorly managed data, of business successes made possible by well-managed data, or the data management actions that make a difference. The result may be the impression that data management is a technology-driven concept in search of a concrete business need.

The problems of unmanaged data are, however, quite real and exist in a broad range of organizations. A major bank seeking to shift its strategy toward a focus on customers finds that it cannot determine how profitable individual customers are, or even what its total business is with each customer, because its customer codes are not common across branches or lines of business. A manufacturing firm with nine plants cannot negotiate favorable purchasing agreements with its major suppliers, because it cannot pool inconsistent data from these plants to find out how much it buys from each supplier. An insurance company discovers it cannot check group health insurance claims against previous claims for the same individual participant, because the structure of the data precludes it. A company attempting to merge two divisions finds that incompatibilities in data definitions and systems provide one of the greatest obstacles to attaining this important strategic action.

These few examples might be dismissed as unfortunate abberations if similar problems were not found in so many organizations today. In fact, it is likely that management's demand for up-to-date information from many different sources at many different levels of aggregration will increase even further as the business environment becomes more competitive (*EDP Analyzer,* 1986). This makes it critical that businesses better appreciate the implications of poorly managed data, and understand the variety of ways in which they can improve the management of data. The three-year study described here attempts to address this need by looking at some thirty data management efforts in 20 firms.

The major finding from this study is that there is no single dominant approach to improving the management of data. Rather, firms have adopted multiple approaches, all of which need to be considered by any organization striving to leverage

data as a valuable business resource. In addition, this study identifies a set of key organizational issues that should be addressed when undertaking any data management effort.

The rest of this section summarizes some current approaches to data management in the literature and describes the research method. The next section presents the major findings using a framework that represents the variety and contingency seen in the data management efforts studied. This is followed by a brief discussion of several key organizational issues that managers should explicitly address as they consider the options suggested by the framework. The article concludes with a discussion of the major lessons learned.

Current approaches to data management

As the business need for information has increased, so has the technical capability to handle information. A rapidly growing amount of data is now available in electronic form—most of it designed and organized to meet the needs of specific applications, with little thought given to compatibility of data across applications or business functions. Managing this data in a manner that best contributes to business objectives has become a complex problem (*EDP Analyzer*, 1986). Various solutions that have been discussed in the existing data resource management (DRM) literature can be categorized into three types of approaches:

Approaches with a technical focus. These include tools and techniques such as database management systems (Curtice, 1986; Date, 1981), data dictionaries (Appleton, 1987; Ross, 1981), and data entity-relationship modeling (Chen, 1976; 1983).

Approaches with a focus on organizational responsibilities. These include the establishment of organizational units such as database administration and data administration (Gillenson, 1985; GUIDE, 1977; Kahn and Garceau, 1985), and the formulation of administrative policies and procedures covering areas such as data ownership, access, and security (Appleton, 1984; Weldon, 1986).

Approaches with a focus on top-down, business-related planning. These include planning processes and methods such as Martin's (1982) strategic data planning, Holland's (1983) strategic systems planning , and IBM's business systems planning (BSP) (IBM, 1981). All of these approaches link the acquisition and use of data with business objectives.

It is increasingly evident that neither of the first two categories provides a completely adequate approach. Coulson (1982) acknowledges that many efforts to solve data management problems through the implementation of a data dictionary have failed. Kahn (1983) presents empirical evidence suggesting that most data administration groups have had little or no success in correcting key data management problems, and Tillman (1987) discusses several reasons for the failure of data administration organizations to live up to management's expectations, such as insufficient management support.

The third type of approach has received great attention, because the ultimate goal of data resource management is not to put tools in place or to create organizational units but to provide data to support the needs of the business. Such planning approaches, however, require significant resource commitments and, as will be discussed later in the article, often are not easy to accomplish.

Research approach

Given the limited general knowledge of firms' experiences with existing approaches to data management and the need to develop new ways of thinking about the area, exploratory case studies have been conducted across multiple firms and industries. One to six days of interviews with IS managers and user managers were carried out in each of 20 large corporations during 1985-86. The firms were from a range of industries, including electronics, consumer goods, insurance, banking, computers, and energy. The largest company was in the top 10 of the *Fortune* 500; the smallest had annual revenues of $500 million.

Table 1 provides brief descriptions of the firms (with disguised names) and their data management efforts. In each company, we focused on one to four data management projects, for a total of 31 data management efforts studied. Almost all of these efforts were viewed as successful by both information systems and user management.

In all, over 230 managers and other professionals were interviewed; approximately 70 percent were from IS departments and 30 percent from user departments. The interviewees discussed the data-related policies, processes, controls, standards, and tools that their firm had in place or had at-

Table 1. Firms and Data Management Efforts in the Study

Disguised Names	Description	Data Management Efforts
Financial Services		
Coolidge International	Financial services, over $3 billion in revenues	Operational SDABs to support core customer financial services
Dobbs Insurance	Among Top 10 insurance cos. in assets	Change in the basic business data collected by one division
Taft Insurance	Over $3 billion in revenues	Information database to support auto insurance business
Van Buren Bank	Over $50 billion in assets	Customer information database for top 1000 customers in corporate and government banking group
Manufacturing		
Blaine Corporation	Personal care products; Fortune 500	Data access services for and users
Crockett	Canadian subsidiary of Fortune 500 U.S. computer company	Operational SADBs for finance and administrative applications and managerial reporting
Eakins Corporation	Multibillion dollar international industrial and service company	1. Information database for consolidated financial data from subsidiaries 2. Information database for employee insurance claims
Foothill Computer	Fortune 250	1. Information centers providing data and data consulting 2. Set of standard data definitions established by corporate task force 3. Strategic data planning for the order flow function
Global Products, Inc.	Fortune 500 manufacturing	Subject area databases being gradually implemented
LDI Electronics	Over $2 billion in sales	1. Corporate information database for engineering specifications 2. Information database for product quality tracking 3. Information database for managerial analysis across product divisions in the components group

Table 1. (continued)

Disguised Names	Description	Data Management Efforts
Matrac Corporation	Fortune 100 manufacturing	Data access services for end users
Spectrum Electronics	Fortune 100	Integrated manufacturing database in one division
Process Industries		
Derrick Energy Products	Largest Subsidiary of Fortune 100 companies	1. BSP in Production Division 2. Six operational SADBs as part of its asset management program
Sierra Energy	Among top 10 energy companies	Information database for consolidated financial reporting
Waverly Chemicals	Fortune 500 diversified chemical company	1. Common manufacturing systems in largest division 2. Common accounting systems used by multiple divisions 3. Strategic data modeling done for IS planning in largest division 4. Set of standard data definitions established by corporate IS group
Windsor Products	Fortune 100	1. Several information databases built 2. "Data charting" effort
Other		
Consumer Publications	Over $1 billion in revenues	1. Strategic data planning for the corporation 2. Operational SADBs to support the promotion function
Diverse Conglomerate	Fortune 500	Information database for use by senior management
National Technologies	Over $5 billion in revenues	Strategic data planning for the corporation
Winslow	Aerospace division of a multi-billion dollar conglomerate	Data access to divisional data through fourth generation tools

tempted. Also discussed were the factors that motivated each organization to take action and the results that were achieved. In addition, the interviews gathered opinions regarding the most important problems and issues concerning the management and use of data.

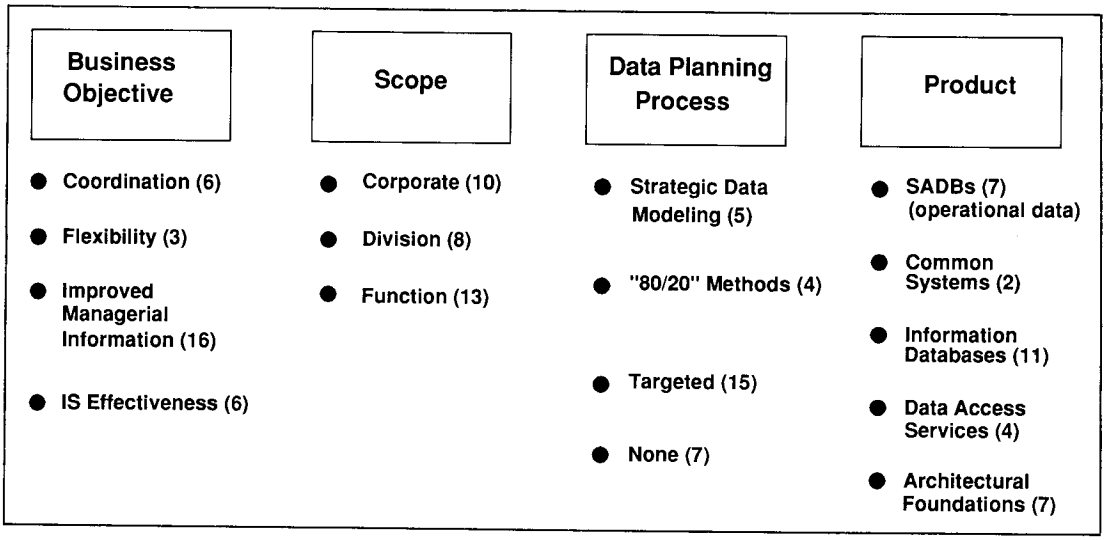
An initial assumption, supported by the present findings, was that similarities in data management issues faced by large corporations outweigh differences among industry groups. In choosing companies to study, the goal was to find a range of firms that were actively trying to improve their management of data. The sample was drawn from firms known to have forward-thinking IS groups. This means that the sample is not random. However, because of the number and variety of firms studied, the findings should be generalizable to other large organizations that have recognized data management as an important issue.

A Contingency Approach to Data Management

The picture emerging from these case studies is that effective data management efforts fit no single clear pattern. In analyzing the cases, there is an interlinked set of choices that depend heavily on organizational considerations. Certainly, one must be careful in generalizing from a non-random sample of 20 companies, but, at least in these organizations, successful efforts appear to be diverse in terms of (1) business objective; (2) organizational scope; (3) planning method; and (4) "product," i.e., major deliverable produced.

As a starting point for visualizing the contingency approach to data management, Figure 1 presents a simple framework that reflects the variety of options found in the case studies. The four main elements of the framework represent the key components of the data management efforts studied. These elements are:

- The identification of a *business objective*. In the successful companies in the sample, data management actions were almost always justified not by conceptual or technical arguments, but by one of four compelling business needs: operational coordination, organizational flexibility; improved managerial information; or IS effectiveness.
- The *scope* of the data management project. The firms studied explicitly defined and limited the organizational scope of their efforts. Some focused on a functional area (such as finance), others on a division, while some were corporate-wide.
- The *data planning* method. Top-down, in-depth stategic data modeling was not the only data planning process. In fact, there appear to be a number of obstacles to accomplishing a large-scale strategic data planning effort. The planning processes utilized varied widely in terms of their formality, their detail, and their emphasis on data models. The range of options varied from strategic data planning to more limited planning approaches to no planning whatsoever.



Note: The numbers in parentheses show how many data management efforts fell into each category.

Figure 1. Framework of Data Management Choices

- The *"product"* of the data management effort. Much of the existing data resource management literature centers on the implementation of subject area databases (Martin, 1982). In the case studies, however, were seen five distinct "products," which were the end results of the data management project team's work. These products are: subject area databases for operational systems; common systems; information databases; data access services; and architectures or standards for future systems.

The next four sections of the article discuss each of the elements in the framework. To facilitate the discussion, the elements are discussed in reverse order from that shown above, with the most tangible element, the "products," first, followed by planning processes, scope, and business objectives.

Five data management "products"

Any successful data management effort results in a product or deliverable such as a new system, service, or policy. The "product" most common in the existing data resource management literature is a set of subject area databases used by multiple operational systems. We also found, however, four other products. Like subject area databases, two of the other product types—common systems and information databases—require a systems development effort. The final two product types, which usually do not involve new systems or databases, were labelled data access services and architectural foundations.

Subject Area Databases for Operational Systems

Subject area databases (SADBs) contain data that is organized around important business entities or subject areas, such as customer and product, rather than around individual applications, such as order processing or manufacturing scheduling. Many different operational applications may share data (i.e., both access and update data) from a single set of SADBs. In seven of the 31 cases, the product can best be described as SADBs for operational data.

> Consumer Publishing, Inc.[1] does many direct mailings using its large customer base and other purchased lists in order to promote its books and magazines. To help support and control this important activity, Consumer Publishing has built a set of SADBs (including product, vendor, postal regulations, and promotion plan) that are used by three major applications: (1) an MRP-like system for planning and execution of mailings; (2) a purchasing system for mailing-related materials; and (3) an inventory system. The implementation occurred in several phases between 1981-84, and was the first time that Consumer Publishing's IS department took a data-focused approach to systems development. The SADBs and applications have helped to simplify and improve mailing-related operations, and have greatly reduced inventory costs.

[1]All company names have been disguised.

Common Systems

A second type of data management product is the set of operational data files or databases that are developed for common systems. Common systems are applications developed by a single, most often a central, organization to be used by multiple organizational units. Physically, there can be one or multiple copies of the system. The concept of common systems is not new. They have often been developed not for data management purposes but rather to ensure common procedures or to lower IS costs. Common systems cannot be developed, however, without surfacing and resolving data definitional issues, since old systems (and old definitions) will be discontinued.

> Waverly Chemicals is a major, diversified chemical company, and its largest division operates about a dozen plants. Since about 1980, this division has emphasized the development of common systems for manufacturing applications such as production scheduling and spare parts inventory. The availability of well-defined, standardized data has enabled the division to reduce inventory costs and to greatly improve coordination among the plants.

While only two of the companies studied developed new common systems, several of the other companies had a significant existing base of common systems. These firms often were able to use the standard data in their common systems to leverage other data management efforts.

Information Databases

A third new systems product is an information database, which can be defined as a subject area database intended for use by staff analysts and line management. Information databases are "secondary" databases, which periodically draw their contents from operational databases and (sometimes) external sources, and often store data in aggregated forms. Significantly, information databases can provide data without requiring

major rewrites of current systems. Instead, "bridges" are built from the existing operational systems to provide the appropriate data to the new database.

Information databases were the most prevalent product in the sample, occurring in 11 (35 percent) of the 31 cases.

> At Windsor Products, a consumer goods manufacturer, corporate management's demands for information led to the development of several new databases. Standard codes and definitions were defined for these databases; however, existing applications and the operational databases on which the transaction systems depend were left in place. Automated bridges from the existing systems populate the new "information-only" databases for customer, product, and shipment. These information databases are now widely used.
>
> LDI Electronics is building an information database to contain data on key characteristics of the parts and materials the company uses in its electrical components, including specifications, availability, reliability, and cost. Most of the data is already collected, in various forms, by existing procurement, engineering, and manufacturing systems. Thus, bridges and translation routines are being built to the new database. A prototype is in use by engineers in nine product groups.

Data Access Services

The first three "products" discussed emphasize developing new databases or files with pertinent, accurate, and consistent data. Four firms in the study, however, focused mainly on improving managerial access to existing data, without attempting to upgrade the quality or structure of the data.

Data access services are usually provided by a small cadre of personnel, often part of an information center, whose goal is to better understand what data is available in current systems and to put in place mechanisms to deliver this data. These mechanisms include locating appropriate data, extracting data from production files, or training users in fourth generation languages. Such efforts are widely applauded by managers who now have help in "getting their hands" on existing data.

> A multi-billion dollar manufacturing firm, Matrac Corporation, has put in place a "data service" for its corporate end users. The data service organization is a small group within the corporate IS organization that locates data, arranges for extracts, and delivers the data in the user's choice of formats. The group maintains copies of most of the data it provides and arranges for periodic updates.

Data access services are expect to be more helpful in companies where existing data is of reasonable quality. Where data is of poor quality, the process of delivering data in its current form to managers may spur action toward increasing data standardization and control mechanisms. Some firms are following up initial efforts to provide data access with the development of a data directory designed specifically to assist end users by listing and cross-referencing the available data.

Architectural Foundations for the Future

In most of the firms studied, managers focused on a limited set of data serving a portion of the corporation. However, there clearly is a danger in approaching data management function by function, business unit by business unit, or subject area by subject area. A company may find itself facing problems in the future if it desires to integrate data across these boundaries. To avoid these future incompatibility problems, some organizations have focused on developing "architectural foundations," which are policies and standards that force systems development efforts to conform to a well-structured, overall data plan.

One type of architectural foundation is a corporate-wide strategic data model designed to serve as an underlying blueprint for all future systems development. Martin's (1982) Strategic Data Planning approach produces such a model as one of its products. IBM's BSP methodology (IBM, 1981) and Holland's (1983) methodology are others that produce a data architecture.

Proponents of these approaches argue that a strategic data model provides an architectural foundation that will lead to consistency of data, more easily integrated systems, and improved productivity in systems development and maintenance.

Five of the firms studied developed a strategic data model primarily as an architectural foundation for future systems development.

> Waverly Chemical's largest division began a strategic data modeling effort for the entire division after the successful implementation of common manufacturing systems. The model was used to help create a strategic IS plan that identified key business areas that had little systems support. Due to a downturn in the division's primary business,

limited action has been taken based on the plan. The division, however, has shown its data model to other Waverly divisions; at least one other division has decided that the model fairly closely fits its business and has used it, with some modifications, as a basis for its IS plans.

A second, more limited approach to data architecture is the standardization of data definitions and codes. Most of the new system products developed by the firms in this study require that line management and IS technical personnel agree on the precise definitions of a specific set of data elements as a prerequisite to building the system. In two firms, however, a set of corporate-wide data definitions was developed solely as an architectural foundation to facilitate meeting future information requirements.

In 1984, Foothill Computer formed a task force, chaired by corporate IS, to identify and define key data elements being used in multiple areas of the business. There were no immediate plans to implement the agreed-upon definitions. Rather, it was assumed that future systems development work would conform to these definitions. In addition, it was established that any group supplying data to another group within the corporation would be required to deliver that data in conformance with the definitions, if asked. After coming to agreement on definitions for over 200 data elements, the task force has more recently refocused its efforts to concentrate only on defining those elements for which a specific business impact can be identified and pursued.

As these examples illustrate, either a widescope strategic data model or a set of standard data definitions can be a product in its own right. When data models or standards are enforced, an organization should gain a major asset of interpretable, shareable data. But usefulness of these architectural foundations can always be questioned, unless the data model is used to guide future systems development, or unless the definitions eventually become incorporated in either operational or managerial databases.

A range of data planning processes

This section focuses on the planning processes organizations use to identify the target for data management action, and to choose the action (or "product") to pursue. To many people, planning for data resource management is synonymous with a large-scale strategic data planning and modeling effort. There are, however, other less comprehensive planning approaches that can be extremely effective. This section categorizes the planning processes from the case studies into four types: strategic data planning; "80/20" approaches; "targeting;" and no explicit planning. These approaches represent a continuum of planning processes that ranges from global, well-defined, rigorous methods through more local, often less formal approaches, to no data planning at all.

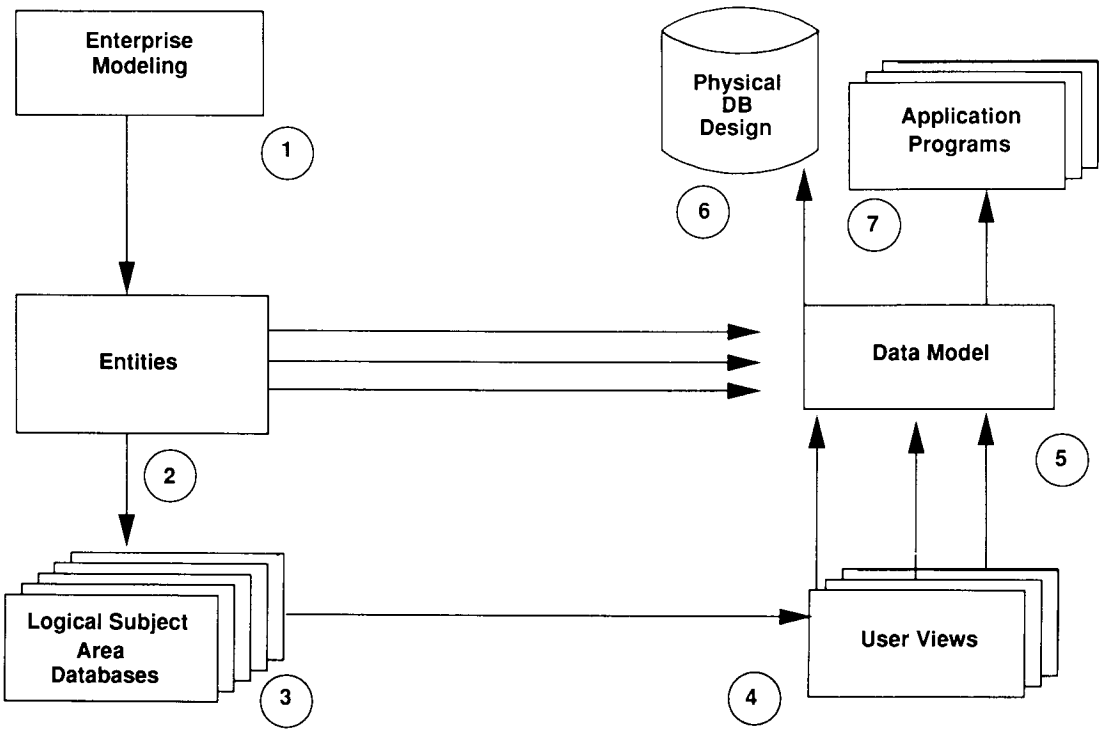
Strategic Data Planning

Strategic data planning is the category that encompasses rigorous top-down planning approaches focused on understanding and modeling data in the context of business functions. The resulting plan defines an architecture of major subject area databases and prioritizes their implementation.[2] The diagram in Figure 2, adapted from Martin's (1982) *Strategic Data-Planning Methodologies,* is representative of these approaches. The left side of the diagram shows a top-down planning approach, leading to the identification of logical subject area databases. In general, only selected portions of the plan are chosen for bottom-up design and implementation.

The underlying assumption of top-down data planning methodologies—that it is impossible to plan effectively if one does not know what the business is, what it does, and what data it uses—is difficult to contest. However, of the 31 data management efforts studied, only five used a strategic data planning approach. In general, these five firms undertook a strategic data planning effort to produce both a strategic data model (which we call an architectural foundation) and a plan of action.

None of these firms saw the kind of success envisioned in the literature—a master data architecture that identifies strategic opportunities and guides all new development. The outcomes of the five efforts varied, but in none did the plans directly lead to the implementation of new systems or sub-

[2]The word plan has two definitions: (1) a scheme of action or procedure; and (2) a representation drawn on a plane, e.g., a map, a model. Although the terms *data planning* and *data modeling* have often been used synonomously, it is helpful to distinguish between them. Data planning is used here to mean an effort to develop a "scheme of action." Data modeling refers to the preparation of a "representation" with predetermined scope and level of detail. The representation may be a useful aid in developing a scheme of action, or when done in great detail, may be the basis for a system design. Many strategic data planning methodologies aspire to produce both a model and a plan.



A strategic data planning process begins with the development of an enterprise or business model (Box 1, above). The enterprise model depicts the functional areas of the firm, and the processes that are necessary to run the business. The next step is to identify corporate data entities and to link them to processes or activities (Box 2). Data requirements are thus mapped onto the enterprise model, leading to the identification of subject areas for which databases need to be implemented (Box 3).

In general only selected portions of the enterprise model and subject area databases are chosen for bottom-up design. Building the logical data model is the first step. The data model (Box 5), results from a synthesis of detailed management and end-user data views (Box 4) with the results of the previous top-down entity analysis (Box 2). Database design and subsequent design of application programs (Boxes 6 and 7) proceed from the logical data model.

Figure 2. Strategic Data Planning[3]

ject area databases. In one case, although the clearest benefit was a better understanding of the data by those involved in the planning process, the effort was viewed as worthwhile. Two of the efforts were generally perceived as failures.

In 1982, the central IS planning staff at National Technologies, Inc., a large high technology firm with 20 divisions, began a comprehensive data planning effort in response to the complexity and variability in National Technologie's business environment. The goal was to link strategic IS planning with strategic business planning and to link a logical model of the business data with the development of physical databases and systems. The planning effort took about a year and involved eight people from IS planning and the user community. Although the strategic data model was completed and turned over to systems development teams, the model was not adhered to. The pressures of the operating environment took hold, and deadlines, not the global data model, became the significant driving force. Also, conflicts among the users about definitions and uses of data arose, despite the generally agreed upon data model. In addition, limitations in data-oriented design tools and relational database technology were noted.

[3]Adapted from James Martin, *Strategic Data-Planning Methodolgies,* 1982, p. 109. Used by permission of Prentice-Hall, Inc., Englewood Cliffs, NJ.

In the other two of the five cases, while strategic data planning did not lead directly to an IS plan of action, it did provide an architectural base for subsequent data management efforts.

Derek Energy Products completed a business system planning effort for its production division in 1982. Shortly after the plan was complete, the division participated in a major reorganization, and the plan was shelved as no longer appropriate. In 1984, Derek formulated a new long-range IS strategy. The strategy identified a "target future state" for the division's information systems. Key user managers participated with IS personnel in the development of an implementation plan based on the "target future state," critical business objectives, and the current slate of system requests. As part of the planning effort, the business process/data model from the BSP was revived and modified by a small group of IS professionals. The BSP model was useful in categorizing 50 current project requests and in making it apparent that a third of these requests depended on the same six subject area databases. These six databases are now being developed.

In most of the data management efforts studied, the planning and implementation process did not proceed as suggested by strategic data planning methods. Figure 3 illustrates the actual planning process for two companies that were typical of the other case study sites and, in contrast to Figure 2, shows an altered sequence of steps. In these two cases, as in most of the other firms studied, the companies skipped or abbreviated the "left side" or top-down portion of the top-down planning, bottom-up design process. In doing so, they followed the alternate planning processes to be discussed in the next sections.

As shown in Figure 3a, Spectrum Electronics chose to develop manufacturing systems without having used any top-down, data-oriented planning methodology to arrive at that decision. The company started with the objective of implementing a particular set of applications (1), then developed a logical data model (2) for this application set's data, and finally designed the physical database and the applications (3).

Sierra Energy (Figure 3b) started with a particular user's view (1)—that of the corporate controller—and designed a data model (2) and physical databases (3) from that perspective. Methods for "bridging" data from existing applications were then developed (4).

Figure 3a.
Spectrum

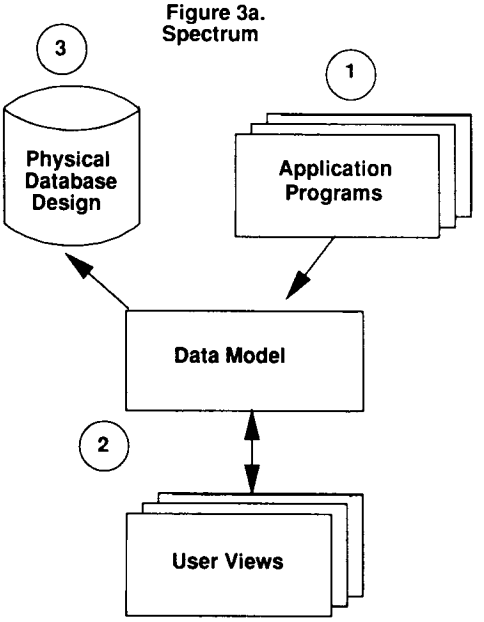


Figure 3b.
Sierra

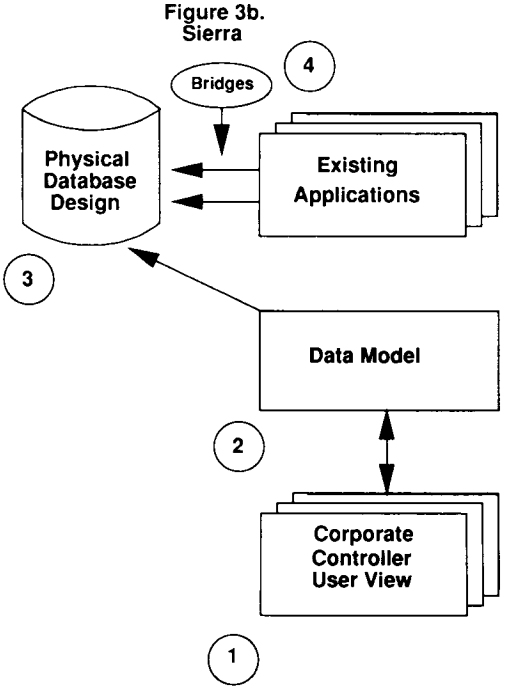


Figure 3. The Planning Reality

There appear to be a number of reasons that help explain why more firms are not successfully using strategic data planning methods. Table 2 lists some of the reasons why it is difficult to gain commitment to the process and to manage expectations regarding the outcome of strategic data planning. The bottom line is that, for many firms, the approach is too expensive, its benefits are too uncertain, and it is organizationally difficult to implement.

Targeting High-Impact Areas

Most corporations that skip or abbreviate top-down planning methods do not act without a plan. There are a variety of alternative planning processes that can be used. The most common process (seen in 15 of 31 cases) is the "targeting" of a particular function or business area. In some companies, important problem or opportunity areas are evident without extensive analysis.

> At Sierra Energy, the corporate controller knew from his experience that he needed, but did not have, consistent, accurate data for corporate reporting purposes. He initiated the development of an information database to be used by the company's many decentralized business units.

> When top management at LDI Electronics made improved product quality a corporate priority, the only quality-related information easily accessible was warranty accounting data. It was clear that additional data needed to be collected and made available. A corporate-wide information database for product quality is being designed.

Neither Sierra nor LDI used a rigorous data planning method. But in both comapnies there were key line managers who could visualize the benefits of accessible quality data. In each case, the data management program was limited in scope but was effective and feasible.

"80/20" Planning Methods

In some firms, there is a desire to get the major benefits of global data planning without having to invest the resources necessary to carry out a full-scale strategic data planning process. The aim in these cases is to zero in quickly on the key "products" to be implemented (bottom-up), while reducing the amount of effort spent in a global planning (top-down) phase. This type of planning, found in four of the 31 cases, can be termed an "80/20" approach, after the adage that for many undertakings, 80 percent of the benefits can be achieved with 20 percent of the total work.

Table 2. Why Strategic Data Planning Approaches Are Difficult to Implement

- The strategic data planning process, done in detail and with a wide scope, can be very time consuming and expensive. For the process to be successful, key operating managers must commit significant time and effort. This commitment is often difficult to obtain (and keep) from these busy individuals.
- Because of the up front effort needed, organizations face a longer and more expensive development process for the initial systems developed with data planning methods. Line managers do not like to see project schedules lengthened. Similarly, IS managers, who have incentives to deliver quickly and to contain costs, may resist the additional effort involved.
- The methodologies require new IS skills and, therefore, may not be easily adopted by IS personnel.
- Often the business will change while the plan is being developed and implemented.
- Total implementation of a wide-scope data planning effort can be extremely expensive. There is a tendency to avoid these new costs, especially if many of the existing systems, which represent a huge investment are still effective.
- When implementing only a subset of the plan, it can be difficult to bridge the gap from the top-down plan to bottom-up design. If proposed and existing systems interface along different boundaries, it may be hard to isolate and replace a subset of existing systems with a subset of proposed systems. The use of application packages also creates interface and boundary problems.
- It is not always clear to the planners or top management whether a strategic data model is being developed to produce a systems plan, create an architecture, or to design new databases. It is difficult to manage the expectations of those involved regarding the results and benefits of the process.

Windsor Products, having carried out its first round of data management in a quick targeted manner, found itself uncertain as to the next information databases to implement. Management decided, however, that a full strategic data model was not necessary for its purposes. It therefore developed its own abbreviated planning approach, which it calls "Data charting." This involved identification of about 100 major data aggregates (i.e., high-level data entities) and the groups in the corporation that used them. This method took less than six man-months of effort, and involved reviews by line managers in all parts of the business. The data chart is serving as the basis of planning for the next round of information databases.

The problem with strategic data planning approaches is the investment of time and dollars needed to obtain results. Drawbacks of "targeting" include the probable inconsistencies that will arise from multiple targeted projects and the fact that in some companies, the most important targets may not be evident. An 80/20 approach, while not providing the detail of strategic data planning or the quick hit of targeted approaches, does appear to offer the major benefits of both previous approaches.

No Planning Process

There are also data management actions that can be taken without any data-oriented planning. For example, if a decision is made to provide better access to existing data without addressing changes in the form of that data, then no data planning methodology is needed. Rather, data can be made available as it is requested. This was the case at Matrac, with its data services approach described earlier and at six other companies.

Bounded scope

In this study, no firm attempted to manage all the data used by the corporation; all limited the focus of the effort in one or more ways. An important factor in the success of data management efforts is that the scope (i.e., the part of the organization to be included in the effort) be carefully selected. Although the scope of eight data management efforts was *divisional,* 13 cases, strikingly and logically, focused on a *functional* area such as manufacturing or finance. This limited scope was usually dominated by a single manager who was able to visualize the results of a data management effort in a segment of the business.

In 10 cases, the scope of the planning effort was *corporate.* In only three cases did the scope include all of the corporation's data; two of these were corporate-wide strategic data planning efforts for which the results were not as useful as the organization had expected. The third was Windsor Product's 80/20 planning effort to develop a corporate-wide data chart.

In the other seven cases, the effort involved a limited subset of the total data used by the corporation. For example, one effort focused on key corporate-wide subject areas, such as customer or product. Two focused on a small set of important data definitions. Others provided users with ad hoc access to existing data files.

In addition to functions and divisions, other suborganizations such as groups, geographic districts, and product lines exist within a firm. Some corporations may choose one or another of these units as a locus for data management efforts. As the next section will show, the scope of the data management effort is substantially determined by the business objective.

Business objectives, not conceptual justifications

The proponents of data management far too often base their arguments on either the conceptual soundness of viewing data as a resource or the rationale underlying data-centered systems design. They assert that processes change while data is relatively stable and that data should therefore be the key element in IS planning. Or they argue that global data management is essential because one needs a global plan before developing the individual pieces. While these arguments are appealing, they rarely engender action in the pragmatic, cost-conscious world of the business manager.

Most successful data management processes observed have been aimed at solving a clear and specific business problem or exploiting an opportunity. In a some cases, the data management effort occurred because of a line manager's need to respond to changes, such as increased competition, in his or her environment. IS departments have also had a key role in initiating many of the efforts and in educating line managers as to how improving the management of data can contribute to the business. This section discusses the business-related reasons why firms are motivated to consider more proactive management of data.

Operational Coordination

A major objective for data management action is to better coordinate operational activities, either within specific functions or business units, or across them. This objective often arises when competitive pressures cause a firm to focus on cost reduction. Improved coordination requires an enhanced ability to communicate within or among organizational units. In practical terms, this implies the ability to readily share data. There are six clear examples of coordination as a motivation in the case studies.

> Both Spectrum Electronics and Waverly Chemicals felt the need to standardize their manufacturing systems so that many plants could be coordinated more effectively. In both cases, their efforts have meant significant benefits. For example, the standardization of data has led to reduced in-process and inter-plant inventories and to the coordination of spare parts availability, which has reduced downtimes. Common data has also facilitated coordinated purchasing, which has enabled special arrangements with vendors to be made.

Organizational Flexibility

A second type of objective for data management, seen in three cases, is the desire for greater organizational flexibility to allow either an internal restructuring of the organization, or a refocusing of the organization due to changes in the environment.

> Waverly Chemicals has restructured its divisional organization several times over the past decade. It merged two large manufacturing divisions in the mid-1970s, and faced major problems with accounting systems that had been designed and implemented separately in the original divisions. In the late 1970s, Waverly combined five old divisions into two new ones. It was quite clear to senior management that there would be other reorganizations in future years. As long as each division had its own accounting systems with much incompatible data, the problems would persist.

Changing an organization's strategic focus can also require more effective data management. Several companies studied have been faced with important changes in the marketplace that put intense competitive pressures on them to change from a product focus to a market or customer focus. Organizational flexibility is often hindered by data structures that have been designed to support particular applications or suborganizations but which are not flexible enough to provide new strategically important "views" of the business.

> In 1984, Dobbs Insurance Companies determined that the basic data structure used by its Group Insurance Division, while still appropriate for 90 percent of its current business, would not support its future needs. For example, the "flexible benefits" products the company was considering offering would require major changes in the way it kept data about policies and policy holders. Given the competitive pressures in the insurance industry, Dobbs felt it had no choice but to move to a more flexible data structure.

Improved Information for Managers

The dominant objective for more effective data management, seen in 16 of 31 cases, was to improve information for senior managers, middle managers, and key staff personnel. The need for better data is recognized, for example, when management wants to analyze changing market trends or more closely monitor profitability. These information consumers want two things: improved access to data and improved data quality.

> Van Buren Bank wanted to manage customer relationships better, especially with its largest clients. Because each bank branch assigned its own customer identifier to each customer with whom it dealt, there was no easy way to aggregate data for a single customer across the entire bank. The bank has now spent over $1 million to develop a customer information database to allow account managers to retrieve information about the bank's 1000 largest customers.

When problems such as these become important enough to management, strong motivations arise to improve data quality and access.

IS Effectiveness

As information and information technology become more important to firms and information systems budgets grow, there is strong pressure on IS groups to not only develop systems faster (while controlling costs and improving quality) but also to be more proactive in addressing business needs. Improved data management can potentially contribute to the effectiveness of IS planning and delivery by linking the data requirements of the business with IS plans, by increasing systems development productivity, or by reducing systems maintenance costs. Data management actions may also be motivated by the recognition of a lack

of integration among existing systems and the difficulties this causes as demand for multi-function or multi-organization systems or information grows.

In six of the 31 cases, the primary motivator for data management efforts seemed to be general IS effectiveness, without any more specific business goals. Four of these six were strategic data planning efforts, while two were efforts to identify and standardize key corporate data element definitions.

Many firms felt that the data management actions they were undertaking would involve greater, not lower, IS costs in the short run. On the other hand, two firms, acting with a clear business objective as the primary motivator, had IS effectiveness as a secondary objective and said that they had achieved reductions in development or maintenance costs.

> Spectrum Electronics eliminated separate programs and programming staffs in its plants by centralizing all data processing and by using a centralized database and common software for all manufacturing systems. The company also claims to have reduced maintenance costs by eliminating not just redundant data, but the programs that updated redundant data and the programmers who maintained those programs.
>
> Crockett, the Canadian subsidiary of a major American computer manufacturer, claims a 40 percent reduction in development costs because of a new development process focused on data, the use of an active data dictionary, and users' generation of their own reports.

Major patterns in the cases

The four critical components for data management action—business objectives, scope, data planning process, and "product"—provide a rough framework for thinking about the 31 data management efforts. By placing those efforts in the appropriate categories of the framework, as shown in Figure 4, we can see which choices predominate, and what combinations emerge as recurrent patterns.[4]

Three major patterns, shown by the arrows in Figure 4, emerge when the sets of choices made by the case study firms are analyzed. The most striking pattern (solid arrows), followed in six cases, represents firms that sought improved managerial information, in a functional area by targeting key business opportunities and by building information databases. Two other firms followed almost this same path, but with a corporate or divisional scope. Management's need to be able to see consolidated financial information, comprehensive data about its customers or profitability of products is a major impetus for data management action and can often be addressed through an information database.

The second prominent pattern (dashed arrows), with four cases, represents firms seeking better operational coordination in a functional area by targeting key business opportunities and building either operational SADB's or common systems. If operational coordination is the goal, then these two products are the most appropriate.

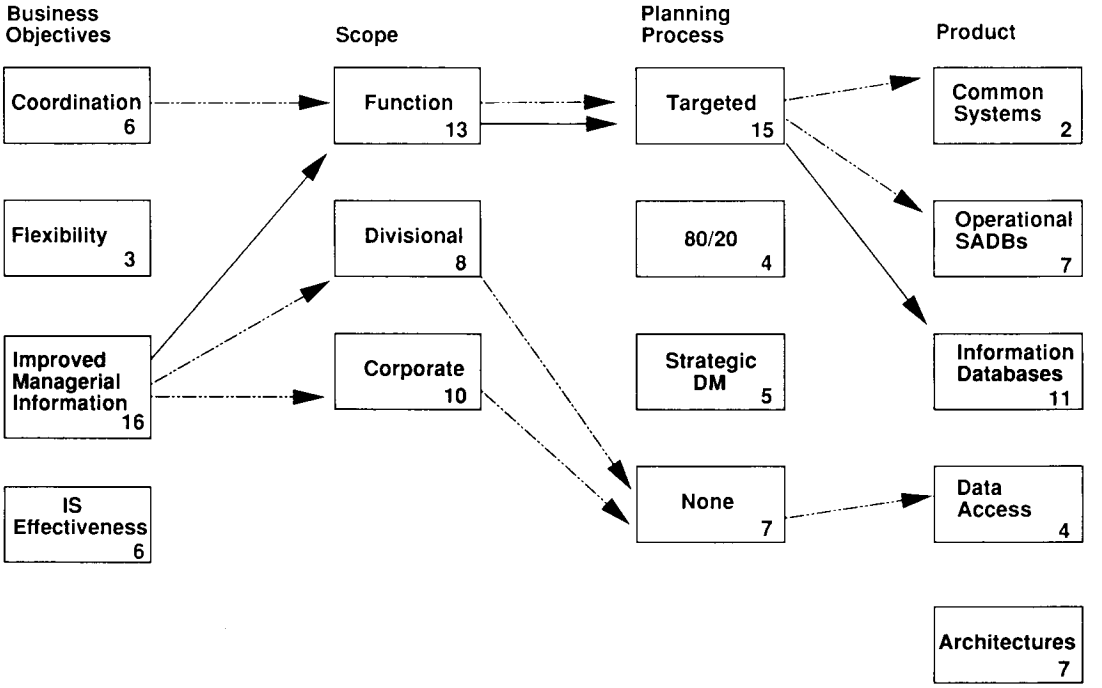
The third pattern (dotted arrows), also with four cases, is made up of firms seeking improved management information, at either a corporate or divisional level, which put in place improved data access services using no explicit data planning process. This is an important option, especially in companies with many common systems extensive data definition and coding standards. This approach rapidly places data where it is valuable—in the hands of end users—and does so at minimal cost.

Two of these three major patterns (and 11 of the 31 cases) involve functional scope and targeted planning. This reflects the importance of managers in specific functional areas who are able to see concrete ways in which better data can assist them in their areas of responsibility.

If we look at the numbers of occurrences in each box of Figure 4, it becomes apparent that for three of the components of data management action, one alternative dominates the others. Sixteen of the 31 efforts were motivated by a business need for better managerial information. Fifteen of the efforts addressed a targeted need without using a more formal planning process. Eleven of the 31 products were information databases. That these alternatives are well represented is not surprising, but the fact that they are so predominant suggests they are "high-action areas" that ought to be carefully considered by practitioners of data management.

Finally, even though there were only four instances of 80/20 planning processes in this study there is a need to emphasize the importance of this approach. In many corporations, after the more obvious targets are addressed, an important shift is expected toward 80/20 planning processes

[4]Examining the patterns by industry group showed no major differences; see the Appendix.



Note: The numbers show how many data management efforts fell into each category.

Figure 4. Major Patterns in the Framework

that identify strategic opportunities without the major investment of more rigorous strategic data planning approaches.

Organizational Issues Affecting Data Management Implementation

In addition to the contingency model of data management choices presented above, the interviews with IS and line managers have suggested five organizational issues that affect the ability of firms to implement data management efforts. This section briefly presents these issues.

Issue 1: Short-term and long-term trade-offs in resource allocation

Managers considering data management actions must decide how to allocate limited resources among activities that will produce immediate benefits and "infrastructure" efforts that often do not have a quick payback. This tension between long and short term is reflected in our framework. The framework's categories represent a continuum of data management actions that can be directed toward any of three aspects of a corporation's data: infrastructure, content, or delivery.

Infrastructure encompasses the standards that force systems development efforts to conform to a coherent data architecture. Actions to build a data infrastructure (e.g., developing a strategic data model) tend to be both difficult and expensive, and the benefits from such actions are most often realized only in the longer term.

Content refers to the choice of what data to maintain, and also to policies that address the accuracy of that data. Systems to capture new or more detailed data and decisions to purchase external data are examples of actions that affect data content. These efforts tend to be moderately expensive, with benefits in the middle term.

Delivery refers to making existing data available to managers who need it. Data consulting services, extract policies, and the provision of fourth generation reporting tools are examples of mechanisms to improve delivery. Actions in this area tend to be less expensive and have short-term benefits.

The choice of where a firm should best allocate its resources—among infrastructure, content, and delivery—depends very much on the willingness and ability of senior management to invest currently for future benefits. A characteristic of American businesses has been the short-term focus of line managers. Decisions to allocate resources to data architecture are in direct conflict with the pressures to achieve demonstrable results, near-term earnings per share, and this year's return on investment. Not surprisingly, most of the successful efforts reported in this article have tended toward the short-term end of the spectrum. On the other hand, firms that have put in place stronger data architectural foundations appear less likely to face problems integrating and sharing data across the organization.

Issue 2: The centralizing tendency of data management

Underlying any effort toward more effective data management is the reality that improved data management can lead to greater centralization of decision making in an organization. Increased standardization of data facilitates increased central control. For example, standard data definitions may be established as common systems are developed. If the resulting data is made accessible to senior executives, they will have an enhanced ability to compare operational details of business units under their jurisdiction. There is indeed a tendency to act on this kind of data; several of the systems described here were instituted to facilitate "central" coordination and control. Even where increased centralization is not a design objective, it may be a result.

Issue 3: Impact on the IS culture

A third organizational issue is the impact of data management on the IS culture. As Durrell (1985) points out, "data administration challenges the basic process-oriented approach that has been employed during the last 20 years. This can be disconcerting and sometimes insulting to many long-time DP professionals" (p. ID/29).

> The new data-centered system used at Crockett has had a major impact on the work of programmers and analysts. The major activity of these people now is working with business managers to define the business rules governing the meaning of data elements and entering those rules into the active data dictionary. Not surprisingly, this has had a significant impact on the attitudes and turnover of the programmer/analyst staff there. While the level of enthusiam of current personnel is high, many programmers found their traditional skills of no value in the new environment and left during the transition period.

The problem is not only one of teaching information systems professionals new skills. There must also be changes in organizational processes and managerial policies to support the move toward data-oriented design. For example, incentive mechanisms must be changed to reward programmers for conforming to a corporate data model even if it involves additional time and resources. Without these changes, when system deadline pressures become high, programmers will have a strong tendency to develop their own local data structures rather than embark on negotiations with the data administrator for changes to the corporate data model.

Issue 4: New responsibilities for user management

If data is to serve business needs, to what extent must line managers, not only IS professionals, assume new responsibilities? In two firms studied user organizations assume almost complete responsibility for data management. At Sierra Energy, a group within the corporate controller's organization provides general policies and support for systems and data management actions related to the firm's financial functions. At Foothill Computer, a data management group within the corporate-level customer administration function is responsible for managing data subject areas such as customer and price. This group views itself as a data custodian, responsible for obtaining data from the appropriate source organization (e.g., price data from the product line managers), for maintaining the integrity of the data and for delivering data to the user organization's transaction or information systems.

Other firms focused on increasing user involvement in the process of managing data. At a minimum, many firms had task forces with user (and IS) representation to establish data definitions.

It seems obvious to say that the effective management of data as a corporate resource requires the participation of business managers. But the exact nature and scope of line management's responsibilities are not well defined.

Issue 5: The process of effectively introducing innovations into the organization

The implementation of initial data management efforts can be usefully viewed as the process of effectively introducing innovations, i.e., new methods or tools of unproven value. Rogers (1962) suggests that in general the diffusion of innovations is dependent on, among other things, five characteristics of the innovation. These are (1) the relative advantage of the innovation over its alternatives; (2) the observability of the results; (3) the compatibility of the innovation with existing values, past experience, and perceived needs; (4) the complexity of the innovation; and (5) its "trialability," or the extent to which the innovation can be experimented with on a small-scale, low-risk basis.

Rogers' (1962) research can help explain why it has been difficult to implement data management actions, especially large-scale efforts, in many corporations. First, the relative advantage of most data management actions compared to current practice is not known. Also, in most organizations there have been few results to observe. Where results are available, it is extremely hard to separate and quantify the impact of data management from other related (or unrelated) actions.

As noted previously, a data-focused approach to systems is not compatible with the existing process-oriented focus, where the goal is to build individual systems to specification on time, rather than to create a data architecture to meet current and future needs. Certainly, data management involves a great deal of complexity as the walls between applications are torn down and the interrelationships between systems, functions, and organizational units are examined. Finally, very often data management actions have not been presented as testable, small-scale low-risk efforts. Instead, data resource management has been sold on the basis that a major financial investment and top-to-bottom commitment in the organization will be needed to achieve results.

Viewing data management as an innovation also helps to explain the successful efforts studied here. From Rogers' (1962) perspective, successful implementation of data management efforts is more likely for more limited approaches where the relative advantage is clearer, the impacts are more observable, and the complexity is lessened. In addition, limited approaches can be viewed as trials or experiments. When the first trial is successful, the organization will probably be ready for a more ambitious second trial and ultimately for significant investment in data management.

Conclusion

These exploratory case studies in 20 organizations suggest that there is no single clear-cut approach to improving the management of the data resource. A wide range of options exists that can be selected to fit the needs of a particular business. The appropriate planning process to use and the best "product" to deliver depend heavily on the particular business objective and organizational scope. However, in spite of this variety in approaches, there are seven important conclusions that can be drawn from this research.

Business benefits can result from improvements in data management. Many of the companies studied have realized significant benefits in their attempts to improve the management of data, as reported by their own evaluations. To highlight a few of the benefits mentioned in the case vignettes: Waverly Chemical attributes a reduction of 20 percent in spare parts inventory to the fact that its dozen plants now use a common system; Sierra Energy has reduced the amount of effort it takes to consolidate financial reports from a six person effort taking two weeks to four people taking four days; Consumer Publications has reduced costly errors caused by the manual transcription of data and has simplified the process of managing a promotional mailing; management at Crockett, using its new operational subject area databases and a special query system, is now able to get previously unavailable answers to wide-ranging ad hoc questions, such as the actual effects of price changes on quarterly revenues. For the most part, the companies that realized major benefits were motivated by specific business goals rather than by conceptual arguments for data resource management or a desire to improve general IS effectiveness.

Lack of data standardization is a key managerial problem today. A great portion of the data maintained by corporations today was originally designed to meet the needs of isolated applications, developed in dispersed or autonomous suborganizations. The resulting lack of data standardization is a major underlying problem with data, often making it difficult or impossible to share or interpret data across application system boundaries. In the study, most of the data-related problems encountered by business managers surfaced when they needed to combine data from several different functions or from several different organizational groups. Almost all of the suc-

cessful data management efforts involved at least some improvement in data standardization (i.e., common definitions and common codes), even if the improvements were to only a few key data elements, such as customer, product, or vendor IDs.

Total standardization is not the goal. Too great an emphasis on data standardization is a mistake. A detailed corporate-wide data model is probably premature in most companies today because of important hard-to-resolve differences in the way data is defined, stored, or used in different parts of the organization. These significant managerial and system differences are a major reason why strategic data planning approaches are so difficult to carry out. It is extremely costly to completely revamp three decades of embedded systems. Because of the expense, data standardization efforts should focus first on the obvious high payoff areas having a clear business impact. The question of whether, for example, standard customer or vendor indentifiers are appropriate targets depends entirely on the business situation. The end goal is not total standardization but only as much standardization as makes sense from a business point of view.

"80/20" processes are growing in importance in data planning. In some situations, it is possible to quickly target the key business impact areas. Where these areas are not apparent, 80/20 planning processes provide an attractive alternative to larger scale strategic data planning methodologies. These 80/20 approaches lead quickly to the next targets for action and can provide a rough interim data model as a starting point for guiding and coordinating various data management efforts. Although this research notes far more "targeted" planning efforts, it is believed that the advantages of 80/20 approaches will, and should, lead to their growing use in the next several years.

Information databases will remain the dominant product for the forseeable future. Operational subject databases are not the only appropriate "product" for data management efforts. An information database can provide a standardized source of managerial data drawn from non-standardized applications. Building information databases is usually less expensive and can be done much faster than rewriting the existing non-standardized applications. They can be developed using technology (e.g., relational databases and fourth generation languages) most appropriate for managerial use. In addition, information databases can provide a significant element of a de facto architecture for future development work.

Resource allocation must balance long-term and short-term considerations. Organizations wishing to address data problems face a resource allocation choice between improvements to infrastructure (or data standardization), development of specific new databases, and enhanced delivery of the existing data resource. While there is a tendency in American business to opt for the near term payoff (for example, addressing delivery or implementing information databases), the long term appears to favor judicious investments in data architecture infrastructures that will ensure greater data standardization.

A number of difficult organizational issues must be addressed. No matter which resource allocation choices are made, there are a number of organizational issues that must be addressed for successful implementation of data management efforts. The managerial predilection for short-term results, the centralizing tendency of data management, and the impact of data management on the IS culture, as well as on the responsibilities of line managers, all present issues that, if not managed well, will severely inhibit the effectiveness of data management efforts. Treating an initial foray into data management as a process of introducing innovation can help managers understand which efforts are practicable in their organizational environment.

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Appendix

An important question is whether the type of data management problems experienced or whether the most effective approaches differ from one industry group to another. Given only 20 companies and 31 data management efforts, it is impossible to give a definitive answer. However, the different industry groups have been compared using the dimensions of the framework. The table below, for example, shows the distribution of data management products for the four industry groups from Table 1.

"Product"

Industry	Operational SADBs	Common Systems	Information Databases	Access Services	Architectural Foundations
Financial Services	1	0	2	0	1
Manufacturing	3	0	5	3	2
Process	2	2	2	0	3
Other	1	0	2	1	1

With the possible exception of the process industry group, there are no clear differences among the groups. The process industry group had the only *new* common systems efforts and a higher incidence of efforts aimed at architectural foundations. These differences could easily be due to chance variations within the groups, to the the smallness of the sample, or might reflect special problems or concerns for that group. A similar analysis of the distribution of the three overall patterns by industry group (shown by the arrows in Figure 4) also shows no clear differences.