THE NATURE AND BEHAVIOR OF FINANCIAL VERSUS MANUFACTURING MANAGEMENT INFORMATION SYSTEMS

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ABSTRACT

Manufacturing management information systems are in a relatively less mature state than financial information systems. This difference in maturity is due in part, to historical reasons, and to the complex and dynamic nature of manufacturing system atttributes. This research compares the various system attributes belonging to manufacturing and financial information systems. Application of inappropriate system design techniques (based on these system attribute differences) has contributed to the relatively high failure rate of manufacturing management information systems. The research analyzes the need for the development of design tools geared specifically toward manufacturing management information systems.

1. Introduction

Historically, much of our systems resources have been devoted to the development and implementation of financial management information systems. These information systems have progressed from highly structured transactions processing systems(TPS) to less structured decision support systems. Manufacturing management information systems are currently at a less mature state than the financial systems (Wight, 1980).

* Manufacturing management information systems experience a relatively high failure rate, compared to financial information systems.

CIM breakdown and disruption has been noted in the industrial engineering literature. Breakdowns are attributed, in part, to the size of complexity of manufacturing systems (Scalpone, 1984).

* Historically, there has been an uneven allocation of systems development resources towards financial information system development, to the detriment of manufacturing systems.

The uneven allocation of systems development resources has been noted by Wight (1980), a founder of MRP (material requirements planning) concepts. MRP is one of the fundamental existing manufacturing management systems.

* As a result of the less mature state of manufacturing management systems, the marginal benefit of developing new successful manufacturing management systems should exceed that of new financial systems.

Research in manufacturing systems has called for the integration of

managerial and technological classes of manufacturing systems (to be described below) into broad based "computer integrated manufacturing systems (CIM)" (Harrington, 1973). Expectations are that CIM has strong profit potential (Ford et al., 1985). These expectations are based, in part, on the situation of manufacturing management systems being in a relatively immature state. Other existing manufacturing management systems e.g., OPT (Optimized Production Technology) have shown to be very beneficial (Bylinsky, 1983) as well as the successful part of MRP installations (Kamenetzky, 1985). These examples indicate that opportunity exists for the implementation of quality manufacturing information systems.

This paper describes the phenomenon of uneven allocation of systems development resources, and seeks to identify certain factors that have impeded the development of manufacturing management systems. The underlying hypotheses of this work are:

* Manufacturing management systems differ in their nature and behavior from financial systems.

* The manufacturing system environment is objectively different from the usual financial environment.

* A contributor to dismal management manufacturing information system performance may be the use of design tools developed in the financial system world, despite system and environmental differences.

Management information systems are typically divided (e.g., Davis and Olson, 1985, Chapter 1) into major functional subsystems (marketing, manufacturing, personnel, finance and accounting, etc.). Each subsystem

is unique in its procedures, programs, models, etc. Kaplan (1984b) explains that accounting and control systems "do not produce the key nonfinancial data required for effective and efficient operations" in a production environment.

Manufacturing systems convert labor, raw materials, and knowledge into output products or services (Buffa, 1983, Chapter 1). Manufacturing information systems are divided into two categories: technology oriented, and management oriented (Figure 1). A fairly high degree of attention has been paid to the technology side (e.g. CAD/CAM, robotics, etc.). However, the management side of manufacturing systems remains much less mature, relative to financial management systems.

As shown in Figure 1, there exist several types of manufacturing management systems. We will divide manufacturing systems into two main categories: project management systems (i.e. CPM, PERT), and resource management systems (mrp for resource management, scheduling, capacity planning, etc.).

This paper seeks to describe some of those factors that have inhibited the development of manufacturing information systems. The paper is based on a paradigm that development of manufacturing management systems is impeded by factors rendering these systems more "complex" than financial management systems. Section 2 presents a framework of system components for the comparison of different types of information systems. Section 3 examines the various differences between

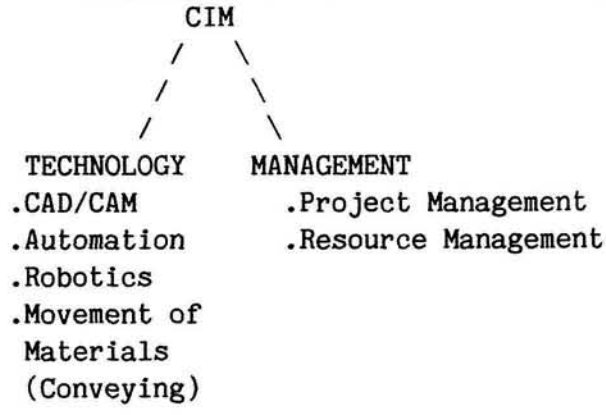

Figure 1: Classes of Manufacturing Systems

financial and manufacturing systems, in terms of the nature and behavior of their components. Section 4 discusses the implications of these differences on the traditional allocation of systems development resources, and its impact on manufacturing management information systems.

2. A Framework of Systems Components and Attributes

This section begins with some historical rationale for the uneven allocation of system resources. Factors that may account for the continued phenomenon follow.

2.1. Historical Factors

One reason for the emphasis on the development of financial systems to the detriment of manufacturing systems is historical in nature. The corporate controller, or accounting department, historically controlled the information systems resource. Therefore, it is natural to understand that accounting applications received priority.

Manufacturing systems were perceived as a "necessary but separate part of the organization" (Ford et al., 1985). Legislation requires timely reporting of financial information (employee withholding, SEC, IRS reports). Financial systems receive priority development and maintenance treatment since they have need for precise outputs (due to the clearcut impact of errors to financial information). It has been noted (Ein-Dor and Segev, 1982) that information systems departments are moving away from reporting to a financial authority, to becoming an autonomous organizational unit.

There is no doubt that historical issues have played into this emphasis of resources on financial systems. However, these historical reasons do not account for the continued lop sided allocation of resources. Information systems departments have matured, often becoming entities independent of the accounting departments. Recent trends find that managers regard management of the manufacturing side an integral part of the overall strategy for a successful organization (Ford, et al, 1985). The continued distorted allocation of resources may then, in part, be due to differences in the nature and behavior of financial versus manufacturing management information systems.

2.2. The Elements of a System

Churchman (1968) defines (among others) five major elements that comprise a system (environment, role, components, arrangement of components, and resources required to support the system). Our comparison of system types deals with the differences between components of financial and manufacturing management systems. Information systems can be broken down into five distinct components: hardware, software, data, people and procedures (Kroenke, 1984). Data runs through a system, and is transformed into useful output information (Figure 2).

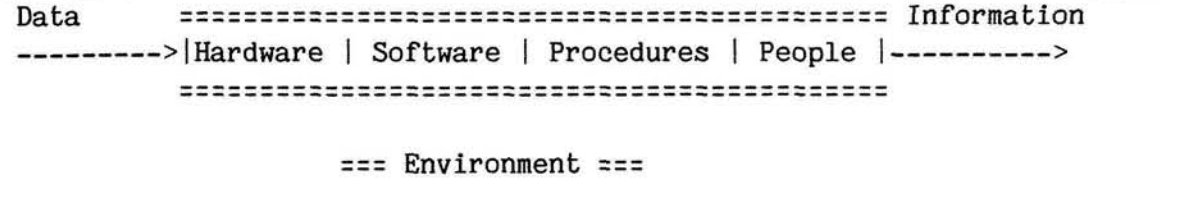

Figure 2: Components of an Information System

Each of these components of an information system has various attributes, whose nature and behavior may vary according to system type. A summary of some of these component attributes follows in Figure 3.

Other research, notably Davis (1974) defines system attributes of purpose, mode and format, redundancy, rate, frequency, deterministic/probabilistic, cost, value, reliability, and validity. Kleijnen (1980, Chapter 6) adds other attributes of privacy and security, user machine modes, flexibility and multiple users to this list.

DATA	-types -volume -lifespan -dynamic/static nature -origin -timeliness -criticality -cost
HARDWARE	-input/output media and communication
SOFTWARE	-static/dynamic nature -degree of process structure -existence of standards
PROCEDURES	-formal/informal -number -complexity
PEOPLE	-number of distinct user levels -degree of user heterogeneity
INFORMATION	-format -contents -timeliness -cost (Ahituv, 1980) -tangibleness of benefits
ENVIRONMENT	-adaptive/organic vrs. mechanistic -degree of uncertainty

Figure 3: Components and Attributes of an Information System

3. Financial versus Manufacturing Information Systems

This section follows the framework described in Figure 3. Financial and manufacturing management information systems are compared along these various parameters. Decision support systems differ from our perception of transactions processing and MIS systems (Sprague and Carlson, 1982). For that reason, much of our discussion pertains to the comparison of manufacturing management to financial management transactions processing and MIS systems. Occasional comparisons are made between manufacturing systems and financial decision support systems. Little research has been done regarding decision support

systems as they relate to manufacturing management (Nof and Gwrecki, 1980).

3.1. System Data

ATTRIBUTES /	FINANCIAL SYSTEMS	MANUFACTURING SYSTEMS
types of data	finite	many
volume per type of data	large	small
lifespan of data	long	short
nature of data	relatively static	relatively dynamic
timeliness of data	more frequent	less frequent

Figure 4: Comparison of Data Attributes

Figure 4 describes those data attributes that differ between manufacturing and financial systems. Note that for financial systems, we describe data characteristics that hold true for transactions processing and MIS type systems. We will note that the least complex manufacturing systems have many characteristics similar to the more complex financial systems (decision support). This is true of amount of data types, flexibility of system, volume of data, ill-defined process structure (Sprague and Carlson, 1982).

Figure 5 illustrates the difference between the main attributes of manufacturing and financial data. Data dynamics (changeability and timeliness of data) in manufacturing management systems is relatively

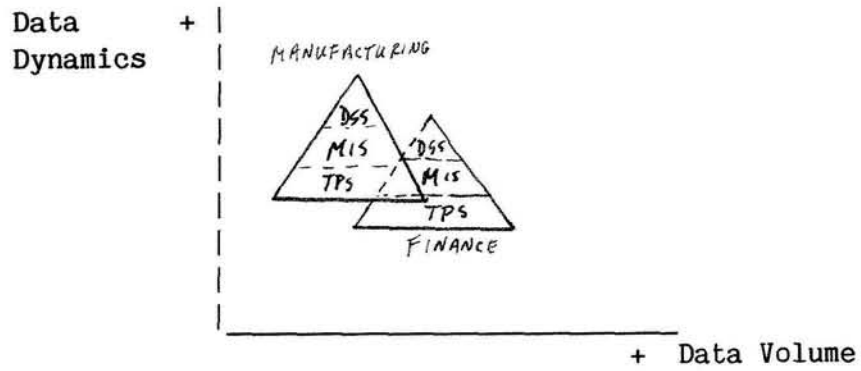

Figure 5: Financial Data versus Manufacturing Data

higher than that of financial systems. It seems that the data changeability of a TPS manufacturing system is as high as more complex financial systems (DSS etc.). However, the volume of data in each type of information system is higher in all types of financial systems.

A financial firm that adds a new product (e.g., a "new" IRA fund), generally follows a similar framework for the processing of information, management and clients reports, etc., relative to its existing product line. However, when a manufacturing firm adds new products (or even produces an existing product for a new client), it is typical to encounter a new framework for processing of information, management and client reports, etc. This framework may not resemble that of any previous situation.

High technology industries require many levels of assembly. These manufacturing systems utilize many processes. As such, a manufacturing management system will require a broad milieu of data. Manufacturing

systems require many types of data, each type generally in low volume. It has also been noted (Polus and Weill, 1985) that the detailed informational requirements of a manufacturing management system are not well defined. McLean et al. (1983), speaking about the "factory of the future", Flexible Manufacturing Systems (FMS), and robotics, indicate that in the future, manufacturing processes will be more complex. To accomodate this, manufacturing systems will need more types of data. Simple financial information systems (transactions processing) typically process limited types of data, each of which may have large volume. More complex financial systems (i.e. DSS) may have somewhat more types of data, with lesser volume.

As discussed, manufacturing data is considered highly dynamic. Manufacturing data will change in terms necessary types of data. This is influenced by the constant change in production requirements. According to Wight (1980), the only constant for manufacturing data is change. The least complex manufacturing systems (transactions processing) resemble the most complex financial systems (decision support) in regard to data types, volumes, and system flexibility.

The nature of the manufacturing world is towards a short time to market. Manufacturing often encounters changes to products, implying that data has a relatively short time until obsolescence. Financial and accounting systems take a conservative approach, as enforced by FASB reporting standards. This may be one of the reasons for relative long data lifespans for financial data. Auditability requires the

preservation of historical data. The issue is further discussed in Kaplan (1983 & 1984a & 1984b).

3.2. System Hardware

Financial and manufacturing information systems hardware differ primarily in terms of the variety of input/output devices that are needed. Manufacturing systems have special communication problems that are derived from the use of many input/output devices. Manufacturing systems receive data directly from other machinery (e.g., CAD/CAM) through optical readers, bar code readers, etc.. Machinery are often nominally incompatible, resulting in the need for complex interfaces.

3.3. Applications Software

Manufacturing applications are highly fluid. As has been discussed, a manufacturing system is subject to constant change. Modifications may be necessary with the introduction of new customers and new products. Financial applications are much more static (Kaplan, 1984a) than manufacturing applications. Once again we note resemblance between manufacturing systems and financial decision support systems.

It is commonplace for manufacturing software to maintain two distinct databases. One database services technological (engineering) data, the other services management data. The complexity of manufacturing systems has made the integration of these two genders of databases difficult. See Beely (1983) and Kutchner and Gorin (1983) for more details.

Few standards exist for manufacturing management software. Even standards for MRP (Orlicky, 1975) are far away from the well established standards for general ledger or financial reporting applications. A documented problem with MRP development has been the inability of data processing staff to deliver software before changes in business conditions made the specifications obsolete (Kamenetzky, 1985). The existence of relative few standards makes reliance on unaltered off-the-shelf software for manufacturing virtually impossible. Sepehri (1985) notes that there exists little or no manufacturing software packages for process, repetitive, or batch types of manufacturing. Manufacturing applications must be developed for ill-structure problems, adding to the complexity of manufacturing software development. Unlike financial decision support system development, manufacturing systems are not perceived as inexpensive "quick hit" systems. Hence, the creation of ill-structured manufacturing applications is time consuming, difficult, and financially risky.

3.4. System Procedures

Manual procedures relating to financial systems tend to be highly formalized (Kaplan, 1984a). Standard reasons include conservatism, need for auditability, dealing with highly liquid assets, etc. Manufacturing systems may lack formal procedures for many processes. As a result, there tends to be more reliance on informal procedures. This will be discussed further in describing "people" (below).

Number and complexity of procedures will be a consequence of

software complexity, data nature, and degree of procedure formality. Therefore, we would expect manufacturing management procedures to be relatively more numerous and complex than the financial system counterparts.

3.5. People

Manufacturing personnel exhibit informal behavior. The manufacturing manager is considerably less disciplined, and this tends to be the behavioral norm. The manufacturing manager's basic responsibility is the production of quality merchandise in a timely, cost efficient manner. Financial reporting that is associated with the production task is of secondary priority.

The major responsibility of a financial system is the generation of quality information in a timely, cost effective manner. Financial personnel, therefore, behave more formally than the manufacturing counterpart.

Manufacturing systems have more heterogeneous users than financial systems. A production process requires the interface of managers and engineers. These different user types may use "different languages", yet they must communicate information to each other. Financial systems relate to a more homogeneous pool of system users.

3.6. Information

	FINANCIAL SYSTEMS	MANUFACTURING SYSTEMS
FORMAT	relatively rigid	relatively flexible
CONTENTS	need for accuracy	more flexible accuracy requirements
INFORMATION BENEFITS	tangible	less tangible

Figure 6: Comparison of Financial versus Manufacturing Information

Manufacturing information is more complex than financial information. Manufacturing information will deal with many products. The systems' informational requirements may change rapidly. Financial systems have need for precision. These systems deal with the representation of highly liquid assets. Errors may have a material effect on the income statement. Manufacturing systems require accuracy. However, there is some slack for less than precise information.

Automation of financial systems may have fairly tangible expected systems benefits. For example, an automated financial system may reduce clerical staffing requirements. More timely information regarding cash position will result in more efficient investment of idle cash balances. Automation of manufacturing systems will have some tangible benefits, e.g. better inventory handling, however these benefits are difficult to predict at the onset of system development.

3.7. System Environment

Manufacturing systems deal in a rapidly changing environment. Manufacturing systems tend to be of the adaptive/organic nature. The system itself is very much influenced by the outside environment. Changes to the marketplace will result in quick production changes. Any production change will manifest itself on a manufacturing information system. Changes to the marketplace will occur in a fairly unpredictable nature. Financial systems tend to be more mechanistic. These systems are somewhat less influenced by the outside environment, and operate in a more stable, predictable system state.

4. Implications of System Differences on Systems Development

As we have seen in the previous section, manufacturing management systems generally have more dynamic input data, complex hardware, lack of problem structure or defined standards, informal procedures, user heterogeneity, and deal in a highly dynamic environment.

We observe at the onset, that development of manufacturing information systems is a risky venture. Since there is little standardization of production information requirements, software vendors are dissuaded from producing packaged manufacturing management software (Sepehri, 1985).

Since manufacturing management systems are large and expensive, conventional wisdom would employ structured design techniques for the creation of manufacturing systems. Structured design techniques are

considered inappropriate for the development of financial decision support systems (Sprague and Carlson, 1982), due to the dynamic nature of data, ill-structured problems, informal procedures, dynamic system state, etc. It appears that manufacturing management systems have many of the same characteristics that make structured design inappropriate for financial decision support systems.

The adoption of decision support system development methodologies would also be inappropriate for manufacturing system design, even for manufacturing transactions processing systems. Manufacturing systems are large and expensive. Decision support systems development methodologies adopt an iterative approach, not very useful for manufacturing management situations. Iterative design (Sprague and Carlson, 1982) is not highly regarded for large system development, since it adopts a "bottom-up" approach. It appears that a distinct approach to system design is necessary to accomodate these distinct manufacturing systems. The approach will need to be a hybrid of the two development paradigms (structured versus iterative design).

5. Conclusions

Manufacturing management information systems differ from financial management information systems in regard to system and environmental attributes. These attributes have dissuaded the development of manufacturing management systems in favor of the more structured, more stable financial information systems. This uneven allocation of system development resources has left manufacturing management systems in less

mature state of development than the financial systems. This gives an excellent opportunity from the cost/benefit point of view (Emery, 1974) to produce profitable manufacturing information systems. This is further evidenced by performance of successful MRP and OPT systems, and by the CIM literature. This research recognizes distinct differences between manufacturing and financial systems. It further recognizes that there lacks adequate system design tools for manufacturing management system development. This is a first step in the pursuit of a new, more even allocation of systems development resources to tap the potential of manufacturing management systems development.

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