AN EMPIRICAL FIELD STUDY OF THE ROLE OF COST ACCOUNTING
IN A COMPUTER-INTEGRATED MANUFACTURING ENVIRONMENT

by

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ABSTRACT

AN EMPIRICAL FIELD STUDY OF THE ROLE OF COST ACCOUNTING IN A COMPUTER-INTEGRATED MANUFACTURING ENVIRONMENT

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A field study was conducted to contrast the role of cost accounting different in four computer-integrated manufacturing (CIM) plants with four traditional (batch-oriented) manufacturing plants. Empirical data was gathered from on-site interviews with accountants, engineers and production personnel. Empirical findings were derived from interview transcripts and plant tour notes.

Four research hypotheses were investigated, one for each of four activities the comprise the defined role of cost accounting: cost identification, cost entry, cost assignment, and cost reporting. It was hypothesized that CIM plants would designate more (but smaller) cost centers, would group their cost accounts by class of resources (materials, workers, machinery and equipment, tooling, technology and information, and facilities), and would establish separate overhead pools for each class of resource.

The CIM sites were expected to choose different resource events as cost transaction triggers for cost entry. Cost assignment at CIM sites was expected to lead to sub-dividing of overhead pools and use of more specific allocation measures tailored for each class of resource. Cost reporting at CIM sites was expected to conform to a weekly reporting cycle, like that production, and generally focus on strategic manufacturing objectives (delivery reliability, production flexibility and consistent high quality). Fourteen related "hypothesis focus points"

were developed from background literature to aid the process of analyzing the empirical findings.

Three of the four hypotheses were weakly supported by study findings and one (cost entry) was not supported. Less contrast between CIM sites and traditional sites was observed then expected. However, the information obtained through analysis of the hypothesis focus points provided many useful insights into the role of cost accounting.

DEDICATION

EDWARD GOSSE
(1917 - 1952)

My father,
who has inspired me
far more than he could have imagined.

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CHAPTER I

INTRODUCTION

Prior to the mid-1970s, U.S. manufacturers competed successfully against manufacturers from other industrialized nations. Then global competition intensified. U.S. manufacturers began to lose market share of large volume products to foreign imports, including motor vehicles and components, electrical and electronic products, consumer appliances, wearing apparel, machine tools, and metal forming equipment [Scott and Lodge (1985)].[1] Initially, U.S. manufacturers responded to foreign competition by focusing their factories [Skinner (1974)], aligning their manufacturing processes with product characteristics [Miller (1981)], or by moving their production off-shore to nations with lower labor rates [Reich (1983, ch. VII)]. But eventually these strategies failed to stem the tide of foreign competition.

Then, U.S. manufacturers began to examine foreign competitors' strategies and practices, which led to changes in the organization and technology of manufacturing processes [Limprecht and Hayes (1982); Wheelwright (1981)]. Responding to foreign competition, U.S. manufacturers began to invest heavily in computer-aided technology used for engineering design, production scheduling and computer-aided machinery. Manufacturers used computer-aided technology to integrate manufacturing processes to a greater extent than typically possible in traditional manufacturing [Gunn (1982)]. This combination of computer-aided technology and integrated manufacturing processes, or "computer-integrated

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[1]For a specific analysis of U.S. manufacturers decline in market share of manufactured products during the 1970s, see Ketterling (1984); other sources include Abegglen (1983), Fallows (1980), Hayes and Abernathy (1980), Hayes and Wheelwright (1984).

manufacturing" (CIM), has changed the context in which cost accounting operates.

This study will look at the contrast between two types of manufacturing: traditional and CIM. "Traditional manufacturing" is defined as batch-oriented production that focuses on economies of scale and is organized around process traits [Reeves and Turner (1972)]. "CIM" is defined as computer-aided production, with integrated processes, designed and operated to achieve economies of "scope" with the cost efficiencies of economies of scale [Goldhar and Jelinek (1985, 1986)]. Both traditional manufacturing and CIM are defined in greater detail in Chapter II.

CIM is organized and managed differently than traditional manufacturing because the manufacturing strategies and process characteristics are different. In traditional manufacturing, products are generally standardized, efficient production lot sizes are large, product life cycles are long, and production technology is stable [Buffa (1984)]. In CIM, manufacturing processes are more integrated and more flexible, products have more variety, efficient lot sizes are smaller, product life cycles are shorter, and technology changes are more frequent [Goldhar and Jelinek (1983); Gunn (1982)]. CIM enables manufacturers to respond quickly to changing market demands and yet attain high levels of quality and delivery reliability [Buffa (1984)].

CIM also changes the nature and patterns of cost incurrence, which has an important bearing on the role of cost accounting. Most contemporary cost accounting concepts and practices are based on an implicit model of traditional batch-oriented manufacturing that may not correspond with the characteristics of the CIM environment [Kaplan (1984b)]. Recent literature suggests that traditional cost accounting systems may no longer be adequate for managing costs. For example, a recent Fortune article says "most companies are working with flawed estimates of what it costs to make their products" [Worthy (1987, p. 43)].[2]

RESEARCH PURPOSE

This research explores four activities that comprise the role of cost accounting: cost identification, cost entry, cost assignment and cost reporting. The purpose is to investigate changes in these activities when CIM is introduced. The research question is:

> **How does the integration of manufacturing processes and the application of computer-aided technology affect the role of cost accounting in cost management systems?**

This question is investigated with four research hypotheses, one for each cost accounting activity. The role of cost accounting and the related hypotheses are specified in the next section. CIM is defined for purposes of the study in a later section of the chapter. The research context is described in greater detail in Chapter II.

THE ROLE OF COST ACCOUNTING

Cost accounting identifies, measures, assigns, and reports costs to managers so the managers can be cost effective in their use of resources

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[2]For examples of recent literature concerning cost accounting systems in CIM environments, see Johnson and Kaplan (1987), Johnson (1987), Kaplan (1983, 1984a, 1984b and 1985a), Dilts and Russell (1985), Johannson (1984 and 1985), Miller and Vollmann (1985), N.A.A. (1986), Seed (1984) and Wingard (1985).

to achieve manufacturing objectives. The basis of cost measurement is a "resource event," which is an instance where an "expendable" resource is consumed or a "durable" resource is used. A "cost" is the result of the consumption or use of resources for the production of other resources, or for support of such production. "Waste" involves the consumption or use of resources but, unlike "cost," does not produce other resources nor support production and does not maintain, support or enhance product value.

"Cost management" is a strategic manufacturing objective. To manage costs is to use cost data in making decisions that involve the consumption or use of resources and thereby control the costs that result. Cost accounting's "role" is to provide cost data for purposes of cost management; this role is comprised of four activities: **cost identification, cost entry, cost assignment** and **cost reporting.**

Cost Identification

Cost accounting begins by identifying costs as resources consumed or used. Since individual managers are accountable for resources provided to them and for the costs that result from resource events, cost identification also includes determination of manager accountability. "Cost identification" is the process of recognizing and classifying costs based on the nature of resources consumed or used and on the specific management responsibility for the resource consuming or using event. Cost identification includes: (1) establishing cost accounts, (2) designating cost centers, and (3) determining levels of management responsibility for costs.

Cost recognition involves certain fundamental definitions. "Resources" are materials, workers, machinery and equipment, tooling, technology and information, and facilities consumed or used in production or to support production. Cost accounts may be grouped by class of resource to reflect the nature of resource events that result in costs. To "consume" a resource is to use it entirely as a discrete event (e.g. to use an expendable fastener or apply lubricants). To "use" a resource is to consume it in a gradual series of events (e.g. repeated applications of a fixture, mold, or die). "Direct" costs follow from outright conversion of input resources to output resources; "indirect" costs involve supportive resource events that precede or follow direct conversion.

Costs are recognized where resource events are measurable and assignable to responsible resource managers, and costs are classified so they can eventually be assigned and reported according to cost objectives. Effective cost identification requires a logical, natural classification scheme with appropriate names for accounts, logical account groupings, correct definition of cost centers, and other means of bounding cost responsibility. All of these are determined by "cost objectives" -- purposes for which costs are reported, or end uses of cost data.

The term "boundaries of cost responsibility" broadly describes cost responsibility recognition, cost account specification, and cost classification. Cost centers are established for collections of resources managed by individual managers. Classification includes a determination of levels of cost responsibility. High level managers are responsible for some costs, such as production planning and control, while lower level managers are responsible for other costs, such as repairs or rework.

CIM changes traditional patterns of resource events, which implies changes in (1) how cost responsibility is recognized, (2) the names used for cost accounts, and (3) how accounts are grouped for cost assignment and reporting. Cost centers may be expected to be redesignated and accounts regrouped. CIM production processes are organized according to product traits, while traditional manufacturing organizes resources according to process traits [Goldhar and Jelinek (1983)]. Large specialized process departments of traditional manufacturing are likely to be replaced in CIM with smaller, product-focused process areas, called cells [Groover and Zimmers (1984)]. Therefore, cost centers in CIM plants are likely to be smaller in size (floor space occupied) but more numerous than in traditional manufacturing. Cost centers will be smaller in size because product-focused resource clusters occupy less square footage of floor space than traditional larger specialized process areas. Smaller cost centers are needed so that the costs and activities within the cost centers are reasonably homogeneous.

Traditional cost accounting systems classify production costs as either materials, labor, or overhead. Manufacturing processes in CIM are more dependent on computer-aided technology, more integrated, and generate significant resource support costs. Traditional cost classifications as materials, labor, and overhead do not adequately define the resource set used in CIM. Accordingly, resource classifications in CIM may be divided into more groupings, such as materials, workers, machinery and equipment, tooling, technology and information, and facilities. As discussed subsequently under cost assignment, CIM provides the opportunity to match support costs with related resources and assign combined resource and resource support costs to cost objectives. Cost identification in CIM requires, therefore, that accounts be grouped by class of resource.

Based on theory developed in later chapters, the "Cost Identification" hypothesis is:

Hypothesis 1: Compared with the traditional setting, CIM will lead to a greater number of cost centers, which will be smaller in size. In addition, classification and groupings of accounts will be based on a wider set of resource groups than materials, labor and overhead.

The "Cost Identification" study area investigates this hypothesis.

Cost Entry

Certain resource events are selected as cost transactions for collection and entry of costs into accounting data files. Resource events are selected to provide objective, reliable measurements and satisfy cost objectives. The resource events that are selected for cost transactions are "cost transaction triggers."

CIM's resource events are likely to be different than those of traditional manufacturing. CIM has a variety of potential trigger events, including entry and exit events, time-oriented events, and events that affirm conformance to specifications. While many of these events also occur in traditional manufacturing, they can be measured more precisely in the data-rich CIM environment. The CIM data collection systems can be expected to take advantage of these and choose different transaction triggers, thereby making cost accounting systems a more integral part of the production management data collection system. The "Cost Entry" hypothesis is:

Hypothesis 2: The events critical to effective CIM production management are different than the events that "trigger" cost accounting data in traditional costing systems. Therefore, cost transaction triggers in CIM will be greater in number and diversity than those of the traditional setting.

The "Cost Entry" study area investigates this hypothesis.

Cost Assignment

When entered as transactions, costs are initially recorded in cost center accounts. Later, based on cost objectives, costs are assigned to products, activities, or functions. Two main purposes for cost assignment are to: (1) to match resource support costs with related resources and (2) to assign the total costs of resources consumed and used to production output.[3]

Some costs are easy to assign because they are easily identified with products or processes, such as materials or parts requisitioned. Assigning indirect support costs can be difficult if the costs cannot easily be related to products or processes (such as automated materials handling costs). CIM involves significant support costs such as maintenance, logistics and other information, and technology-oriented kinds

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[3]Indirect production support costs are described in more detail in Chapters II and III. Support costs make up a substantial portion of overhead costs in CIM plants.

of production support [Cooper and Kaplan (1988); Miller and Vollmann (1985); Porter (1985 p. 67)].

Traditionally, direct labor has been used as the assignment factor for production support costs. However, the direct labor to overhead relationship is weaker in CIM because the set of resources in use is broader with greater use of non-labor, technological resources. Given the magnitude of non-material and non-labor costs as a proportion of total production costs, the cost assignment research hypothesis focuses on costs that have traditionally been pooled into the broad definition of overhead.

Materials and labor are the only two classes of resources classified as direct costs in traditional cost account groupings. Overhead pools, as traditionally classified, contain three kinds of costs: some direct production costs, many production support costs, and many facilities capacity costs. Since production support costs are substantial in CIM, cost management requires that support costs be assigned to the related class of resources supported (materials support assigned to materials resources, workers support to workers resources, etc.).[4] To accomplish this, support costs in overhead pools can be reclassified into "resource support" pools for each class of resource. Support costs can then be assigned to cost objectives based on factors that relate support costs with resources supported.

Combining two purposes of cost assignment, the "Cost Assignment" hypothesis is:

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[4]Figure 3 in Chapter II illustrates the patterns of cost assignment that exist when support costs are assigned by class of resources supported.

Hypothesis 3: Cost assignment in CIM will be changed by explicitly relating support costs with resource costs and assigning both types of cost to cost objectives by class of resource, using relevant cost assignment factors. This is contrasted with traditional manufacturing where all overhead costs are typically assigned based on direct labor or some other single factor.

This hypothesis is investigated in the "Cost Assignment" study area.

Cost Reporting

The final stage in cost accounting activities is to report costs, either in formal reports or by making cost data accessible by inquiry. Reporting requirements are derived from a variety of cost management needs, including strategic business management, production planning, manufacturing management, inventory determination, and financial reporting. Cost objectives are derived from such various reporting requirements.

Reporting requirements are dictated in part by strategic manufacturing objectives. While traditional manufacturing emphasizes production efficiency and resource utilization [Reeves and Turner (1972)], CIM's strategic manufacturing objectives are delivery reliability, quality assurance, production flexibility, and cost management [Buffa (1984)].[5]

The differences in emphasis of CIM's strategic manufacturing objectives affect cost reporting in several ways:

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[5]Strategic manufacturing objectives are explained in greater detail in Chapter II.

- Cost data are used by resource managers more frequently in CIM and, therefore, cost data are processed more frequently. CIM operates in a fairly short time frame; many plans or actions are carried out within a daily or weekly time horizon. A monthly time frame is more typical in traditional manufacturing.

- Due to inter-dependencies of integrated processes in CIM, costs are monitored at a more comprehensive, aggregate level. In traditional manufacturing, efficiency and cost effectiveness are monitored primarily at departmental levels.

- CIM has a greater emphasis on cost management versus financial reporting. Cost reporting in CIM focuses primarily on strategic manufacturing objectives and secondarily on product costing for financial reporting, the opposite of traditional manufacturing.

- Like cost entry, CIM cost reporting systems are likely to be an integral part of production data collection and reporting systems.

- Cost reporting in CIM is driven more by comparison with plans and future decisions than by past history, whereas traditional costing tends to focus on comparisons with the past.

For all these reasons, cost reporting is expected to be different in CIM in terms of the form, format and frequency with which cost data are made available. Accordingly, the "Cost Reporting" hypothesis is:

Hypothesis 4: In the CIM setting, accounting information will be updated more frequently, "real-time" query form of reporting will occur more frequently, and the focus of periodic accounting reports will be on strategic manufacturing objectives versus the financial product costing objectives of the traditional setting.

This hypothesis is investigated in the "Cost Reporting" study area.

Having described the role of cost accounting in connection with the research hypotheses, the terms "CIM" and "integrated processes" are now described in greater detail.

COMPUTER-INTEGRATED MANUFACTURING -- "CIM"

Throughout the study, computer-integrated manufacturing (CIM) is defined as computer-aided technology applied to coordinated, interdependent manufacturing processes. Literature defines "CIM" with a broader technical connotation. For example, Stover (1984, pp. 171-72) defines CIM as "a total process flow using computerized systems working with database management programs involving resource planning, engineering, quality control, flexible machining centers and materials handling systems." Groover and Zimmers (1984, pp. 441-42) define CIM as "a complete integration of numeric control machines and robotics equipment with engineered process control, coordinated by computer driven materials handling and process inspection systems." Goldhar and Jelinek (1985) describe CIM as "a combination of hardware, software, database management and communications technology for flexible automation."

Descriptions of CIM in the literature emphasize both its technology and its integrative scope. CIM is more than state-of-the-art computer driven technology. It is the combination of advanced technology with comprehensive integration that makes CIM a radical change from traditional manufacturing [Ettlie (1988)]. CIM may be placed in perspective by considering a continuum of automation. At one end is fixed (dedicated) automation; in the middle is flexible automated machinery in non-integrated, stand-alone configurations (sometimes described as "islands of automation"); and at the other end of the continuum is CIM, integrated processes using flexible automation [Groover and Zimmers (1984)]. CIM links materials handling, engineering systems, production scheduling information, and integrated flexible process centers. CIM's scope of integration includes: (1) business control systems with the production processes, (2) engineering design with manufacturing, and (3) the entire set of linkages between suppliers, production and key customers [Ettlie (1988, p. 11)].

Very few U.S. manufacturers fit the technical description of CIM of the preceding paragraphs. Most "CIM" companies are in a transition from traditional manufacturing to CIM and do not have complete CIM systems in place, but have systems with various attributes of CIM. Therefore, for practical purposes for the study, CIM is defined in a more limited way as "the combination of computer-aided technology and integrated manufacturing processes." This definition seems consistent with the emphasis in the literature.

Complementing this definition are certain CIM attributes that were considered in selecting the field research sites. These are described in Chapter IV (and listed there in Table 8):

- Use of Materials Requirements Planning (MRP) in planning resource requirements
- Use of manufacturing cells
- Presence of "pull-through" control of production flow[6]
- Adoption of specific procedures to reduce set-up times
- Use of computer-aided design (CAD) and computer-aided machinery (CAM) and robotics equipment.

These attributes are consistent with the definition of CIM as computer-aided technology combined with integrated manufacturing processes.

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[6]"Pull-through" control of production flow is usually associated with a "just-in-time" (JIT) philosophy of delivering materials or inventory requirements just when required only in the quantities required. See Hall (1983) for further elaboration.

The definition of "integration" as used in the study is of more limited scope than that described in the literature. Integration as described in the literature includes (1) detailed data linkages between engineering design of components and products with specification of machine processes, (2) planning and operational linkages between production and the total manufacturing data base system, and (3) functional linkages between purchasing, production and marketing [Gunn (1982); Vollmann, Berry and Whybark (1984)]. However, "integration" in the study is defined as and limited to linkages among manufacturing processes among manufacturing cells (product-focused clusters of flexible automation equipment) and within manufacturing cells.

As explained by a production engineer at one of the field visit sites, CIM technology and information has made it possible to operate flexible processes together, like a "symphony" of integrated resources rather than a "cacophony" of stand-alone dedicated process areas. Compared with other kinds of integration, the integration of manufacturing processes affects traditional patterns of cost incurrence and seems most relevant for the study.

CONTRIBUTION OF THE STUDY

The comparisons between traditional manufacturing and CIM provided by this study will help accountants and management assess the impact of introducing CIM into a traditional manufacturing environment. Accountants have limited experience in assessing the impact of introducing CIM into a traditional manufacturing environment. The results of the study will suggest areas where research is warranted involving detailed modeling and experimental discovery. Since the study findings are obtained from the context in which accounting is actually operating, the findings should help authenticate the theoretical basis of future research on the topic [Hopwood (1983)].

LIMITS OF THE STUDY

This is an exploratory study that deals with an emerging issue. In general, CIM firms are in the early stages of reorganizing their production activities and developing their cost management systems. Revisions to cost accounting systems in CIM are still under development. Not many CIM firms exist for extensive comparison with traditional manufacturing firms. Therefore, the study necessarily is drawn from a small set of firms whose revisions of their cost accounting systems are not well developed nor tested. The findings of the study reflect a process of change that is still in transition. Similar research carried out at another set of selected firms may not yield the same results obtained in this study.

CONTENT OF OTHER CHAPTERS

Chapter II establishes the context of the research problem by contrasting CIM with traditional manufacturing. Chapter II also explains certain definitions and logical linkages to provide structure for the other chapters. Chapter III examines relevant background literature, summarizes theoretical concepts, and specifies the study hypotheses. In Chapter IV, the research design is specified, which is a field study involving visits to four traditional and four CIM manufacturing plants. Chapter V analyzes the findings derived from empirical data gathered during visits to the field sites. Conclusions are summarized in two tables at the end of Chapter V. Results of the study and implications for further research are discussed in Chapter VI.

CHAPTER II

RESEARCH CONTEXT

The purposes of this chapter are to describe the context of the research and to define certain terms and logical relationships used in later chapters. The chapter begins by comparing CIM with traditional manufacturing and describes the impact of CIM on cost objectives and cost accounting activities. After making these comparisons, the chapter then defines various terms and logical linkages for use throughout the study.

MANUFACTURING: A MATTER OF RESOURCE MANAGEMENT

To manage manufacturing activities is essentially a matter of **managing resources**: materials, workers, machinery and equipment, tooling, technology and information, and facilities. These resources provide the capacity to convert procured inputs into saleable outputs. Between procurement of convertible resources and delivery of marketable products is a complex set of activities and technology that creates competitive advantage for a firm. Four resource management objectives are stressed in CIM literature: **responsive flexibility, quality by design, delivery reliability,** and **cost management** [Buffa (1984)].

Responsive Flexibility

Prior to CIM, changing production conditions usually meant losing efficiency. Two patterns of competitive innovation, described by Abernathy (1976 and 1978) as "fluid" and "specific," are typically found in traditional manufacturing. The **fluid** state is the initial one, where products with novel performance features are offered to customers. Costs and sales prices are both relatively high in this state. As unit prices are subsequently pushed down, the fluid state evolves to a specific state of well-developed, standardized products [Abernathy (1978)].

Goldhar and Jelinek (1983) use the terms "economies of scope" and "economies of scale" to describe the motive for the fluid and specific states, respectively. Because of enhanced flexibility, manufacturers can use advanced CIM technology to gain competitive advantage from both economies of scope and scale. "Flexibility" is defined as the capability of changing production output design or quantity in response to changes in market demand [Cohen and Zysman (1987, p. 131)]. Firms can use CIM technology to introduce new product designs quickly and effectively because costs of engineering design, testing and production inefficiencies during early stages of the product's life cycle are reduced [Gunn (1982)].

According to Cohen and Zysman (1987, ch. 9), flexibility in the CIM environment includes both "static" and "dynamic" flexibility. "Static" flexibility refers to near-term ability to change operations, whereas "dynamic" flexibility is the ability to respond steadily to changing technology by improving production processes and innovating product designs [Cohen and Zysman (1987, p. 131)].

Dynamic flexibility appears to be more cost effective in CIM than it has been in traditional manufacturing. According to Abernathy (1978), traditional manufacturers operate with a relatively low level of static flexibility, using standardized production processes in order to push down unit costs. Without standardization, manufacturing processes were too inefficient and costly [Abernathy (1978)]. Traditional manufacturers specify the engineering of their machine processes and workers' tasks carefully and introduce engineering changes cautiously and infrequently.

According to Kusiak (1985), CIM can provide "systems flexibility," enabling a firm to manufacture a variety of parts cost effectively, handle a variety of materials flow configurations, adapt its data systems to changing specifications, and organize its activities to accommodate near-term and longer-term changes responsively. The term "flexibility" is broad, encompassing systems for manufacturing, materials handling, and data base information, as well as organizational responsiveness.

Quality by Design

CIM technology permits consistent control of machine processes, which removes a significant amount of human error from manufacturing processes and improves the level of quality achieved [Goldhar and Jelinek (1983)]. Computer-aided technology helps to link product design with production processes, to set up processes correctly, and to detect when processes begin failing to meet process tolerances. Quality is "designed into" production processes rather than relying on "inspecting out" quality defects [Sasaki and Hutchins (1984)].

In traditional manufacturing, quality is typically controlled by inspecting production samples according to acceptable levels of quality failures defined by policy. In CIM, however, sources of quality failures are identified and eradicated rather than accepted [Sasaki and

Hutchins (1984)]. Quality failures arise in production when human effort lacks precision or when damage occurs as parts are packed, moved and unpacked. Integrated computer-aided processes help on both counts. Computer-aided processes are less dependent on imprecise human intervention, and less buffer work in process inventory is required between stages of production. Indeed, because advanced technology makes it feasible to have consistently high quality production, quality by design has become a source of competitive advantage.

Delivery Reliability

Delivery reliability is a vital manufacturing objective. Manufacturers' customers demand delivery on time and in sequence so they can meet their own customers' delivery commitments. Managers want to retain flexible capabilities in the plant, produce to very high quality standards, and yet, at the same time, supply product output precisely when needed. Delivery is reliable because production flow is controlled as it is **pulled** through process areas, rather than **pushed** through production to meet scheduled requirements. With "pull-through" control, new production of fabricated materials and components replenish consumed production in manufacturing process areas that feed other assembly.

By contrast, traditional plants generally "push-through" production by releasing work orders based on anticipated production output requirements. Managers forecast future requirements with the aid of scheduled production plans, inventory status records and Materials Requirements

Planning (MRP) systems.[7] Orders for finished goods are filled from open warehouse stock or back-logged for short periods until final assembly is completed.

Cost Management

Cost management is a pervasive, underlying manufacturing objective that supports the other objectives. Traditional cost accounting measures are generally viewed as accounting tools, used primarily to determine product costs and secondarily to monitor cost control. In CIM, however, cost control takes on the broader perspective of cost management and is the primary, not the secondary, objective. Managing costs is a broader task than controlling costs. CIM firms compete with reliable delivery of high-quality products, produced with responsive engineering design and flexible processes. In addition to achieving all of these objectives, they must manage costs. Firms that fail to manage costs may be at a serious competitive disadvantage [Cohen and Zysman (1987)].

Traditional manufacturers control costs by focusing on two primary production objectives: efficient production and capacity utilization. Materials efficiency is managed through scheduling and effective engineering; labor efficiency is managed with close supervision and cost accounting variance measures. In CIM, continued emphasis on cost measures that emphasize efficiency and utilization will not produce adequate

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[7]"MRP" is defined in the APICS dictionary as "a set of techniques which use bills of material, inventory data, and a master production schedule to calculate requirements for materials" [Wallace and Dougherty (1987, p. 18)]. See Orlicky (1975) for a detailed explanation of MRP.

information for cost management purposes. Efficiency and utilization alone do not address CIM management objectives. In fact, some writers have criticized traditional cost accounting for being too oriented to labor-based measures of efficiency and utilization, saying these measures are not consistent with CIM's manufacturing objectives [Johannson (1984); Kaplan (1983); Wingard (1985)]. Since CIM's broad set of resources operate in an environment of integrated information and technology, labor-oriented efficiency and utilization measures do not adequately capture cost implications of resource events.

The Cost Management Challenge

Reliability, quality, and flexibility have become the key strategic in CIM, ranking ahead of key traditional manufacturing objectives of stability, efficiency and utilization. Not that it is no longer important to stabilize the production environment, or use resources efficiently, or use available capacity -- it is a matter of strategic ranking of importance. The way to strategic, competitive success is to deliver high-quality products while having the capability to change quickly as the demands of the market change. The cost accounting challenge is to adapt in ways that support cost management objectives. Strategic manufacturing objectives create greater demand for cost management data than traditional cost systems have been accustomed to providing.

CONTRASTING TRADITIONAL MANUFACTURING AND CIM

In general, CIM changes resource management decisions from **reactive** to **proactive** by providing managers the capacity to deal with complexity with reduced uncertainty. Table 1 compares CIM objectives with those of traditional manufacturing.

TABLE 1

COMPARISON OF MANUFACTURING OBJECTIVES

Objectives of the CIM Setting	*Objectives of the Traditional Setting*
Responsive flexibility: With integrated, coordinated processes, production can accommodate variety in quantity and mix. New product designs are introduced quickly and efficiently. Firms can respond effectively to short-term changes in market demand. Economies of scope outweigh economies of scale.	**Stability:** Economies of scale are the key to cost competitiveness, with reliance on stabilized production to drive costs down precludes much variety in product designs. Processes are sequential and not well linked. Engineering design changes are introduced cautiously and infrequently.
Quality by design: Computer-aided processes are precise without depending on human skills. Quality is "designed into" production processes rather than depending on "inspecting out" quality failures. Prevention of quality failure is the key.	**Quality by inspection:** Quality is typically controlled by sampling and inspecting production according to acceptable levels of quality failures defined by policy. Detection of quality failure is the key.
Delivery reliability: Delivery reliability is a competitive objective. Final assembly is scheduled with very high reliability; other production is "pulled through" process areas to supply final assembly.	**Scheduling of released production:** Production of complex, assembled products are planned with Materials Requirements Planning (MRP) systems. Scheduling focuses on release of work to the shop floor. Production is subject to "push through" control.
Cost management: Costs of CIM's variety of conversion resources, including technology and information, are managed rather than merely controlled. Cost management systems focus on manufacturing objectives of flexibility, quality, and delivery reliability, and measure events involving all cost drivers, including technology and information. The aim is to minimize integrated production costs at the <u>macro</u> level.	**Cost control:** Traditional manufacturers provide information on cost control, focusing on two production objectives: efficiency in the use of materials and labor, and utilization of labor and machine capacity. Cost minimization is aimed at the <u>micro</u> level.

The contrasts between CIM and traditional manufacturing relate mostly to the additional capabilities that computer-aided technology can provide and improved linkages between highly integrated processes. Because of the power of technology and information in CIM, certain long-time assumptions -- such as the need for a high degree of stability, buffer inventories, and a cost-effective quality failure rate -- are replaced by others more suitable. The new assumptions have important implications for cost accounting activities.

IMPLICATIONS FOR COST ACCOUNTING ACTIVITIES

Flexible production, with consistent high quality, inventory minimization, and pull-through production control -- these are dramatic changes in the cost accounting's implicit model of manufacturing activities. Failure to adapt cost accounting systems to reflect a different manufacturing model may inhibit managers' efforts to manage costs in CIM environments. For example, managers may not be able to determine the potential impact of cost reductions on total product costs, or engineers may not be able estimate accurately the effects of proposed engineering changes.

Changes in cost accounting systems are not made easily. Cost accounting measures are relied upon to provide data for financial statement reporting. Two legitimate concerns are that a transaction audit trail be maintained and that transactions be recorded consistently between financial reporting periods. These concerns explain a degree of reluctance to change cost accounting practices. CIM's organizational and technological characteristics suggest changes in cost accounting activities, including revised cost classifications for identifying costs (groupings of accounts according to resources and redesignation of cost centers), changed data collection techniques, revised assignment of resource support costs, and changed ways of reporting cost data.

Revised Categorization for Identification of Costs

Categorization includes specifying names of accounts, grouping of accounts for cost assignment purposes, and designating boundaries of cost centers. While specifying names of accounts is a matter that depends on each particular firm, classification schema presumably will change to better reflect the kinds of resources used in CIM.

Groupings of accounts by resources. A traditional practice has been to group costs into two "direct" classifications (direct materials and direct labor) and an "indirect" classification (overhead). Materials and labor have been considered "direct" costs because materials quantities and labor hours can be identified with units of output. In addition to materials and labor, other resources are used in production, such as machinery and equipment, tooling, and facilities. Since in traditional manufacturing these resources cannot easily be identified with units of output, the costs are classified as overhead and allocated to cost objectives, usually in proportion to direct labor. In effect, direct labor is used as a surrogate for costs of other resources.

Direct labor is not a satisfactory surrogate for technological resources in CIM. Compared with traditional manufacturing, a smaller proportion of total labor is direct. CIM workers handle a variety of duties and work in teams rather than as individuals. Their time is not concentrated on specialized, narrowly defined tasks. Therefore, since output cannot be associated with individual workers, much of their time is classified as indirect labor. With more labor being classified as indirect and with increased costs of technology recorded in overhead, a higher amount of overhead is applied with a reduced amount of direct labor.

In addition, direct labor is a less appropriate surrogate for costs of non-labor resources because the cost incurrence patterns of the other resources are poorly reflected by the cost incurrence pattern of direct labor. Relying on direct labor to assign costs of technological resources can have the effect of obscuring the transaction events that drive the costs [Cooper and Kaplan (1988)]. But the traditional approach is to pool costs of technological resources and redistribute them to cost objectives based on direct labor. If this is no longer appropriate, what is the alternative?

The alternative is to expand the set of resources identified as direct resources and to group remaining indirect costs into more homogeneous pools. Traditional cost systems identify materials and labor as the only direct resources, with all others being considered "overhead." Replace these classifications in CIM with a wider set of resource classifications. Based on observations made in the field during this study, a recommended set of resource classes is: materials, workers, machinery and equipment, tooling, technology and information, and facilities.[8] Other classification sets can be suggested, but this particular set

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[8]These classifications may help to resolve problems of cost distortions arising in "two-stage" allocations of overhead costs as described in Johnson and Kaplan (1987, ch. 8), and in Cooper and Kaplan (1988).

seems consistent with the field research observations and will be used in the study as a common reference point. Each of these classes of resources have separate instances of use, are more or less documented separately in transactions, and are controlled separately. These resource classifications can be adopted in cost accounting systems in place of the traditional classifications of direct materials, direct labor, and overhead. Direct costs can be assigned from each resource class to cost objectives (products, cells or cost centers) based on appropriate measures of "cost driver" events that require the consumption or use of the resources.[9]

Overhead costs in CIM plants include not only technological resource costs but also substantial costs of supporting resources, which can be classified by class of resource. An overhead cost pool can be sub-divided into separate pools of support costs for each class of resource. These support pools can be assigned to direct resource cost groups based on resource transaction factors, such as those suggested in Miller and Vollmann (1985). Then the combined costs of resources and support can be assigned to cost objectives with more authentic reflection of cost drivers than possible with traditional resource account groupings.

Table 2 compares account groupings for CIM resource costs and related support costs pools with traditional cost accounting groupings.

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[9]See Porter (1985), chapter 3 for additional discussion about cost drivers reflected by transactions.

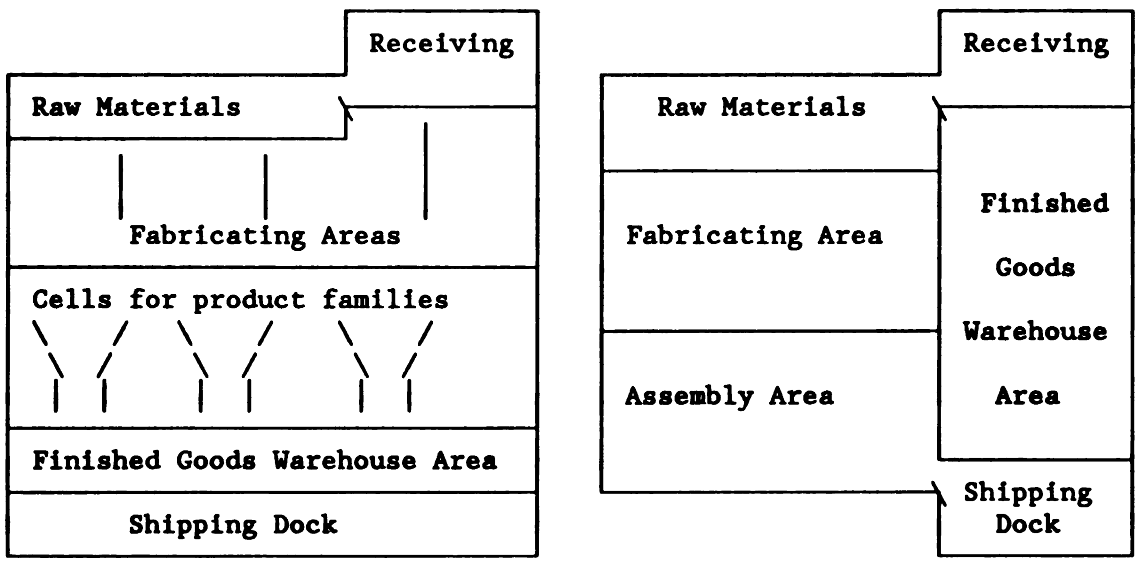
TABLE 2

COMPARISON OF RESOURCE ACCOUNT GROUPINGS

RESOURCE ACCOUNT GROUPINGS IN CIM		TRADITIONAL GROUPINGS
Resource Groups	*Resource Support*	*Resources and Costs*
Materials Direct materials	**Materials Support** Indirect materials Materials handling Stockroom costs	**Materials** Direct materials
Workers Direct labor	**Workers support** Indirect labor Supervision Employee benefits Training	**Workers** Direct labor
Machinery and Equip. Depreciation Operating costs	**Mach. & Equip. Support** Repair and Maint. Set-ups	**Manufacturing Overhead** Indirect materials and materials support Indirect labor and workers support Machinery & Equipment and support Tooling and support Technology and information Facilities and support
Tooling Tools, jigs and fixtures	**Tooling Support** Tooling design and Repair	
Technology and Information Data systems Software Engineering	**Technology and Information Support** Amortization Maintenance	
Facilities Building deprec. Building maintenance Insurance	**Facilities Support** Custodial services Maintenance and repair Utilities	

By grouping accounts into resource classes, production support costs can be planned and controlled in connection with resources being supported. This is not feasible when several resources and their support costs are co-mingled in a single grouping of manufacturing overhead costs. Furthermore, the term "support" has a more appropriate connotation to resource managers who are demanding or providing support.

<u>Designation of cost centers</u>. Traditional cost center boundaries generally match specialized process areas in manufacturing, such as fabrication, machining, welding, painting or finishing areas. Process specialization distinctions are blurred in CIM, where resources are organized to focus on products rather than processes. Product-focused CIM cells typically include a variety of processes. Cost centers in CIM encompass broader manufacturing capabilities, but are smaller and more numerous than the larger specialized cost centers of traditional plants. Where production flow is controlled by "pull-through" based on scheduled delivery of finished products, fabricating areas produce on a replenishment basis. Figure 1 illustrates the effects of pull-through production flow by comparing the floor layouts of CIM and traditional plants.



Floor layout -- CIM Plant
(Pull-through production flow)

Floor layout -- Traditional Plant
(Push-through production flow)

Figure 1: Comparison of Floor Layouts, CIM and Traditional Plants

In the CIM plant, production flow is in a pull-through direction (bottom of the figure to the top), with the impetus of the "pull" originating from scheduled deliveries out of the Finished Goods Warehouse Area. These scheduled deliveries are supplied by product family cells, where virtually all of the conversion of the product occurs. Cells draw fabricated materials from adjacent containers filled by the Fabricating Areas, where production is initiated only when containers become empty. That is, production is not scheduled in Fabricating as in the cells. Instead, replenishment is activated when a need is made apparent by an empty container.

Production in the traditional plant begins with the release of scheduled orders into the Fabricating Area. These orders are committed into assembly in sufficient time to meet a scheduled delivery commitment into the Finished Goods Warehouse Area. Production flow "zig-zags" from top to bottom in the figure. The smaller areas for Raw Materials and Finished Goods in the CIM plant reflect the inventory reduction benefits of pull-through "just-in-time" production control [see Hall (1983)]. Furthermore, the wider shipping area in the CIM plant allows products to be delivered from cells very soon after production is complete.

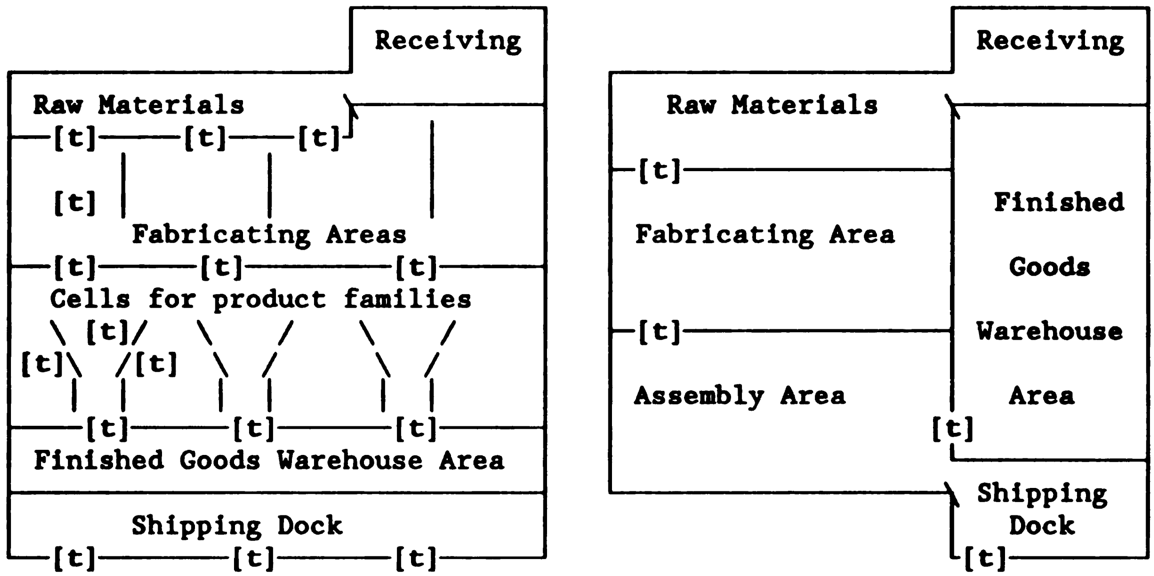
The changes in plant lay-out and direction of production flow are dramatic. Pull-through production flow improves coordination and permits more production throughput in a smaller area of floor space. Replenishment-oriented areas require less tracking by inventory control systems. These changes affect data collection procedures as different resource events are chosen as transaction triggers.

Changes in Data Collection

In replenishment oriented fabrication areas of a pull-through CIM plant, less inventory tracking is needed than in traditional plants. Programmable microprocessor controllers provide the technical specifications to the fabricating equipment so that the same equipment can make a variety of parts. Standardized containers filled with pre-set quantities make it easy to see the inventory already produced for the cells. In short, visual information is sufficient for operators to know their inventory status.

Cell areas have new trigger points suitable for flexible production. Included are points of cell entry or exit, which can be used to measure elapsed time. Some resource costs and support costs could be assigned based on elapsed cell time. Other points where conformance with quality or other specifications is affirmed may provide triggers to measure quality assurance costs or to detect and record waste.

CIM has technology that can facilitate effective data collection techniques. Electronic reading of magnetic strips, or "bar coding" is an example. With this technology, it is feasible to choose appropriate resource events for transaction triggers. In certain areas, more trigger events may be needed to satisfy requirements for up-to-date information about production status if not obvious from visual information. Also, CIM requires more detailed evidence of the incidence of costs, and this can be provided by appropriate triggers. The opportunity for choice of triggers is more limited in traditional manufacturing, where cost transactions are typically triggered when production is initiated or completed (entry and exit), or transferred between inventory storage locations. Figure 2 compares trigger points in CIM with traditional manufacturing.



Trigger points -- CIM Plant   Trigger Points -- Traditional Plant

"[t]" symbolizes places where resource events are trigger points.

Figure 2: Comparison of Transaction Trigger Points

In the CIM plant, trigger points of entry into each of the fabricating areas indicate where requisition withdrawals from the Raw Materials Stockroom occur when the Fabricating Areas replenish their supply. The act of replenishment is initiated when a cell team empties a standard container of fabricated parts, which signals a need to refill it. The replenishment act is quite similar to a reimbursement of a petty cash fund. No trigger is needed when the container is filled; instead, the inventory on hand in the containers (which contain standard quantities) is counted when necessary at the end of accounting periods.

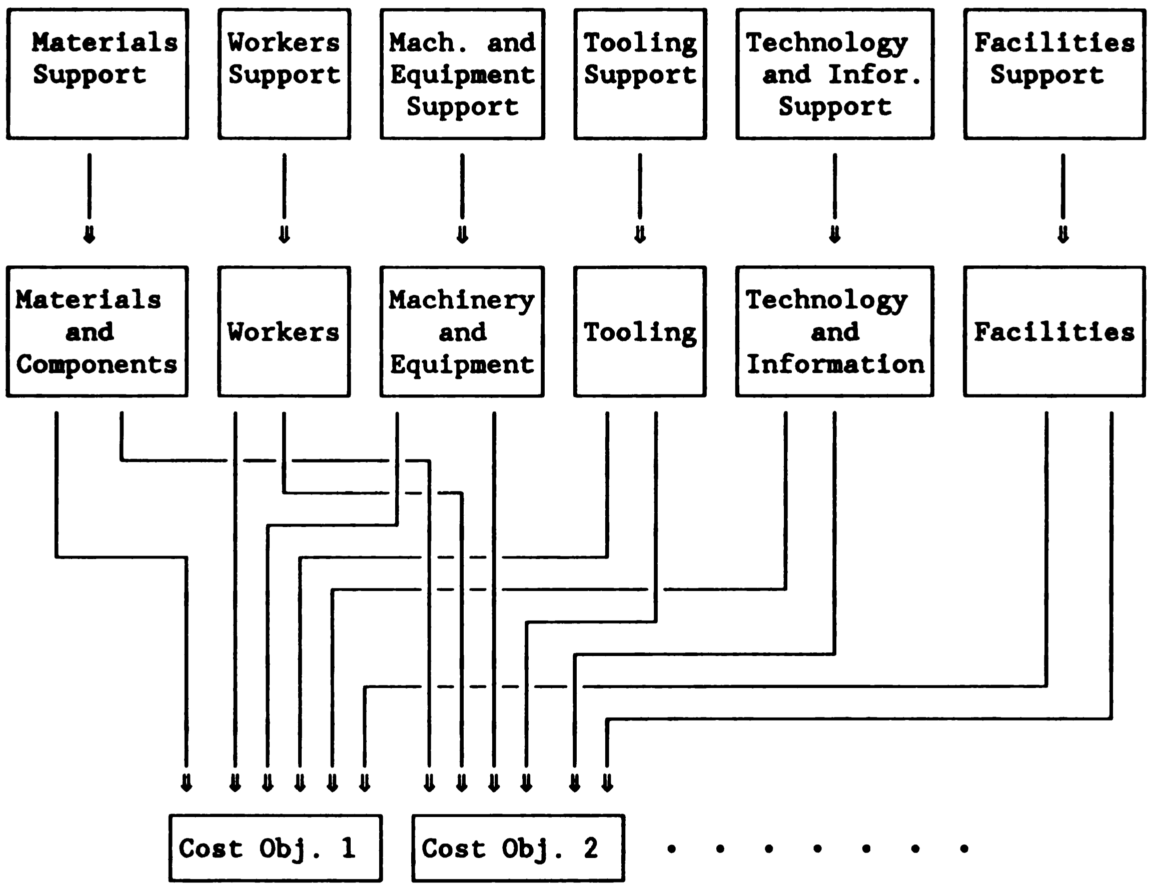
Trigger points exist at entry and exit from the cells, so that elapsed time can be measured. Note that because of advanced data collection capabilities, multiple triggers within cells are available as needed to measure conformance with specifications, to track production status, or to collect cost data. Figure 2 illustrates multiple trigger points in the first cell. Additional trigger points occur at shipment.

Trigger points in the traditional plant are where raw materials and components are requisitioned into production, production leaves the Fabrication Area to go into the Assembly Area, and finished product leaves Assembly to go into the Finished Goods Warehouse Area. Payrolls and shipments from the warehouse provide additional triggers. Shipment is made directly from the area near the cells of the CIM plant.

Cost Assignment Based on Resources

Production flow in traditional manufacturing depends largely on direct laborers' efforts. However, production flow in CIM relies extensively on information-oriented activities, such as ordering, scheduling, releasing, receiving, and transferring. These activities are vital for effective production management, but are only indirectly associated with the line worker efforts. The proportion of manufacturing input represented by direct labor effort decreases in CIM, while the proportion represented by information, technology and other indirect costs increases [Miller and Vollmann (1985)]. Accordingly, traditional overhead cost pools are likely to be divided in CIM by regrouping some costs into direct resource pools and by subdividing support costs according to the groups of direct resources. The objectives of such a classification are to match support costs with relevant resources and to assign support costs to cost objectives consistent with the assignment of the resources costs.

Figure 3 illustrates the arrangement of resource groupings with related support pools.



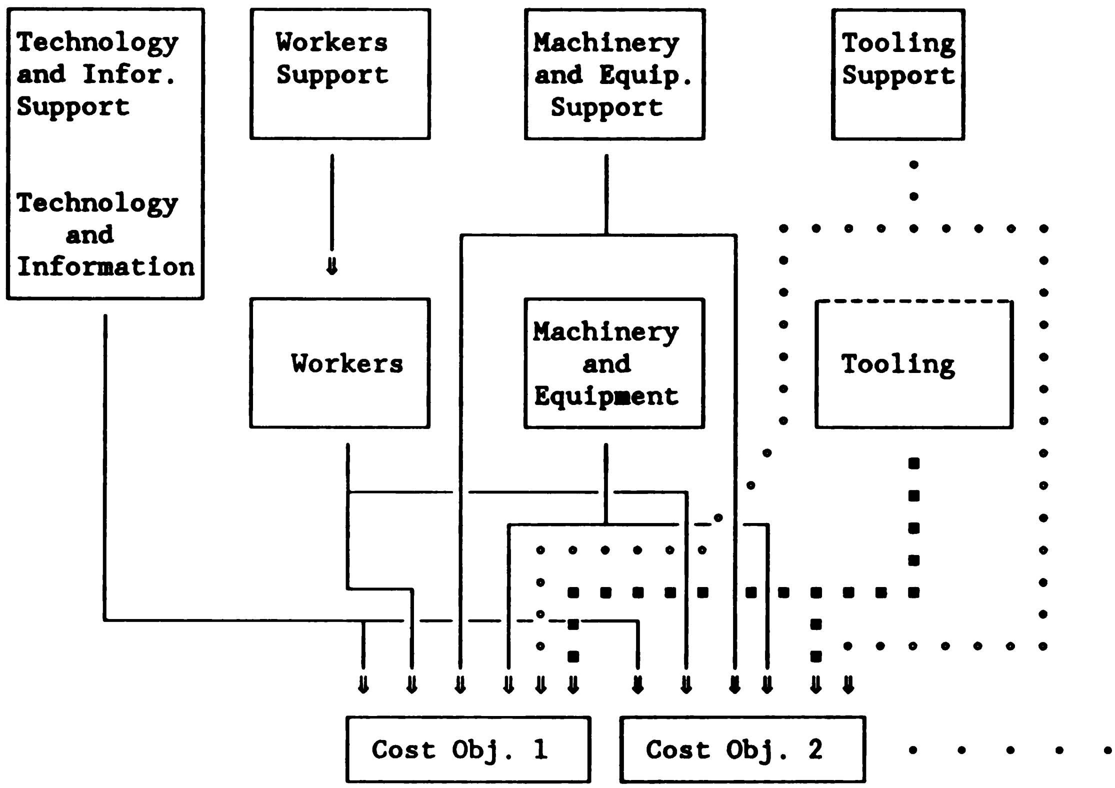
COST OBJECTIVES (A job, cell, or other cost center)

Figure 3: Patterns of Cost Assignment

In this figure the resource costs are grouped into six cost pools, with cost assignments of resource-related support costs to those groups initially, followed by assignment of combined resource and support costs to cost objectives. Although only two cost objectives (products or cost centers) are illustrated, the assignment pattern would apply just as well to any cost objectives (which are listed in the next section in Table 3).

Moreover, Figure 3 is not meant to imply that only those six groups might be established in any particular firm. Some firms may decide to combine some of the groups into less than six; others may find more than six desirable. It is not the number or even the names of the groups that is most important, but rather the notion that resources should be grouped in such a way that more costs can be accounted for as direct costs and that cost assignment can be improved.

Figure 3 follows the sequence of assigning support costs first to relevant resource groups and then assigning combined resource and resource support costs to a cost objective. For any of the resource groupings, there could be other variations in the cost assignment pattern. For some resource groupings in certain circumstances, it may be appropriate to establish a combined pool of resource costs and support costs and use a single assignment factor for the combined pool. In other cases, there may be separate pools for the resource and support costs but with a single cost assignment factor and separate assignment. Or, there may be separate pools and separate (different) assignment factors. These alternative cost assignment patterns are illustrated in Figure 4.



COST OBJECTIVES
(A job, a cell or some other cost center)

Figure 4: Alternative Patterns of Cost Assignment

Figure 4 illustrates four alternative cost assignment patterns:

- The first support pool, Technology and Information Support, is classified in the same pool as the related resource costs and assigned with one factor as combined costs.

- Support for the Workers resource group is pooled separately, but then assigned to the Workers resource cost group before assignment together to cost objectives as a combined cost.

- The third resource, Machinery and Equipment, has a separate support pool. Both the resource costs and support costs are assigned separately, but with the same assignment factor.

- The fourth resource, Tooling, not only has a separate support pool, but is assigned separately with a different factor for support costs (e.g. number of set-ups or hours of set-up time) and for resource costs (e.g. cost of tools actually issued or installed). The Tooling support and Tooling resource assignment factors are symbolized by "•" and "▪," respectively.

The key to assigning costs to cost objectives is to identify and use cost driver factors that measure resource use or consumption. Traditional cost assignment methods may combine many heterogeneous costs and therefore poorly reflect cost drivers.

Cost Reporting and Cost Objectives

Cost reporting requirements are driven by cost objectives. Cost reporting requirements are different in CIM than in traditional manufacturing. Traditional cost accounting reporting is based on stabilized data sources and periodic reporting cycles. CIM has more variety and more frequent change; cost data is accessed more frequently. CIM's integrated processes mean costs are monitored at a more comprehensive level, cost data must be more timely, and up-dated more frequently. CIM has a daily or weekly time horizon, compared with traditional manufacturing where a monthly time horizon is typical.

Cost objectives serve more purposes in CIM. Costs are used to help manage resource demands. Evaluation of integrated process operations is aided by cost data. There is constant monitoring of quality failures and other kinds of costly production failures. By contrast, cost objectives in traditional manufacturing relate primarily to tracking costs to cost centers, measures of efficiency and utilization, and product costing for inventory determination. The contrast between cost objectives in CIM and traditional manufacturing is summarized in Table 3.

TABLE 3

COMPARISON OF COST OBJECTIVES

CIM COST OBJECTIVES	*TRADITIONAL COST OBJECTIVES*
Strategic Manuf. Objectives Delivery reliability costs Flexibility costs Quality assurance costs	Inventory cost determination (proper loading of inventoriable costs)
Resource needs and status	Capacity utilization
Macro cost control at integrated levels	Micro cost control at cost center levels
Production planning	Labor productivity Efficiency Utilization
Failure costs Emergency maintenance Set-ups Quality	Budget preparation
Resource waste costs	Variances Actual vs. plan Actual vs. standards
Budget preparation	
Variances Actual vs. plan Actual vs. standards	
Inventory cost determination (Proper loading of inventoriable costs)	

More cost objectives exist in CIM, reflecting the use of cost data for cost management. Costs are needed both at the level of local cells or work stations and also at higher integrated levels. Detection and elimination of failures is a point of emphasis in CIM, including such failures as emergency maintenance, avoidable set-ups, or quality failures. Cost objectives exist for each of the strategic manufacturing objectives of delivery reliability, flexibility, and quality.

Cost Accounting Activities Summarized

Table 4 compares the cost accounting activities of each area:

TABLE 4

COMPARISON OF COST ACCOUNTING ACTIVITIES

Cost Accounting Activities in a CIM Environment	*Cost Accounting Activities in a Traditional Environment*
Cost Identification: Process areas are organized around product families. Clustered resources in cells means smaller, more numerous cost centers. Cost accounts for resources and related support are grouped in multiple resource classes, including machinery, tooling, technology and information.	**Cost Identification:** Cost center boundaries generally match those of specialized areas in manufacturing, such as fabrication, machining, welding, painting or finishing. Resource groupings are materials, labor and overhead.
Cost Entry: More resource events are available for transaction triggers. Trigger events are where production enters or exits a process area, or where conformance with specifications is affirmed. Advanced data collection technology (i.e., bar coding) makes more triggers feasible.	**Cost Entry:** Cost transactions are typically triggered when production is initiated, completed (entry and exit) or transferred between inventory storage locations.
Cost Assignment: Costs of technology, information and other indirect support are a larger proportion of total product costs. Redefined overhead cost pools relate resources with resource support costs resulting in improved use of relevant cost assignment factors.	**Cost Assignment:** A substantial portion of overhead costs are presumed to be labor-related. Overhead costs are commonly applied on the basis of direct labor.
Cost Reporting: More cost objectives exist to report cost management data, including measures of costs incurred to meet plantwide objectives of flexibility, quality, and delivery reliability. Cost data are updated frequently, kept timely, and accessed frequently; the cost data time frame is daily or weekly. Cost reporting is an integral part of production management reporting.	**Cost Reporting:** Cost accounting systems rely on stabilized budget and standard cost data files and follow a monthly reporting cycle aimed predominantly at product cost for financial reporting. Cost reporting is separate and often independent of production reporting.

As indicated by Table 4, cost accounting's role is changed by CIM in each of the four activity areas. Account groupings and cost center designations will be changed because the organization pattern of resources and production flow patterns will be changed dramatically. There are likely to be more transaction triggers so that cost data can be obtained frequently and can be aggregated to meet a need for macro level data that measures aggregated plant-wide costs. Cost assignment will change to reflect a revised configuration of resources and resource support pools. There are a greater number of cost objectives to be satisfied by reported costs.

Defined Terms

At this point it is appropriate to summarize several of the defined terms mentioned throughout Chapters I and II.

Manufacturing is essentially a matter of managing resources with distinct activities intended to add or maintain production value; these activities are **cost driver** activities [Porter (1985)]. Costs are measures of **resource events** that result from resource management decisions and cost driver activities intended to accomplish **strategic manufacturing objectives** (flexibility, quality by design, delivery reliability and cost management). A resource event involves either **consumption** of an **expendable** resource or **use** of a **durable** resource. Resource events may contribute directly to the conversion of particular resources into other resources, or may support conversion directly or indirectly.

Cost identification, cost entry, cost assignment and **cost reporting** are the four activities that comprise the role of cost accounting. The cost identification and cost entry activities recognize, classify and record costs based on the nature of the resource events require consumption or use of resources. Cost assignment aims at linking the recorded costs with cost objectives, which are the bases for cost reporting. A **cost objective** is any purpose for which a cost is reported, including cost estimation, inventory determination, or a variety of cost management purposes, such as labor efficiency, capacity utilization, or quality failure monitoring. Cost objectives are driven by production management, marketing and financial reporting requirements.

SUMMARY

This chapter has contrasted objectives of CIM with traditional manufacturing and has described four activities that comprise the role of cost accounting. Expectations regarding the impact of CIM on cost accounting activities and objectives are stated. In the next chapter, support for these expectations is developed from background literature, concluding with the research hypotheses.

CHAPTER III

BACKGROUND FROM RELEVANT LITERATURE

INTRODUCTION

The role of cost accounting is defined in Chapter I as four activities: cost identification, cost entry, cost assignment and cost reporting. Chapter II described how CIM has changed the context in which the role of cost accounting is carried out. This chapter summarizes background literature relevant to the role of cost accounting and the impact of CIM on that role. Two classes of literature are examined: (1) literature on traditional cost accounting concepts and practices and (2) literature on the nature of CIM and its impact on cost accounting.

Literature on traditional cost accounting is important for understanding traditional objectives of cost accounting in the historic context from which those objectives originated. Part of the process of adapting the role of cost accounting is to reinterpret these traditional objectives in the light of contemporary cost management objectives. Literature on CIM establishes the characteristics of CIM and suggests the implications for cost systems and the role of cost accounting.

The background literature was reviewed with a particular aim in mind: to identify theoretical points that could serve as a framework for developing the theory for this study. Theoretical points discussed throughout the chapter are the basis for the research hypotheses specified later in the chapter as well as several "focus points" specified for each hypothesis. These focus points are used later in Chapter V to organize the discussion of the empirical findings.

LITERATURE ON TRADITIONAL COST ACCOUNTING

Today's cost accounting systems include concepts and practices traceable to historic origins of traditional manufacturing [Kaplan (1984a)]. The literature reviewed in this section establishes how some basic elements of today's cost accounting systems first emerged. The section begins by defining and describing the term "traditional manufacturing" for purposes of the study. Then, historic literature on cost accounting is examined. This historic literature reveals the origins of concepts and practices still existing in today's cost systems, including labor-oriented costing, use of standard costs, assignment of manufacturing burden (overhead), cost centers, and the notion of "attaching" costs to products. Then early literature on standard costs is reviewed because it provides additional conceptual insights into the intended role of cost accounting when traditional manufacturing was developing. In the final part of this section, a field study of the role of the controller is examined because its findings help to explain cost accounting activities.

TRADITIONAL MANUFACTURING DEFINED

For purposes of the study, the term "traditional manufacturing" is defined as "make-to-stock," batch-oriented conversion of materials and components into discrete products built for inventory for later sale [Harrington (1984), Reeves and Turner (1972)]. There can be variations of this description in practice. For example, some traditional manufacturers are organized as "make to stock" for components but "assemble to order" for final products.[10] For more specialized production, other traditional manufacturers produce on a "make to order" or, in some cases, "engineer to order" for highly specialized products. The key distinction here is that "traditional manufacturing" is used in this study to describe relatively large volume production with stabilized, dedicated processes. Traditional manufacturing has had the greatest influence on the development of existing cost accounting concepts and practices [Chandler (1977, ch. 8,14); Kaplan (1983 and 1984a)].

Since the early part of this century, manufacturers have sought economies of scale by organizing production with dedicated machine processes and fixed assembly lines [Chandler (1977), Hayes and Schmenner (1978), and Cohen and Zysman (1987)]. Stability is a key element in traditional manufacturing strategy. Product designs for new products are tailored to process requirements, thus enabling production volume to rise quickly and realize economies of scale [Abernathy (1978)]. Uneconomic production was often attributed to mismatching of product characteristics with process characteristics [Hayes and Wheelwright (1984, ch. 7)]. Traditional manufacturing was viewed primarily in operational (not strategic) terms, where the emphasis was on stability, efficiency, and capacity utilization. In traditional manufacturing, workers were rewarded for their skills and rapid task performance; they worked as individuals.

In summary, two attributes of traditional manufacturing are significant for the theory of this study:

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[10] For further discussion of make-to-stock and make-to-order production, see Buffa (1984, ch. 3).

- Historically, traditional manufacturing has been viewed as a costly activity but not a source of competitive strategy. Cost effectiveness was a paramount focus of management attention, which has led to an emphasis on measures of labor efficiency and labor utilization.

- The worker in traditional manufacturing has generally been viewed as the key to attaining production efficiency and effectiveness. The worker added specialized skill to generalized technology. Understandably, cost systems emerged which provided detailed data to management about the workers' performance, with far less detail about other resources used in production.

HISTORIC ORIGINS OF TRADITIONAL COST ACCOUNTING

Existing cost accounting concepts and practices originated from the context of traditional manufacturing. Literature on the historic origins of cost accounting establishes the historic basis for labor-oriented costing, standard costs, manufacturing overhead, cost centers and cost attaching to products.[11]

Product costing can be traced back to "job shop" production of the latter part of the nineteenth century. Foremen of that era functioned as "inside contractor" employees and were compensated as independent contractors [Chandler (1977, p. 271) and Litterer (1961b)]. After substantial growth in the scale of manufacturing early in the twentieth century, the role of the foreman began to change to that of a supervisor specialist, subject to more detailed accountability for production costs. When electric power and transportation became more widely available, manufacturing firms expanded and their production operations became more diverse. Complex, dedicated process technology came into

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[11] For additional discussion of the historic origins of existing cost accounting concepts and practices, see Kaplan (1984a), Chandler (1977), and Litterer (1963).

use for mass production of standardized products. Knowledge of this technology resided primarily with the foremen. Top management began to rely on cost accounting data to control the decisions and actions of foremen. Cost accounting systems became formalized and refined [Chandler (1977)].

Emergence of Labor-Oriented Costing

This was the period of the emergence of "scientific management" promoted by production engineers and attributed to Taylor (1911). During that same period, some engineers (including Alexander Hamilton Church, Harrington Emerson, and Henry R. Towne) published articles on organizing "systematic management" cost systems compatible with scientific management [Litterer (1963)]. This early literature advocated categorization of direct and indirect costs and assignment of overhead costs based on direct labor [Chandler (1977, Chapter 8)]. Engineering data systems, developed between 1910 and 1920, made it possible to track costs as a means of evaluating process control and productivity. Formal "scientific management" procedures developed by Frederick W. Taylor became the basis for cost accounting measures of dissimilar operations in multi-divisional manufacturing companies [Taylor (1911)]. The engineering data were labor-oriented, so cost accounting became labor-oriented.

Early Standard Cost Systems

The rudiments of today's cost accounting systems were formalized during the historic period when mass production emerged. The worker was a principal resource used in conjunction with complex process technology to produce in large volumes. Cost measurement systems were developed to help upper management control production without detailed supervision. Developments in engineering data systems also helped to formalize standard cost accounting systems. Engineers used "scientific management" concepts and procedures to standardize production tasks and time requirements and save costs. Production laborers' tasks were formalized and specialized through job analyses and time and motion studies developed by Taylor, Gantt and others. [Chandler (1977); Taylor (1911)].

Emergence of Factory Burden

Specialization led to departmentalizing of production activities and the creation of factory staff support positions, including timekeepers and production control clerks. With the creation of such positions, production control became a costly and necessary organizational burden to ensure control. The support costs became known as "factory burden," which were assigned from cost centers to products, so that all supportive costs were allocated to production as it flowed through the plant [Chandler (1977, p. 278)].

Creation of Cost Centers

Alexander Hamilton Church advocated cost centers to provide control of overhead costs [Litterer (1961a)][12]. Church defined five

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[12]Based on publications by A. Hamilton Church cited in Litterer (1961a): "Practical Principles of Rational Management," *Engineering Magazine*, Vols. 21,22 (1901); later published in: A. Hamilton Church, *Production Factors*. New York: Engineering Magazine Co., 1910.

manufacturing functions -- Design, Equipment, Control, Comparison and Operation -- and developed cost center measures for each. Early efforts to formalize cost accounting in factories were furthered in Clark (1923), a comprehensive examination of the nature of overhead costs, and by a very detailed specification of standard costs systems in Harrison (1921 and 1930). Church, Clark and Harrison helped document cost accounting concepts and practices applicable to that era of growth in manufacturing and scientific management. Much of what they wrote is still found in today's cost accounting practices [Chandler (1977); Johnson and Kaplan (1987); Kaplan (1983, 1984a)].

A strong connection between direct labor and manufacturing overhead developed during this era. There were two sources of overhead costs, support for workers and production accounting costs, both of which were considered legitimate production costs. Factory burden was justified as a means of management supervision and control, made necessary by the specialized nature of worker tasks. Workers' skills were considered a resource to be used carefully. Costs of supporting workers required accountability in factory burden accounts. Since the worker was the primary resource focused on by management, allocation algorithms based on direct labor were used to assign factory burden to product costs.

Attaching Costs to Products

Traceable back to early cost accounting systems is a notion that costs can be "attached" to products as they travel from functional departments [Johnson (1987), Johnson and Kaplan (1987, p. 132)]. As industrial engineers organized production in a smooth flow through functional departments, engineered standards began to be used in cost accounting measures. Engineered bills of materials were used for measures of required materials, operations routings data were used for measures of direct labor hours, and labor time was the basis for assigning other indirect costs from burden pools [Chandler (1977, ch. 14)]. Meanwhile, auditors found engineered data to be an attractive and objective means of assigning costs to inventory. Thus, it became common practice to attach costs to products as materials flowed through various stages of production. Cost attaching procedures eventually became the basis for accepted cost accounting concepts [Johnson and Kaplan (1987)].

Originally, cost accounting helped managers control costs; cost data instilled cost accountability. But as accountants and auditors recognized the convenience of using cost systems to determine inventory by "attaching" costs to products and as the influence of financial reporting became stronger, cost attaching began to out-rank cost managing as the focus of cost accounting [Johnson (1987)].

To summarize, early cost accounting systems used formalized engineering specifications of materials and labor to attach costs to products and determine inventory costs. In addition, engineering data provided the means for development of standard cost systems. The measures were labor-oriented because the focus of control was primarily on the worker's tasks. The next major source of development of cost concepts and practice was the development of standard cost systems.

STANDARD COST SYSTEMS

A "standard cost" is a target measure of expected production cost under normal manufacturing circumstances.[13] Standard costs are calculated for a product or component by multiplying normal quantities of materials, component parts and labor hours times normal prices and wage rates. Concepts developed for standard cost systems are relevant for theory about cost accounting. Since many standard cost concepts have become accepted as cost accounting concepts, standard cost literature were examined in search of further theoretical support for study. Out of the body of standard cost literature, Harrison (1921 and 1930), Henrici (1960), N.A.A. (1974), and DeWelt (1975) were selected as representative sources.

Harrison (1921 and 1930)

G. Charter Harrison's Cost Accounting to Aid Production (1921) and Standard Costs: Installation, Operation and Use (1930) describe standard cost concepts and methods developed by engineers from scientific management theory. Harrison (1921) includes the following areas of emphasis pertinent to the present study:

- Standard costs should specify expected costs both in total and by detailed operation, pre-determined under normal operating conditions (pp. 7-8).

- Standard costs should distinguish between productive costs and idle costs (p. 9).

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[13]N.A.A.'s terminology publication (1983, p. 100) defines standard cost as "a forecast of the cost of performance that should be attained under projected conditions as determined by reasonable estimates or engineering studies."

- The accounting function should establish the standard costs, based on data determined and maintained by engineering (p. 36).
- Information reports comparing standard and actual costs should be prompt and accessible to production managers (p. 12).
- Cost reports should focus on exceptions that require management attention (p. 14).

These areas of emphasis are continued with greater elaboration in Harrison (1930), which includes several detailed charts showing the flow of transactions through the standard cost system.

Several conceptual ideas are derived from Harrison's views on standard costs. Standard costs help reveal where costs are incurred in processes involving inter-related resource events and should help managers isolate wasted costs from productive costs. Standard cost measures should be coordinated with measures used by engineering and production. Coordination keeps cost data current and accurate. Coordination helps managers understand and accept that cost data are measurements of production results rather than merely accounting results. This encourages managers to feel a sense of ownership of cost data. While accountants are responsible for and "own" cost **measures** (measuring tools), manufacturing managers are responsible for and "own" cost **measurements** (measured cost data). Managers can easily perceive accounting measurements as "accounting's numbers" rather than a reflection of their own resource accountability.

Harrison's works are an important source of cost accounting concepts. They articulate the motives and objectives of cost data in an era when cost identification, entry, assignment and reporting practices were becoming widely accepted, many of which have lasted to the present day.

Henrici (1960)

Henrici (1960, pp. 31-32) defines "cost center" as a "unit of endeavor under the lowest level of supervision, buying materials and services from other centers, incurring expenses within itself, and in turn perhaps selling materials and services to other centers." Henrici said costs should be measured at the level of process operations and defined an "operation" as "a plant activity at the first degree of subdivision, which has a known unit of output and whose costs differ from those of other activities" [Henrici (1960, p.33)]. Operations identified in standard costs should be coordinated with the operations identified for control of manufacturing processes. With coordinated definitions, costs of individual operations can be aggregated to measure total cost of production. Henrici also warned against combining costs of separate cost centers, thus concealing traceability.

DeWelt (1975)

DeWelt, an accountant employed by a heavy equipment manufacturer, wrote about using standard costs as an aid for inventory control where Materials Requirements Planning (MRP) is used.[14] DeWelt explains why standard cost data and reports need to be timely and coordinated with MRP processing cycles. Since MRP focuses attention on scheduled production and inventories required to support production activities,

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[14]Materials Requirements Planning (MRP) is a methodology for determining quantities and timing of up-coming deliveries of materials and components. MRP combines ordered and on-hand quantities with planned production requirements, taking into account production lot sizes and delivery lead times [Orlicky (1975); Wallace and Dougherty (1987)].

status information is up-dated frequently (daily or weekly) in MRP systems. Manufacturing managers who use timely MRP inventory and production status data are likely to want their cost data to be current and coordinated with MRP data. DeWelt points out that traditional accounting systems typically have a monthly time frame but MRP systems require that information be up-dated daily or weekly, because the consequences of being unaware of resource status can be very costly. In such circumstances, failure to provide up-to-date cost data may diminish the ability of managers to interpret the cost consequences of their resource decisions.

Standard Costs and Variance Analysis (N.A.A. 1974)

This publication brought together N.A.A. Bulletins 11 through 15, plus 22, which were published originally during the 1950s. A section from pages 7 to 13, entitled "Standard Costs for Cost Control," is summarized here.

Basic Questions Answered by Standard Costs. Operation control is acknowledged to be a precedent for cost control. By addressing appropriate questions, standard costs can be applied to operation controls to help achieve cost control. Questions addressed by standard cost systems include:

- Cost objective: for what are the costs incurred?
- Cost accountability: who is responsible for control of the costs?

Cost objectives and control objectives are related. Cost objectives are purposes for which costs are measured; control objectives are purposes for which costs are incurred. Manufacturing managers' actions are guided by control objectives and are evaluated according to cost objectives. Cost accountability is a combination of cost objectives and control objectives.

Cost control is a matter for individuals to address. Therefore, a standard cost system classifies costs according to the organizational structure of cost management responsibility, making individual cost control possible:

> Experience shows that control is most effective when standards are set in terms of personal responsibility for each cost incurred. Actual results are then measured against the respective standards in order that each individual may know how his performance compared with that which was expected [N.A.A. (1974, p. 10)].

Standard costs were important to the development of cost accounting procedures as a means of cost control. Engineers' specification of quantities of materials and labor hours could be incorporated into accounting measures through standard costs. This simplified the task of providing pre-determined costs where needed and assessing actual costs of production. Cost accounting concepts and measures became more formalized through the influence of standard cost measures and variance reporting procedures. Furthermore, standard costs systems helped to coordinate cost accounting data with engineering data, which is a crucial aspect of integrated manufacturing data systems.

THE ROLE OF THE CONTROLLER

Simon et al. (1954) reports the findings of a field study of the role and responsibilities of controllers in business organizations. Controllers, accountants and operating executives of seven companies

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were interviewed to provide the data for the study. Interviews focused on (1) the organization and scope of the controllership function; (2) the structure, content, and distribution of accounting reports; and (3) patterns of communication within the controller's department and with operating departments [Simon et al. (1954, p. vii)]. Three topics were especially relevant to the present study: accounting activities for reporting cost data, impediments to acceptance of cost data, and cost data measured in physical terms.

Accounting Activities for Reporting Cost Data

The Simon et al. (1954, p. 3) study classified controllers' duties into three activities: score-card, attention-directing and problem-solving. Score-card activities measure and enter transactions. According to the study, controllers, concerned about the accuracy of accounting data, want valid transaction entry procedures to ensure the integrity of recorded data [Simon et al. (1954, p. 29)]. When data integrity is lacking, resource managers lose confidence in the data, become skeptical about its implications and may make unwarranted, wasteful decisions [Simon et al. (1954, p. 32)].

Attention-directing activities involve analysis of recorded cost data to discover evidence of operational problems or data errors. The Simon study found that cost data have more attention-directing value when the data convey information not easily obtained from other sources:

> Supervisors up to factory department heads use accounting reports for attention-directing purposes largely in areas that are not easily visible in the course of day-to-day supervision [Simon et al. (1954, p. 26)].

What can be interpreted from this finding is that accounting data do not necessarily draw attention more easily or more quickly than other functional sources, but accounting data can affirm what is reported by other sources. This has relevance to a point made later in the present study about reporting affirmative cost information.

Problem-solving activities are those where controllers offer their advice, participate in planning, or take corrective actions. Controllers interpret recorded cost data or provide prospective analytical cost data. As reported in the Simon study, "the operating executive has special needs for periodic accounting reports on items that are not visible from direct, day-to-day supervision" [Simon et al. (1954, p. 27)].

An interpretation of these Simon study findings is that accountants can interpret and report both the operational and accounting view of business operations and thus have a knowledge advantage. A key purpose of cost accounting activities is to transfer this knowledge advantage to resource managers who then might be more effective at managing costs.

Impediments to Acceptance of Cost Data

The Simon study dealt with impediments to acceptance of accounting data by operating managers. The researchers found that managers accept accounting data if the managers believe the data are authentic. For example, when standard cost variances are reported to managers for explanation, they:

> . . . were inclined to accept a standard to the extent that they were satisfied that the data were accurately recorded, that the standard level was reasonably attainable, and that the variables it measured were controllable by them [Simon et al. (1954, p. 29)].

On the other hand, the researchers found that if managers doubt the integrity of accounting data, they tend to ignore the data in assessing their own performance, unless they are forced to act on it to defend their position with superiors:

> When there were doubts as to the accuracy of recording or classification of data, when the factors causing variances were thought to be beyond their control, the executives simply did not believe that the standard validly measured their performance. Then they were influenced by it only to the extent that they were forced to think about the reactions of their superiors [Simon et al. (1954, p. 29)].

Reassignment of cost data may cause managers to doubt the integrity of accounting data. The research team reported on managers' objections to cost assignment:

> Some objected to oversimplified determinants of standards that failed to account for important external factors causing variability in costs. A second major source of distrust of accounting standards was the recirculation of indirect costs, on two counts. First, operating people dislike having their statements include cost items regarded as not within their control, especially when such items trigger variances. Second, for recirculated indirect cost items admittedly partially controllable, the accuracy of the charges was doubted [Simon et al. (1954, p. 30).]

These Simon study findings underscore the vital importance of data integrity to sustain managers' confidence on cost data. Managers are more confident about cost data they believe reflect the underlying reality of resource events that drive costs.[15]

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[15]For another source on impediments to the use of information, see Mintzberg (1977).

<u>Cost Data Measured in Physical Terms</u>

The Simon study found that receptivity to accounting data is enhanced if users can interpret the data in physical terms:

> In those companies where the products can be measured at least roughly in physical units, manufacturing executives make more use of data expressed in physical units than data measured in dollars. Dollar comparisons are made largely in those situations where there is no other common denominator for comparing production or inventory totals [Simon et al. (1954, p. 31)]

The Simon study findings suggest several key insights about resource managers' perceptions:

- Managers are more likely to use cost data if they believe the cost data are authentically and accurately reflect underlying resource events. Managers may either ignore or be defensive about data perceived to lack integrity.
- Managers may distrust recirculated cost data if they are suspicious that cost allocations obscure underlying resource events or cost drivers.
- Accounting data that can be related to physical units of measure seems to be more authentic and acceptable because the data more clearly reflect operational realities.

SUMMARY: TRADITIONAL COST ACCOUNTING LITERATURE

Several points were gleaned from the literature on traditional cost accounting.

- Cost accounting became a formalized means of identifying and classifying costs of production during the historic period of mass production development in the early part of this century. Cost assignment focused on direct materials and labor because materials and workers were the primary resource controlled by production management.

- Overhead pools and allocation methods developed as production activities became more complex and additional indirect costs of supervision and accounting became significant. These pooled indirect production costs were assigned to products based on labor because they were part of the cost of managing labor.

- Cost centers were established to improve control over specialized production areas, and eventually cost centers were also established to control burden costs.

- After a period of time, financial accountants began to appreciate the objectivity of cost measures for inventory valuation, and procedures for attaching costs to products became commonly accepted.

- Standard cost systems helped formalize cost accounting concepts regarding direct versus indirect costs and helped to coordinate cost measures with engineering data systems.

- Classifications of cost accounting activities from the Simon et al. (1954) field study support the role of cost accounting as described in this study.

Historic cost accounting literature explains how cost accounting activities developed in traditional manufacturing. Cost accounts were established and classified to help management monitor costs of complex production based on engineering data; the classifications were labor-oriented because the worker was a key resource to manage. Cost data became accepted as the primary basis for inventory determination. The Simon et al. (1954) study revealed that a controller's participative role had developed through using cost data to provide score-keeping measures of production output, direct attention to cost control problems, and provide analytical cost data to help solve problems.

LITERATURE ON CIM AND ITS IMPACT ON COST ACCOUNTING

This section summarizes: (1) literature relevant to the characteristics of CIM described in Chapter II and (2) recent accounting literature about the impact of CIM on the role of cost accounting. Both of these groups of literature were reviewed for theoretical development of hypotheses and hypothesis focus points presented at the end of this chapter.

LITERATURE ON CIM CHARACTERISTICS

CIM literature reflects the recency of CIM in the manufacturing environment. Most of the CIM literature discusses concepts and implications in broad terms. Literature on applied situations is not extensive. The CIM literature generally suggests, but does not confirm, implications of CIM implementation. Nevertheless, the literature does provide some useful insights about the likely impact of CIM on cost accounting activities.

A variety of literature describes CIM characteristics. Some of the literature addresses CIM's technical aspects and operational advantages; this literature includes Goldhar and Jelinek (1983 and 1985), Groover and Zimmers (1984), Gunn (1982), and Stover (1984). Literature concerned with accounting implications of CIM includes Cooper and Kaplan (1988), Dilts and Russell (1985), Johnson (1987), Johnson and Kaplan (1987), Howell et al. (1987), and McNair, Mosconi and Norris (1988). This literature plus others have been examined for additional theoretical support for the hypotheses and focus areas of the study.[16]

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[16]Other literature examined but not summarized in this section includes Bruns and Kaplan (1987), Bylinsky (1983), Cohen and Zysman (1987), Ettlie (1988), Hill (1985), Richardson (1988), and Skinner (1985).

CIM: Characteristics and Advantages

Based on Goldhar and Jelinek (1983 and 1985), Groover and Zimmers (1984), Gunn (1982), Harrington (1984), and Stover (1984) characteristics and strategic advantages of CIM are summarized as follows:

- CIM is controlled by the flow of information between flexible, product-focused process centers. This is in contrast with traditional manufacturing, which is organized by the flow of materials between dedicated process areas.

- CIM integrates information and computer-aided technology with materials characteristics and enables the formation of cells to focus on product attributes rather than process attributes.

- Improved information and flexible processes reduces the need for buffer inventories near process centers to cover for uncertainties and disruption. Elimination of unnecessary buffer inventories can reduce waste, scrap damage, inventory risks and inventory carrying costs.

- With CIM, competitive advantage is not confined to economies of scale but can also include economic advantages of variety, flexible response to changing market demands, delivery reliability, high output quality, as well as cost competitiveness.

- CIM technology allows sophisticated, inexpensive inspection as well as quick, low-cost process changeovers and set-ups.

- CIM plant layouts are not organized with large areas of specialized processes (stamping, welding, grinding, etc.). Product-focused, cellular configurations of flexible equipment using work crews are cost effective.

- Support costs for design, maintenance, and status information are significant in CIM; many such support costs are incurred in advance of and separate from the production activities that benefit from them.

CIM: Influence on Cost Accounting

The preceding points summarize characteristics and advantages of CIM as described in CIM literature. The same literature was examined closely to interpret CIM's influence on cost accounting. This section presents several interpretations developed from a synthesis of the CIM literature cited previously.

Since CIM is organized into product-focused process areas, traditional patterns of production flow are changed. This has a bearing on cost identification. Costs in CIM can be identified more effectively with revised account names and regrouped accounts to match resource classifications suitable for CIM. By regrouping accounts for both resources and resource support, cost assignments can be made directly to product groups.

Furthermore, since CIM depends on timely production flow through integrated processes, the consequences of disruption and delay can be costly. Instances of disruption or delay may be recognized and captured as a routine part of cost identification and entry.

Steps are taken in CIM to reduce the time required for process setups, so that production can be run in smaller lot sizes and still be virtually continuous. Variety in production affects cost assignment since more variety exists in manufacturing processes, which can complicate the assignment of costs. CIM generates more indirect costs than traditional manufacturing, some of which precede production by such an extent that it is difficult to attribute it to production. This also complicates the cost assignment task.

It is not unusual in CIM occasionally to have idle equipment. Integrated processes require that process cells produce output only when needed (not in advance) and in balance with other process areas. Period-oriented depreciation and other accounting charges are, therefore, less valid in CIM. Traditional measures of utilization may show inefficiencies in sub-units while the plant operations as a whole may be cost effective.

Information is used extensively in CIM, so extensively that it is actually a resource or at least a significant cost driver. Since CIM's information needs can be costly, separate measures of information costs may be needed for direct assignment of information costs to resource groups.

RECENT COST ACCOUNTING LITERATURE

Recent literature on the impact of CIM on cost accounting has questioned the relevancy of costs determined by traditional cost accounting systems. Some literature has focused on a lack of appropriate cost measures. For example, Kaplan (1983) says cost accounting's implicit model of manufacturing operations fails to recognize key changes in manufacturing management objectives brought about by CIM. Kaplan says innovative cost measures are needed if cost management systems are to provide feedback responsive to CIM. In similar fashion, other contemporary literature, including CAM-I (1985 and 1986), Cooper and Kaplan (1988), Dilts and Russell (1985), Johnson (1987), Johnson and Kaplan (1987), and Miller and Vollmann (1985) criticize the relevancy of cost accounting practices in CIM, implying they are no longer supportive of management objectives. Still other literature, including Bruns and Kaplan (1987), Howell et al. (1987), McNair, Mosconi and Norris (1988), and Richardson (1988) focus on implementation of improved cost accounting practices, based on research carried out at individual companies.

Out of this extensive body of recent cost accounting literature, CAM-I (1986, 1985), Cooper and Kaplan (1988), Dilts and Russell (1985), Johnson and Kaplan (1987), Johnson (1987), Kaplan (1983, 1985a) and Miller and Vollmann (1985) are representative sources.[17]

CAM-I (1985 and 1986)

In 1985, Computer-Aided Manufacturing International (CAM-I), an industrial research organization, initiated a cost management systems (CMS) development project to "identify a body of knowledge and to influence practices in environments with advanced manufacturing technology" [CAM-I (1985)]. Two CAM-I documents summarize the aims of the CMS project: Cost Management Position Paper (1985) and Cost Management System (CMS) Project Prospectus (1986). These documents include several points useful for theory about cost management in CIM; the points are summarized in the following paragraphs.

Architectural Shortcomings. CAM-I observed that in traditional manufacturing (1) a relatively small number of parts or products were produced, (2) lot sizes were large in order to be economical, and (3) manufacturing processes were labor intensive. Since CIM differs from traditional manufacturing in all three respects, CAM-I (1985, p. 3) concluded that traditional cost accounting concepts and practices have "architectural" shortcomings. According to CAM-I, today's cost management systems continue to have cost tracing objectives of traditional

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[17]Additional relevant literature on contemporary cost accounting practices include Eiler (1986), Hall (1983), Johannson (1984 and 1985), Porter (1985), Seed (1984), and Wingard (1985). This literature is consistent with the literature reviewed in this section.

manufacturing and lack a good fit with cost drivers and control aspects of CIM. In addition, CAM-I says the role of cost accounting in traditional manufacturing is one of passive historic review, while CIM requires an active cost management system, integrated with manufacturing process control.

Variety and Demands on Resources. According to CAM-I (1985), traditional cost accounting systems do not measure demands on production resources precisely enough. CIM processes handle a variety of product designs and parts, and greater variety of product designs and parts means less consistency in demands on production resources. CAM-I notes that some mature products may have reached the stage of their life cycle where demand on resources is consistent and reduced to a minimum; others may be in the introductory phase of their life cycle where demand on resources is inconsistent and not yet minimized. In addition, complexity of product features can vary demand on production resources. Some products may be marketed with attractive, but costly, options; others may be marketed with straight forward, simple designs. For all these reasons, it is more important now that cost management systems have measures of differing levels of demands on resources [CAM-I (1986)].

CAM-I's comments underscore a theoretical point argued in this study: identify costs in relation to the resource events that cause the consumption or use of resources. Failure to measure consumption or use of manufacturing resources with reasonable precision can seriously jeopardize management's ability to assess their competitive position. Managers who perceive the costs of such products to be more than justified by demands on manufacturing resources may fail to compete aggressively with high volume, high quality products. Furthermore, managers may introduce new products without a full awareness of how costly the products will to be in terms of demands on manufacturing resources.[18]

Reduced Set-up Times. Traditional cost accounting practices were developed in manufacturing environments where production lot-sizes and intervals between set-ups were planned to minimize process interruptions. Set-ups and tear-downs were time consuming and costly to perform. CIM technology has reduced set-up times and costs substantially. Set-up times are reduced by changing fixtures and improving fasteners to speed up the set-up tasks, or by dedicating machines to processes thereby eliminating set-ups. On computer-aided equipment, set-ups can be installed with great precision and, therefore, require relatively few "try-out" parts. With reduced set-up times, small production lot sizes can be produced economically. Work-in-process inventory is reduced substantially, freeing up floor space for more capacity. Set-ups and tear-downs occur more frequently, but require less time with each occurrence.

In traditional manufacturing, set-up times are typically not specified as direct labor on operations routing sheets. Therefore cost accounting systems generally do not measure costs of set-ups directly, but record set-up costs in manufacturing overhead. However, managing set-ups gains importance in CIM, which suggests that more specific cost accounting measures of set-ups may be warranted.

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[18]See Johnson and Kaplan (1987) and Worthy (1987) for further discussion of this point.

Less Dependence on Direct Labor. Much of traditional manufacturing is relatively labor-intensive, either in terms of labor content in product costs, or in terms of dependence of production processes on workers' skills. CIM is technology-intensive more than labor-intensive. In a CIM environment, direct labor costs are reduced while equipment, technology and support costs are increased.

High Overhead Rates. CIM costs include computer-aided equipment and tooling, computer-aided testing, computer-controlled materials handling, and information from computer data base systems. A variety of other technology-related support costs are incurred, including costs of software and salary costs of technical and planning employees. All of these technology and support costs are typically recorded in manufacturing overhead accounts. Therefore, CIM plants have high overhead application rates. According to CAM-I (1986), overhead costs take on the appearance of being unmanageable, and managers may be motivated to take unwise actions to avoid overhead charges. In fact, "overhead" as a single classification of indirect production costs is less appropriate in CIM. Multiple overhead pools may be more appropriate.

Cost Driver Relationships. Traditional cost accounting concepts are built on two specific cost categories, direct materials and direct labor, and a generalized cost category, manufacturing overhead. CIM's advanced technologies involve additional significant cost drivers which do not relate strongly with direct materials, direct labor, or with production volume. Direct labor has traditionally been measured very closely, in part due to a high number of job classifications and the existence of labor incentive pay schemes. In CIM, fewer physical tasks are performed by workers. Consequently, fewer job classifications usually are found in CIM than in traditional manufacturing. Workers' tasks are more versatile. Workers guide or monitor manufacturing processes, utilizing computer-aided information, tooling, and materials handling equipment. Furthermore, labor is typically performed in small groups at various manufacturing cells and, therefore, it is difficult to associate production output with individual workers.[19]

Incentive pay schemes are appropriate where workers can exercise individual control over the pace of production or the volume of output. However, workers tending automated processes have little control over the pace of production or volume of output; efforts of individuals cannot be readily associated with production output. Wages of such individuals may be classified as indirect labor. Advanced technology, therefore, is likely to reduce the number of jobs that can be classified as direct labor jobs. For this reason, assignment of overhead costs based on direct labor is unlikely to represent demands on production resources.

<u>Tracking Parts</u>. CIM's integrated cellular arrangements of work areas and reduced work-in-process inventories actually reduces the need for tracking production status with entering detailed data. Fewer costs are traced through the flow of production. Where data entry is required, in CIM parts can be identified with magnetized bar code strips,

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[19]Where automation is introduced the number of jobs that can be measured as direct labor jobs is reduced. Carlson (1982) reports declining use of incentive pay schemes for individuals' wages in industries where automation is introduced into production processes.

which can be read easily and accurately for entry into production control data systems.

The "architectural" shortcomings noted in CAM-I (1985, p. 3) support the cost identification hypothesis and focus points later in the chapter. Without changes in account classifications and groups and in the designated boundaries of cost centers, cost systems fail to take into account the variety of resource events, the different character of set-ups, the diminished dependence on direct labor and correspondingly high overhead rates, and the existence of new cost driver relationships. CAM-I also observed that there are opportunities in CIM to improve classifications of overhead costs and improve the tracking of materials and components through production.

Cooper and Kaplan (1988)

This research is based on visits to more than 20 firms, where the authors found that traditional cost measures distort product costs by understating costs of low volume products and overstating costs of high volume products. The reason is the use of volume-based cost allocations, which fail to recognize the differential costs of transactions per unit of product. The article recommends the following:

(1) Recognize variable costs at transaction points, since many variable costs are a function of the number of transactions the products require, and

(2) Allocate costs from cost pools by using multiple allocation bases that suitably reflect cost drivers rather than using volume-based allocation factors.

These recommendations support two themes emphasized in this study: that transaction triggers be chosen to measures costs based on consumption or use of resources and that individual cost pools be used for major classes of resources.

Dilts and Russell (1985)

In explaining the flexible processes of CIM, Dilts and Russell (1985) describes several manufacturing characteristics that are relevant to cost accounting systems, paraphrased below:

- Manufacturing processes are accurate and reliable and provide consistently high quality of output.

- Computer-aided machines or processes are easy to set up and require fewer "set-up tryout" parts. Long production runs are no longer required to minimize overall costs because set-up times and costs are reduced.

- Because computer-aided machines are versatile, machine utilization can be increased. Furthermore, more output variety can be achieved without reducing capacity utilization.[20]

- Since less direct labor is required for manufacturing processes, process throughput time is reduced. Consequently, work-in-process inventories and overall space requirements are both reduced. Growth can be attained without expensive capacity expansion.

- All of the preceding attributes combined suggests that there is a wide range of manufacturing volumes at which CIM's process areas are economically cost effective.

- CIM production focuses on variety and flexibility, whereas traditional manufacturing strives for stabilized production.

The attributes of flexible manufacturing described in Dilts and Russell (1985) are strikingly different than the stabilized production

[20]Recent research casts some doubt that machine utilization is increased by CIM technology [Jaikumar (1986); Hayes and Jaikumar (1988)].

characteristics upon which traditional costing concepts are based. The difference in attributes underlies a major theoretical contention of the study: that cost measures and assignment should focus on consumption or usage of direct resources.

Johnson and Kaplan: "Relevance Lost" (1987)

As the title suggests, the aim of Johnson and Kaplan's Relevance Lost is to explain why cost accounting systems fail to help managers identify costs of their processes and products. Johnson and Kaplan say collection and reporting of cost data are driven by financial accounting reporting and disclosure requirements and as a result "accounting information is too late, too aggregated and too distorted for use by managers in making their planning and control decisions" [Johnson and Kaplan (1987, p. 1)]. Johnson and Kaplan say the loss of relevance has three consequences:

(1) Accounting reports currently provided are not sufficiently helpful for cost management purposes. The reports do not aid efforts to improve productivity or reduce costs, and in fact may actually distract attention from critical cost management factors:

> By not providing timely and detailed information on process efficiencies or by focusing on [relatively insignificant] inputs . . . such as direct labor . . . the management accounting system not only fails to provide relevant information to managers, but it also distracts their attention from factors that are critical for production efficiencies [Johnson and Kaplan (1987, p. 2)].

(2) Product costs provided to managers for their decisions are not accurate, primarily because of the use of simple, arbitrary measures

which do not accurately measure demands made by products on the firm's resources.

(3) Because of strong influence brought on accounting practices by financial reporting requirements, the planning and control horizon of managers contracts to a short-term monthly cycle of financial accounting. A more appropriate horizon for decision making is the life cycle of products and processes. In the long run, businesses must manage effectively throughout the entire life cycle of products and manufacturing processes.

These points support the cost identification, entry and reporting hypotheses that cost accounts and transaction measures in CIM will be revised to identify and report costs of resource events more explicitly and with a shorter time horizon than has been customary in traditional manufacturing.

One serious shortcoming cited by Johnson and Kaplan is "cross-subsidies" among products, where some products appear to be more costly and others less costly because demands on production resources are not well identified:

> Although simplistic product costing methods are adequate for financial reporting requirements -- [to] yield values for inventory, cost of goods sold to satisfy external reporting and auditing requirements -- the methods systematically bias and distort costs of individual products. The standard product cost systems typical of most organizations usually lead to enormous cross subsidies across products. When such distorted information represents the only available data on "product costs," the danger exists for misguided decisions on product pricing, product sourcing, product mix, and responses to rival products [Johnson and Kaplan (1987, p.2)].

This observation supports the cost assignment hypothesis that cost pools will be sub-divided and assigned according to resource group.

Johnson and Kaplan say cost systems can collect more exact cost data by taking advantage of advanced information technology for data collection and recording. Data too difficult or costly to collect in a traditional environment can now be collected more easily and relatively inexpensively. In fact, environments in which advanced technology is employed in manufacturing planning and process control offer the opportunity for greater use of real-time data.

> Simplified, aggregate procedures, adopted in earlier decades because more relevant and timely procedures would have been too costly or even infeasible, no longer need to be tolerated. The computing revolution of the past two decades has so reduced information collection and processing costs that virtually all technical barriers to the design and implementation of effective management accounting systems have been removed. The increased complexity of operations in today's global, technological economy has been matched by a corresponding increase in the capabilities of systems to provide relevant and timely information on the operations [Johnson and Kaplan (1987, pp.5-6)].

The cost reporting hypothesis is based on the assumption that cost management systems of CIM firms will use advanced technology to collect and maintain cost data. Resource managers may actually prefer on-line inquiry to paper documentation since on-line inquiry provides a "real time" grasp of costs of resource sacrifices at points of occurrence.

<u>Johnson (1987)</u>

Johnson distinguishes between the terms "cost accounting" and "cost management." Cost <u>accounting</u> concentrates on attaching costs to products for inventory valuation. Cost <u>management</u> focuses on using resources cost effectively to accomplish production objectives. Since these are not equivalent management objectives, cost accounting and cost management developed along separate paths. But, Johnson says, since about thirty years ago cost accounting information has been used for cost management purposes. Johnson questions the wisdom of assuming that cost accounting concepts and practices can satisfy cost management objectives.

One source of difference between cost accounting and cost management objectives is the accounting treatment of indirect manufacturing costs. When manufacturing output is diverse, costing procedures for attaching indirect costs to units of product can produce misleading results. With diverse output, demands are placed on manufacturing resources at varying rates, which may not be reflected in overhead absorption rates based on direct labor.

> Cost accounting treats indirect costs in the least costly manner possible--aggregating them in a few cost pools and usually attaching them to products with a single denominator. Cost management, on the other hand, requires that indirect costs be traced carefully to the consumption of specific resources that cause costs. Product cost accounting information, therefore, is not useful for product cost management if there is any diversity among products [Johnson (1987, p. 8)].

This comment from Johnson (1987) supports the cost assignment hypothesis. Unless indirect production costs are pooled separately by class of resource, such as machinery, tooling, or technology, overhead pools would contain a mixture of costs of resources (machinery, tooling, technology) and costs of resource support.

Kaplan (1983, 1984a, 1984b)

Like other literature on CIM and cost accounting, Kaplan's articles discuss traditional costing assumptions, now outmoded, about the nature of manufacturing processes and activities in CIM. He argues for changed measures of manufacturing cost performance, including new measures for quality, flexibility, inventory performance, innovation and productivity.

Reasons for inadequate cost measures are suggested by the theory developed in this study. If inadequate measures exist in cost management systems, ambiguous motives for the measures may be the cause. Given that "cost" is defined as a measure of productive (non-wasteful) resource sacrifice, costs are identified based on events where resource sacrifices are observable and where accountability of resource managers can be established. There are fairly specific measures for financial reporting requirements and for "audit trail" substantiation, for which the motives are relatively unambiguous. But cost management motives have been articulated less clearly in the past and, consequently, measures for effective cost management are not well developed. One response to Kaplan's call for improved measures is to shift the focus of production cost identification from cost attaching attributes to resource sacrificing attributes.

Kaplan (1985a)

Kaplan (1985a) describes visits made to four leading manufacturing firms where innovative manufacturing technology had been implemented. He expected to find their cost accounting practices to be modified to correspond with manufacturing innovations. Instead, he found a lag: innovations in manufacturing had occurred but the expected corresponding cost accounting adaptations had not. Cost accounting practices, firmly established to provide information for financial reporting, were slow to adapt to information requirements of integrated manufacturing.

One company's cost accounting systems aggregated its accounting numbers in ways not comparable to its reorganized manufacturing operations. Another company's traditional standard cost system focused on labor costs even though labor had become an insignificant cost element; that company was forced to calculate its actual product costs informally, outside the accounting system. Another company's indirect costs were a large proportion (and its direct labor costs a low proportion) of its total production costs. Its extremely high burden rate distorted its cost allocations and make versus buy decisions. A fourth company continued to employ outmoded accounting performance measures that did not reflect major changes in product characteristics, process technology or the market environment. Kaplan's findings indicate that companies with advanced manufacturing technologies and integrated manufacturing processes may be slow to adapt their cost accounting measures and practices to correspond with the data features of CIM.

In interpreting Kaplan (1985a), only recently has cost management become a crucial issue to manufacturers. This may explain why Kaplan found adaptation of cost accounting systems lagging behind manufacturing modernization efforts. While the concern appears to be one of obsolescence in cost accounting practices, the response is likely to emerge from re-directing the focus of cost management systems from tracking costs toward just what the name implies: managing costs, where costs are identified based on appropriate resource events. When costs are well identified, wasteful events can be identified and eliminated, and cost accountability can be maintained effectively.

Miller and Vollmann (1985)

Even though control of manufacturing overhead costs is a leading cost management issue, cost accounting models allocate overhead costs but do not explain them, according to Miller and Vollmann (1985). This is because most of the driving force behind overhead costs is not in direct labor nor units of production volume. Likewise, overhead costs may correlate with units of volume, but volume is not what is driving overhead costs. The bulk of overhead costs are derived in a "hidden factory" of transaction sources [Miller and Vollmann (1985, pp. 144, 146)]:

- *logical* transactions which execute or confirm movement of materials;
- *balancing* transactions to ensure that supplies of materials, labor and technological capacity are equal to demand;
- *quality* transactions which identify and communicate specifications, certifications, etc.; and
- *change* transactions which update manufacturing information systems for changes in engineering designs, materials specifications, bills of material, standards, routings, and schedules.

The article goes on to say that forces that drive these various transactions need to be identified for cost management purposes. By careful analysis, it can be possible to eliminate some transactions without restricting production. Stabilizing the manufacturing environment reduces transactions and errors, and also eliminates transactions required to correct discovered errors.

Summary: Recent Cost Accounting Literature

Contemporary cost accounting literature generally supports Chapter II's theoretical analysis of changes in the role of cost accounting, as indicated in the following summary:

- CAM-I (1985 and 1986) identified "architectural" shortcomings in traditional cost accounting's model of manufacturing, including failure to take into account the variety that now exists in CIM, the different character of set-ups, a diminished dependence on direct labor, correspondingly high overhead rates, and the existence of new cost driver relationships.

- Dilts and Russell (1985) describe characteristics of CIM that are relevant to cost measures and objectives.

- Johnson and Kaplan (1987) explain cost accounting's loss of relevance by saying that the shortcomings in cost accounting's model result in data that is too aggregated to reflect demands on resources. Consequently, product costs are imprecisely measured, resulting in cross-subsidies among products.

- Johnson (1987) distinguishes between cost accounting and cost management. The former deals with determination of unit costs of products for financial reporting, and the latter deals with effective use of production resources to meet management objectives. Since costing for cost accounting has dominated over cost management, there are areas of inadequacy in cost accounting concepts and practices, especially for indirect production costs.

- Kaplan's series of articles trace the history of developments in manufacturing that have led to today's inadequacies. His report on visits to four plants reveals how difficult it can be to bring about changes in cost accounting activities.

- Cooper and Kaplan (1988) describes how product costs are distorted by the use of volume-based measures and allocations. They recommend transaction based measures and multiple allocation bases. Both recommendations are similar to the ideas about choice of transaction triggers and resource oriented cost allocations described in this study.

- Miller and Vollmann (1985) describes how the role of information impacts overhead costs because of the extensive amount of support that advanced technology resources require.

The shortcomings described by CAM-I, Johnson, Kaplan and the others can be rectified by improved cost identification and entry based on characteristics of manufacturing resource events in CIM, and by clear linkage between cost assignment bases and cost objectives, upon which cost reporting is based. Improvements like these are the basis for the research hypotheses.

RESEARCH HYPOTHESES AND FOCUS POINTS

Four research hypotheses identified originally in Chapter I are presented again in this section and linked with theory delineated from the literature. Major theoretical points are also developed into "focus points" to accompany the hypotheses. The focus points are used later in Chapter V to organize the study findings, support the hypotheses, and amplify significant aspects of the research hypotheses. There are fourteen focus points, each numbered according to the hypothesis to which it relates. The focus points are listed in Table 10 in Chapter V.

COST IDENTIFICATION

A cost system needs pre-determined means of identifying and classifying costs in accounts. Cost identification includes creation of account names consistent with the nature of resource costs, grouping accounts by class of resource, designation of cost center boundaries and determination of the management level of responsibility for the costs. The cost identification hypothesis is:

Hypothesis 1: Compared with the traditional setting, CIM will lead to a greater number of cost centers, which will be smaller in size. In addition, classification and groupings of accounts will be based on a wider set of resource groups than materials, labor and overhead.

Traditional batch manufacturing is organized with large cost centers that specialize in machine processes (press department, machining department, etc.) [Reeves and Turner (1972)]. CIM organizes clusters of flexible process areas that focus on attributes of products rather than machine processes [Goldhar and Jelinek (1983 and 1985)]. Restructured manufacturing activities in CIM justify redefinition of cost centers and pools of cost accounts so that boundaries of cost responsibilities match patterns of consumption or use of resources; that is the justification for the cost identification hypothesis. In addition, several issues raised in the review of the literature pertain to cost identification and are detailed in the following focus points.

1.1 REDESIGNATION OF COST CENTERS — In CIM as contrasted with traditional manufacturing, resources are regrouped to focus on product families and production flow patterns are restructured. Therefore, to retain the homogeneous character of cost center activities it is necessary to designate more cost centers, which will be smaller in size or area.

It has been a long-standing concept in cost accounting that a cost center defines the boundaries of manager control over reasonably homogeneous resource activities [Litterer (1961a)]. However, the strategic manufacturing objectives of CIM (flexibility, quality by design, delivery reliability and cost management) change the organizational configuration of resources (the plant floor layout), restructures manufacturing activities, and revises production flow patterns. Therefore, to continue to attain homogeneity with cost centers, more cost centers are established, though they are smaller in size (floor space occupied).

1.2 CLASSIFICATION OF RESOURCES AND SUPPORT

In CIM as contrasted with traditional manufacturing, a substantial proportion of production costs relate to resources other than materials or workers; therefore additional classes of resources and support are carved out of traditional overhead cost pools.

For historic reasons, cost identification in traditional manufacturing focused on materials and labor [Chandler (1977), Henrici (1960)]. In CIM, many technological costs are not strongly related to materials or labor [Miller and Vollmann (1985)]. In traditional cost systems, costs of non-labor resources, such as machinery and equipment, tooling, and technology and information, are classified in manufacturing overhead pools but in CIM these costs will be more directly recognized as resource costs. In addition, other indirect costs will be classified into resource support pools.

1.3 IDENTIFICATION OF COST MANAGEMENT RESPONSIBILITY

In CIM as contrasted with traditional manufacturing, some costs are incurred by individual cost center but are managed at a higher integrative responsibility level; thus, such costs although traceable to individual cost centers are assigned to the higher responsibility level cost centers.

One aspect of integrated manufacturing processes is that efficiency at the local (micro) level of work stations or cells does not necessarily imply overall efficiency at a higher macro level, such as for a product group or an entire plant [Goldhar and Jelinek (1985)]. Cost of local work stations or cells in CIM are likely to be monitored within a higher macro-level context [Johnson (1987)]. It is conceivable, therefore, that a cost may be traceable to a local work station or cell but in fact be the responsibility of a manager at a higher integrated level.

If so, the cost will be recognized at the local level and identified with the higher level cost center.

1.4 CLASSIFICATION OF DIRECT COSTS In CIM as contrasted with traditional manufacturing, some worker-related and technology-related costs traditionally classified as indirect are now classified as direct; examples include costs of set-ups, inspection and maintenance.

Managers in the field prefer direct costs over redistributed costs [Simon et al. (1954)]. Given the previous point about the establishing of additional classes of direct resources, in CIM more traditionally indirect costs will be classified as direct costs. An example is the labor cost of performing machine set-ups, which likely will be classified as direct labor costs in CIM.

COST ENTRY

The second hypothesis concerns the choice of "trigger" resource events that can be used to capture cost data for cost entry. The flexible nature of CIM activities and the changes hypothesized for cost responsibility boundaries suggest that a different set of cost transaction triggers will be used in CIM. Therefore, the hypothesis is:

Hypothesis 2: The events critical to effective CIM production management are different than the events that "trigger" cost accounting data in traditional costing systems. Therefore, cost transaction triggers in CIM will be greater in number and diversity than those of the traditional setting.

The aim in selecting resource events as transaction triggers is to capture costs where the relevant resource activities occur. This is a more important issue in CIM because of the flexibility and variety that exists in pursuing the strategic manufacturing objectives. Several issues regarding cost transaction triggers are developed into four focus points.

2.1 PLACING TRIGGERS CLOSE TO RESOURCE EVENTS In CIM as contrasted with traditional manufacturing, strategic manufacturing objectives and CIM technology require that costs be captured more closely to the points where demands on resources can be identified, rather than at traditional points of entry/exit transfers or labor operations.

Given that "cost" has been defined as a measure of resources consumed or used (gradual consumption over time), an ideal trigger event is one where resource consumption or usage can be captured. Moreover, the strategic manufacturing objectives of CIM suggests that there are numerous resource events available as triggers. Traditional manufacturing involves less close scrutiny of detailed resource events, and therefore costs generally are captured at transfer exit points. However, exit points may be too far removed from resources to be satisfactory as triggers in CIM [CAM-I (1985 and 1986)].

2.2 RESPONSIBILITY FOR COST DATA -- A SENSE OF DATA OWNERSHIP In traditional plants, collecting and maintaining cost data is typically an accounting responsibility, separate from responsibility for collecting and maintaining engineering or production data. In CIM plants, collection of both production and cost data is largely merged into one data collection system with the result that resource managers have a greater sense of "ownership" of cost measurements.

Historically, cost accounting evolved to provide monitoring capability to manufacturing, and cost data were considered part of manufacturing data [Chandler (1977)]. Since then, other uses of cost data have made cost accounting a separate data collection system. Managers have come to view cost data as "owned" by accounting, provided to them from accounting [Johnson (1987)]. However, CIM will bring about a reintegration of data collection activities. This will renew in manufacturing managers a sense of ownership responsibility for collection and use of cost data.

2.3 TRIGGERS FOR EXPENDABLE AND DURABLE RESOURCES In CIM as contrasted with traditional manufacturing, triggers can distinguish between expendable resource consumption and durable resource usage. Costs of durable resources are assigned on the basis of usage measures rather than period-oriented charges for capacity provided.

Durable resources generally have been the source of production capacity in manufacturing. A key objective has been to keep capacity utilization at a high level so that all fixed overhead capacity costs are absorbed into products [Johnson (1987)]. Accordingly, costs of machinery and equipment, tooling and other capital assets have been assigned as fixed, period-oriented capacity charges. However, the integrated flexibility of production in CIM, suggests that the basis for cost assignment of durable resources be changed from period-oriented capacity to usage. In order to accomplish this, events involving usage of durable resources will trigger cost transactions.

2.4 KEEPING COST DATA CURRENT In CIM as contrasted with traditional manufacturing, cost data will be kept more current by collecting data at trigger events where demands on resources occur, files will be up-dated more frequently, and a shorter planning and control time horizon will apply.

This focus point pertains to the relative currency of cost data, which depends on how frequently costs are captured. To meet its flexibility and delivery reliability objectives, CIM operates with a shorter planning and control time horizon than the monthly time frame typical of traditional manufacturing [Goldhar and Jelinek (1983)]. Accordingly, CIM's triggers are expected to capture costs more frequently than traditional cost triggers.

COST ASSIGNMENT

The third hypothesis concerns the linkage between identified costs and cost objectives for cost reporting. The hypothesized changes in cost identification (involving resource classifications) and transaction triggers lead to changes in the bases of cost assignment. In addition, there is a greater need in CIM to assign indirect support costs consistently with related direct resources, since support costs are substantial in CIM [Miller and Vollmann (1985)]. Accordingly, the third hypothesis is:

Hypothesis 3: Cost assignment in CIM will be changed by explicitly relating support costs with resource costs and assigning both types of cost to cost objectives by class of resource, using relevant cost assignment factors. This is contrasted with traditional manufacturing where all overhead costs are typically assigned based on direct labor or some other single factor.

A strong motive in CIM for reclassifying costs traditionally classified as manufacturing overhead into classes of resources is that managers are dealing with more cost drivers, which are obscured if left in overhead. Also, many of the cost drivers do not relate strongly to direct labor and need to be assigned more directly or based on a more appropriate resource factor. Three focus points elaborate on these issues.

3.1 ASSIGNING SUPPORT COSTS WITH RELEVANT RESOURCE FACTORS

In CIM as contrasted with traditional manufacturing, resource support costs are a more significant cost component and are assigned based on usage of relevant resources supported rather than based on traditional assignment bases (direct labor, machine hours, or direct materials).

Costs are assigned to reflect the underlying relationship between resources consumed or used and production output [Porter (1985, ch. 3)]. Given the level of resource support in CIM, it is logical that accounts for support costs be grouped by class of resource (as suggested in Hypothesis 1). Assigning these costs will then be on the basis of a factor relevant to the class of resource supported. Aggregate costs can then be penetrated back to their source, or penetrate product costs to their underlying components, as discussed in focus point 3.3 below.

3.2 ASSIGNING COSTS BASED ON COST MANAGEMENT OBJECTIVES

In CIM as contrasted with traditional manufacturing, cost drivers are more diverse. Also, costs are assigned with assignment factors that link cost objectives with a greater number of cost pools or classes rather than with traditional broad cost pools and a single factor for cost assignment.

This focus point aims at the need to clarify the assignment of resource costs to cost objectives by linking resource activities more directly to cost objectives. Different cost objectives will exist in CIM to support strategic manufacturing objectives, and different cost assignment will be needed [Miller and Vollmann (1985)]. This focus point accompanies point 3.1 above, which relates resource support to resource classes; this focus point relates combined resource costs (direct resource costs and support) to cost objectives.

3.3 PENETRABLE COSTS WITH TRANSPARENT COST ASSIGNMENT In CIM as contrasted with traditional manufacturing, strategic manufacturing objectives present a greater need for penetrable cost data, which require transparent cost assignment procedures.

Managers often want to trace costs to underlying cost drivers and, therefore, expect to be able to penetrate cost accounting data through cost assignment and classification schema. The Simon et al. (1954) study found that cost data are more likely to be used by resource managers if they perceive that the data clearly reflect the resource events for which they are responsible [Simon et al. (1954)]. "Transparent" is defined here to mean that the means of assigning costs do not obscure the source of the cost, and the user of cost data can "see through" the assignment to underlying cost drivers or resource events where the costs were incurred. "Penetrable" costs means assigned costs can be decomposed backward to their underlying components. Penetrable is a cost attribute that depends on transparent cost assignment procedures.[21] Given the variety of cost drivers existing in CIM, data transparency and cost penetration capabilities are likely to be more important to managers than in traditional manufacturing.

COST REPORTING

The fourth hypothesis concerns changes expected in reporting of costs in CIM:

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[21]The source for these notions is an interview with a systems designer at one of the CIM sites.

Hypothesis 4: In the CIM setting, accounting information will be updated more frequently, "real-time" query form of reporting will occur more frequently, and the focus of periodic accounting reports will be on strategic manufacturing objectives versus the financial product costing objectives of the traditional setting.

Cost data that support CIM's strategic manufacturing objectives are current, readily available and focused toward cost objectives consistent with the manufacturing objectives. Focus points deal with cost reporting issues involving supportive cost objectives, currency of data, and focusing on cost objectives at a macro level.

4.1 COST OBJECTIVES AND STRATEGIC MANUFACTURING OBJECTIVES — In CIM as contrasted with traditional manufacturing, cost objectives will reflect a greater emphasis on strategic manufacturing objectives than on financial product costing objectives.

Traditional cost accounting has evolved to have a relatively strong orientation to product costing for financial reporting. CIM's cost management requirements are likely to re-orient cost objectives with more emphasis on forward looking planning and control, rather than summarizing past costs for financial reporting [Johnson and Kaplan (1987)].

4.2 COST MANAGEMENT REPORTING FOR COST MONITORING — In CIM as contrasted with traditional manufacturing, production monitoring will focus more on integrated costs at a macro level than is the case in traditional manufacturing, where cost monitoring focuses on the individual work center.

Given the integrated nature of CIM's manufacturing activities, cost monitoring will necessarily be done at more of a macro level. Cost control will focus on local cost center levels, but cost efficiency and capacity utilization will be assessed at a macro, integrated level [Cohen and Zysman (1987, pp. 165-67); Richardson (1988, pp. 90-91)]. The means of cost reporting and reporting formats will reflect these changes.

4.3 REPORTING COST CONSEQUENCES OF DISRUPTION AND WASTE In CIM as contrasted with traditional manufacturing, reported cost information is used to a greater extent to identify sources of production waste, either through variance analysis or through specific account recognition.

Detection and elimination of waste is a point of emphasis in CIM, not only because of the direct cost of waste itself, but also because of the serious disruptive consequence of sources of waste [Harrington (1984); Goldhar and Jelinek (1985)].[22] Reported costs will be used to a greater extent in CIM to help discover and eliminate the sources of waste.

SUMMARY

This concludes the specification of the research hypotheses and associated focus points for research analysis. Taken together, they can be summarized in the following list:

- Costs are identified where resources are used or consumed; resource event patterns are different in CIM than in traditional manufacturing, leading to revised cost classifications, account groupings and cost center boundaries.
- CIM cost transaction triggers will be based on events that reflect demands on resources, affirmation of resource objectives, or conformance to specifications.

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[22]Waste is cost incurred that neither enhances nor maintains value. Waste can result from value-lost events or activities, such as scrap due to damage to inventory in transit or in storage.

- Cost assignment to products or cost centers in CIM is based on two classes of cost drivers: resources and resource support. Resource support will be classified in CIM by class of resource and assigned on the basis of measures of resources supported.

- Cost reporting in CIM has cost management objectives as well as financial reporting objectives. For cost management purposes, cost data must be kept up-to-date, have a current time frame orientation, and be available for on-line inquiry.

A field study design is specified in the next chapter to investigate the four hypotheses and related focus points for the purpose of assessing the impact of CIM on the role of cost accounting.

CHAPTER IV

RESEARCH DESIGN

INTRODUCTION

Previous chapters have described the changes occurring in manufacturing with regard to integration of manufacturing processes and the application of computer-aided technology. As stated in Chapter I, the basic research question is:

> **How does the integration of manufacturing processes and the application of computer-aided technology affect the role of cost accounting in cost management systems?**

A field study design was determined to be appropriate for this question. The design included visits to both traditional and CIM plants where interviews were conducted with accounting, engineering and production personnel. This chapter specifies the field study design and describes the sites visited. In addition, the chapter describes the methodology used to gather and analyze the empirical data. The findings that resulted from these procedures are presented in Chapter V. The chapter begins with a discussion of research design objectives, followed by a section on site visits, and concludes with a description of data analysis procedures.

RESEARCH DESIGN OBJECTIVES

This study focuses on an emerging issue, which is still in an exploratory stage. Manufacturers are in the process of integrating their production activities and are experiencing significant organizational changes in the process. Relevant theoretical constructs about the role of cost accounting in CIM are not well developed nor grounded in knowledge about, or experience with, relationships among variables. This research can make a contribution by discovering in a field context descriptive findings useful as grounded theory for future research. Exploratory field research can discover patterns of descriptive findings, which may be articulated into testable propositions for further research [Kaplan (1985b); Yin (1981)]. Such exploratory research builds theoretical understanding, focusing on explanation as much as verification.

Stone (1978) describes exploratory research as an early stage of a complete cycle of theory building and testing. As described in Stone (1978), the cycle begins with observation of real world phenomena from which explanations of apparent phenomena are induced. From the explanations, predictive hypotheses are deduced, which then are tested by rigorous comparison with real world phenomena. The results of the tests may return the researcher to the initial exploratory stage again, top of the circle again, with more phenomena to be explained, and so on. The evolving impact of CIM on the role of cost accounting is a research question that corresponds to the early exploratory stage of Stone's research cycle.

Exploratory research is interested in processes reflected in the field context being investigated. Research on processes differs in certain respects from research involving measures of variance among variables [Mohr (1982)]. Process research examines interactive patterns of events driven by objectives, or "syndromes."[23] Theory may suggest

[23] Seashore (1961) defines "syndromes" as identifiable patterns that reveal underlying generalizable characteristics or concurrent relationships among variables.

what causes the events to interact. Rather than proving cause, the main purpose of process research is to learn how the events interact and how that interaction is manifested [Mohr (1982)].[24]

THE DESIGN CHOICE -- A FIELD STUDY

Given that the aims of this research are deductive exploration and explanation rather than proof or verification, a field study design is the appropriate design. Field studies can provide theoretical explanations from which verifiable hypotheses can be induced. Since the study findings are based on explanations obtained directly from a "real world" context, theory deduced from the findings stand a good chance of inducing realistic testable hypotheses. In that sense, this research responds Hopwood's call for research on how accounting actually operates and in the context in which it is carried on [Hopwood (1983)].

Field studies are designed to capture contextual understanding. The design aims at discovery in two dimensions: a single incident dimension revealed by anecdotal insight, and a more general dimension revealed in discovered patterns or trends [Yin (1984)]. The primary source of empirical data for this study is on-site interviews with people whose responsibilities include engineering, production, accounting and plant management. The intention is that theory about changes in the role of cost accounting will emerge from an analytical synthesis of the hypotheses and supporting findings.

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[24]For additional sources on process-oriented research see George and McKeown (1985), and Mohr (1985).

DESIGN GUIDELINES FOR THE FIELD STUDY

Five sources, Bonoma (1985), Kaplan (1985b), Mohr (1982, 1985), Stone (1978), and Yin (1981, 1984), were relied upon to establish specific design guidelines for the on-site investigation procedures. Several guidelines were derived collectively from these sources:

- **Site Selection.** Several sites were visited to enable access to multiple sources of evidence, thus helping to reveal emerging patterns. Sites were selected to enable comparison of attributes expected to be similar and unaffected by change, and contrast of attributes expected to be different and affected by change.

- **Focus of Inquiry.** To make sure the inquiry procedures had focus and purpose, along with reasonable consistency of procedure at all research sites, each field visit was governed by an orderly plan and a field interview guide was prepared and used. The guide was prepared in draft form for the first site visit and then modified for the other visits.

- **Seeking Richness in Data.** A variety of means of data gathering were used at the sites, including interviews, documents, sketches, etc., to capture some of the richness of the context within which the subject of inquiry is operating.

- **Data Gathering Procedures.** Care was taken that the research procedures did not intrude upon the subject of inquiry, causing the outcome to be manipulated by the inquiry procedures. Multiple sources of data input were tapped at each site to provide some degree of verification. This helped to increase the chances of discovering explanations through emerging patterns.

Each of these guidelines were considered and implemented in the study design, as discussed in the sections that follow.

Site Selection

The plant sites selected for the study are metal fabricators in Michigan and nearby states. Elements of CIM have been implemented in half of the sites. The firms produce a variety of products in large volumes. The products and manufacturing processes are similar enough to be able to use a comparative field study design.

Potential research sites were identified by obtaining recommendations from faculty members, CIM consultants, and participants at professional conferences on cost accounting and CIM, and by identification of companies publicized in business journals and newspapers. Telephone calls were made to high level executives of potential companies to explain the purpose of the study and to request an initial interview. Following the initial interviews with executives of participating companies, an arrangement letter was sent to confirm the intent and general arrangements for their participation. An example of an arrangement letter is reproduced in Appendix II.

The initial intention was to identify a single set of sites comprised of manufacturers in the same industry, half of which would be CIM plants. Such a set of plants could be differentiated on the CIM dimension and compared on other dimensions, and their industry characteristics and manufacturing process characteristics would be reasonably comparable. However, early discussions with potential firms quickly revealed strong sensitivity toward competitors. The firms were uncomfortable with the notion of research being conducted within their business and also with their competitors.

An alternative approach was adopted, which was to seek pairs of sites, with similar products for each pair, but with one of the pair a CIM producer and the other a traditional producer. Four pairs of manufacturers of metal products were selected. In two cases, two plants out of divisions of the same firm were paired. The pairings of firms selected for the study were:

Pair 1 Producers of steel sheet metal products
Pair 2 Producers of components for automobiles
Pair 3* Producers of components for trucks
Pair 4* Producers of frames for vehicle passenger seats

* Pairs within the same company

In the case of each pair, one of the sites had elements of CIM already implemented or in the process of being implemented.

Classifying the Sites

Certain criteria were used to classify half of the sites as CIM sites. The initial intention was to classify a site as a CIM site if it had "MRP II" attributes. "MRP II" refers to "Manufacturing Resources Planning," a broader connotation than "MRP," an acronym for "Materials Requirements Planning' [Wight (1981)]. Wight (1981) provided classification criteria useful for determining how closely specific firms fit the ideal of an MRP II firm. In particular, Wight's ideal MRP II firm has a "whole company" system with three features of MRP II (Wight (1981):

- The accounting system and manufacturing operating system are integrated, using the same transactions and the same measurement data. The accounting data are extended from operating data.
- The MRP II data systems have simulation capability, making it possible to handle "what if" inquiries.
- The MRP II system is a whole company system, involving all business facets that pertain to manufacturing resources: sales, production, purchasing, inventory, planning and coordinating of schedules, and cash flow.

Initially, the intention was to classify a site "CIM" if operational data systems had a "whole company" perspective and cost and production data were used to simulate alternatives. These criteria were used to classify four of the firms as CIM sites when selecting them for site visitation. Upon visiting the sites, the CIM sites all appeared to meet the first and third of the above criteria, but none satisfied the "what if" simulation criterion. While all of the CIM sites were capable of using their integrated data systems for "what if" simulations, they were not doing so to any substantial degree.

Ultimately, the classification decision was resolved by applying as additional criteria certain elements of CIM derived from literature reviewed in Chapter III:

- Use of Materials Requirements Planning (MRP) in planning resource requirements
- Use of manufacturing cells
- Presence of "pull-through" control of production flow
- Adoption of specific procedures to reduce set-up times
- Use of computer-aided design (CAD) and computer-aided machinery (CAM) and robotics equipment.

Specific characteristics of the each selected site are summarized later in the chapter in Table 7.

Giving Focus to the Field Inquiry

Field studies are designed to ensure that the field inquiry is focused. Yin (1984, p. 31) says the focus of inquiry can be considered the "unit of analysis," for which the effects of change are being explored. For this study, the unit of analysis is the role of cost accounting (as defined) in a context of change as CIM is introduced. An interview guide was used to help ensure that the scope and subject matter of inquiry stayed on track and in focus. Both interviews and documentation were the sources of empirical findings for determination of the role of cost accounting.

Objectives for Data Gathering and Analysis

The primary means of collecting empirical field data was discussion with individuals who hold production, engineering or accounting positions. Based on Stone (1978) and Yin (1984), the following objectives were adopted for interviews and other data gathered in the field:

- During interviews, listening to the interviewee was responsive and yet non-obtrusive. Affirmative (but neutral) replies were used to encourage elaboration.

- Descriptive terms, acronyms or measures expressed by interviewees were followed with requests for definition and examples. Terms defined in one way at one site were occasionally defined differently at others.

- Examples, both in the form of oral scenarios and documents, were requested. Copies of documents were annotated to describe and define headings, captions, and terms.

- To a certain extent, questions were repeated across individuals at the same sites to strengthen the validity of findings. However, statements made by one interviewee were not revealed to other interviewees. Each interviewee was assured that their specific comments were taken in confidence and if quoted, their identity would not be revealed.

- Interviews were taped with the permission of the interviewee (no secret recordings were made).

- Maps or sketches were obtained for plants toured and were annotated to show resources and resource activities.

- With permission of management, photographs were taken of some areas toured. Assurance was given that the photographs would not be published or shown to others and all proprietary information would be protected.

Each of the objectives was incorporated into the field data gathering procedures in the study. All interviewees were willing to have their interviews taped. A limited number of photographs were obtained, but were not shown to others and are not included in the study.

To summarize, design objectives for the field study included site selection, focus of inquiry, multiple sources and types of data, and responsive, unobtrusive interviewing without intervention on the views and knowledge of the interviewees.

FIELD RESEARCH PROCEDURES

This section describes four aspects of the field research procedures. First, criteria used to select four pairs of field sites are described. Table 5 shows the contrasts sought in choosing and pairing the sites. Then, using hypothetical names, the sites actually selected are listed in Table 6 and described in some detail in the ensuing pages. Table 7 summarizes site characteristic described in the discussion. Finally, a field interview guide is described, which contains a set of nine manufacturing decisions (listed in Table 8) used to focus the site interviews. Specific site visit procedures are described in the final part of this section.

CRITERIA FOR SITE SELECTION

The main objective was to find sites with general similarity in the nature of their products manufactured and their manufacturing processes. For CIM sites:

(1) the sites would be similar with regard to use of computer-aided technology and integrated manufacturing processes,

(2) data would be available to interpret how computer integration had changed the manufacturing activities,

(3) contrasts between the CIM firms and the traditional manufacturers were to concentrate on changes made to CIM firms' cost accounting systems, and

(4) ideally, the sites were to provide comparative insights about changes in the quality and availability of cost information after the introduction of CIM.

Selection of the Firms -- Four Comparative Pairs

Four pairs of firms were selected for the study. Each pair had similar production activities and output. One site had implemented CIM, and the other was a traditional manufacturer. Table 5 summarizes the desired characteristics of the pairs of firms.

TABLE 5

COMPARISONS OF INDIVIDUAL PAIRS OF FIRMS

	$Pair_i$	
	CIM_j	$Traditional_k$
Products	Similar	Similar
Manufacturing Processes	Similar	Similar
Manufacturing Control Systems	CIM	Traditional
Cost Accounting	Adapted	Traditional

$Pair_i$ [$i = 1,2,3,4$] are the CIM/Traditional pairs listed in Table 6; CIM_j [$j = A,C,E,G$] are CIM firms; and $Traditional_k$ [$k = B,D,F,H$] are traditional firms.

As Table 5 shows, this field study was carried out in several manufacturing company locations where (1) the manufacturing processes are devoted to the fabricating or assembly of components and are relatively similar across the locations, (2) production can be carried out using either CIM or traditional manufacturing processes, and (3) cost accounting data can be observed and analyzed. The design called for field work at four pairs of manufacturing sites, including pairs of divisions or plants within individual firms. CIM has been introduced at four of the sites to a sufficient degree that comparison of the cost accounting activities and use of accounting data is possible. The comparisons addressed two dimensions: (1) across the entire set of sites and (2) within the CIM firms, comparing the present and past manufacturing controls and cost accounting systems. The bases of comparison are those suggested by the research hypotheses and supporting focus points detailed in Chapter III.

THE SITES DESCRIBED

Eight plant sites were selected where products are manufactured out of metal. Some of the plants manufacture heavy products from steel castings or forgings; others manufacture products from sheet steel. By arrangement with the participating companies, the identities of the sites are not revealed and hypothetical names are used. Table 6 shows the pairings of sites visited.

TABLE 6

PAIRINGS OF SITES VISITED

	CIM SITES	TRADITIONAL SITES
Pair 1:	Abnett	Bladnu
Pair 2:	Ceston	Dolnar
Pair 3:	Elnep	Flaxtin
Pair 4:	Gledbul	Holpin

Each of the plants is described in the next several pages, followed by Table 7, which summarizes comparative data about the plants.

Abnett -- (CIM Site)

Abnett plant produces a major component for large trucks. The product is machined and assembled from steel forgings and bar stock. Manufacturing processes include machining, grinding, welding, cutting, heat treating and assembly. The cost of the product is comprised of 55 percent materials, 7 percent labor and 38 percent overhead. Overhead costs at the plant are about 550 percent of labor costs. Production volume is approximately 7,000 units per month, although in the past production has been as high as 25,000 units per month. The plant facility was built in 1969, is 360,000 sq. ft. in size, and has about 320 production employees.

The "Abnett" and "Bladnu" plants (Site 2) are both part of a vehicle components division of a large multi-divisional manufacturing company. Division management recommended that both Abnett and Bladnu plants be visited, Abnett as a CIM site and Bladnu as a traditional site. Since customers were imposing strict expectations concerning timing and sequence of delivery, restructuring was underway in the Abnett plant to make it the focus plant for final assembly. Changes were being implemented at Abnett to create a pull-through production flow pattern based on very precise scheduling of final assembly. A substantial capital investment had been made in a flexible machining center (which was being installed) adjacent to the assembly area. This large multi-task machining center would manufacture parts for two new models to feed to assembly, where the machined parts would be combined with other components supplied from the Bladnu plant, another plant of the division. Abnett had moved three machining lines over to the Bladnu plant to make room for the flexible machining center.

A major emphasis on just-in-time (JIT) pull-through production flow was also taking place. The aim was to achieve reliable delivery of assembled product with uninterrupted production flow, while tolerating variety in the product models. As stated by the Plant Manager: "Timing is everything! Flow is everything!" In addition, major reductions in set-up times had been achieved by changing set-up procedures.

Abnett was going through a transition from a traditional setting to a CIM setting, re-organizing the patterns of production flow to derive a pull-through Just-in-Time flow rather than batch production. Cells were being formed and set-up times were being reduced. A substantial amount of investment had been made in computer-aided machinery. For these reasons, Abnett was classified as a CIM site in the study.

Bladnu -- (Traditional Site)

Bladnu is another plant in the same division as Abnett, but located in a different city. Bladnu's plant was built in 1972, occupies 490,000 sq. ft, and has about 500 employees, including 350 direct laborers. There are seventeen production cost centers in the plant. Bladnu produces machined component parts used in the product assembled at Abnett. Manufacturing processes include cutting and grinding of rough forgings, and heat treating. Cost content of the product is 52 percent materials, 7 percent labor and 40 percent overhead. The plant overhead rate is nearly 600 percent of direct labor. About $8 million of inventory is in the plant.

Production operates on a push-through basis, scheduled by an MRP system. The MRP system is not a closed-loop and does not provide formal order releases. There are daily meetings of foremen to make arrangements to cover shortages and immediate production order commitments.

There are ten numeric control machines in use at the plant, although no significant investments in CIM technology have been made in the past three years. Much of the production equipment is inflexible, and dedicated. However, Bladnu has been conducting a study to determine how to change the processes to permit using more flexible automation.

The Bladnu plant does not have elements of CIM or JIT and therefore has been classified as a traditional plant for the study.

Ceston -- (CIM Site)

Ceston and Dolnar (Site 4) are two plants in a division of a large company that manufactures a component of automobiles and small trucks.

Ceston was recommended by division management as a CIM site and Dolnar as a traditional site. Ceston's plant is about 280,000 sq. ft. in size, was built in 1966 and employs 400 people, including 350 hourly workers. The plant produces fifty models of its end product. Manufacturing processes include stamping, tube making, wire bending, welding, and some limited assembly. There are no sub-assemblies. Cost content of the product is 50 percent materials, 10 percent labor and 40 percent overhead. The plant overhead rate is approximately 400 percent of direct labor.

The plant was originally laid out in a process orientation, with functional departments. Recently, the production flow has been rearranged to achieve a pull-through pattern oriented to product families. Nearly $100,000 was spent to rearrange equipment into cells. The reasons were to reduce production throughput time, do a better job of meeting schedule commitments, improve quality, and utilize more capacity without buffer inventory. Inventory has been cut from $4 million to less than $2 million. Scrap rates have also been reduced.

Nine robots are used in the plant. Visual information is provided in prominent places in the plant to inform employees about the schedule. "Kanban" cards are used in the stampings area to trigger replenishment of stampings as used.[25] Container sizes limit quantities of inventory in production areas. Cells have been established, where improved labor utilization and reduced tooling and rework costs have been observed.

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[25]"Kanban" are move cards that authorize replenishment of containers when emptied. See Hall (1983, ch. 3) for further discussion and an example.

CAD is used for new product designs. There are about ten to fifteen new designs each year. Standard costs are used, and are revised annually.

Ceston has been classified in the study as a CIM plant because of the rearrangements made in the plant to implement JIT concepts and achieve pull-through production flow.

Dolnar -- (Traditional Site)

Like the Ceston plant, the Dolnar plant manufactures welded steel seat frames for use in motor vehicles. The plant is 250,000 sq. ft. in size, has about 300 employees (160 direct laborers) and $1.4 million of inventory. Purchased materials for the products include steel tubing and thick steel wire, both of which are cut, shaped and welded to make seat frame assemblies. Manufacturing processes include stamping, wire bending and welding. There are several models used for seat cushions and seat backs for motor vehicle manufacturers. The products are mature in design and have about a three-year design life cycle. The cost content of the products is 57 percent materials, 8 percent labor and 35 percent overhead. The average departmental overhead rate is about 450 percent of direct labor.

Dolnar's plant was in the early stages of reorganizing its production flow patterns to implement pull-through JIT concepts. The plant had proposed a $700,000 capital expenditure for costs of plant rearrangements and flexible machining centers. The objectives of the proposed expenditure were to expand its daily capacity and improve its on-time delivery performance. The plant was near new plants being constructed by potential major customers. Some cells had already been created in the plant to focus on certain models, including cells where part of the equipment has been provided by the customer. Four robotic machines were in use and more were planned. Recent capital investments included about $250,000 for information systems enhancements to support pull-through production under JIT concepts.

The Dolnar plant was aiming to accomplish a change-over to a JIT pull-through production environment, just as its sister plant, Ceston, had already done. At the time of the visit, however, production was essentially batch-oriented, and scheduled on a push-through basis by an MRP system. Since the Dolnar plant lacked the integrated processes of a CIM facility, it has been classified as a traditional plant.

Elnep -- (CIM Site)

The Elnep plant is a 330,000 sq. ft. facility built during the 1960s. The plant has approximately 350 production employees (260 direct workers). A major component for large trucks is manufactured at the plant. The product is mature, has a highly respected quality reputation, and supplies a major share of the U.S. market for the product. Procured raw materials, which comprise 40 percent of the product's costs, include castings, forgings, bar stock, valves and other miscellaneous hardware. Manufacturing processes include turning, grinding, drilling and other heavy metal machining operations, followed by heat treating, finishing and assembly. Direct labor represents about 12 percent of product costs, and Manufacturing Overhead 48 percent. Practical capacity of the plant is 250 units per day. Actual volume at the time of the visit was about 130 units per day.

Elnep's plant is one of three plants in a division of a large multi-divisional U.S. company. Of the three plants, division management recommended the Elnep plant as the one with the most CIM attributes: use of CNC machines, CAD/CAM, MRP, and manufacturing cells. Prior to the visit, the plant had made significant reductions in inventories and improvements in inventory turnover.[26] Cells had been formed in several areas to reduce production throughput time and reduce costs by taking advantage of commonality of parts across models. One divisional executive responsible for materials management said:

> The plants have reduced their throughput time by about 50 percent. Today it takes five days to process a gear and seven days to process a shaft. Four years ago it took four weeks for a gear and four to six weeks for a shaft.

Elnep has been classified as a CIM plant for the study, although some characteristics blur the classification. Elnep's MRP system is not a "closed loop" system because capacity planning and shop floor control are not integrated with MRP scheduling. Furthermore, although cells are used in several areas the overall pattern of production flow is not a pull-through just-in-time (JIT) pattern. However, Elnep was undertaking a program to implement CIM. The program had been developed by divisional management, involved the investment of several hundred thousand dollars in equipment and rearrangement costs and was underway at the time of the visit. On balance, classifying the Elnep plant as a CIM plant seemed to be the most appropriate classification.

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[26]Schonberger (1986) cited the plant as an "honor roll" plant because of its substantial reductions in inventory and improvement of inventory turnover.

Flaxtin -- (Traditional Site)

The Flaxtin plant is owned by a large manufacturer of motor vehicles. The Flaxtin plant manufactures a motor vehicle component out of sheet metal. The 123,000 sq. ft. site (with approximately 125 employees) is part of a larger plant area in which other components are also manufactured. A real-time accounting data access system was in use on an experimental basis in the manufacturing process area. Data obtained at the site pertained to both the site and to the larger plant operations of which the site is a part. Flaxtin is not a CIM site, since the equipment, process lay-out and other aspects of production are traditional. Thus, the Flaxtin site was classified as a traditional site in the study.

Gledbul -- (CIM Site)

Gledbul is a large (800,000 sq. ft. with 1,100 employees) plant facility, which manufactures an assembled sheet metal product for commercial use. Raw materials include coil steel, bar stock, wheels and ornamental materials. Machining operations include stamping, cutting, grinding, welding, and assembly. Cost content of the product is about 45 percent materials, 6 percent labor and 49 percent overhead. The average overall overhead rate is about 800 percent of direct labor.

Gledbul is owned by a leading manufacturer of commercial products made from sheet metal, a company which has a national reputation for innovative products and superior quality. Its plants use advanced technology to produce with very high reliability. Gledbul uses CAD/CAM extensively, has numerous manufacturing cells, robotics, manufacturing cells and an effective "closed loop" MRP system. Inventory turns over very rapidly at the plant; about five days of production output is in the plant at any one time (amount of inventory was not made available). The Gledbul plant was classified as a CIM plant because its operations are well integrated, rely on very accurate information and use advanced CIM technology, including manufacturing cells, pull-through production, computer-aided design linked with computer-aided processes, and minimal inventory.

Holpin -- (Traditional Site)

The Holpin plant is a 180,000 sq. ft. traditional plant with four functional process areas: initial fabrication, final fabrication, painting and final assembly. The plant is a subsidiary company owned by a large manufacturer of a commercial sheet metal product. Eighty percent of production is sold to the parent company. Holpin has approximately 130 employees, including 60 direct laborers. Processes include cutting, roll forming and stamping of coil steel, and welding. Cost content of the product is 48 percent materials, 9 percent labor, and 43 percent overhead. The average plantwide overhead rate is 515 percent of direct labor. Production is batch oriented.

Standard costs are not used for product costing or monthly transactions. An MRP system is being implemented for the first time, and steps are underway to orient employees to MRP and to improve data accuracy. Holpin lacks CIM attributes and therefore is classified as a traditional plant in the study.

Summary of the Selected Sites

Having described characteristics of each site in some detail, Table 7 summarizes the selected sites, with the CIM sites on the first page of the table and traditional sites on the second.

TABLE 7

SUMMARY OF CHARACTERISTICS OF SELECTED SITES

	CIM PLANTS			
	ABNETT	CESTON	ELNEP	GLEDBUL
PLANT FACILITIES				
Size: sq. ft.	360,000	280,000	330,000	800,000
No. of hourly workers	320	350	350	1,100
Year built	1969	1966	Not available	1974
PRODUCT CHARACTERISTICS				
Description	Major truck component	Component for vehicles	Component for trucks	Commercial product
Cost content:				
Materials	55%	50%	40%	45%
Labor	7%	10%	12%	6%
Overhead	38%	40%	48%	49%
Types of materials	Steel forgings, bar stock	Steel wire, tubing	Castings, forgings, bar stock, valves, fasteners	Coil steel, bar stock, wheels, ornamental materials
Assembled product?	Yes	No	Yes	Yes
PROCESS CHARACTERISTICS				
Types of processes	Cutting, machining, grinding, welding, assembly	Tube making, wire bending, welding	Turning, grinding, drilling, tapping, heat treating, finishing assembly	Metal cutting and forming, machining, welding and painting
Overhead rate	550%	400%	400%	800%
Production flow	Pull-through	Pull-through	Push-through	Pull-through
CIM ATTRIBUTES				
MRP	X	X	X	X (Closed loop)
Manufacturing cells	X	X		X
JIT -- pull through flow	X	X		X
Set-up reductions	X	X	X	X
Use of CAD	X	X	X	X
CAM -- CNC machines	X		X	X
Robotic equipment		X		X
ACCOUNTING ATTRIBUTES				
Integrated files	X	X	X	X
Standard costs	X	X	X	X
Frequency of revision	Monthly	Annually	Annually	Quarterly

TABLE 7. continued.

	TRADITIONAL PLANTS			
	BLADNU	DOLNAR	FLAXTIN	NOLPIN
PLANT FACILITIES				
Size: sq. ft.	488,000	250,000	123,000	180,000
No. of hourly workers	350	245	125	110
Year built	1972	Early 1970s	Not available	Not available
PRODUCT CHARACTERISTICS				
Description	Components (for Abnett)	Component for vehicles	Sheet metal component	Sheet metal products
Cost content:				
Materials	52%	57%	Not available	48%
Labor	7%	8%	Not available	9%
Overhead	40%	35%	Not available	43%
Types of materials	Forgings, bar stock	Steel wire, tubing	Sheet metal, plastic	Coil steel, fasteners paint
Assembled product?	No	No	Yes	Yes
PROCESS CHARACTERISTICS				
Types of processes	Cutting, machining, grinding, heat treating, treating, welding	Stamping, wire bending, welding	Stamping, welding, assembly	Cutting, roll forming, stamping, painting
Overhead rate	600%	450%	Not available	515%
Production flow	Push-through	Push-through	Push-through	Push-through
CIM ATTRIBUTES				
MRP	X	X		X
Manufacturing cells				
JIT -- pull through flow				
Set-up reductions	X	X		
Use of CAD	X	X		
CAM -- CNC machines	X			
Robotic equipment		X		
ACCOUNTING ATTRIBUTES				
Integrated files	X	X	X	No
Standard costs	X	X	X	Not used
Frequency of revision	Monthly	Annually	Annually	

FIELD INTERVIEW GUIDE

A field interview guide (reproduced in Appendix I) was used for interviews at the plant sites. Based on case study literature [Stone (1978); Yin (1984)] and advice of consultants, the guide was initially drafted for use in the first site visit. Minor additions were made during that visit and the guide was revised to final form for use at the other sites. The guide is structured around a set of nine representative manufacturing decisions listed in Table 8. The nine decisions served to stimulate discussion during interviews and helped to focus the interviews on the four defined cost accounting activities and research hypotheses. The intention was to encourage interviewees to discuss (1) how cost accounting data are used to make the decisions or actions and (2) whether the uses of cost accounting data are different where CIM had been introduced. Each decision was investigated in both the traditional and CIM settings. The manufacturing decisions were expected to: (1) depend on cost information, (2) occur in both manufacturing settings (CIM and traditional) and (3) provide strong support for acceptance or rejection of the hypotheses or provide explanations pertinent to the hypothesis focus points. Each decision was expected to provide primary support for one hypothesis and secondary support or explanatory information for other hypotheses. Table 8 lists the nine decisions.

TABLE 8

MANUFACTURING DECISIONS AND HYPOTHESES

	HYPOTHESES			
MANUFACTURING DECISIONS	Cost Identific.	Cost Entry	Cost Assignment	Cost Reporting
Determining the work center schedule	P			s
Choosing routings for production	P			s
Undertaking a cost reduction analysis	s	P	s	s
Deciding to change manufacturing processes		P		s
Changing methods for setting or revising standard costs	s	P	s	
Establishing overhead application rates	s	s	P	
Developing quotes or bids for new business			P	s
Revising transaction cut-off practices		s		P
Revising the form or frequency of cost accounting reports			s	P

KEY TO NOTATIONS:

P - The manufacturing choice is expected to provide primary support for acceptance or rejection of this hypothesis.

s - The manufacturing choice is expected to provide secondary support and explanatory information for this hypothesis.

The decisions listed in Table 8 are discussed in the next several paragraphs, classified according to the four cost accounting activities.

Decisions Related to the Cost Identification Hypothesis

Manufacturing operations are carried out in configurations which form natural boundaries of management responsibility [Harrington (1984)]. Manufacturing decisions that rely on cost information may be affected significantly if cost centers are restructured. Two representative manufacturing decisions were selected to determine whether reconfigured processes and revised cost centers have affected how those decisions were made: (1) determination of a work center schedule and (2) the choice of routings (regular or alternate) for a process. These decisions are linked with the cost identification hypothesis.

Determining the work center schedule. Decisions regarding the schedule of work at shop floor work stations are typically made each week [Vollmann, Berry and Whybark (1984)]. Capacity limits at critical work stations require judgments of priorities, the basis of which at least in part depends on cost effects. Since capacity is likely to be managed more precisely in CIM (to accommodate more variety), there should be observable differences in the way these decisions are made in a CIM environment compared with a traditional batch environment.

Choosing routings for production. Routings specify the locations and sequence through which production is directed (routed). Standard routings are specified by the manufacturing engineering function. Alternate routings may be selected for a production order when called for by priority assessments, or to reduce the work at an overloaded work center [Vollmann, Berry and Whybark (1984)]. The choice of alternate routings may result in unfavorable standard costs variances at individual work centers, and yet this may be a cost effective choice when viewed collectively with other work stations and other orders. The information available in a CIM setting facilitates the process of choosing alternate routings. Cost accounting measures of standard cost variances can attribute to the appropriate responsibility area the responsibility for utilizing alternate routings.

Investigating existing procedures and documentary evidence for setting the work center schedule and choosing the production routings should provide evidence of changes in designated cost centers if such changes have occurred after CIM was implemented. If the designation of cost centers have not changed, this may be evidence of a lag in the adaptation of cost accounting procedures. Alternatively, it may suggest that the cost accounting-designated cost centers need not line up precisely with natural manufacturing responsibility boundaries. That is, cost information derived from boundaries designated by cost accounting is used without adjustment or reinterpretation in making manufacturing decisions.

Decisions Related to the
Cost Entry Hypothesis

Cost accounting has much to do with the definition of transaction points at which costs are collected. Manufacturing operations involve decisions made on the basis of aggregated costs collected at data collection points. Decisions or actions involve collected accounting data and therefore might be affected by the redefinition of collection points. Three representative decisions were selected because the decisions depend on cost collection mechanisms: (1) undertaking a cost reduction analysis, (2) changing a manufacturing process, and (3) changing the methods used to establish or revise standard costs. These decisions are linked to the cost entry hypothesis.

Undertaking a cost reduction analysis. A theme of the CIM setting is a continual effort to identify cost reduction opportunities [Hall (1983)]. This can involve an analysis of the build-up of the total cost of a completed component or an analysis of cost alternatives for manufacturing tooling or processes. The purpose of cost reduction analysis is to identify sources of cost incurrence, discover opportunities to reduce costs, and thereby gain a competitive advantage [Porter (1985, Chapter 3)]. In a CIM setting, there should be observable evidence of a continuing effort to identify ways to reduce costs. There should also be evidence that cost information provided by cost accounting systems is being used to track the incurrence of costs to causal sources.

Deciding to change manufacturing processes. Decisions to change the application of manufacturing processes are made partly on the basis of costs. An example is a decision to fabricate components by sending materials out to an outside processor. This is a "make vs. buy" decision, the resolution of which depends on the determination of the cost of the "make" alternative contrasted with estimated costs of outside processing. In the CIM setting, there is likely to be recurring use of cost information for making alternative choices regarding manufacturing processes with greater frequency than is true in the traditional setting [Gunn (1982)].

Changing methods for setting or revising standard costs. Traditional methods of standard setting utilize cost accounting data files, which are established with information provided by the purchasing and engineering functions. Since the CIM environment relies on unified data bases, changes in cost accounting practices for setting cost standards would be expected. In particular, CIM cost accounting systems would be expected to use unified CIM data base files and not establish their own data files for cost standards [Gunn (1982); Harrington (1984)].

These choices should reveal changes in cost data collection ("trigger") points if such changes occur after CIM is implemented. A close analysis of causal origins of costs, such as those taking place in a cost reduction study, would reveal instances where costs are being collected at illogical or otherwise inappropriate trigger points. Therefore the trigger points would be changed; likewise for decisions to change the manufacturing processes. Decisions to change the methods for setting or revising standard costs may result from initiatives of either production management or cost accounting. If the introduction of CIM changes the underlying assumptions of cost standards, revisions of standard setting methods are likely to occur.

Decisions Related to the Cost Assignment Hypothesis

Cost accounting systems assign costs initially to cost centers for ultimate reassignment to products or other cost objects. CIM strategies and practices may justify revisions to cost assignment concepts or procedures. Two decisions were selected to test the impact of revisions made to cost assignment practices: (1) establishing overhead application rates and (2) developing cost estimates to quote for new business. Both decisions are linked to the cost assignment hypothesis.

Establishing overhead application rates. The concepts and procedures for setting overhead rates may undergo revision in CIM settings. The objective of such revisions would be to attain a better match of overhead costs with production activity factors, with the general purpose of effecting better control over overhead costs [Cooper and Kaplan (1988)]. This may include restructuring of overhead pools or revising the identification of the overhead application factors [Johnson and Kaplan (1987)].

Developing quotes or bids for new business. When new business is obtained, the additional scope of operations may change existing patterns of manufacturing, which in turn may affect existing cost assignment practices. Furthermore, the preparation of the quote may involve interpretation of special aspects of circumstances that pertain to the subject of the quote. Realistic, well-measured, and accurate cost data are required to develop quotes for new business. Traditional cost measurements may be revised in CIM by integrating cost accounting data with data provided by other functional areas [Gunn (1982); Harrington (1984)].

Each of these decisions would be impacted by changes in cost assignment practices if such changes follow the implementation of CIM. In the CIM environment, where overhead rates established according to traditional practices would be extremely high, it is reasonable to expect to find alternate ways of measuring the overhead costs incurred as well as different overhead application factors. The motivation is to classify the overhead costs to permit direct rather than indirect measurement, and then to assign the incurred costs with direct application factors. Consequently, compared with the traditional setting, the CIM setting should have the overhead costs classified into a larger number of pools, with each pool having assignment factors that differ from the traditional factors (labor hours, labor costs, machine hours). Examining procedures used to develop quotes for new business should also reveal support for the hypothesis on changes in cost assignment practices. CIM brings intensive cost reduction competitive pressure; as a result, there should be close analysis of cost elements and procedures for cost assignment.

Decisions Related to the <u>Cost Reporting Hypothesis</u>

Two decisions were selected to represent cost reporting: (1) revising end-of-period transaction cut-off practices and (2) revising cost accounting reports -- form and frequency. Both of these decisions are linked to the cost reporting hypothesis.

<u>Revising end-of period transaction cut-off practices</u>. It is not unusual in the traditional setting to find a lag between resource events in manufacturing areas and the accounting entry of the events [Reeves and Turner (1972)]. The lag allows for the processing of documentation, which sometimes must wait for all paper work to be gathered. For example, a purchase may be received as an account payable, but not entered until the vendor's invoice is matched with a purchase order and receiving ticket. Special manual accruals may be required at month-end or year-end to enter "cut-off items" into the accounting system.

Cut-off lags pose a problem to CIM data base systems where all functions are operating from the same data files. An integrated data base system requires that the accounting transaction "cut-offs" match those of the manufacturing data entry systems [Vollmann, Berry and Whybark (1984)]. Where CIM has been introduced, revised cut-off practices should follow.

<u>Revising the form or frequency of cost accounting reports</u>. The CIM setting requires continual knowledge about the status of manufacturing resources or operations and frequently calls for simulating alternatives [Groover and Zimmers (1984)]. More frequent need for status data and use of simulation for decisions may lead to revised reporting practices

for cost information. Such revisions may result from restructured cost centers, which would change existing practices for accounting for overhead costs, and would change the hierarchical structure of responsibility accounting reports.

CIM impacts cost reporting with tighter linkage between cost accounting data and data maintained by other manufacturing functions. Therefore the manufacturing and cost accounting cut-offs of data entry should coincide, an attribute which is more critical than in the traditional setting. This should lead to revised cost accounting cut-off procedures to ensure that accounting transaction data are accurate and complete, and that they coincide with recorded manufacturing transaction data. Along with changes in cut-off procedures, related revisions in the form and frequency of cost accounting reports are likely, especially with respect to on-line data inquiry capabilities. In the CIM setting, demand frequently exists for cost accounting data to do "what if" analyses when developing plans and schedules. Compared with the traditional setting, cost data in CIM are more often needed at the "front end," before production takes place. This need may lead to revised ways and means of reporting cost data.

The nine representative decisions, together with characteristics of CIM determined from CIM background literature were the basis for constructing the Field Interview Guide, which is reproduced in Appendix I. Sites were selected by contacting selected firms in Michigan and nearby states. Arrangements made for visits to the sites were confirmed in an arrangement letter, reproduced in Appendix II. Specific site visit procedures are discussed in the next section.

SITE VISIT PROCEDURES

Discussion of the site visit procedures includes (1) advance arrangements and (2) interview procedures.

Advance Arrangements

After making initial contacts with prospective firms about participating in the study, a meeting was set at their premises, where the objectives and scope of the study were explained. When they agreed to participate, an arrangement letter was provided to them, in which the data gathering procedures were described and assurance was given to keep proprietary data confidential. An example of such an arrangement letter is reproduced in Appendix II.

Interview Procedures at Site Visits

Several visits were made to each of the sites, where interviews were conducted with several people holding various positions. Company personnel were provided copies of the interview guide, and questions were usually allocated to several individuals according to the nature of the questions.

All participating companies permitted tape recording of interviews, provided that there not be extensive quoting of comments directly in the research report. Interviews were preceded by a plant tour, for which plant lay-out sketches were usually provided. Each interview lasted from one to two hours. People interviewed had responsibility for such positions as plant managers, design engineering, plant engineering, marketing, production scheduling, purchasing, plant supervision and cost accounting. Similar questions were frequently posed to more than one interviewee at a plant; repeated questions enabled inconsistencies to be detected and clarified and helped strengthen the validity of the responses. Whenever possible, interviewees were asked to cite or provide examples, including copies of documentation. Care was taken to listen responsively, encouraging elaboration but without influencing the interview content. Taping of the interviews was done unobtrusively and with the consent of the interviewees. Each interviewee was assured that their comments would be kept confidential, not discussed with others and would not be traceable back to them or to the company. There was no evidence that recording the interviews had any effect on the content of the interviews.

Each company provided numerous examples and was very cooperative. Example documents obtained at the companies included:

Bills of materials and labor routings for a typical product
Examples of cost estimates for quotations
Chart of accounts
Organization charts

Proprietary data obtained were kept confidential. All companies were concerned about the risk of sharing proprietary data, especially data pertaining to pricing practices and technology of manufacturing processes. At times it was difficult to ascertain whether data requested were in fact proprietary. These situations were typically resolved by obtaining examples with hypothetical numbers rather than real numbers.

POST-VISIT DATA ANALYSIS PROCEDURES

Following the site visits an extensive amount of data analysis was done to identify and isolate findings for summarization in Chapter V. The data analysis procedures are described in this section.

Transcription of Interview Tapes

After the interviews, the tape recordings were transcribed, and they became the primary source for data analysis. Each tape was played and transcribed personally by the researcher. Once transcribed, the transcriptions were read as the tapes were replayed, and errors or omissions were corrected. More than forty interviews were conducted. The transcriptions exceeded 600 single spaced pages.

Search Through Transcriptions for Findings

The transcribed interviews were then read meticulously in search of "findings" relevant to the theory developed in Chapter III. A typical "finding" is a statement by an interviewee that pertains, directly or indirectly to a particular hypothesis or hypothesis focus point. Each finding was extracted and copied, and a caption and explanatory comment were added. Here is an example of a specific finding from one of the sites that pertains to a focus point on Accountability and Data Ownership:

> **Creating a Sense of Ownership.** This comment suggests the importance of a sense of data ownership: "It's a matter of ownership. If you give them a sense of control, they begin to own that process. They begin to own the responsibility to use it and keep it updated. But they cannot own it unless they understand it." [comment by a cost accountant at Dolnar]

More than 800 specific findings were discovered and classified.

Analysis of the Specific Findings

The next step was to group the specific findings into collections from which a more aggregate, higher level of results could be obtained. The specific findings were classified by hypothesis and focus point. Some were identified as "major" findings relevant to the hypotheses or focus points; others were classified as "minor" findings supporting the major findings. From this analysis, a set of more than 130 "major" findings were obtained. These were synthesized into a smaller set of "focus point issues" and used to prepare the analysis presented in Chapter V.

SUMMARY

The design of this study provides for comparisons of four pairs (CIM and traditional) of manufacturers, where interviews were carried out and documentation obtained in accordance with the Field Interview Guide reproduced in Appendix I. All interviews were transcribed. A thorough analysis of transcribed interviews provided a set of major findings and a basis for synthesis of results, which are reported in Chapter V.

CHAPTER V

THE EMPIRICAL FINDINGS

INTRODUCTION

Visits were made to each of the four CIM and four traditional plant sites described in Chapter IV. Interviews were conducted at each site with persons holding accounting, engineering and production positions, including plant managers, plant accountants, engineers, production schedulers, and factory supervisors. Each interview lasted one to two hours and each site visit lasted about three days. The sources of empirical data were transcripts of the interviews, notes taken during tours of the plant facilities and a limited amount of company documentation.

All of the interviews were tape recorded. The taped interviews were transcribed and analyzed in detail. More than 800 individual "findings" were derived from close analysis of the empirical data.[27] Each individual finding was cross-referenced to one of the hypothesis focus points developed in Chapter III. Once cross-referenced, the findings were then synthesized into a smaller set, which became the basis for this chapter.

The chapter is organized into four sections:

- The initial section presents several important "salient" findings deduced from the empirical data.

- The second section summarizes the extent to which support was found for the research hypotheses.

[27]The term "finding" is defined in Chapter IV and an example of a finding is presented there.

- A third section that summarizes the findings in connection with the hypotheses "focus points" from Chapter III.

- A final section to draw conclusions about the role of cost accounting in CIM compared with traditional manufacturing.

Conclusions, recommendations, and ideas for further research are given in Chapter VI.

SALIENT FINDINGS

Certain key, "salient" findings were deduced by interpreting the underlying implications of the empirical data. These findings are major issues pieced together from patterns suggested by specific findings. As discussed in Chapter IV, one of the objectives of a field study design was to identify patterns that reveal generalizable characteristics or concurrent relationships [Seashore (1961)]. The salient findings are derived by broad interpretation and therefore are not presented with detailed support, specific examples, or quotations from interviews. That kind of support is given for findings discussed in greater detail later in the chapter.

The underlying theme of the salient findings is that CIM managers are not satisfied with their cost systems in two ways:

(1) Costs are identified ambiguously in CIM cost systems, making costs difficult to manage.

(2) In CIM, product costs cannot easily be penetrated (decomposed) to identify cost driver sources; therefore, managers cannot easily assess the cost effectiveness of their resource management decisions.

Both points of dissatisfaction were evident in interviews with managers at all of the CIM sites. Managers said that costs are hard to manage because cost drivers are ambiguous, cost systems do not help them discover and eliminate sources of production waste, and cost systems exaggerate the importance of measures of labor efficiency and utilization.

In spite of these concerns, the study findings suggest that cost systems are not adapting quickly to improve cost identification and to make reported costs more penetrable. What explains this apparent lag in adaptation of cost accounting systems? Why do cost accounting activities fail to identify costs unambiguously and fail to determine product costs that can be traced back to cost driver sources? There appear to be three principal reasons:

(1) Cost accounting as a function is not providing enough leadership in the pursuit of cost management objectives,

(2) The nature and resource events of CIM technology applied to integrated manufacturing processes are not well specified in data available to cost systems, and

(3) Too much reliance is being placed on direct labor to assign costs and judge production effectiveness; the worker resource is not an effective surrogate for other technological resources used in manufacturing processes.

Cost Accounting as a Function Should Provide More Leadership

Cost accounting does not seem to have clear responsibility for either leading or supporting cost management as a strategic manufacturing objective. Cost accounts, account groupings and assignment bases are driven more by intra-company financial reporting forms and accumulation procedures than by cost management requirements. Cost accounting can provide a sharper focus on cost driver activities by adapting account names, account groupings, cost centers, transaction triggers, and assignment factors.

Manufacturing's Technological Resource Events are not Well Specified

CIM is organized and managed differently than traditional manufacturing, but the revised patterns of resource events are not well articulated in revised routings or in new ways to quantify production output events for cost recognition. Cost management systems use engineering and production data to trigger cost transactions and to assign costs to cost objectives. Inadequate or imprecise articulation of resource events makes it difficult for accounting to improve its choice of trigger events, or its factors used for cost assignment.

At each CIM plant site, managers said that their cost systems do not recognize costs in enough detail, in large part because costs are not captured close to where the resource consumption or usage occurs. Cost drivers are obscure and consequently costs are hard to manage.

Manufacturing cells had been formed at each of the CIM sites. Presumably, the revised patterns of production flow through cells might have precipitated changes in cost centers, transaction triggers and cost assignment factors. However, there was far less change in these areas than expected. The means of cost recognition used by the cost accounting systems had not changed at the sites where the processes had been reconfigured. Account titles were not revised to capture the technological nature of production costs more precisely. Accounts were not regrouped into categories by resource class. New transaction triggers were not specified to capture costs closer to where resources were consumed or used. Without these kinds of changes, managers would understandably sense that cost drivers are not well identified.

The comments of the CIM plant managers strongly suggest that traditional means of recognizing costs are too coarse. When costs are recognized coarsely, plant managers find it difficult to decompose costs of finished products to underlying cost drives or resources consumed. The findings also suggest that adapting cost systems to improve cost identification is difficult to do. In CIM, costs driven by technological, non-labor resource events are not as well specified in engineering or production data as are events involving direct materials or labor. Furthermore, changing cost systems is complicated because it involves internal financial reporting and budget systems and inter-plant reporting procedures in multi-location divisions. Companies appear to adapt cost systems slowly and cautiously.

Direct Labor is not an Effective Surrogate for Technological Resources

Cost systems at CIM plants rely on traditional measures of direct labor to assign costs of technological resources used or consumed in conversion. Direct labor is used to assign costs of equipment technology, tooling, production flow logistics, and other production support that are not driven directly by workers' tasks. But although other bases might logically be preferred, they were not readily available. Technological resources were not easily measured by cost systems, because events involving support for non-labor resources were not well articulated in engineering or production data. Workers' wages are measured more regularly and in more detail than other technological resources, which explains why measures of direct labor are relied upon as a surrogate for other resources used in conversion.

Measures of direct labor are also used to assess efficiency and utilization in production. Managers at CIM sites were critical of cost management systems' emphasis on measures of labor efficiency and labor utilization. Their complaint was that total plant efficiency results from the combined, integrated operation of all product cell areas. Measuring the efficiency of each individual area, or of individual workers, does not assure aggregate efficiency. The managers observed that strategic objectives and commitments may at times require less than total utilization of all direct laborers. Cost systems of CIM plants measured labor efficiency and utilization in more detail than the efficiency and utilization of equipment, tooling and technology. But technological non-labor resources may have more to do with effective production than tasks performed by workers.

The salient findings suggest that better linkages are needed, both among the four cost accounting activities and between cost accounting systems and strategic manufacturing objectives. Linkages can break down for several reasons, including:

- when transaction triggers are remote from where demands are placed on resources,
- when cost assignment factors do not relate support costs with resources being supported,
- when too much reliance is placed on direct labor to assign costs of non-labor resources,
- when cost assignment is based on product cost objectives that poorly reflect cost management objectives, and
- when structural constraints of financial reporting and inter-divisional reporting requirements hamper attempts to direct cost reports at strategic manufacturing objectives.

Future integration of cost accounting activities with CIM objectives depend on solutions to these linkage problems.

SUPPORT FOR THE RESEARCH HYPOTHESES

Having discussed the salient findings, the discussion now turns to the research hypotheses. Since the CIM sites had not changed their accounting procedures for cost identification or cost entry, the findings, in general, do not support the research hypotheses. Given the absence of change in cost identification and cost entry procedures, it is not surprising that further change in cost assignment and cost reporting was also not found.

The individual hypotheses were evaluated in terms of levels of support, defined by the number of CIM plants where the hypothesized changes were found. "Change" is defined as differences in accounting practices observed in the CIM plants in contrast to the traditional plants. If the changes were found at one CIM site or none, the hypothesis was judged to be "not supported." If the changes were found at two of the four CIM sites, the hypothesis was judged to be "weakly supported." If the changes were found at three or four CIM sites, the hypothesis was judged to be "supported." In addition, the empirical data was used to evaluate the support for the hypotheses focus points. The evaluation of the support for the focus points contributed to the conclusions about the support for the hypotheses. The discussion of hypothesis support begins with the Cost Identification hypothesis.

COST IDENTIFICATION

In earlier chapters, the case was made for redesignating cost centers and account classifications to improve cost identification. The expected result is designation of more (but smaller) cost centers and revisions of account groupings. The cost identification hypothesis is:

Hypothesis 1: Compared with the traditional setting, CIM will lead to a greater number of cost centers, which will be smaller in size. In addition, classification and groupings of accounts will be based on a wider set of resource groups than materials, labor and overhead.

Limited findings from three of the four CIM sites support the cost center component of this hypothesis. Each of the CIM sites had in fact formed some new cost centers for product-focused cells. However, little evidence of comprehensive revision in the designation of cost center boundaries to improve cost identification was found. Less support was found for the other components of the hypothesis. Few revisions of account titles had been made at three of the CIM sites to better reflect the nature of CIM resources in use. Only at one site were some account groupings changed to match resource classes.

In general, changes in cost identification were occurring gradually and cautiously at all of the sites. While certain aspects of the hypothesis were supported, no support was found for others, and so a "weak support" conclusion was attributed to the hypothesis as whole.

The findings include substantial justification for new cost centers where product-focused cells are formed in CIM plants. New cell areas were formed at the CIM sites when new product designs were put into production, and new cost centers were formed for those cells. At two CIM sites, large departments were divided into two or three smaller departments after major rearrangements of equipment or installation of equipment with advanced, flexible technology. Managers holding various positions at each of the CIM sites expressed a desire for more, smaller cost centers.

However, the evidence was less clear that cost centers were redesignated to *improve* cost identification. The CIM elements at the sites were being implemented gradually and so accounting systems changes were occurring gradually also. Cost account classifications and account groupings were not changed to any significant extent beyond ordinary occasional changes that occur from time to time. Discussions with plant accountants indicated that production and engineering managers were not requesting extraordinary changes, which they would usually make only in response to a specific need. Higher level accounting managers were not pushing for change nor promoting integration of cost management objectives with financial reporting objectives.

The accountants also said that changing cost systems is complex because it involves inter-plant reports and budget determination procedures. The plants were constrained from making radical, sudden changes to their cost systems because their accounting and reporting procedures had to conform with other plants within the same division.

To summarize, the findings suggest that the ways of identifying and classifying costs in CIM plants were changed to a limited extent by establishing smaller cost centers where cells had been formed. Some new accounts had been created to better reflect the nature of technological resources in use. Substantial revisions of cost centers or account classifications and groupings had not occurred, however, for the express purpose of improving cost identification. Managers claimed that their costs were being identified ambiguously, which was a source of dissatisfaction with cost data.

COST ENTRY

While the cost identification hypothesis deals with the pre-established mechanisms for classifying cost accounts and responsibility areas, cost entry is concerned with capturing costs at the right time in the right places. Given the patterns of resource events of CIM and the techniques available for capturing data, it is hypothesized that a different set of resource events would be selected as cost transaction triggers. The cost entry hypothesis is:

Hypothesis 2: The events critical to effective CIM production management are different than the events that "trigger" cost accounting data in traditional costing systems. Therefore, cost transaction triggers in CIM will be greater in number and diversity than those of the traditional setting.

Essentially, the findings do not support this hypothesis. At no site was evidence found of the existence of an expanded set of diverse cost transaction triggers. The resource events used as transaction triggers were basically the same at all sites: labor "pay points" and inventory "entrance/exit" transfer points.[28] Between entry and exit

[28] A "pay point" is where production output is measured for purposes of computing wages of workers.

points are interim events where demands on resources can be measured. These include labor pay points, of course, but also include other points where data are available, such as where scheduled work flow is released, quality assurance is ascertained, tooling and technology is applied, or production flow is interrupted. Given the existence of these data sources and of CIM's data collection techniques, more trigger points should be expected. But this was not borne out in the findings. The cost systems did not utilize these potential triggers to any significant extent at any of the sites visited.

Discussions at the sites suggest two possible explanations for the lack of change in transaction triggers. First, the advantage in improving transaction triggers is not clear to either accountants or resource managers who want and use cost data. While both accountants and managers generally agreed that costs are difficult to capture in "pure" form close to where costs originate, they did not perceive how using different trigger events would help provide better costs. Second, (based on interview discussions) accountants seem to have the view that collecting cost data just for the sake of cost data is a questionable objective. Their view was that since collecting cost data is costly, cost data that are collected must be limited to what is generally available as production or engineering data. This is a curious view in comparison with other functions that require data. For example, the engineering and production functions are not hesitant to specify the kind of data required to accomplish their purposes, but the accounting function is more reticent in this regard.

In summary, the cost entry hypothesis was not supported by the findings. There was no evidence that the CIM sites chose different resource events as transaction triggers than the traditional sites. At two CIM sites some evidence was found of attempts to place transaction triggers closer to events where resources are consumed or used to more closely reflect demands on resources.

COST ASSIGNMENT

Given the hypothesized changes in cost identification and cost entry, the cost assignment hypothesis expects improved linkages between recognizing, capturing, and reporting costs. This includes improved procedures for pooling and redistributing costs to achieve a better match between resources and costs of supporting those resources. Therefore, support costs will be matched with resources supported by using resource cost pools and relevant assignment factors. The cost assignment hypothesis is:

Hypothesis 3: Cost assignment in CIM will be changed by explicitly relating support costs with resource costs and assigning both types of cost to cost objectives by class of resource, using relevant cost assignment factors. This is contrasted with traditional manufacturing where all overhead costs are typically assigned based on direct labor or some other single factor.

This hypothesis is weakly supported by the findings, in this sense: more kinds of overhead costs were being charged directly to cost centers based on resource demand factors rather than assigned through allocations. Accountants realized that such costs as engineering, maintenance, computer-aided equipment software, and technical assistance were too significant to be obscured in overhead allocations from large pools of costs. More specific factors were being used to assign certain kinds of engineering and technological overhead costs.

However, the findings do not support the hypothesized expectation separate pools would be created by class of resource or that support costs would be classified by resource. Although overhead pools generally contain some indirect costs of resources consumed and some period-oriented absorption of fixed capacity costs, the largest portion of overhead pools is for support of resources. Yet, the overhead pools at the sites did not reflect any special distinction for support costs. The accounting classifications and assignment procedures were quite detailed with respect to direct materials and direct labor, but were less detailed for all other production costs.

To summarize, the hypothesis was that CIM plants would have changed their overhead pools and cost assignment practices to relate support costs with the kinds of resources supported. The strength of the findings in this regard was less than hypothesized. While the CIM sites had made overt attempts to charge overhead costs directly where possible, their overhead pools were not sub-divided into separate pools by class of resource.

COST REPORTING

CIM plants are expected to have different cost reporting objectives than traditional plants, mainly because of a difference in strategic manufacturing objectives. Traditional plants focus on absorbing costs into products and minimizing costs of labor inefficiency or idle time.

CIM's focus on delivery reliability, quality and responsive flexibility will require suitably revised cost objectives, which report how and where costs are incurred.

CIM has a daily or weekly time horizon for production plans and schedules, whereas traditional accounting systems have a monthly time horizon. CIM's comparatively shorter time horizon will likely stimulate frequent demand for cost data, requiring that the data be kept current throughout each month. A daily or weekly up-dating cycle is preferable to a monthly cycle.

Incorporating the expected changes in cost objectives and time horizon, the cost reporting hypothesis is:

Hypothesis 4: In the CIM setting, accounting information will be up-dated more frequently, "real-time" query form of reporting will occur more frequently, and the focus of periodic accounting reports will be on strategic manufacturing objectives versus the financial product costing objectives of the traditional setting.

This hypothesis is weakly supported by the findings. At the CIM sites, more reporting was done for cost management objectives (although some of this was in special reports prepared on local micro-computers). Also, the cost data were being up-dated more frequently at CIM plants than the traditional once-per-month updating cycle at traditional manufacturing plants. However, not as much "real-time" (on-line) inquiry of cost data was found as was expected. Since the only support found was for informal cost reporting, the hypothesis was determined to be weakly supported. Very little formal accounting system change had taken place to support cost reporting for strategic manufacturing objectives.

Interview discussions with engineers, product managers, and other non-accountants indicated that when product cost estimates were required, they did not use cost data reported from the cost accounting system. Instead, they sought cost data from non-system sources, such as telephone inquiry or manual calculations. Furthermore, resource managers were not relying on system-provided cost data to make production decisions such as production lot sizes, lot sequence, or frequency of set-ups. They considered costs and tried to minimize costs; their interview comments confirmed their cost minimization intentions. But their assessments of cost effects were either intuitive or based on manual (off-system) analyses.

Engineers and production managers were asked why they hesitated to use cost data directly available from the accounting system. They replied with various reasons, which, taken together, suggest that cost data obscure cost consequences of decisions or actions. In particular, cost data provide neither a sufficient perspective of total costs at a macro level, nor enough detail about costs by significant classes of resources. Furthermore, cost data were not tuned to the daily or weekly time frame typical of integrated manufacturing; the traditional monthly time frame continued to drive much of the cost data. For all of these reasons, managers were not using on-line inquiry to a much greater extent in CIM plants than in traditional plants.

In summary, the findings support the cost reporting hypothesis, although one aspect -- the use of on-line inquiry -- was not supported. Furthermore, although cost reporting at the CIM plants was different than cost reporting at the traditional plants, the difference was not radical. The differences observed pertained to provision of detailed costs more frequently, primarily with special reports prepared outside the formal cost system. There was far less difference in the formal processing and reporting of cost data than hypothesized.

Summarizing for all hypotheses, the empirical data from the eight sites support three of the four hypotheses, but the contrast between the CIM and traditional sites was less pronounced than expected. A different set of sites might have yielded a sharper contrast. Had the CIM sites included some highly automated plants with very advanced CIM technology in use for several years, the results might have shown more contrast. However, the findings may be representative of the existing situation in many companies in the transition from labor-oriented traditional cost accounting to resource-oriented cost management accounting of CIM.

ANALYSIS OF HYPOTHESES FOCUS POINTS

Although the findings did not provide strong direct support for the hypotheses, the empirical data include many findings that are interesting and informative beyond specific support for the hypotheses. Hypothesis focus points developed in Chapter III were used to identify and classify these other informative findings. Table 9 lists the focus points. Following the table, the findings for each focus point are discussed within the context of the basic premises of the research hypotheses.

TABLE 9

LIST OF HYPOTHESES FOCUS POINTS

COST IDENTIFICATION
- 1.1 Redesignation of cost centers
- 1.2 Classification of resources and support
- 1.3 Identification of cost management responsibility
- 1.4 Classification of direct costs

COST ENTRY
- 2.1 Placing triggers close to resource events
- 2.2 Responsibility for cost data -- a sense of data ownership
- 2.3 Triggers for expendable and durable resources
- 2.4 Keeping cost data current

COST ASSIGNMENT
- 3.1 Assigning support costs with relevant resource factors
- 3.2 Assigning costs based on cost management objectives
- 3.3 Penetrable costs with transparent cost assignment

COST REPORTING
- 4.1 Cost objectives and strategic manufacturing objectives
- 4.2 Cost management reporting for cost monitoring
- 4.3 Reporting cost consequences of disruption and waste

COST IDENTIFICATION HYPOTHESIS

The four focus points for the cost identification hypothesis pertain to designation of cost centers to match reorganized manufacturing processes, grouping of accounts for resource costs and related support costs, attributing traceable costs to the level at which they are managed, and direct versus indirect classifications of costs.

1.1 REDESIGNATION OF COST CENTERS

In CIM as contrasted with traditional manufacturing, resources are regrouped to focus on product families and production flow patterns are restructured. Therefore, to retain the homogeneous character of cost center activities, it is necessary to designate more cost centers, which will be smaller in size or area.

CIM plants are organized to focus on product families. Patterns of production flow in CIM plants differ sharply from traditional plants, where large production departments are organized to concentrate on process traits rather than product traits.[29] Each traditional site did in fact have designated manufacturing areas for specialized processes, including stamping, machining, welding, etc. Because product-focused cell areas had been formed at each of the CIM sites, cost centers were expected to be redesignated at those sites. At three of the four CIM sites, new cost centers were established where new cell areas had been formed. Beyond these new cost centers, however, the CIM plants had not redesignated other cost centers to any significant extent. Yet, managers at each of the CIM sites said their cost systems do not identify costs with enough precision. The managers wanted improved cost identification by capturing costs where cost driver events actually occurred. When asked whether smaller cost centers would improve cost identification, the managers said "yes." But, they emphasized that changing cost center structures was relatively difficult to accomplish because the existing cost center structure was ingrained in budget and inter-plant reporting systems.

Three findings were derived concerning redesignation of cost centers:

(1) The CIM plants did reconfigure their manufacturing processes to focus on product traits.

(2) The CIM plants had not changed their cost centers to any significant extent.

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[29] See a comparison of plant layouts (CIM and traditional manufacturing) in Figure 1, Chapter II.

(3) The CIM plant managers were calling for improved, more precise cost identification.

The CIM Plants Reconfigured Their Manufacturing Processes

Consistent with background literature, the CIM sites were in fact reconfiguring their manufacturing processes into "cell" clusters of equipment, each cell focusing on a related group or family of products. Where cells had been created, fabrication areas fed raw steel materials (cut to size) to the cells. The cells in turn performed all necessary machining, welding, and assembly operations to deliver assembled products to painting or shipping areas.

For example, at one CIM site during a holiday period, the entire plant lay-out was revised -- from a sequential push-through flow in a zig-zag, north-south direction to a straight pull-through flow in an east-west direction. Nearly $100,000 was spent to carry out the rearrangements. At the other CIM sites, cells were usually established within larger process areas to concentrate on production for individual customers. In some cases the cells were established with the advice and assistance of the customer whose products were to be produced in the cell. In one case, part of the equipment in the cell belonged to the customer. Cells were being established in each of the CIM sites visited, but the overall changes on cost centers were not occurring.

In observing these changes on plant tours and discussing them during interviews, an important distinction between traditional process-focused departments and product-focused cells became apparent. The distinction is in the homogeneity of costs: costs are more homogeneous in process-focused departments than in product-focused cells, mainly because the resources are more homogeneous in process focused departments. Cells have more kinds of resources and a greater variety of resource event patterns. Costs cannot easily be recognized in cells with traditional means of cost recognition. Cells contain a variety of machines and other resources, are operated by a team of workers in a coordinated way, which means the cell resources are not in constant use. Compared with a CIM cell, a traditional process-focused department has more homogeneous resources and consequently, more homogeneous costs. Its resources typically are in use more consistently. The greater variety of resource events and patterns of resource usage complicate the task of identifying costs.

In the interviews, plant managers were questioned about their motives for establishing cells. Their responses suggest three key motives for forming product-focused cells:

(1) To make the processes achieve very reliable delivery by joining conversion tasks which otherwise are performed in separate locations;

(2) To remove costs from the processes by eliminating duplicate materials handling, reducing set-up costs, and reducing scrap damage and undetected quality deficiencies; and

(3) To keep the processes flexible and capable of responding quickly to changes in design or output quantities demanded.

Plant managers discussed the advantages of cells. They said that forming cells to focus on product families gave them processes that are flexible and versatile, and actually improved the quality of production output. They also reported significant cost savings in several ways. Tooling costs were reduced because of better coordination between machinery and tooling. Improved quality meant less inspection and rework costs. The ratio of labor earned versus labor paid was improved.

Capacity utilization, or "up time," was raised, freeing up additional capacity without additional investment in facilities. Costs of indirect support for materials handling and inspection were reduced. Each of these kinds of cost savings were reported at CIM plants where cell clusters of product-focused resources had been formed.

Cost Centers in CIM Plants Were Not Redesignated on a Large Scale

The CIM sites were expected to have redesigned their cost centers to maintain a certain degree of homogeneity of costs within each cost center. Indeed, where cells were formed for new products, new cost centers were designated for those cells. On the other hand, where cells were formed to concentrate on welding or assembly of existing products, redesignations of cost centers did not occur. Furthermore, very little redesignation of existing cost centers occurred in places where installation of computer-aided machine processes reduced the homogeneity of both resources and costs.

Production managers and plant accountants were asked why smaller cost centers were not designated. Their answers varied, but two of the common explanations were: (1) changing cost accounting systems is difficult if engineering and production data are not available to specify the resource events to be measured by accounting triggers and (2) budget preparation and monitoring procedures may either stimulate accounting adaptation or inhibit it.

Routings procedures were discussed at each of the sites. Based on those discussions, process routings (as opposed to operations routings) are apparently not well developed for application to cells where teams are working with collections of equipment. Traditional engineering routings are generally designed for labor operations performed on individual machines. Thus, since cost accounting data rely on traditional engineering routing data, cost centers may not be redesigned until process routings are established.

Regarding the budgetary impact, resource managers provide budget input data and are accountable for actual results compared with budgets. Accountants at all of the sites emphasized a need for tracking historic data to explain budget versus actual comparisons. The accountants were concerned about non-comparability of budget figures between accounting periods when cost centers are changed. They were reluctant to change cost centers until a certain amount of historic data could be accumulated. Historic data were needed to derive comparable budget figures and to establish assignment factors for overhead costs.

Furthermore, plants that are part of multi-location divisions cannot easily change their budget data structure. Their cost reports need to remain consistent with other plants in their groups. Changing budget structure in such cases poses a dilemma to plant accountants who must do special tracking of what is really non-comparable data. As one plant accountant said:

> The hardest thing is to go from the old ways to the new ways. It is much easier to start fresh, which is what we had to do with our new cells area where we have been tracking the data only since January.

Reluctance to change cost center designations exists because cost centers are part of budgetary structures of supervisory responsibility. Failure to change these structures can lead to inconsistent accountability and supervision between budget structures and manufacturing.

For example, in one CIM plant three individual supervisors had budget performance responsibility for portions of two departments. The manager of this plant said:

> I now have three supervisors in charge of parts of two departments. It makes it difficult to budget. I work out the budgets for all three cost centers myself. I would like to have my supervisors involved in the budgets -- and I would if the supervisors were separately in charge of their own areas. So I try to do what is practically impossible: I try to tell each supervisor what their allotment is. But I just can't control the charges because it is very hard to keep track of who is being charged what, in what account.

In situations like this, where the structure of budget supervision is not matching manufacturing supervision, redesignation of cost centers is advisable but difficult to bring about without disrupting existing budget and financial reporting procedures.

Managers Call For Improved Cost Identification

Plant managers at all of the CIM sites were perplexed by an inability to trace costs to production sources. They stressed that cost systems are not recognizing the resource events where costs actually occur. These comments arose during discussions about capturing costs where manufacturing cells had been formed and production flow patterns had been reorganized. Managers recognized the need for better cost recognition, but plants were not redesignating cost centers because of constraints imposed by reporting and budget procedures.

1.2 CLASSIFICATION OF RESOURCES AND SUPPORT In CIM as contrasted with traditional manufacturing, a substantial proportion of production costs relate to resources other than materials or workers; therefore additional classes of resources and support are carved out of traditional overhead cost pools.

A variety of cost accounts are created to differentiate the source and nature of demands on resources. A reasonable basis for differentiation is by class of resource and CIM involves more classes of resources than traditional manufacturing. Differentiating resources by class makes it feasible to relate support costs to resources supported. CIM sites were expected to have grouped cost accounts by resource class, but they had not yet done so. In fact, their relatively large overhead pools were driven by a variety of cost drivers not well identified by their cost systems.

Each of the plants monitored non-labor costs with reference to direct labor. Overhead costs were assessed in terms of dollars per direct worker, described as costs per "head count." Using "head count" to assess costs of technology and other non-labor resources suggests that production support costs are driven by actions of production workers. The "head count" view is a strong, traditional perspective in managers at all of the CIM sites. Apparently, managers were accustomed to perceiving their own cost accountability in terms of direct labor even though many costs were more related to technological resources than to workers.

Two findings emerged for this focus point: (1) the fact that the nature of cost drivers changes substantially in CIM was not recognized in the account groupings of cost systems and (2) non-labor costs were monitored in terms of cost per direct worker, or "head count," but non-labor costs were only weakly related to direct workers.

Cost Systems Have Not Recognized the Changed Nature of Cost Drivers

When discussing high overhead application rates, managers at CIM sites suggested two reasons for high overhead rates. First, in CIM there are fewer production tasks assignable to individual workers. More of the work is done in teams. Consequently, there are fewer jobs that can be measured as direct labor and less of the output can be associated with individual workers. Second, compared with traditional manufacturing, CIM has more cost drivers due to greater dependence on applied technology and information. Costs of tooling and other forms of applied technology, information and production support are traditionally classified in overhead costs. As a result, overhead costs are very significant in relation to direct labor.

Continued use of traditional overhead account classifications and assignment methods in CIM indicates a failure to recognize the changed nature of cost drivers. The plant managers at the CIM sites were aware that overhead has a different composition in CIM. At three of the four CIM sites, production managers and plant managers said they believe: (1) much of the overhead supports production and can be identified with and charged against the resources supported and (2) more detailed knowledge about the composition of overhead would help them make decisions involving priority trade-offs. However, these opinions had not led to changes in the identification of overhead costs at the CIM sites.

Technological Resource Costs are Monitored with Direct Labor

Overhead costs are presumed to be driven by, and incurred in support of, direct labor. At both CIM and traditional sites, overhead costs were not only assigned with direct labor, but were monitored and evaluated with reference to direct labor. For example, one of the CIM sites produced very detailed reports showing, line-by-line, each overhead cost as a percentage of direct labor costs. A labor orientation also appeared in the classification of overhead costs. Overhead costs for labor-oriented activities are classified in some detail, but costs of technology, information or technological support were lumped together into single pools.

To summarize this focus point, none of the sites reclassified its accounts into new classes of resources, and none formally recognized the distinction between resource costs and support costs. The changing nature of cost drivers in CIM were not reflected in revised cost systems' account classifications. Groupings and significant costs of non-labor technological resources were monitored in terms of direct labor or "head count."

1.3 IDENTIFICATION OF COST MANAGEMENT RESPONSIBILITY In CIM as contrasted with traditional manufacturing, some costs are incurred by individual cost center but are managed at a higher integrative responsibility level; thus, such costs although traceable to individual cost centers are assigned to the higher responsibility level cost centers.

Accountability for a particular cost is usually assigned to the cost center to which the costs can be traced. Linking cost accountability with traceability is appropriate for independent cost centers that have clear responsibility for traceable costs. But CIM plants have inter-dependent cells for processes between materials fabricating areas and shipping of products. Precisely scheduled shipments often include combinations of products for a single order, scheduled for delivery right from production. Meeting tight shipping commitments requires coordinated output from all cells. More coordination of process areas is necessary in CIM than in traditional process manufacturing areas, which are sequential and relatively independent of each other. Accordingly, costs of CIM processes cannot be strictly managed at the level of local cost centers only. In CIM, costs are not necessarily managed where they are traceable; instead they are managed within the context of a larger integrated collection of process areas.

With this in mind, the findings of the CIM sites were examined for evidence of a distinction between where costs were traceable (a local cost center) and where costs were assignable (a higher level cost management level). Given the kind of close coordination between shipping and cell process areas, it was expected that methods of monitoring integrated costs over entire cell areas would have been observed.

Three of the four CIM plants identified costs only where they were traceable, at the local cost center level. The other CIM plant had taken steps to rely on a "visual information approach" (per the plant accountant) to make it less necessary to rely on cost accounting output to assess cost performance of the cells. Included in this "visual information approach" were signs and charts kept posted near the cells in full view of the cell teams. These charts tracked materials, tooling, scrap and other resource costs. Also, the parts containers were color coded and stacked prominently near the cells to permit easy determination of upcoming production.

Circumstances observed at all of the CIM sites support the notion that costs cannot be simply monitored only where they occur and are traceable; they also are monitored at higher, coordinated levels. However, at the CIM sites in this study, higher level monitoring was not supported by cost data provided for that purpose.

An observation emerged after taking the plant tours and considering the comments of the managers: cost systems can make a distinction between replenishment production and committed or scheduled production. Replenishment production occurs in basic fabrication areas that convert purchased raw materials to usable form for component production. At two of the CIM sites, these areas are set up to produce only on demand in order to replenish previous output as it is taken from them. Containers in these areas are designed to trigger replenishment production as the containers are emptied. Costs transaction triggers for replenishment areas can be very simple. They are replenishment triggers similar to typical imprest petty cash replenishment vouchers. The act of replenishment is the basis for managing the costs and the corresponding capturing of costs by the cost system. Committed or scheduled production occurs in areas that produce to meet a specific delivery objective. Transactions in committed areas can be triggered in more conventional ways, either by production orders completed or by traditional process costing measures. In either case standard costs can be used.

Costs of the committed (as opposed to replenishment) variety are likely to be traceable to a lower management level than where the costs are actually managed. None of the CIM sites distinguished between the type of production -- replenishment or committed -- in the type of transaction triggers they used. While recognition of higher level responsibility for committed costs was evident at the CIM sites, little evidence was found of actual changes in the assigning of committed costs to responsible managers.

1.4 CLASSIFICATION OF DIRECT COSTS — In CIM as contrasted with traditional manufacturing, some worker-related and technology-related costs traditionally classified as indirect are now classified as direct; examples include costs of set-ups, inspection and maintenance.

Apparently identifying costs as direct costs is preferable to pooling and redistributing costs through allocations. Resource managers at several of the sites (both CIM and traditional), said they have more confidence in direct costs than they have in allocations of pooled costs. They believe that costs charged directly are identified better than indirect costs. This was the subject of extended conversation and inquiry with several managers at six of the sites. Piecing together their observations, an explanation was developed of why the direct versus indirect cost classification is important to them.

In the view of production managers, costs classified in indirect cost accounts are not all necessarily "indirect" since some may be identifiable with units of output or with individual cost centers. Examples include maintenance, machine repair, technological machine instructions and software, and tooling. Managers are uneasy about being charged for these costs in the form of redistributed costs because they suspect the allocations do not reflect their personal efforts to manage the costs. In one plant (which happened to be a traditional plant), for example, a computer terminal on-line access connection was placed at the disposal of a department manager so the manager could inquire about departmental costs as often as desired. Interestingly, the department manager said the greatest benefit was to be able to challenge and correct cost assignments to her department.

The CIM managers observed that as long as the other "indirect" costs are not greatly heterogeneous, traditional ways of pooling and redistributing the costs provides satisfactory cost assignment. But they also observed that, in CIM costs of technology and services are not articulated in bills of materials or operations routings but may be directly identifiable with units of output or with cost centers. Managers wanted better, more direct identification of these costs. Pooling and redistributing the costs does not provide adequate cost identification.

In an apparent attempt to improve the identification of costs of technology (both resources and support), some of the plants (both CIM and traditional) charge technological support costs to departments directly on demand rather than by pooling and redistributing them. For example, indirect supplies or services (maintenance, for example) are charged directly to departments upon demand. Plant accountants explained that this procedure is used to try to get more specific control over significant overhead costs.

Some technological costs of supplies and services, traditionally classified as indirect, were expected to be classified as direct costs in CIM plants. The findings weakly support this expectation, but not with specific examples of instances where CIM plants had formally revised its classifications of indirect costs. Managers preferred to be accountable for direct costs and they were uncertain or skeptical about their own accountability for redistributed costs. Based on the comments of the managers, traditional notions of "direct" and "indirect" might better be replaced by "resources" and "support" in many cases.

Summary -- Hypothesis 1 Focus Points

Focus point 1.1 was supported by the findings. In three of the four CIM plants, cells had been formed by regrouping of manufacturing equipment to focus on product families and production flow patterns were restructured. Some additional smaller cost centers had been formed, but only for newly formed cells. Little evidence was found that cost centers were redesignated to ensure homogeneity of costs within cost centers. No support was found for the second focus point, 1.2, concerning separate classifications of resource cost accounts carved out of the overhead pools. Nor was support found for focus point 1.3 concerning the traceability and manageability of costs. Weak support was found for focus point 1.4, concerning classification of certain traditionally indirect costs as direct costs. Production managers, engineers and plant accountants all expressed a desire for better recognition and identification of costs.

The findings for the Hypothesis 1 focus points suggest these conclusions:

- The main contrast between traditional production cost centers and CIM cost centers is homogeneity: traditional cost centers have homogeneous processes, whereas CIM cost centers have homogeneous product families but somewhat heterogeneous processes.

- Manufacturing processes at CIM plants are regrouped into product-focused clusters of resources, breaking down traditional process-focused departments. Production flow patterns are changed and simplified. Where these changes have occurred, managers want improved cost identification.
- Eventually, in response to managers' desire for improved cost identification, cost centers and account groupings are likely to be redesignated, but these changes involve other aspects of inter-plant and budgeting reporting requirements, and therefore the changes come slowly.

Basically, the strength of the support for the cost identification hypothesis was lessened because a lack of focus in how the nature of cost identification might be improved. Both accountants and managers were uncertain about what kinds of changes in cost classifications and cost center designations are required. Cost identification continues to concentrate on materials and labor as the primary resources and has not yet become more broadly oriented to all classes of resources.

COST ENTRY HYPOTHESIS

Cost entry involves choices about where costs are captured and what events are selected to trigger cost transactions. Costs cannot be identified well unless they are captured with appropriate transaction triggers. On the other hand, costs that are captured with transaction triggers can become obscure if account classifications and groupings do not permit clear cost identification.

Advanced technology and integrated processes in CIM provide the opportunity to choose different events to serve as transaction triggers. The cost entry hypothesis has four focus points: (1) choosing triggers close to resource events, (2) clarifying responsibility for collecting cost data to instill a sense of data ownership, (3) using triggers that distinguish between expendable and durable resources, and (4) keeping data current.

2.1 PLACING TRIGGERS CLOSE TO RESOURCE EVENTS In CIM as contrasted with traditional manufacturing, strategic manufacturing objectives and CIM technology require that costs be captured more closely to the points where demands on resources can be identified, rather than at traditional points of entry/exit transfers or labor operations.

Transactions may be triggered by resource events within process areas or at entry/exit points into or out of process areas. Since CIM has a variety of resources within process areas, more transaction triggers might be necessary to make sure costs are recognized and captured close to resource events. Traditional plants usually do not have many transaction triggers at interim points between entry into and exit from a process area or cost center, except for measures of labor operations performed.

Given the advanced data collection techniques available in CIM and the extensive use of production data, more interim trigger points were expected at the CIM sites. But this expectation was not borne out in the findings. The CIM sites had not adopted new transaction triggers at interim points, and continued to rely on direct labor "pay points" where workers' output is measured to record production entries. Production managers were asked about places for potential new cost triggers, such as events relating to production performance and quality assurance. These discussions led to some suggested places for new triggers.

Traditional Entry/Exit Transfer Points are not Where Costs Originate

One of the items of discussion with managers at all of the sites was whether costs can be captured satisfactorily as production output exits from a process area. CIM production managers said capturing costs at the point of exit may be too late because by that point the costs are a conglomerated mixture resulting from several resources. Within CIM process areas, the point of exit can be remote from points where resources are consumed or used.

A systems designer at one CIM site discussed the place for trigger points. She explained that data should be captured at its "point of origin," before the data are put through additional processing after the data originates. For cost data, the point of origin is where resources are consumed or used. The systems designer said:

> When you begin to look at where people get their information, their source may not be the origin of the data. We have found it helpful to begin at a starting point where there are no inputs, such as engineering data or information created and fed to many other systems areas. The systems start there. We look at all the information created there and determine where all the interfaces are and where they should be. Then our goal is to find all the ways the information can be commonized. When that is done, the interfacing can permit cost penetration. We want timely information at the earliest place where it can be interfaced, in its purest form.

Accountants realize that the ideal is to capture costs where events reflect most precisely demands placed on resources. As a plant accountant at a traditional site said:

> In the past, we have always picked up whatever transactional information that has been available, and it may have been changed extensively before accounting could get it. The ideal is to get at the data before it is substantially affected by how it is gathered.

Cost systems at the traditional sites did not have intra-process triggers to capture costs close to resource events where costs originate. Such triggers may not be necessary in traditional manufacturing, where the resource events are not as diverse as in CIM. At the CIM sites, where some attempt was made to capture costs within processes, reliance was placed on labor "pay points." Labor events were relied upon extensively at both CIM and traditional sites to measure both production output and costs. As a plant accountant at a traditional site said:

> The thing that starts the inventory transaction flow is the worker's time card. It is used to cost out labor and tells us the parts made from each operation so we can update the part in our inventory from its raw materials condition.

Since traditional cost systems seek inventory transactions primarily, and since intermediate production data have generally not been available prior to the CIM era, traditional cost trigger points are at entry to or exit from processes. Intra-process triggers generally are not part of the system. CIM's cost manufacturing objectives suggest the potential for additional triggers where feasible means of data collection exist.

Potential New Trigger Points Implied by Cost Management Objectives

Discussions with various individuals at the CIM sites revealed that production management includes and emphasizes monitoring of conformance with pre-determined specifications. Additional cost triggers can be based on events that confirm or ascertain conformance with specifications, or events that reveal disruption to production flow or waste. A trigger point might be where bottleneck operations occur. The slowest operation in a manufacturing cell can constrain other operations and impede the flow of production. Measures of disruption or waste can be placed in the proximity of control risks, including quality failure, output rate, etc. Places where control risks are subject to close scrutiny and frequent conformance assurance may also provide trigger events. None of the sites had triggers at these points, but the potential is there.

Emphasis on uninterrupted production flow suggests the need for triggers for production flow interruptions. A CIM plant manager said:

> We can do marvelous things with respect to flowing material out of the machine shop to our newly reorganized assembly area. But how do we flow the material from the time it leaves our receiving dock until it is consumed in assembly? That is by far our biggest issue. Yet, it is the other issues that we deal with. We can have a bigger impact from the issue of keeping our flow moving than we would have from other issues.

Triggers to detect waste may be based on departures from prescribed conditions, which may occur to meet delivery commitments. A CIM site accountant said: "there were silly times when we sent planes around the country to pick up boxes of parts or took products apart to get parts, just to meet schedule." This is the cost entry question: are there triggers that capture the extra costs when such departures from prescribed conditions occur?

Based on analysis of a number of individual findings, the following potential places for triggers appear to exist in the CIM environment:

- at points of release of resources or application of tooling;
- at end points where satisfaction of delivery requirements is noted;
- where use of capacity is monitored; and
- at bottleneck points where production flow might be delayed or stopped.

Better choice of trigger events may improve the identification of costs, but in addition, improved triggers may make cost data more credible and understandable to users. Where triggers are remote from resource events that drive costs, cost data takes on a certain mystique which may inhibit managers from using the cost data. As a plant supervisor at a traditional site said:

> I don't understand the system as well as I should as far as the impact of different things on costs. I cannot look at an account and decide whether something should be done about the amount shown in the account. We need to deal with the accounting information in simple terms so I can understand it well enough to respond to it.

The essence of this focus point is essentially that the best triggers are those that capture resource events when and where they happen. While this focus point may be logically appealing, it was not supported by evidence observed in the field, other than the fact that several individuals (like the systems designer) agreed with it.

2.2 RESPONSIBILITY FOR COST DATA -- A SENSE OF DATA OWNERSHIP In CIM plants, collection of both production and cost data is largely merged into one data collection system with the result that resource managers have a greater sense of "ownership" of cost measurements.

CIM requires data from engineering, production, and accounting files. Advanced data collection technologies available in CIM plants make it feasible to collect all data within one data collection system. Furthermore, collection and maintenance of cost data are logically parts of cost management responsibility. For these reasons, it was expected that resource managers would have more responsibility for data collection in CIM plants than in traditional plants, and would generally reflect a greater sense of ownership of cost data. The findings weakly support these expectations. At three of the CIM sites and two of the traditional sites there was evidence that more responsibility for collecting cost data was being assigned to manufacturing managers or workers. This matter was discussed during interviews. But the findings were not clear about the extent to which resource managers and workers consider collection of cost data their responsibility rather than the responsibility of accountants.

Resource Managers are Cost Conscious

The findings indicate that resource managers are "cost conscious" in making their resource management decisions. Interestingly, managers' perceptions of costs are often interpreted in resource terms rather than dollar terms. Managers emphasized the importance of avoiding waste and disruption and of using resources efficiently. Discussions with the managers suggested that their view of costs is framed in resource events, although they recognize that costs are measured in dollars. Managers are "resource conscious" more than they are "cost conscious" in the sense of dollars of costs. Plant supervisors commented that while that accounting measures tend to focus cost measures on labor, real cost management is attained by managing technological resources at their disposal. They also observed that some of their most effective ways of managing costs are not measured in accounting data. For example, a supervisor at a traditional plant discussed minimizing costs of running production orders:

> Most of the guys know which part numbers run better with other part numbers. Where we can, we try to run in a sequence that will minimize the number of times we set-up and other such costs.

The point the supervisor was making was that he knows, and the workers he supervises know, how to conserve on costs using knowledge and information not available to the cost system, but that rather than interpreting costs directly, they interpret resource events. Generally this is because they do not receive cost data at that level of detail. This supervisor went on to say that cost consciousness is enhanced where managers and workers are responsible for collecting the cost data, which is the subject of the next point.

<u>Resource Managers are Collecting More of Their Cost Data</u>

Instilling a sense of data ownership follows a natural sequence. With better triggers to capture resource events where they occur, managers are more interested in using cost data. With more interest in the data, they become more involved in collecting the data, keeping the data accurate, and using the data to evaluate their resource decisions. They develop a greater sense of data ownership. Three of the CIM sites gave increasing responsibility for collecting cost data to managers and workers. As explained by one plant accountant where more responsibility for collection of cost data had been given to manufacturing managers:

> They hadn't taken ownership of the cost data. But now those clerks actually keep a scorecard on the supervisors and get them to go out and check load tags and discipline employees.

While the accounting system is responsible for providing cost <u>measures</u>, the actual <u>measurements</u> are the responsibility of the resource managers who manage the costs.

2.3 TRIGGERS FOR EXPENDABLE AND DURABLE RESOURCES

In CIM as contrasted with traditional manufacturing, triggers can distinguish between expendable resource consumption and durable resource usage. Costs of durable resources are assigned on the basis of usage measures rather than period-oriented charges for capacity provided.

This focus point is about a difference in the nature of resources. Since expendable resources (e.g. replacement tooling, supplies, direct materials or direct labor) are consumed quickly, charges can be triggered when the resources are issued. Durable resources (e.g. equipment, reusable tooling, computer-aided machine software) are consumed gradually; costs of durable resources can be triggered by usage of the resources. Traditional cost transaction triggers do not distinguish between expendable and durable resources. Such distinctions were expected to be found at the CIM sites.

The expected distinctions were not found, however, at any of the sites. None of the plants used triggers that particularly distinguish between expendable and durable resources. The matter was discussed with resource managers at all of the sites. They suggested that individual managers tend to concentrate mostly on effective usage of resources provided to them, and cannot at the same time be too concerned about absorbing capacity costs. One manager observed that a helpful measure is capacity costs as a percentage of time in use.

This focus point did not yield any supporting findings, though it may represent a potentially valid point for CIM plants in the future.

2.4 KEEPING COST DATA CURRENT In CIM as contrasted with traditional manufacturing, cost data will be kept more current by collecting data at trigger events where demands on resources occur, files will be updated more frequently, and a shorter planning and control time horizon will apply.

Accounting typically reports monthly data, but the CIM time frame is daily and weekly. Therefore, cost data are likely to be updated frequently in CIM to allow managers to assess their daily or weekly operating results. This focus point describes the expected impact of a shorter time frame on cost transaction triggers. The findings did not support the expectation of a shorter cost accounting time frame, at least in terms of formal up-dating of cost data. However, certain informal ways of providing weekly up-to-date cost data were occurring. Plant accountants at each CIM site were taking informal steps to match production's weekly time frame, with special daily and weekly reports on materials, labor and scrap, and with their own personal summaries (which they reconciled with formal monthly reports). As to production, there was clear evidence that a daily and weekly time frame is employed. For example, a production planner at a CIM site said:

> Every Monday morning, we receive by electronic mail delivery releases from our customers. These are detailed into the next immediate six weeks and then each of the next five months thereafter. We plan a weekly build schedule from that data for our product departments and our component departments. On the first of each month, we do put out a monthly build schedule, but it is the weekly build schedule that we operate from.

Informal approaches to providing weekly cost feedback were found at the CIM sites. But no evidence was obtained to indicate that the cost systems were formally changing to a weekly basis for triggering cost transactions. For this reason, "weak support" was the conclusion for this focus point.

Summary -- Hypothesis 2 Focus Points

As far as the choice of cost transaction trigger events close to demands on resources, as suggested by focus point 2.1, relatively little formal change had occurred at the CIM sites. Nor was there much evidence of formally integrating cost data collection into production data systems as described in focus point 2.2. However, there were informal indications of a desire to better link collection of cost data to production data systems and to foster in resource managers a greater sense of data ownership. The CIM sites were taking some steps to pass more responsibility for collecting cost data to resource managers and workers. A sense of ownership of cost data was evident in managers at the CIM sites.

No findings were obtained which support the expected distinction between expendable and durable resources described in focus point 2.3. Support was found for focus point 2.4, which anticipated more current maintenance of cost data. The changes were informal, "off-system" approaches. Plant accountants at three of the four CIM were issuing special weekly reports in which costs of materials, labor, and scrap were highlighted. The formal cost systems at all of the sites adhered to a monthly reporting cycle. In general, the cost entry hypothesis was supported with some informal evidence but not with formal systems changes.

COST ASSIGNMENT HYPOTHESIS

Given the hypothesized changes in classifications of resources, account groupings, and choice of trigger events, the cost assignment hypothesis is that resource support costs in CIM will be linked with resources supported and assigned based on resource usage factors or related activity measures. Cost assignment thereby provides the linkage between identified costs and cost reporting objectives. Linkages, clarity, and objectivity appear to be critical concerns in cost assignment work, concerns which become more critical in the CIM environment.

3.1 ASSIGNING SUPPORT COSTS WITH RELEVANT RESOURCE FACTORS In CIM as contrasted with traditional manufacturing, resource support costs are a more significant cost component and are assigned based on usage of relevant resources supported rather than based on traditional assignment bases (direct labor, machine hours, or direct materials).

When assigning costs to cost objectives, the choice of assignment factor is a critical step in retaining the resource-based nature of the costs. The CIM sites were expected to choose particular assignment factors for each class of resource costs. The findings support the contention that relevant factors are desirable, although the degree to which relevant resource factors were used at the sites was mixed. These points emerged from the findings:

(1) The CIM plants' overhead cost pools contained substantial costs of resource support.

(2) The CIM plants had taken specific steps to identify and charge certain overhead support costs directly to supported cost centers.

(3) Relating support costs with relevant supported resources was difficult because factors for some resources were not well specified.

(4) Operational support costs were not distinguished from capacity costs in overhead pools.

These points are discussed in the following sub-sections.

Overhead Pools Contained Substantial Costs of Resource Support

Compared with the traditional plants, the CIM plants' overhead cost pools contained appear to contain substantially more costs of support for technological resources used in production. Managers at the CIM sites affirmed that their overhead pools included significant costs for technological aid, quality control, information, maintenance and various services. However, management at all of the CIM sites were unwilling to provide exact overhead cost data for comparison of their overhead pools with others. One traditional site, however, did provide a breakdown of their overhead cost pool, shown in Table 10.

TABLE 10

COMPOSITION OF OVERHEAD POOL AT ONE TRADITIONAL SITE

Resource Supported	Support Costs as a Multiple of Direct Labor Costs
Employees	2.38
Machinery and Equipment	1.24
Tooling	.73
Facilities	.62
Materials	.56
Technology	.34
Information	.13
All other indirect	.35
Total overhead	6.35

Based on discussions with CIM managers, the proportions related to support of tooling, technology, and information are likely to be greater at CIM plants than those shown in Table 10, and the proportion for support of employees is likely to be smaller. However, none of the CIM sites provided detailed figures to substantiate their proportions.

Overhead Support Costs Were Being Charged Directly to Cost Centers

One source of evidence of the significance of production support costs to management was the extent to which certain kinds of costs were being identified as direct charges rather than indirect allocations. Each CIM site had taken specific steps to identify and assign costly types of production support (e.g. set-up and maintenance costs) directly to production cost centers when incurred. This is in contrast to pooling such costs with other indirect items and allocating them through applied overhead. While no evidence was found that any overhead cost pools had been sub-divided into separate pools to better match with resource classes, the efforts to assign some costs as direct charges indicated a desire for improved cost identification and assignment.

Support Factors for Non-Labor Resources Were Not Well Specified

During the site interviews, managers were asked about assigning support costs with relevant resource assignment factors. At all of the traditional sites and two of the CIM sites, the managers said this was being done satisfactorily at their plants. Managers at two of the CIM sites said the cost assignment factor they use (percentage of direct labor costs) was too general for many of the items in their overhead cost pools. They essentially said it is desirable to assign overhead support costs to resources supported, but this would require detailed specification of each type of resource used in CIM, including such technological resources as robotics and other computer-aided equipment, technological information and software, tooling, and inspection apparatus. All of these were cited as costs included in overhead pools that were not as well specified in engineering data as are materials quantities or labor tasks. Matching support costs with related resources is difficult in present circumstances, given the degree of resource specification in available data. Improved assignment of support costs is not likely until engineering data for non-labor, technological resources are specified in more detail.

Distinguishing Operations Support From Capacity Absorption

Several of the sites used measures of labor utilization (labor hours absorbed in production output versus total labor hours paid). Several plant managers and department supervisors were concerned about the effectiveness of utilization measures. They said labor utilization measures are easily manipulated, easily misunderstood, and therefore are not effective. Some managers observed that labor utilization is only part of the story. Equipment capacity also is utilized. They pointed out that cost accounting systems do not measure percentages of "up time" to evaluate how fully machine and labor capacity is utilized. The findings, though not sufficient to reach a definitive conclusion on this, suggest that cost assignments could improve by distinguishing between operation of versus absorption of capacity. Cost systems tend to commingle facility operating costs (e.g. utilities, maintenance, or supervision) with absorption of capacity costs (e.g. building depreciation, insurance, property taxes, and other fixed building occupancy costs). However, operating costs are managed differently than occupancy costs; each have different cost management objectives.

3.2 ASSIGNING COSTS BASED ON COST MANAGEMENT OBJECTIVES In CIM as contrasted with traditional manufacturing, cost drivers are more diverse. Also, costs are assigned with assignment factors that link cost objectives with a greater number of cost pools or classes rather than with traditional broad cost pools and a single factor for cost assignment.

Cost assignment factors are selected to represent cost drivers. Given that CIM (with its more extensive technology) has more diverse cost drivers compared with traditional manufacturing, the findings were examined for the consistency of cost assignment factors with cost drivers and cost management objectives. Two basic findings emerged: (1) managers need "cost visibility," which can be enhanced by resource-based cost assignments to manage costs in CIM and (2) resource managers in CIM plants do not understand accounting procedures for assigning overhead costs.

Cost Visibility Through Resource-Based Cost Assignment

Cost "visibility" describes the ability to anticipate cost consequences of potential decisions or actions before they are carried out. Cost visibility begins with resource-oriented cost identification and continues with measures of appropriate resource events to trigger cost transactions. However, cost visibility can be obscured by cost assignment procedures which fail to link costs (as initially recorded and classified) with cost objectives that govern cost reporting.

Traditional cost systems take costs at their lowest level of identification and aggregate them upward. Interactions may be obscured in the upward aggregation. As a plant accountant said at a traditional site:

> You could take a machine in an area where there is a particular absorption rate, and you could move the machine to another area with a different absorption rate and show that you have saved money. That's never done, of course, as a basis for moving equipment, but similar results can happen in production areas. Interactions lead to cost effects, which makes it difficult to measure costs in the aggregate.

Similar comments were made by several resource managers. The comments suggested that the key to assigning and aggregating costs is to link resource consumption or usage events with resource management objectives. CIM plant managers were each asked about their key resource management objectives. Their discussions of their key priorities suggested the following key resource management objectives:

1. Deliver, on schedule, with nearly perfect reliability.

2. Achieve delivery without wasteful investment in buffer inventories.

3. Attain high quality in production by conforming with specifications (by "making it right the first time" (to quote a visual display in one of the plants), rather than depending on inspection to maintain quality.

4. In addition to accomplishing these objectives, manage costs -- by minimizing wasteful consumption or use of resources and minimizing opportunity costs due to poor utilization.

The fourth objective, cost management, requires cost visibility. Managers at the CIM sites described a variety of anecdotal situations where they desired or used cost data to assess their priorities and alternative choices. They were asked about situations where cost data were either not available or not helpful. In reply, they described cost data that lacked visibility, apparently as a result of cost assignments. Several of their replies suggested that cost assignments fail to focus on key manufacturing objectives, which (they believe) explains a lack of cost visibility in cost data.

Resource Managers do not Understand Overhead Cost Assignment

While discussing overhead cost assignment procedures, plant accountants at two of the sites (one traditional and one CIM) voiced reluctance to "tamper" with overhead accounting procedures. They explained that overhead costs are not well understood by production managers and changing the procedures might reduce their understanding even more. An accountant at a traditional site said:

> Our system has a feature available where you can calculate burden on machine hours. But I don't see us wanting to do it that way. We've always used percentage of direct labor dollars. Everybody is comfortable with that. They understand how it works. When I first came here a couple of years ago, there were people out on the floor who knew they were accountable partly on burden absorption, but they didn't know how we did it. If we were to go to a different type of absorption now, they would have to relearn it all.

Most of the plant accountants are satisfied with existing assignment procedures for overhead costs. While they believe that more overhead cost information may be useful, they do not see a need to change the overhead pool structure. As one accountant at a traditional site said:

> In the future there may be more work centers requiring burden allocation rates, but I don't anticipate changes in the identity of the burden pools. We will stay with the four pools we have now.

What is interesting in this comment is that the names of the pools at the plant: "Hourly Indirect Labor," "Salaried Indirect Labor," "Labor Fringe Benefits," and "Purchased Burden." The names suggest a strong labor orientation in the designation of the burden pools. Yet there was no evidence that pools were going to be redesignated to improve the assignment of non-labor overhead costs.

The findings for this focus point were inconclusive. The accountants agreed that overhead costs could be assigned with various factors more consistent with cost management objectives. But generally they believed their present cost assignment factors were suitable. The production managers and engineers seemed to view the entire matter of overhead cost assignment as an accounting issue about which they had little opinion, except that cost drivers are obscured by cost assignment mechanisms. Basing assignment of overhead costs on direct labor is a long-standing, historic tradition, one that may change gradually to cost assignments that are more resource-oriented and less labor oriented.

3.3 PENETRABLE COSTS WITH TRANSPARENT COST ASSIGNMENT

In CIM as contrasted with traditional manufacturing, strategic manufacturing objectives present a greater need for penetrable cost data, which require transparent cost assignment procedures.

As explained in Chapter III, "penetrable" cost data are decomposable back to resource events where costs are incurred. Cost penetration requires "transparent" cost assignment procedures that do not obscure underlying cost drivers. The issue addressed in this focus point is whether the need for cost penetration is greater in CIM than in traditional manufacturing, due to CIM's strategic manufacturing objectives.

The findings were inconclusive on this point. Managers at the CIM sites did not discuss cost penetration directly, nor did their comments support the expectation of a greater need for cost penetration in CIM. However, some of their comments helped to explain the notion of cost penetration.

Reasons Cited for the Need for Cost Penetration

Cost penetration is essentially the converse of cost build-up and is more difficult to achieve where resource events are not well specified. CIM managers want better cost penetration to distinguish costs of resources of different types. For example, in CIM there can be different levels of automation which may not be distinguished when costs are assigned. As one plant accountant said:

> Area wide burden rates do not really cause much of a problem generally. Where it does begin to give us a problem is where automated and non-automated production lines get mixed together. There is a big difference in underlying burden costs in automated vs. non-automated machine operations, probably a two to one difference ratio.

A systems designer at a CIM plant suggested distinguishing levels in cost structures in a matrix fashion:

> Cost build-ups at the divisions need to have a matrix-like approach. That way, when divisions' costs come together, cost penetration matrices can be used to determine the components of the costs. The company then can be in a position to consider various alternatives and penetrate down into costs to appraise cost effects. This can't be done where cost methods at lower levels are inconsistent or lack the necessary detail.

Several plant managers suggested that penetrable costs help them manage product lines effectively. For example, a product manager said:

> The financial systems end up giving product costs, but lose the ability to penetrate into the total product cost. It is important to track all costs by product line so high level decisions can be made by product line. You have to know whether to stay with a product or cut it out of the line.

While the findings suggest cost penetration may be desirable, cost assignments were not made in ways that assure penetrable costs, at either the CIM sites or traditional sites.

Relating Transparent Cost Assignment with Cost Penetration

Some evidence of nontransparent cost assignment was reflected in the findings from the traditional sites. For example, a plant supervisor discussed burden allocations to areas containing large press machines:

> In our fabrication area, there's a substantial difference in the cost of an automated versus a regular press. Right now our burden allocation system will not allow us to recognize the difference in the allocation. This is something we need and are concerned about. We need it for criteria for our quotes for new business. We know the need is there, but it is not happening yet.

A supervisor at another traditional plant wanted more specific measures of variable overhead costs:

> One thing I would like to see in our cost system is better pinpointing of the actual costs. We can do this for direct labor because the payroll system does it. But we need better ways of measuring consumption of our variable overhead costs. When we start dealing with a particular product or family of products and try to make cost reductions, it is important that the ways of managing the costs not be short-sighted. The effect on the rest of the plant as a whole must be considered, how it affects the rest of the production altogether.

Failure to maintain transparency in cost assignments may explain why some costs cannot be penetrated. For example, a production department supervisor at a traditional plant observed:

> We have not had a systematic way to build a profit plan by department from ground level. We knew the picture for the total plant, but it has never been broken down into separate departments where we could build up and consolidate by department.

One plant accountant at a CIM site observed that accounting systems are often limited in how precisely they can assign costs to support cost penetration:

> The framework may be there to do the job we want to do, but the accounting system is not set up to measure finely enough to do it. Some things are measured finely, such as scrap, which is measured as finely as production counts are. The labor figures are measured finely. But, beyond that, accounting generally does not measure that finely. For example, there could be differences in tooling, maintenance or supplies costs in automated vs. non-automated lines. Tooling requirements can be quite different depending on the kind of exterior finishing required on our products, sometimes manual tools, sometimes air tools. Our accounting just does not make these distinctions.

This focus point on transparent cost assignment was not supported by findings. Neither the CIM plants nor the traditional plants were using cost assignment procedures to ensure that the assigned costs could be penetrated to cost driver sources. While the term "cost penetration" was not used by managers directly, managers at CIM plants seemed to emphasize the need for cost penetration more than managers at traditional plants. The reason apparently was that the strategic manufacturing objectives of CIM pose more alternatives to managers, more frequently. At the same time, more of CIM's costs are technology costs, which are assigned through overhead cost pools. Thus managers frequently need to penetrate costs that are hard to trace. One systems designer described the need for cost assignment to support cost penetration, but this was not found to be a point of emphasis at either the CIM or traditional sites.

Summary -- Hypothesis 3 Focus Points

Essentially, the support provided by the findings for the cost assignment hypothesis and focus points was mixed. The findings indicated that the CIM plants were attempting to assign overhead costs more directly to production cost centers than through the more generalized allocations found in traditional plants. These findings tended to support focus point 3.1, except that little specific evidence of identifying and assigning support costs to classes of resources supported was found. Overhead costs at all CIM sites included substantial costs of supporting resources, which managers agreed could be assigned based on more relevant resource factors. Limited evidence was found to indicate the CIM plants were using more specific assignment factors for overhead costs, but no evidence of sub-dividing overhead pools was found.

No support was found for focus point 3.2 concerning the use of cost assignment factors tailored for cost management reporting objectives. Focus point 3.3 was addressed by comments of managers at each CIM site who emphasized the need for cost assignment factors and procedures that permit cost penetration. However, focus point 3.3 was not supported by evidence to suggest that the CIM plants were changing their cost assignment procedures to produce more penetrable costs.

COST REPORTING HYPOTHESIS

Costs are reported to satisfy a cost objective. Since a "cost objective" is any purpose for which a cost is reported to users of cost data, the term includes both cost management and product costing objectives. CIM shifts the primary focus of traditional cost objectives away from product costing for financial reporting toward strategic manufacturing objectives of delivery reliability, quality and flexibility. In addition, compared with traditional manufacturing, CIM entails more frequent demand for cost data and requires that cost data be kept more current. Accordingly, the cost reporting hypothesis pertains to strategic manufacturing objectives, frequency of up-dating and access to online real time data. Three focus points were developed for this hypothesis, including (1) cost objectives to support strategic manufacturing objectives, (2) cost reporting to support cost monitoring, and (3) reporting the costs of production disruption and waste.

4.1 COST OBJECTIVES AND STRATEGIC MANUFACTURING OBJECTIVES In CIM as contrasted with traditional manufacturing, cost objectives will reflect a greater emphasis on strategic manufacturing objectives than on financial product costing objectives.

The argument was made in Chapter II that a contrast exists between cost objectives of CIM and traditional plants. Cost data are used in CIM for primary and secondary reasons -- primarily to evaluate and execute strategic manufacturing objectives and secondarily to determine product costs. Cost data are used in traditional plants primarily for product costing and secondarily for evaluation of cost center performance. CIM's principal strategic manufacturing objectives were cited earlier: delivery reliability, high quality production, and flexible response to market demands and conditions. These objectives dominate resource management actions and can sometimes outrank traditional production objectives of efficiency and capacity utilization.

The empirical data were examined to see whether CIM's emphasis on strategic manufacturing objectives were reflected in changed reporting practices. Three conclusions were developed: (1) cost systems could provide more cost data that is designed to affirm achievement of strategic manufacturing objectives -- cost data to help managers assess production conformance with specifications in addition to cost performance; (2) cost data summarized weekly can be provided to support the weekly time frame of production, and (3) various kinds of special daily and weekly cost reports are being issued by plant accountants at the sites. These findings are discussed in detail in the following sub-sections.

Cost Systems Can Provide More Affirmative Cost Data

Resource managers were asked what cost information they would like reported in addition to the information in formal cost reports they now receive. Managers at two of the CIM sites said they liked the affirmation that cost information can provide when costs as measured are consistent with other evidence available to them. This kind of "affirmative" cost data ratifies other data, indicating that the strategic manufacturing objectives are being achieved. Affirmative cost data compares actual costs with expected costs to affirm conformance with manufacturing specifications.

Based on interview comments, cost systems in CIM plants could provide more affirmative data, both more frequently and also in non-traditional ways. The managers were asked specifically why there should be a greater need for affirmative cost data in CIM. Their reply was that in CIM there is a strong emphasis on avoiding disruption to production flow and eliminating waste.

Cost accounting data can affirm the economic effect of what is going on. But this depends on resource-based cost identification, appropriate triggers and effective cost assignment and also depends on reporting cost data frequently to affirm that manufacturing objectives are being satisfied. As a plant accountant of a traditional plant said:

> The goal is to be able to identify any problem there is, and know specifically where the problems are. Right now we have gut feelings. We know we've had a lot of problems. But we don't know the specific area, which operators, or what specific details are pertinent to solving the problem.

Some weak evidence was found that indicates the CIM sites were producing more affirmative cost data than the traditional sites. Plant accountants at the CIM sites were issuing special daily and weekly reports with affirmative data on set-ups, tool replacements, rework, and scrap. In discussing these reports, the accountants commented that not only was the content of these reports important in assuring conformance with specifications, but also the reports were frequent and timely.

Summarized Weekly Cost Data Helps Managers Assess Their Operations

Weekly reports often are more informative as sources of affirmative cost data than are either daily or monthly reports. Much like weekly news magazines, weekly reports provide a perspective that may be more perceptive than either daily or monthly data. For example, an accountant at one traditional plant said:

> Our labor reporting system devised several years ago provides daily reports that tell each area what their charges are today. Now our system summarizes a whole week for them in a glance, the number of hours they worked, what was transferred in. It provides a much easier reference compared with all of the daily reviewing of the data.

Not only are weekly data more recent than monthly data, and more consistent with the weekly time frame of production scheduling and control, weekly data also provide more of a summary perspective than daily data. At three CIM sites, the plant accountants confirmed that their cost systems were looking for ways to adapt to a weekly reporting cycle, particularly with respect to data that affirms key manufacturing objectives. However, at the time of the visits, none of these sites had adopted weekly closings or taken other formal means to coincide their cost accounting monthly time frame with the weekly production time frame. For the time being, the plant accountants were taking informal steps to produce special weekly or daily cost reports.

Plant Accountants are Issuing Special "Off-System" Reports on Costs

Plant accountants at each of the CIM sites were providing special cost reports regarding labor (both direct and indirect), scrap, maintenance, and tooling. These were usually prepared on local micro-computers with spreadsheet software. The accountants commented that their cost systems do not have all of the necessary mechanisms to report this kind of affirmative data regularly and systematically. One plant accountant at a CIM site said:

> What we need is a tracking method. If we had codes that classify, say, major repairs and minor repairs, vendor-caused scrap, damage on the floor, or whatever, and we can accumulate such codes, then these reports could easily be retrieved. But we don't have in place the mechanisms for that.

The "mechanisms" this plant accountant was describing are more likely to be in place where cost systems are driven by resource-based cost identification and cost management-based reporting objectives. Since the cost systems were not well aligned with resource-based cost measures and reporting objectives, the systems were not well equipped to track the kinds of costs described above.

4.2 COST MANAGEMENT REPORTING FOR COST MONITORING In CIM as contrasted with traditional manufacturing, production monitoring will focus more on integrated costs at a macro level than is the case in traditional manufacturing, where cost monitoring focuses on the individual work center.

As discussed in the cost identification section, plant managers at each CIM site wanted costs to be identified more precisely to better track underlying cost drivers. The same managers talked about being better able to relate costs reported at a local (micro) level (individual components, products, or cost centers) to the aggregate (macro) level of product lines or plant operations. They emphasized that since production is a coordinated operation, costs cannot be monitored at local work stations in isolation from the combined operations of other work stations performing related work. With these points of emphasis in mind, the empirical data were analyzed and two conclusions were identified: (1) managers want to know cost consequences in more detail but they did not seek cost data to make resource decisions and (2) macro level cost reporting addresses both conformance and performance.

Managers Want to Know Cost Consequences in More Detail

Resource managers holding a variety of responsibilities at all of the CIM sites generally echoed the following plant manager's concern about cost management:

> To me, there is a desperate need to manage our costs in a much better manner. We look at costs, say they're too high, but we don't really manage them. We need better data to give us a better history. We want to take advantage of it to make decisions and change what we do in the future. We also need to communicate it. Sometimes the data are there but we don't know where it is available.

This individual was stressing the need for cost data to provide a history base for resource decisions made from time to time.

In spite of comments like this, the findings actually suggest that managers do not seek out cost data as a necessary source of prerequisite information before moving ahead with decisions or actions. While managers are provided costs by their cost systems, they do not depend on it to take action. It seems that cost data are not so much desired at the point of decision to make the decision, but are desired instead to provide a track record of cost consequences of decisions as they are made. An engineer at a CIM site put it this way:

> There is some benefit in knowing what the cost of the decisions are. Over a period of time, when the decisions happen with some frequency, the cost results might point to some needs -- such as to change capacity, operations processes, or tooling, for example.

Essentially, the findings about managers' desire for details about cost consequences are unclear. When discussing this point with CIM managers, they emphasized that they want to know more details about cost consequences of decisions they have made. Yet, there was little evidence that had cost data been provided to CIM managers in greater detail, they would have actually used the data to make their decisions. Their responses to questions about the cost consequences of potential decisions indicated that, while concerned about cost effectiveness, they did not request detailed cost data from the cost system to determine cost consequences prior to making their decisions.

An accountant's comment at a traditional site suggests that micro level cost focusing might be the explanation. Since resource managers are primarily concerned with operating the processes and utilizing available capacity, they could not concentrate on cost minimization:

> I can see that cost data should be used to make decisions, and that is probably the areas where we are the weakest. One of the reasons is that our first concern is not the cost but where the capacity is and just to get the job done; we haven't worried about the cost effects. We have never had to recognize the effect of cost competition until recently. In my opinion, we are way behind in providing the necessary [cost accounting] tools for people to make the proper decisions.

It appears that the issue of using, as well as wanting, cost data is an unresolved matter. Cost systems may eventually change cost identification and assignment to focus on resources broadly, rather than more narrowly on labor and materials. If so, there may be a better opportunity to try to determine whether managers will become more dependent on cost data to make their decisions. As for this study, it is unclear whether reporting cost data for both micro and macro level perspectives would stimulate managers to use the data to make decisions.

Reporting on Both Conformance and Performance

Nearly all of the plants visited rely on overall plant measures of performance, including measures of efficiency and utilization. Two of the plants (one CIM and one traditional) emphasize these measures in compensating their managers. The efficiency and utilization measures analyzed direct labor by comparing hours of direct labor paid with hours produced and hours available.[30] Resource managers were critical of the effectiveness of these measures, saying the measures focus too much on direct labor, have weak interpretive power and are easily manipulated. Some of their comments follow:

> As a measure, gross utilization [direct labor hours produced vs. total hours paid] encourages stretching out the interval between set-ups in order to keep your utilization up. Actually, you should be minimizing lot sizes and running with more frequent changeovers. When we started to implement our JIT ["just-in-time"] concepts, we really whacked down our lot sizes. But it cut down our gross utilization and increased our overtime. It caused quite a bit of dissention. But it did highlight set-up problems and quality problems because inventory did not cover them up. [Plant supervisor at a CIM site]

> Managers in our plants use the gross utilization measure to judge the plant's effectiveness. But it does not measure quality levels, inventory levels or the flexibility of our equipment. It is an ideal place for a better measure. [Assistant Plant Manager at a CIM site]

> An efficiency measure [direct labor hours produced vs. direct labor hours paid] is easily manipulated. The input hours can be easily massaged on the floor to get whatever results you want. It measures only the labor hours and expresses very little about the effectiveness or quality of production. The gross utilization measure is not so easy to manipulate but it also says nothing about the quality of the work. [Plant manager of a traditional site]

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[30]The measures were: Gross Utilization = standard direct labor hours in production output divided by actual labor hours paid (SDLhrs/ALhrs); Labor Utilization = actual <u>direct</u> labor hours paid divided by actual labor hours paid (ADLhrs/ALhrs); and Labor Efficiency = standard direct labor hours in production output divided by actual direct labor hours paid (SDLhrs/ADLhrs). Gross Utilization equals Labor Utilization multiplied by Labor Efficiency (SDLhrs/ALhrs = ADLhrs/ALhrs x SDLhrs/ADLhrs).

At one CIM plant, several individuals were quite vocal about the shortcomings of labor efficiency and utilization measures, saying the measures poorly reflect the results of their attempts to accomplish strategic manufacturing objectives. In particular, they believe the utilization measures were deceptive, too aggregative and too unfair to judge performance. One explanation for their reaction may be that labor efficiency and utilization measures tend to focus on the worker as a singular resource. Managers at CIM plants who take a macro view toward cost monitoring assess their resources more broadly, taking actions that may (in a narrow sense) not be strictly efficient for direct labor but still be appropriate in the wider sense of the integrated resources. Cost systems might be able to provide measures of efficiency and utilization for the broader set of resources. For example, several of the plants keep track of "up time" (percentage of time up and running to time available) of their major pieces of equipment. Length of tool life is another potential measure.

Even though managers' comments indicated an interest in macro reporting, no evidence was found to support the focus point. The purpose of this focus point was to determine whether the CIM plants report costs with a broad, macro scope for integrated operations. The findings were scarce and inconclusive and do not indicate to what extent managers use macro level cost data to make resource management decisions. Managers suggested the need for reporting of cost data directed at cost management purposes but there was no evidence that they actually seek and obtain such data. One theme that managers did stress was the need to rid the operations of disruption and waste, the topic of the next focus point.

4.3 REPORTING COST CONSEQUENCES OF DISRUPTION AND WASTE In CIM as contrasted with traditional manufacturing, reported cost information is used to a greater extent to identify sources of production waste, either through variance analysis or through specific account recognition.

Waste is the result of activities that cause loss of value, as contrasted with activities that maintain, support or add value. CIM seeks consistent production flow without relying on large lot sizes and buffer inventory to smooth the demands on resources. Resource managers at the CIM sites explained that waste is especially counter-productive in CIM, not only because waste absorbs resource capacity (as in traditional manufacturing) but also because waste can be a cause of disruption to production flow. The managers said there is as much concern for the source of waste as there is with the amount of it. Discussions of waste and production disruption at the plants resulted in two conclusions: (1) cost systems can help to control waste by identifying and measuring instances of production disruption and (2) waste control may be improved by tracking and reporting the cost effects of production disruption.

Measuring Cost Consequences of Disruption to Identify Waste

Waste occurs where resources are consumed or used without legitimate purpose or by mistake. Waste happens because resource events occur too frequently, resource prices are too high, the quantity demanded is too much, or the resources lack quality. Both cost and production systems have little difficulty defining waste: the problem is identifying it. Where is waste detectable? This question was posed to resource managers at each of the sites. The findings suggest several possible places to identify waste.

The managers observed that cost systems may be able to measure waste by capturing the cost effects of process interruptions or other forms of non-routine occurrences. The counter of waste is the ability to handle variability in production without increased costs. Managers were asked to give examples of sources or causes of waste. Production supervisors at three of the CIM sites described specific examples indicating that waste can be caused by characteristics of any of the resources involved: the materials, skills of the workers, function of the machinery, the tooling, technology or information used. Production or cost systems might be able to measure these kinds of resource characteristics and help managers detect sources of waste.

Three managers pointed out that there is a high probability of waste where disruption occurs. Disruption causes inefficient demands on resources and can cause high opportunity costs. They suggested that cost measures distinguish between the expected and unexpected circumstances; an example would be to record planned maintenance separately from emergency or break-down maintenance. As one CIM plant manager said:

> I visited another plant recently. There the maintenance was 95 percent scheduled maintenance and 5 percent unexpected, sudden maintenance. Ours is the opposite, most of it is unscheduled. The important thing is when you are geared to produce with flexibility, you have to do the maintenance to make sure the operations are not disrupted.

The consequences of disruption can be captured with measures for non-routine circumstances, such as when an alternate routing is used because of a machine break-down. In fact, however, such measures were not being used at any of the sites. While positive steps had been taken at each of the CIM sites to reduce waste or mitigate its sources, these steps had not led to specific accounting measures of non-routine circumstances resulting in wasted resources. Evidence was found at each of the CIM sites that variance analyses or specific cost account analyses were used to monitor cost accounts that might include waste -- but not to any greater extent than at the traditional sites.

Summary -- Hypothesis 4 Focus Points

Focus point 4.1 expected a reorientation of cost reporting from historic cost measurement to forward looking planning and control, linking cost objectives to strategic manufacturing objectives. This expectation was supported by the findings. Managers and plant accountants were using special cost reports to monitor significant costs of materials, labor, tooling, maintenance, scrap, and other significant production costs. However, these were special reports, produced with micro-computer software rather than drawn from the formal cost system.

Focus point 4.2 was also supported by the findings. Macro level cost monitoring was emphasized more at all of the CIM sites than at the traditional sites. And, all CIM sites emphasized the need for measures of waste and instances of disruption to production flow, as expected by focus point 4.3. However, like focus point 4.1, informal, "off-system" approaches by plant accountants in cooperation with production managers supported focus points 4.2 and 4.3. Less change was found in formal cost system procedures.

The main conclusion drawn from the cost reporting hypothesis focus points is that untapped opportunities exist to adapt formal cost system procedures to better support cost management objectives. Considering the lack of change found in the other three cost activity areas, this conclusion perhaps is not surprising. Had more change been found in those areas, then more evidence of formal changes in cost reporting might have been found to support the fourth hypothesis.

SUMMARIZING THE FINDINGS FOR CIM AND TRADITIONAL FIRMS

The study had hypothesized that the role of cost accounting found in a CIM firm would differ in certain key respects from that of a traditional manufacturing firm. Costs would be identified in accounts and account groupings would be specified to capture the diversity of resources used in CIM to integrate technology, information and teamwork skills of workers. The account classifications would reflect a less dominant reliance on direct laborers. Cost centers would be designated differently to match reconfigured resources organized to focus on product traits rather than process traits.

As to transaction triggers, CIM firms would use more of the measurable resource events, would capture costs more frequently, and up-date cost data more frequently. Costs traditionally classified as indirect overhead would be classified by resource class and be identified as direct resource costs or indirect costs of support for the relevant resources. Cost data would be reported daily or weekly in formats and content aimed primarily at cost management objectives; the same cost data would be used to record product costs and inventory transactions, but these objectives would be secondary to the cost management objectives.

Such was the hypothesized image of a typical CIM firm. But the findings obtained at the sites visited in this study suggest that the cost accounting activities of a CIM firm are not very different from those of a traditional firm. A greater contrast in the role of cost accounting was hypothesized than was revealed in the findings. Perhaps adapting of cost systems simply takes more time; change may be occurring, but at a slower rate than expected. The particular four CIM sites visited may not have moved as far through the transition as expected and therefore have not changed their cost systems as much as they will eventually.

Although there was less contrast than expected, some descriptive contrasts between CIM firms and traditional firms are suggested by the analysis of the empirical data. These comparative descriptive findings are presented in the remainder of this section, organized according to the four cost activity areas. The comparisons are illustrated by describing two hypothetical firms, identified as "Firm CIM" and "Firm Trad."

Cost Identification -- CIM vs. Traditional

Firm CIM has been reconfiguring its manufacturing processes by forming cell clusters of versatile, computer-aided equipment, operated by teams of workers. These manufacturing cells focus on product traits rather than process traits. As a result of the reconfiguration of its manufacturing resources, Firm CIM's cost centers have a greater variety of resources and the costs are less homogeneous than its counterpart, Firm Trad. Resource managers at Firm CIM are saying their costs are identified ambiguously, which apparently means that costs do not reflect underlying cost drivers and events where resources are consumed or used. Ambiguous costs result from cost identification failure, including:

- failure to use appropriate transaction triggers to capture costs where demands are placed on resources,
- once captured, failure to classify costs into accounts that reflect the underlying nature of the resources or cost drivers, or
- failure to categorize accounts into groups by class of resource.

Firm CIM continues to use account titles and groupings that were used when its manufacturing was more traditional. The groupings tend to be detailed with respect to materials and labor but not with respect to technology, tooling and information costs.

The cost systems of Firm CIM are adapting to the need for improved cost identification by designating different boundaries for cost centers and by establishing a finer set of accounts in which to classify costs. But these changes are occurring gradually because cost accounting classification and reporting practices are inter-related with inter-plant and financial reporting practices. In general, Firm CIM has not reached the point of deciding specifically what changes in cost identification are warranted to improve cost management, although the firm recognizes that improved identification of costs is desirable.

Cost Entry -- CIM vs. Traditional

Firm CIM is controlled by an abundant amount of data, including data for production scheduling and quality assurance. These data provide the opportunity for improved cost transaction triggers. The empirical findings suggest, however, that Firm CIM is not taking full advantage of the opportunity to improve its choice of transaction triggers. Existing triggers are solidly ingrained in accounting systems and controls. There is not yet a clear conviction that better triggers would improve cost identification, or that better identification of costs would improve cost management. Without evidence that improved triggers would improve cost management, changes in the choice of triggers are not taking place.

Both Firm CIM and Firm Trad continue to capture costs at trigger points where there are transfers from one area to another, or "pay points" where labor is measured and reported. Since labor pay points are virtually the only points between entry/exit transfer points where process operations are captured, the transaction triggers are essentially labor oriented. Costly events involving use or consumption of non-labor resources, such as computer-aided robotics and other equipment, tooling, and other technological events, are not captured by the transaction triggers. Of course, the costs are eventually captured, but not at and perhaps not even close to the point where resources are consumed or used.

More than Firm Trad, Firm CIM has a problem with failure to capture costs between entry/exit transfer points because Firm CIM's processes use more technological resources, and because Firm CIM's laborers have a different role. They guide and assist the processes, working in teams. They have fewer easily identified pay points to use as a basis for measuring costs and output. The complexity of integrated operations makes it difficult for Firm CIM's managers to intuitively perceive cost consequences and make decisions that conserve costs. It is more difficult in such circumstances to trace excessive or wasteful costs to their origin. Firm CIM's managers, therefore, are likely to conclude that some kind of improved cost identification is warranted. Part of the solution is to select more and better resource events as cost transaction triggers.

Cost Assignment -- CIM vs. Traditional

The empirical findings suggest that, like Firm Trad, Firm CIM assigns overhead costs to products based on direct labor. Firm CIM is continuing a traditional reliance on direct labor to serve as a surrogate for other conversion resources to assign overhead costs. There are two problems with this. First, CIM has fewer "direct" laborers. More of its conversion efforts are derived from automated equipment and less of the workers' time is spent on direct operational tasks. Second, Firm CIM's overhead includes substantial technological costs for both technological resources and support. Due to these two factors combined, reduced direct labor and expanded overhead content, overhead application rates appear to be intolerably high and unmanageable.

Firm CIM is not satisfied with its costing of overhead. Its managers do not seem to understand overhead costs. The findings suggest that Firm CIM's accountants are making extended efforts to analyze and explain overhead costs to managers. The managers, on the other hand, are making extended efforts to scrutinize and correct overhead charges to their accounts.

The empirical findings suggest that Firm CIM is attempting to trace overhead costs to causal sources where possible, by using direct charges to cost centers for costs like maintenance, tooling, and supplies, and by using a greater variety of assignment factors. What Firm CIM has not changed, however, is the pooling of overhead costs. Firm CIM has not sub-divided its overhead into concentrated pools that are focused on the various classes of resources.

Cost Reporting -- CIM vs. Traditional

For Firm CIM, providing enough reports or enough access to cost data through on-line inquiry are not the key issues. Instead, the key issue is the "penetrability" of the cost data that are reported. Firm CIM's managers want to be able to unravel and trace reported costs to where they originate. The managers want to do this to help them decide where costs can be removed and where waste can be avoided. They want penetrable costs so they can have more cost visibility into the potential cost consequences of their resource management decisions. They want cost visibility to help them evaluate the effectiveness of their strategies and the trade-offs those strategies require. Furthermore, their scope of interest is not merely local, limited to their individual sphere of responsibility. They are as interested in the macro, plant wide level as they are in the micro local work station level. Penetrable costs permit attention at both levels.

Firm CIM's managers respect the necessity of using cost data for financial and inter-plant or inter-divisional purposes. But they also want cost data that are more effectively oriented to and supportive of cost management objectives. To these managers, cost management has become an urgent strategic necessity. They want cost data reported that can support their cost management strategies.

Firm CIM's managers are more interested in cost identification than in cost absorption. They are more interested in weekly cost summaries than in inquiry of cost account balances, especially if the accounts are up-dated less frequently than weekly. They are as much interested in cost data that affirm achievement of objectives as they are in cost data that criticize apparent problems with after-the-fact aggregated measures. Firm CIM's managers want cost accounting data that help them detect and eliminate sources of waste, instances of unwarranted disruption to production flow, or other forms of undesirable demands on resources. Finally, they do not believe aggregate measures of labor efficiency or labor hour utilization are effective at helping them manage costs. They want efficiency and utilization to be measured and judged more broadly, encompassing integrated production results evaluated with reference to major resources, not just direct labor.

"Firm CIM" and "Firm Trad" contrast the essence of the findings obtained at the CIM and traditional manufacturing sites, taken as a whole. Similar contrasts were derived from comparisons made of each of the four pairs of sites listed in Table 6 in Chapter IV. Careful attention was given to comparisons of the individual pairs during the entire process of analyzing the detailed findings.

SUMMARY OF SUPPORT PROVIDED BY THE EMPIRICAL DATA

Tables 11 and 12 were prepared from the empirical data to summarize the support provided for the hypotheses and hypothesis focus points.

TABLE 11

SUMMARY OF SUPPORT FOR HYPOTHESES

RESEARCH HYPOTHESES	*FORMAL RESEARCH SUPPORT**	*RESEARCH DATA EXPLANATIONS*
COST IDENTIFICATION		
CIM sites were expected to have more (but smaller) cost centers and were expected to group cost centers by class of resource identification.	Weakly Supported	Some new cost centers were formed, but only for newly formed cells. Some new accounts were established to reflect the nature of techno-logical resources. However, accounts were not grouped by class of resource. Broad changes in cost centers or account classifications to improve cost identification were not observed.
COST ENTRY		
CIM sites were expected to use additional, different events to trigger cost transactions.	Not supported	All sites (both CIM and traditional) rely on entry/exit transfer points and labor pay points for transaction triggers. Intra-process pro-duction measures were not used as cost trans-action triggers.
COST ASSIGNMENT		
CIM sites were expected to assign support costs by class of resource supported and to base cost assign-ments on relevant resource factors.	Weakly Supported	CIM sites were charging more kinds of overhead costs directly to cost centers based on resource demand factors. However, no sites had sub-divided their overhead pools by class of resource.

*The manner by which "support" was defined and determined is explained at the beginning of the section in this chapter entitled "SUPPORT FOR THE RESEARCH HYPOTHESES."

Table 11. Continued.

RESEARCH HYPOTHESES	FORMAL RESEARCH SUPPORT	RESEARCH DATA EXPLANATIONS
COST REPORTING		
CIM sites were expected to update cost data more frequently, use more on-line access to cost data, and focus cost reports more on strategic manufacturing objectives.	Weakly Supported	Changes were observed in informal "off-system" procedures but not in formal reporting from the cost system. Plant accountants were using spreadsheet software to prepare daily or weekly reports on materials, tooling, labor and scrap. The time frame of the cost systems did not match the production system time frame. The CIM sites did not use on-line access to cost data to a significant extent.

TABLE 12

SUMMARY OF SUPPORT

TABLE 12

SUMMARY OF SUPPORT FOR HYPOTHESES FOCUS POINTS

FOCUS POINTS	FORMAL RESEARCH SUPPORT	RESEARCH DATA	COMMENTS OF INTERVIEWEES
1.1 REDESIGNATION OF COST CENTERS	Supported	CIM sites had regrouped their production processes into cells, which focused on product families. Cost centers were designated for new cells but were not otherwise revised to attain homogeneous costs within cost centers.	Production managers said costs were not being identified with enough precision to support strategic manufacturing objectives. CIM plant accountants were not pushing for redesignation of cost centers to improve cost identification, citing the need to retain existing budgetary and financial reporting procedures.
1.2 CLASSIFICATION OF RESOURCES AND SUPPORT	Not supported	Account groupings at CIM sites did not recognize the changed nature of cost drivers. Most non-labor costs were monitored in reference to direct labor ("head count" monitoring). Overhead pools were not sub-divided.	Several production managers voiced opinions that cost measures rely excessively on head count monitoring.
1.3 IDENTIFICATION OF COST MANAGEMENT RESPONSIBILITY	Not supported	CIM sites were unable to derive macro level cost data to evaluate operating costs of integrated production.	Managers said budget/responsibility reporting systems constrain them from obtaining macro level cost management information.
1.4 CLASSIFICATION OF DIRECT COSTS	Weakly supported	Some costs (machinery related tools and supplies, maintenance) were being charged directly as incurred rather than pooled and allocated.	CIM managers expressed more confidence in direct charges to accounts or cost cost centers than in allocations of pooled indirect costs. Some managers believe set-up costs should be treated should be treated as direct costs.

TABLE 12. continued.

FOCUS POINTS	FORMAL RESEARCH SUPPORT	RESEARCH DATA	COMMENTS OF INTERVIEWEES
2.1 PLACING TRIGGERS CLOSE TO RESOURCE EVENTS	Not supported	CIM sites continued to use traditional events as transaction triggers. Events measured for production scheduling or routings were not being used as transaction triggers as expected.	CIM managers indicated that existing cost trigger events are remote from cost driver activities. They suggested places for new triggers, including applications of tooling, measures of capacity utilization and bottleneck events.
2.2 RESPONSIBILITY FOR COST DATA -- A SENSE OF DATA OWNERSHIP	Weakly supported	CIM plants were giving managers increasing responsibility for collection of cost data.	CIM managers appear to interpret cost consequences in terms resource consumption rather than cost dollars.
2.3 TRIGGERS FOR EXPENDABLE AND DURABLE RESOURCES	Not supported	CIM plants did not distinguish between expendable and durable resources in cost entries. No production managers expressed desire for such distinction.	CIM production managers suggested that their main concern is the effective use of resources and absorption of capacity costs is a secondary concern.
2.4 KEEPING COST DATA CURRENT	Weakly Supported	There were clear indications of attempts to align the accounting time frame with the production time frame, with special weekly cost reports at the CIM sites. However, cost systems were not triggering cost entries and updating cost account balances on a weekly basis.	CIM managers encouraged weekly updating of cost data so the data time frame would coincide with the weekly production control time frame.

TABLE 12. continued.

FOCUS POINTS	FORMAL RESEARCH SUPPORT	RESEARCH DATA	COMMENTS OF INTERVIEWEES
3.1 ASSIGNING SUPPORT COSTS WITH RELEVANT RESOURCE FACTORS	Weakly supported	CIM plants' overhead cost pools included substantial resource support costs and capacity costs which, when assigned, were not being matched with relevant resources. The reasons appeared to be that non-labor resources were not well specified in engineering data and capacity usage was not measured.	CIM managers said their cost systems rely heavily on measures of labor utilization to monitor capacity costs, but such measures were not effective.
3.2 ASSIGNING COSTS BASED ON COST MANAGEMENT OBJECTIVES	Not supported	No sites had adopted cost assignment factors tailored for strategic manufacturing objectives.	CIM managers said they need more cost "visibility" to anticipate the cost consequences of their resource management choices. Their comments suggested that basing cost assignments on cost management objectives would improve cost visibility. CIM plant accountants said managers often do not understand overhead costs and cost assignments.
3.3 PENETRABLE COSTS WITH TRANSPARENT COST ASSIGNMENT	Not Supported	No evidence was found to suggest the CIM plants were changing their cost assignment procedures to produce more penetrable costs.	Managers at each CIM site emphasized the importance (in their minds) of cost penetration and their desire for cost assignment procedures that permit cost penetration.

TABLE 12. continued.

FOCUS POINTS	FORMAL RESEARCH SUPPORT	RESEARCH DATA	COMMENTS OF INTERVIEWEES
4.1 COST OBJECTIVES AND STRATEGIC MANUFACTURING OBJECTIVES	Supported	Informal "off-system" reports were being issued to provide affirmative cost data. CIM sites were looking for ways to conform the accounting transaction cycle and reports to the weekly production cycle and reports.	CIM managers said they need cost data that affirm conformance to manufacturing specifications.
4.2 COST MANAGEMENT REPORTING FOR COST MONITORING	Not Supported	Although CIM managers were critical of accounting measures of labor efficiency and utilization, no evidence of macro level cost reporting was found.	CIM managers indicated they want cost systems to judge cost effectiveness in a macro sense rather than focusing on efficiency and utilization of direct labor. Discussions with CIM managers suggested their desire for cost data was to affirm their decisions more than to make their decisions.
4.3 REPORTING COST CONSEQUENCES OF DISRUPTION AND WASTE	Weakly Supported	The CIM sites emphasized detection and elimination of waste but did not report costs resulting from disruption to production flow.	Managers suggested that cost systems could report instances of waste more specifically.

CONCLUSIONS

The empirical data have been summarized according to a framework provided by four research hypotheses and related focus points. The conclusions regarding the hypotheses and focus points are summarized in Tables 11 and 12. It is now appropriate in the light of these conclusions to consider again the basic research question:

> **How does the integration of manufacturing processes and the application of computer-aided technology affect the role of cost accounting in cost management systems?**

Based on the findings from the empirical data and the conclusions summarized in Tables 11 and 12, the following responses to the research question are offered:

(1) When firms implement CIM, no immediate change in cost identification procedures are likely. However, managers may doubt whether costs are identified with sufficient precision and in response, the firms will eventually revise their cost account classifications and redefine their process cost centers. In making these revisions, more explicit recognition will be given to technological resources and cost drivers.

(2) While additional cost measures or transaction triggers may be available to CIM firms, it is not clear from the results of this study whether CIM firms will make significant changes in choices of events to use as transaction triggers.

(3) CIM firms will change their cost assignment procedures to charge production support costs directly to cost centers rather than assigning such costs through allocations. Eventually, CIM firms may sub-divide their overhead pools into separate resource-oriented support pools.

(4) Cost reporting will increasingly focus on cost management information as a primary objective, while also accommodating financial reporting requirements. With increasing emphasis on cost management objectives, managers will begin to rely more heavily on the formal cost system as a primary source of cost data.

Recommendations and implications for further research are presented in the next and final chapter.

CHAPTER VI

CONCLUSIONS AND OPPORTUNITIES FOR FURTHER RESEARCH

INTRODUCTION

This field study was undertaken to investigate the impact of CIM on the role of cost accounting. Hypotheses were developed from background literature for each of four cost accounting activities which comprise the role of cost accounting. Field visits were made to eight manufacturing plants to gather empirical data. Findings from the empirical data suggest that cost accounting's role had changed at the CIM plants, but less than hypothesized. The purposes of this chapter are to interpret these results, draw certain conclusions, and suggest opportunities for further research. The chapter is organized into two sections: (1) discussion of the hypotheses in retrospect, given the findings obtained, and (2) discussion of areas that warrant further research investigation.

DISCUSSION OF THE HYPOTHESES IN RETROSPECT

Research hypotheses were specified in Chapter III for each cost accounting activity: cost identification, cost entry, cost assignment and cost reporting. As summarized in Table 11 of Chapter V, the empirical findings provide only weak support for three of the hypotheses and no support for the other hypothesis. The purpose of this section is to discuss this result in retrospect, beginning with the Cost Identification hypothesis.

COST IDENTIFICATION

Based on the background literature examined and summarized in Chapter III, the structure of cost incurrence is likely to change where CIM technology is used and production processes are integrated. Cost incurrence patterns are more complex because production areas are highly integrated. Costs of technology and technological support make up a higher proportion of production costs. For these reasons, changes in the means of cost identification (accounts and cost centers) in CIM were hypothesized. Accounts would be organized according to classes of resources. To ensure homogeneous costs within cost centers, smaller cost centers would be designated.

General Conclusions

The empirical data indicated less change in the means of cost identification than hypothesized, even though plant managers and others said they want costs to be better identified. Discussions with CIM managers in interviews inferred that their existing cost drivers are not being measured with sufficient precision to enable them to manage costs effectively. Yet adapting cost accounting's role in these plants to improve cost identification did not appear to be a matter of high priority among the plant managers, plant accountants, or production managers.

Two factors appeared to slow the rate of adaptation of cost accounting systems in the CIM plants:

(1) Systems and procedures used to identify costs focus primarily on direct materials and direct labor as measures of two resources, materials and workers. By contrast, production systems focus on a broader resource set, including machinery and equipment, information and technology, and tooling. Cost identification's narrow focus inhibits the identification of significant cost drivers not closely related to materials or workers.

(2) Improved identification of cost drivers depends on the availability of detailed information about technological resources (machines, tooling, machine software), but such information does not appear to be available in engineering data systems for use in cost identification.

Specific Suggestions

Based on opinions expressed by plant managers, engineers and production managers during field interviews, three suggestions follow in response to the conclusions about cost identification:

(1) Broaden the focus of cost identification to the full set of resources (as defined in Chapter I).

(2) Link cost identification data to better specification of non-labor technological resources.

(3) Where appropriate, especially for areas with manufacturing cells, redesignate cost centers according to product traits rather than process traits.

A brief discussion of each of these suggestions follows.

Broadening the focus to a wider set of resources. Rather than focusing primarily on materials and workers, cost identification could focus more broadly on cost drivers of the entire set of resources (as defined in Chapter I). This suggests organizing accounts to reflect "direct" events involving all significant classes of resources and grouping the accounts by class of resource. It suggests capturing support costs by class of resource rather than pooling them into generic "overhead" or "factory burden" accounts. Finally, it suggests that the term "resource support" replace the traditional "overhead" term. The primary objective of these kinds of adaptations is to instill a view of cost identification that can be shared by both accountants and production managers: that costs result from resources where resources are used or consumed.

Developing improved specification of technological resources. Traditional cost measures have relied heavily on quantified data in engineering bills of materials and operations routing files. Cost identification might improve if additional detailed specifications were available for all significant costs of tooling, technology and technological support services. Ideally, "bills of resources" and "process routings" would be suitable replacements for bills of materials and operations routings.

Designating cost centers for product-focused cells. The traditional manufacturing focus is on homogeneous process areas, but CIM plants tend to form clusters of diverse resources to focus on product families. Cost centers designated for CIM product-focused areas may include less homogeneous cost drivers than traditional cost centers. However, this lack of homogeneity of cost drivers can be accommodated by a cost system capable of identifying costs of a broader set of resources. Cost centers in CIM plants may be homogeneous as to products but heterogeneous as to processes.

COST ENTRY

The cost identification activity establishes the framework (accounts, account groupings and designated cost centers) by which costs can be recorded and classified. The next task is cost entry, the activity that selects and measures events that best reflect consumption or usage of resources. Theory developed in Chapters II and III suggest that the set of trigger events in CIM would be larger and more diverse than the set of triggers of traditional manufacturing. Since CIM operates with an ample amount of engineering and production data, CIM should offer more choice of resource events compared with traditional manufacturing. Theory also suggests that the triggers in CIM should be in close proximity to cost driver events since there is a greater variety of resources in use. Otherwise, identified costs fail to reflect underlying cost drivers because costs are captured at points too remote from where the costs are actually incurred. Therefore, the cost entry hypothesis was that a larger and more diverse set of cost transaction triggers would be found at the CIM cites.

General Conclusions

The empirical data did not confirm the hypothesized differences in cost entry at CIM sites. Costs were generally triggered at the CIM sites by the same events (entry/exit transfer points and labor pay points) as those of the traditional sites. Given that less change was found regarding the cost identifications hypothesis, change in transaction triggers was also less likely. The results are interdependent. If steps are taken to identify costs more explicitly, then changes in the choice of triggers are likely to follow. Furthermore, the findings suggest that the advantages of a better choice of trigger events may not be clearly apparent to cost accountants. It may not be clear why better triggers would produce better cost identification, which in turn may improve cost management.

New cost transaction triggers may need to be designed, something accountants at the plants are often not able to do easily. Discussions with plant accountants indicated they were reluctant to design and use new cost measures. Accountants seem more reluctant to specify their own data requirements than engineers and production control managers, who design their data requirements and gather the specific data they need. Accountants, however, generally try to use existing measures for accounting purposes. This posture is often justified, of course, by cost/benefit considerations. However, interviews with plant accountants suggest a view that outright collection of cost data for the primary purpose of cost measurement is inappropriate. This view may change in the future if greater emphasis is placed on cost management as a key part of competitive strategy.

Specific Suggestions

Discussions with engineers and production managers resulted in certain suggestions about potential new cost transaction triggers:

(1) Where production is controlled with pull-through procedures, use replenishment events as transaction triggers.

(2) Use triggers that recognize the use of durable resources.

(3) Identify and use process "pay points" where appropriate to replace labor "pay points."

These suggestions are explained in more detail below.

Replenishment events as transaction triggers. Within process areas, between entry and exit transfer points, are events which may be of a replenishment nature. Such events are common in fabricating areas of plants organized with pull-through production concepts. Replenishment triggers can be used in areas where refilling of an emptied container to replenish its contents is the basis for an authorization to produce. Recording such replenishments would be similar to recording replenishments of imprest cash funds.

Triggering events of usage of durable resources. Most events involving resources are measured when the resource is issued or consumed. Cost accounting systems typically do not have measures to capture events where durable resources are used. Given the greater flexibility inherent in CIM cells and production processes and the greater diversity of resources in process areas, transaction triggers that capture usage of durable resources may provide improved cost monitoring. Such triggers may be feasible if resources and process operations are well specified in engineering data, such as in "bills of resources" or "process routings" as suggested above.

Triggers that capture process "pay points". Measures of labor operations or labor "pay points" are often relied upon to capture production inputs. A broader inclusion of process operations (rather than labor or machine operations) involving all resources may provide more comprehensive capturing of costs closer to underlying resource events. Using process "pay points" as triggers may be feasible, if bills of resources and process routings are developed to include machinery and equipment, technology and information, and tooling.

COST ASSIGNMENT

Once costs are identified and entered into accounts, the next step is to assign costs to cost objectives, defined as the purposes for which costs are reported. Theory suggests (and the findings confirmed) that substantial amounts of technology-related support and service costs are included in overhead costs of CIM plants. The overhead pools are large and their contents diverse. It was hypothesized that the overhead pools of CIM plants would be sub-divided by class of resource (so that the pools would be more homogeneous) and assigned with relevant factors for each class of resource.

General Conclusions

The empirical data confirmed that the CIM plants were using cost assignment procedures to identify and treat significant support costs as direct costs. This was consistent with the cost assignment hypothesis. However, the overhead pools of the CIM sites had not been sub-divided into separate pools for each resource. Resource managers and plant accountants at all of the CIM sites confirmed that overhead costs were significant and contained substantial amounts of resource support costs. Yet, on the whole, the cost assignment procedures were virtually the same at the CIM and traditional sites. Given that the hypothesized changes in cost identification and entry had not taken place, and overhead accounts were not grouped by class of resources, then it can be expected that the overhead pools were not subdivided either.

Specific Suggestions

Several suggestions regarding cost assignment emerged from the field visit discussions with resource managers and accountants:

(1) Classify overhead costs into pools that distinguish the nature of the costs.

(2) Use cost assignment procedures which permit matching of support costs with the relevant resources supported.

(3) Where possible, use measures of usage to assign costs of durable resources and of capacity.

These suggestions extend the general notion that cost systems become more oriented to resource-based cost recognition and reporting.

Classifying overhead pools to distinguish the nature of the costs. The overhead pools of all of the visited plants generally contained three kinds of costs: indirect production costs too trivial to identify as direct costs, production support costs, and capacity costs. For cost management purposes, overhead cost pools could be sub-divided to distinguish support and capacity costs from indirect production costs so that each category may be assigned separately.

When assigning costs, match support costs with resources receiving the support. Since support costs are significant in CIM (as evident at the CIM sites), and since CIM uses a broad set of diverse resources, cost assignment procedures that match support costs with the class of resources supported may help to link cost identification with cost reporting. Managers would then be better able to penetrate the costs, identify the cost drivers and plan for the cost consequences of their strategic manufacturing decisions.

Measure the usage of capacity resources to assign capacity costs. Capacity costs are typically amortized to overhead accounts at a flat rate per time period. Such costs relate generally to resources such as buildings or general supervisors, which provide the space or atmosphere in which production is carried out. If capacity-providing resources are not utilized consistently, use of flat rate amortization may result in assign capacity costs in patterns inconsistent with utilization patterns. Idle capacity costs may not be recognized. Assigning capacity costs as a form of rental, based on usage, may provide useful information for cost management purposes.

COST REPORTING

The strategic manufacturing objectives of CIM were expected to affect the form, format, and frequency of cost reporting. There would be changes in the form, content, and means of access to cost data. Also, resource managers would access cost data frequently as a normal part of their management routine.

General Conclusions

Support for the cost reporting hypothesis was found at all of the CIM sites, although the extent of contrast in cost reporting practices between the CIM and traditional sites was less than hypothesized. In addition, less support was found in the form of changes to the formal cost systems as contrasted with informal efforts to provide special cost reports. Increased use of on-line access to computer data files was hypothesized, but was not found to be a regular means of cost reporting at any CIM sites. Some general conclusions were reached to explain why more change was not found.

One factor was the relative lack of change in cost identification, cost entry and cost assignment. Changes in cost reporting are more likely to occur where cost identification is adapted to capture costs of all resource classes, and where cost assignment uses resource-based assignment factors.

A more fundamental explanation may be that cost management has not yet become the central purpose of cost reporting at CIM plants, not to the extent suggested by theory from background literature. Literature suggests that CIM should bring about a shift in emphasis in cost reporting, with more emphasis on managing costs as part of overall competitive strategy. This is balanced with the continuing requirements for product costing for inventory determination. Some evidence was found that this shift in emphasis was taking place at the CIM sites, but the shift was subtle rather than clearly evident.

If cost reporting is gradually shifting in emphasis to cost management as its central purpose, then significant abrupt adaptation of cost reporting practices is not likely. Some revised reporting practices will emerge as changes in organizational patterns or technology occur. But most changes in cost reporting are likely to take place gradually over an extended period of time. Meanwhile, accountants at CIM sites will adapt cost reporting needs informally by preparing special analyses reports for specific cost management needs, such as reports on materials and scrap, labor and down time, rework, tooling and other major overhead costs. These will be prepared with cost data obtained from the cost system. Reports are still not likely to be drawn directly from the cost system. Reporting of costs are likely to be part of a larger scope of reporting for financial statement and budget analysis purposes rather than an integral part of production cost management.

The field interviews with resource managers did support the basic notion that cost reporting links with the resource-based, cost management theme of the other cost accounting activities. Managers clearly desired costs that are more penetrable so that they can have more cost visibility for their decisions. Yet, a somewhat surprising discovery at the CIM plants was that engineers and production managers tend not to use the cost system as a source when they need cost data to make cost estimates.

Engineers and production managers were asked why more reliance was not placed on the cost system as a source. They suggested that cost data was gathered and prepared primarily for accounting's own uses or purposes (financial reporting and budget analysis) and that these purposes require cost allocations and manipulations that are obscure. The engineers and production managers felt more secure by creating their own cost estimates. Their apparent insecurity with costs obtained from the cost system may be a manifestation of the fact that cost reporting is not being driven by cost management objectives.

Specific Suggestions

Discussions with plant accountants, plant managers, engineers and production managers included a variety of opinions and explanations concerning cost reporting. Based on these discussions, two groups of suggestions were identified. The first group consists of suggestions for cost reporting to support cost management objectives and the second group consists of ways to encourage resource managers to use the cost system as the primary source for cost data.

Cost reporting to support cost management objectives. As discussed above, CIM is likely to encourage a shift in emphasis toward cost management objectives. In this regard, several suggestions are offered:

(1) Focus cost reports on data that support the key manufacturing objectives, which include:

- Achieving timely delivery of highly reliable output with minimal reliance on buffer inventory to meet delivery commitments;
- Attaining very high quality in production by conforming to specifications rather than "inspecting in" the quality; and
- Minimizing wasted consumption of resources and minimizing opportunities costs due to poor utilization of resources.

Issue weekly reports with cost data that affirms the achievement of these strategic manufacturing objectives.

(2) Incorporate into cost reports data that address the reasons for forming manufacturing cells:

- Cells are formed for flexible, product-focused processes. Process costing is a useful way to measure costs within cell process areas equipped to handle variety with minimal process interruption.
- Cells are formed to reduce costs of materials handling, scrap, tooling and set-ups. Measure and report on each of the cost areas where particular attempts are being made to reduce costs.

- Cells are formed to achieve quality with minimal costs of inspection and rework. Measure both kinds of quality costs: quality assurance and quality failure.

(3) Since managers tend to be "cost conscious" in terms of resource characteristics (rather than dollars), relate reported costs to physical measures of related resources where possible.

(4) Adapt measures of efficiency and utilization to focus on technological resources (machinery and tooling) as well as workers.

(5) Structure budget supervisory responsibility to match production supervisory responsibility, rather than the other way around.

(6) Measure and report cost consequences of process interruptions and other instances of waste. Cost data can help production managers to discover and eliminate sources of waste.

(7) Develop ways of aggregating costs from local to macro levels to coincide with the macro level production authority or responsibility structure.

<u>Encouraging resource managers to use cost system as a primary source of cost data</u>. As discussed above, engineers and production managers at CIM sites appeared to be reluctant to use cost data from the formal cost system. Several suggestions were identified to encourage them to use the cost system as their primary source of cost data:

(1) Clarify responsibility for cost data. Accounting is responsible for the measures. Resource managers are responsible for the resulting measurements.

(2) Get the production managers and workers involved in collecting and maintaining cost data. A greater sense of data ownership will develop where managers have a stake in collecting and maintaining data.

(3) Synchronize the time frame of cost data with production data.

(4) Make cost estimating a responsibility of the cost accounting function.

SUGGESTIONS FOR FURTHER RESEARCH

The role of cost accounting in CIM is a research topic that is still evolving. The results of this study were somewhat inconclusive in all four cost activity areas. Support was found for only three of the four study hypotheses and the support was weak. As cost accounting systems continue to evolve at CIM sites, further research is needed to develop specific theory and models concerning cost accounting activities. Three kinds of research appear to be needed:

(1) More field studies at additional sites to provide further validation and additional information;

(2) Analytical model research to specify theory about resource-based cost entry (transaction triggers) and cost assignment.

(3) Field experimental research to test hypotheses developed from analytical models.

ADDITIONAL FIELD RESEARCH

Field studies at other sites may provide additional information about resource-oriented cost classifications, support-resource matching, cost management-oriented reporting, and other concepts not exhaustively investigated in this study. The findings of this study were obtained from a small set of companies. The CIM sites were only partially through their own evolution of CIM and cost management characteristics. Further field study investigation could help to validate (or refute) conclusions reached in this study. Areas for further validation include:

- Investigation of groupings of resources to determine whether the groupings suggested in this study (materials, workers, machinery, tooling, technology and information, and facilities) are appropriate for general use at CIM firms.
- Investigation of the feasibility of using production measures and activities as transaction triggers.
- Investigation of changes in the composition of overhead to evaluate the relative importance of the three types of overhead found at the sites visited in this study: indirect production costs, production support costs, and capacity costs.

ANALYTICAL MODEL RESEARCH

Analytical model building research may provide more specific definition of theoretical constructs suggested in this study, such as the linkages between cost identification, entry and assignment to achieve penetrable costs for cost reporting. A model that addresses all classes of resources is needed. The traditional cost accounting model focuses on materials and labor as the two primary classes of resources. Traditional cost accounting classifies direct costs based on specifications of materials and labor. It is uncertain how the distinction between direct and indirect would be made in a resource-based analytical model.

FIELD EXPERIMENTAL RESEARCH

Field experiments would confirm or disprove specific testable hypotheses developed from the analytical models. Field experiments can be conducted on the effectiveness of various transaction triggers, cost assignment procedures, and cost reporting (objectives, form and frequency). Additional experimental research is needed to determining the cost/benefit relationships of various stages of the process of change in cost management systems.

CONCLUSION

Literature has suggested that CIM is moving cost accounting into a new era. This study has investigated characteristics of change in the role of cost accounting by comparing cost accounting activities at four CIM plants with four traditional manufacturing plants. The results of the study provide some limited support for the changes hypothesized in three of the four defined cost activity areas. In addition, the empirical data produced by the study contribute important descriptive insights about the kinds of changes likely to occur where CIM is introduced into traditional manufacturing.

APPENDICES

FIELD INTERVIEW GUIDE

INTRODUCTION:

This field study investigates cost accounting practices in manufacturing companies. The investigation should lead to development of a representative synthesis of cost accounting practices found in the various participating companies. The general purpose of the study is to compare cost accounting practices in advanced Computer-integrated manufacturing (CIM) settings with those in traditional manufacturing settings.

Section I presents a series of general, demographic inquiries about the nature of the company's products, manufacturing sites and processes and cost accounting systems. Section II concerns the integration of CIM into the manufacturing activities. Section III pertains to the role of cost accounting, which is defined in this study as four selected activities:

- Defining cost responsibility boundaries
- Identifying transaction trigger points
- Specifying cost assignment practices
- Reporting (or providing access to) cost information

Section IV specifies the inquiries pertaining to each of nine particular manufacturing decisions:

- Determining the work center schedule.
- Choosing routings for production.
- Undertaking a cost reduction analysis.
- Deciding to change manufacturing processes.
- Changing methods for setting or revising standard costs.
- Establishing overhead application rates.
- Developing quotes or bids for new business.
- Revising "cut-off" practices for entry of transactions.
- Revising the form or frequency of cost accounting reports.

SECTION I **GENERAL INFORMATION**

These inquiries serve the purpose of describing the operating context within which manufacturing and cost accounting practices occur. The questions pertain to the products manufactured, the manufacturing plant facilities, the manufacturing processes utilized, and the role of cost accounting.

I.I **PRODUCT LINES**

Within product families, there may be a variety of product lines. Knowledge about the product families and product lines is a necessary prerequisite for understanding manufacturing operations and consequent demands for cost accounting information.

1. What product families are manufactured and sold by the company/division?

   a. Plant identification: in which plants are the product families manufactured? [See §I.II]

      i. Obtain a list, showing plants where major portions of fabrication and assembly occur.

      ii. Also determine the relative magnitude of production, as well as the proportions distributed among the product families.

   b. Product identification: what specific products are included in each of the product families?

   c. End-items: for each of the major products, identify the end-items which drive the Master Production Schedule.

   d. Relative magnitude: what are the annual sales volumes of each of the families, in ranking order?

e. **Value added:** to what degree are the products' content manufactured rather than procured?

f. **Stage in Product Life Cycle:** relatively how mature are the product families? What are the newest and relatively oldest products in each of the product families?

I.II MANUFACTURING FACILITIES

This section focuses on the manufacturing context in which cost accounting practices are executed. The manufacturing plants are described, with a view toward important manufacturing activities taking place, as well as the organization structure of manufacturing control.

1. Describe the manufacturing plants. Prepare a summary schedule of plants, showing for each plant a description, its location and size (sq. ft and no. of employees).

2. Prepare a map sketch of the manufacturing facility chosen for the study. The map should show:

- Departmental boundaries for factory control and supervision
- Departmental boundaries for flexible budget purposes
- Critical work stations*
- Material handling systems*
- Major fabrication/assembly equipment*
- Production flow patterns*
- Inventory storage areas*

* Aspects where CIM facilities or JIT restructuring might occur.

3. What capital improvements have been implemented in the plant since 1984? Specifically, what investments in CIM have been made during the past three years? Describe the nature and amount of capital investment expended in this plant for new and improved manufacturing facilities during the past three years.

4. Describe the manufacturing processes which take place in the plant:

a. Design-- Is computer assistance used to aid in the design of new products or modification of existing ones? Are group technology concepts used?

b. Fabrication-- What fabrication operations are carried out? Are numeric control machines in use? Work cell concepts used?

c. Assembly-- Describe the plant's assembly operations. How is assembly scheduled? Pull-through concepts used?

5. What measures of activity indicate the plant activity level?

a. Number of part numbers of fabricated and assembled parts.
b. Number of levels in Bills of Materials.
c. Number of new product designs.
d. Number of Engineering Change Orders (Notices).

6. Select a representative finished product and describe how it is built:

Fabrication (any special processes, such as heat treating, plating, painting?)
Finishing and assembly
Quality: design, testing and inspection
Inventory: Stages and locations
Standard cost roll-up: Obtain a standard cost build-up for the representative product and compare it with the other information obtained about the representative product.

I.III MANUFACTURING SYSTEMS

Manufacturing systems are defined as those which (i) design and engineer the products and production processes, (ii) plan and schedule the production, (iii) manage the inventories, (iv) plan the tooling and maintenance. Generally, manufacturing systems aim to produce marketable products and assure timely delivery and desired quality. Manufacturing seeks to be both effective and efficient. Cost accounting systems and practices are expected to (i) support manufacturing objectives, (ii) measure the cost impact of significant manufacturing events (transactions) and output, and (iii) evaluate the cost of manufacturing activities.

1. Describe the procedures generally used for **product engineering**, including implementation of Engineering Change Orders.

2. Describe the systems and facilities used for **planning and scheduling** of manufacturing activities.

   a. **Order releases:** Observe several representative order releases and follow them through production. Map the process of order release and order completion.

   b. **Choosing routings:** observe whether standard routings are used; whether **alternate routings, split operations** and **operations overlapping** occur. Inquire about the frequency and relative significance of each of these routing aspects.

c. **Dispatching work orders:** what dispatching priority rules exist? Is cost information used to help set dispatching priorities? Relatively how significant is cost minimization as a priority factor?

d. **Input/Output control:** What procedures are used to manage the level of work released to the shop area?

3. Describe the procedures and files used for inventory management systems.

a. What transactions are recorded in the inventory records used by manufacturing?

b. Are manufacturing inventory records synchronized with accounting transactions, and are they reconciled? What procedures are used?

4. Is Closed-loop MRP in use?

a. Obtain (or prepare) a description of the MRP system; diagram the process flows and data file configuration; obtain examples of input and report formats.

b. Are MRP plans linked well with the production plan, capacity requirements plan and the shop floor dispatch list? Are these plans costed out by applying standard cost data?

c. Is MRP sufficiently integrated with other manufacturing and accounting systems to enable simulation of operational decision alternatives? Request and summarize a few examples of uses of MRP data file information to simulate decision outcomes.

5. **Computer integration:** Observe the extent to which CIM has been integrated into the manufacturing activities relating to:

- product and process design
- setups
- robotics applications
- JIT structuring
- file integration
- MRP, CRP and SFC

Write up summaries in response to this step, using diagrams and examples.

I.IV COST ACCOUNTING SYSTEMS

To be most effective, cost accounting measures should be acceptable to manufacturing users. Acceptance generally implies close linkage between cost measures and manufacturing operations. Cost accounting/manufacturing linkages are to be observed to attain a correct understanding of the role of cost accounting. The linkages pertain to (i) identification of cost centers, (ii) use of standard costs and variances, (iii) pools and factors used for overhead costs, (iv) application of flexible budget systems, and (v) maintenance of cost accounting files.

1. **Cost center definition:** Obtain a hierarchical structural chart of cost centers and responsibility levels used for flexible budget reports.

a. How are cost centers defined? Which function is primarily responsible for adopting or revising definitions of cost centers?

b. Has the structure of cost centers been revised in response to changes in manufacturing organizational structure or technology? How frequently have such changes occurred?

c. Which cost centers have manufacturing cells?

d. **Does the cost center structure equate to the responsibility structure employed for manufacturing control?**

2. **Use of standard costs: Are standard costs used to track transactions and measure and report variances from standard, by cost center?**

a. **Standard cost files: Does cost accounting keep its own files or use files of related functions, such as purchasing and materials management?**

b. **Establishing new standards: How are standards set for new parts or products? Which function has the primary responsibility for developing cost standards for new parts?**

c. **Revision of cost standards: How (method and frequency) are existing standards updated to reflect changes in manufacturing methods or prices? Which function has the primary responsibility for such revisions? Are ECO's monitored to identify the need to revise cost standards? What is the dollar significance of broad-scale revisions of cost standards?**

d. **Measuring and Reporting Variances: What are the names of variances reported by the cost accounting system? What is the ranking order of the variances (most to least significant)? How are variances reported?**

e. **Interpreting variances: Who is responsible for interpreting or explaining variances from standard costs or flexible budgets? Is this a significant management task?**

3. **Overhead pools and application rates:** Obtain a list of overhead accounts, identify the overhead pools and determine the overhead application factors. Also determine whether and how service center costs are allocated to overhead accounts.

   a. Have any of these aspects of overhead practices changed in recent years due to changes in manufacturing circumstances?

   b. What function has primary responsibility for establishing or revising these practices?

   c. Are overhead variances reported? Are they prorated to inventory accounts?

4. **Flexible budget reports:** Describe the flexible budget system and reports distributed.

   a. Are such reports linked with and reconcilable to periodic reports of manufacturing performance?

5. **Cost accounting systems files:** What cost accounting files are used? To what extent are these files integrated with the files used in manufacturing operations or support functions?

   a. Describe the monthly cut-off procedures usually followed.

   b. Describe procedures usually followed for physical inventory or cycle counts, including adjustments to book inventory. What has been the relative magnitude (both amounts and percentage) of book-to-physical inventory adjustments?

   c. How are Work in Process inventories measured periodically? Who is primarily responsible for determining WIP? (production, accounting, or both?)

SECTION II INTEGRATION OF CIM INTO MANUFACTURING

This study attempts to differentiate the cost accounting practices of traditional manufacturing with cost accounting practices of CIM manufacturing. CIM is admittedly a broad term, which relates to computer assistance with design, process planning, scheduling, machine operations, materials handling, and quality control. This section inquires into each of these areas to assess the extent to which CIM has been introduced into the manufacturing activities.

II.I PRODUCT DESIGN (CAD)

1. Is computer assistance used to aid in product design?

   a. To what extent are product design engineering tasks computer-aided?

   b. Engineering change orders (ECO's): How are ECO's developed and given effectivity? Review the procedures for implementing ECO's. What are the most frequent reasons for ECO's?

   c. Describe the history of the plant's use of CAD/CAM and its impact on product design and ECO procedures.

   d. Have investment justification criteria been developed for CIM investments? Describe such criteria.

II.II PROCESS PLANNING (CAPP)

1. How are routings established and revised?

2. Are alternate routings sometimes used? How is the choice of alternate routings made, controlled and evaluated? How frequently are alternate routings employed?

II.III COMPUTER-AIDED MANUFACTURING (CAM)

1. **Are numeric controlled machine processes used?**

   a. **Review the extent to which machine processes are subject to numeric control (NC) and direct numeric control (DNC).**

   b. **Are DNC controlled machines in use to form Flexible machine cells (FMC's)?**

2. **To what extent are robotics equipment used? For what types of manufacturing operations are robotics used?**

II.IV COMPUTER-AIDED PLANNING AND SCHEDULING SYSTEMS

1. **Review and describe procedures for developing and revising production plans and master production schedules.**

   a. **What is the size of the schedule time horizon and the time buckets?**

   b. **Are periodic meetings held to resolve schedule feasibility issues? How frequently?**

   c. **How are the end-items defined for use in the master production schedule?**

2. **Review and describe the MRP procedures.**

   a. **Is a closed loop MRP system in use?**

      i. **How is the Master Schedule resolved at periodic intervals?**

   b. **How frequently is MRP regenerated?**

   c. **Are "what if" simulation procedures carried out?**

3. Review and describe Capacity Planning and Shop Floor Control procedures.

 a. How is rough-cut capacity measured for establishing the feasibility of the Master Production Schedule?
 b. What capacity planning factors are used?

 c. Are Input/Output controls used to control the release of shop orders?

 d. How are dispatch priorities determined?

SECTION III ASSESSMENT OF COST ACCOUNTING ACTIVITIES

In general, the role of cost accounting is to facilitate cost effective decision making and to provide monitoring information for use in evaluating performance results. For purposes of this study, the role of cost accounting is defined by identifying four activities:

- Defining cost responsibility boundaries
- Identifying transaction trigger points
- Specifying cost assignment practices
- Reporting (or providing access to) cost information

III.I COST RESPONSIBILITY BOUNDARIES

1. What functional area has primary responsibility for establishing cost centers for purposes of monitoring and control?

 a. Obtain an organization chart for the plant. To whom does the plant accountant report?

 b. Inquire about any substantial changes made in the cost center structure since 1983, due to implementation of manufacturing systems revisions.

2. Develop a map showing manufacturing activities, types of data collected, patterns of data flow, and control points (cost centers and critical work stations).

3. Prepare a list of cost centers and examine how they are integrated into the flexible budget systems.

   a. Which are the significant cost centers?

   b. Which cost centers have the most CIM?

4. Has significant redefinition of cost center boundaries occurred in recent years as a direct result of restructuring of manufacturing activities on the plant floor?

III.II IDENTIFICATION OF TRANSACTION TRIGGER POINTS

1. Defined accounting transactions: examine and trace the measures and procedures that lead ultimately to the monthly cost of goods sold entry.

2. Significant transaction events: Trace the movements of one typical product from start to finish, noting both manufacturing and accounting points of transfer interface (transfers between responsibilities).

   a. What changes have occurred in the definition of transaction trigger points during recent years?

   b. Observe the extent to which the data collection procedures are aided by systems integration or automation.

3. Review the procedures for executing the monthly cutoffs of purchases, manufacturing and sales shipments. Determine whether these have changed during recent years.

III.III COST ASSIGNMENT PRACTICES

1. Review the procedures for budgeting overhead costs.

a. Relate to mapping of cost center structure.

b. Analyze the functional responsibilities for overhead budgeting to assess the extent to which manufacturing sets overhead budgets.

i. Who is primarily responsible for estimating the budget amounts?

ii. Who is primarily responsible for investigating budget/actual variances?

2. Review the procedures for allocating service or functional costs from cost pools.

a. How are the pools structured and restructured? Who has responsibility for this?

b. Has significant restructuring of overhead pools occurred in recent years following introduction of CIM or restructuring of manufacturing?

3. Review the methods of establishing overhead rates.

a. What overhead application factors are used? How are they chosen?

b. What function has responsibility for selection of application factors?

4. Review the practices for allocating overhead variances between inventory and period expense.

III.IV REPORTING (OR ACCESSING) OF COST ACCOUNTING DATA

1. Prepare a list of reports issued frequently which convey cost accounting information.

   a. How frequently are the reports distributed?

   b. To whom are they distributed?

   c. Are responsibility accounting concepts used to determine the aggregation of detail in the reports?

2. Determine what significant changes have been made to the content and presentation in the reports with regard to cost accounting information.
   Flexible Budget reports
   Variance reports and investigation

3. Describe the type and extent of cost accounting information made available through computer terminal inquiry. Inquire about the frequency of usage.

SECTION IV COST RELEVANCE OF MANUFACTURING DECISIONS

In this section, nine representative manufacturing decisions are selected to serve as analytical units for research purposes. The objective of investigating each of the decisions is to observe the impact of changed manufacturing circumstances on cost accounting practices. Here is the set of nine decisions:

- Determining the work center schedule.
- Choosing routings for production.
- Undertaking a cost reduction analysis.
- Deciding to change manufacturing processes.
- Changing methods for setting or revising standard costs.
- Establishing overhead application rates.
- Developing quotes or bids for new business.
- Revising "cut-off" practices for entry of transactions.
- Revising the form or frequency of cost accounting reports.

IV.I DETERMINING THE WORK CENTER SCHEDULE

1. Select three critical work centers. Determine how the schedule for each of these work centers is set and revised.

 a. Are cost differences considered in setting the priorities for the work centers? How important is the cost information to the decisions?

 b. What cost data are available which might help to set order release priorities? To what extent is such data used?

 c. Have structural changes occurred in recent years which have changed the significance of work centers for scheduling purposes, or have changed the way priorities are set at work centers?

IV.II CHOOSING ROUTINGS FOR PRODUCTION

1. Select three representative subassemblies or components and determine how the standard routings were established for them.

 a. Determine whether the standard routings were followed. What proportion of the time?

 b. Determine whether alternate routings are sometimes used; if so, inquire how the choice of alternate routings is made.

  i. Are cost differences part of the consideration?

  ii. What cost data are available which might help to assess the use of alternate routings? To what extent is such data used?

2. Determine how the standard cost variances are measured when alternate routings are chosen.

   a. How frequently are such variances reported?

   b. To whom are such variances reported?

   c. How are such variances interpreted or used?

IV.III UNDERTAKING A COST REDUCTION ANALYSIS

1. Select two or three examples of studies made to find ways to reduce product costs. Review the findings.

   a. Describe how and why the cost reduction analysis was initiated. What role did engineering, purchasing, operations and plant accounting play in initiating the study?

   b. Was cost accounting data available to help the decision process? Did the findings use cost accounting data? How important was the cost data for the results derived?

   c. Was the accounting data provided directly from the cost accounting system? From some other source?

   d. Was it necessary to alter the cost accounting data for it to be useful?

IV.IV DECIDING TO CHANGE MANUFACTURING PROCESSES

1. Find an instance in which a decision was made to change the manufacturing processes for producing a component or assembly. This might include changes related to outside processing.

 a. Describe how and why the manufacturing process change was initiated. What role did engineering, purchasing, operations and plant accounting play in initiating the study?

 b. Was cost information used to make the decision? If so, was the data provided directly from the cost accounting system? From some other source?

 c. Was it necessary to alter the cost accounting data for it to be useful?

IV.V CHANGING METHODS FOR SETTING OR REVISING STANDARD COSTS

1. Select three representative subassembly products and determine how cost standards were set for them.

 a. Identify the critical cost elements that are included in the standard cost. Describe how those elements are estimated.

 i. How is the responsibility for establishing those elements shared between cost accounting and other functions?

 b. Have the standard setting procedures been affected by structural changes made to the manufacturing activities? Should such procedures be affected?

 c. Have the standard setting procedures been affected by redesignation of cost centers?

IV.VI ESTABLISHING OVERHEAD APPLICATION RATES

1. Identify the overhead cost pools.

 a. Obtain a list of accounts in each overhead cost pool.

 b. Have the identified overhead accounts and cost pools changed due to restructuring of manufacturing activities?

2. Determine how the overhead application factors are selected. Have these changed due to restructuring of manufacturing activities?

IV.VII DEVELOPING QUOTES OR BIDS FOR NEW BUSINESS

1. Select three recent instances where quotes for new business have been developed.

 a. Examine the use of cost information. What cost data are available which might help to assess the appropriate cost for the quote? Was the cost data provided by the cost accounting system? Some other source?

 b. Was it necessary to alter the cost accounting data for it to be useful?

 c. Was it necessary to reconfigure the cost detail to fit the circumstances of the quote?

APPENDIX I -- FIELD INTERVIEW GUIDE

AN EMPIRICAL FIELD STUDY*
OF THE ROLE OF COST ACCOUNTING
IN A
COMPUTER-INTEGRATED MANUFACTURING ENVIRONMENT

FIELD INTERVIEW GUIDE

Darrel I. Gosse
Ph.D. Candidate
Michigan State University

* A study sponsored by the National Association of Accountants (N.A.A.).

APPENDIX I -- FIELD INTERVIEW GUIDE

FIELD INTERVIEW GUIDE

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IV.VIII REVISING "CUT-OFF" PRACTICES FOR TRANSACTIONS

1. Review the procedures followed for monthly cut-offs:

   Purchases -- inbound purchase deliveries, receiving tickets, purchase orders
   Shipments -- outbound deliveries, order entry
   Production-- order releases; order completions

2. Do the accounting cut-off procedures conform with those of production?

3. Have such cut-off procedures been revised in recent months due to restructuring of manufacturing activities?

IV.IX REVISING THE FORM, FREQUENCY (OR ACCESS TO) COST ACCOUNTING REPORTS

1. Describe the planning and budgeting cycle employed insofar as it relates to manufacturing operations.

   a. Determine the stages of budget preparation and identify who participates.

   b. Describe how this process integrates with:
      - Production plan and Master Schedule
      - MRP regeneration
      - Flexible budget determination and reports

2. Examine the format of monthly flexible budget reports; determine the distribution list.

   a. Have the format or distribution list changed in recent years due to changed manufacturing circumstances?

   b. Identify the ways these reports are used for:
      i. Monitoring: Review of operating results
      ii. Decision making: Action choices

3. Prepare a list of ways in which cost accounting data can be accessed at terminals or other non-report means.

   a. Have these changed significantly in recent years due to changed manufacturing circumstances?

APPENDIX II -- FIELD VISIT ARRANGEMENT LETTER

Corporation
Division
, Michigan

Dear Sirs:

This letter is to confirm the arrangements made with you in connection with an N.A.A. sponsored research project I am conducting as part of the requirements for a Ph.D. degree at Michigan State University. The general purpose of the research study is to investigate changes in basic activities of cost accounting systems which occur following the implementation of computer integration to manufacturing activities.

A summary report of the findings derived from the research will be made available to you when the project is complete. The project will be based on a synthesis of findings obtained at several companies; however, confidentiality of information will be protected and the names of the companies will be disguised.

The focus of the investigation will be a set of coordinating and monitoring actions or decisions, which are believed to be common in both manufacturing settings (CIM and traditional):

- Determining the work center schedule.
- Choosing routings for production.
- Undertaking a cost reduction analysis.
- Deciding to change manufacturing processes.
- Changing methods for setting or revising standard costs.
- Establishing overhead application rates.
- Developing quotes or bids for new business.
- Revising "cut-off" practices for entry of transactions.
- Revising the form or frequency of cost accounting reports.

The research procedures will include: (1) structured and unstructured interviews with production and accounting personnel, which I will be transcribing into script form; (2) document examination; (3) preparation of map-like diagrams to show changes discovered in the structural patterns of cost activities and manufacturing responsibilities. The research will be conducted at times we agree upon to suit our mutual convenience, to begin as soon as practicable. Of course, every effort will be made to avoid undue disruption to your normal operating activities.

I look forward to your assistance with this project. I am confident that this project will make an important contribution and that you will be able to look upon your participation with satisfaction.

Sincerely,

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