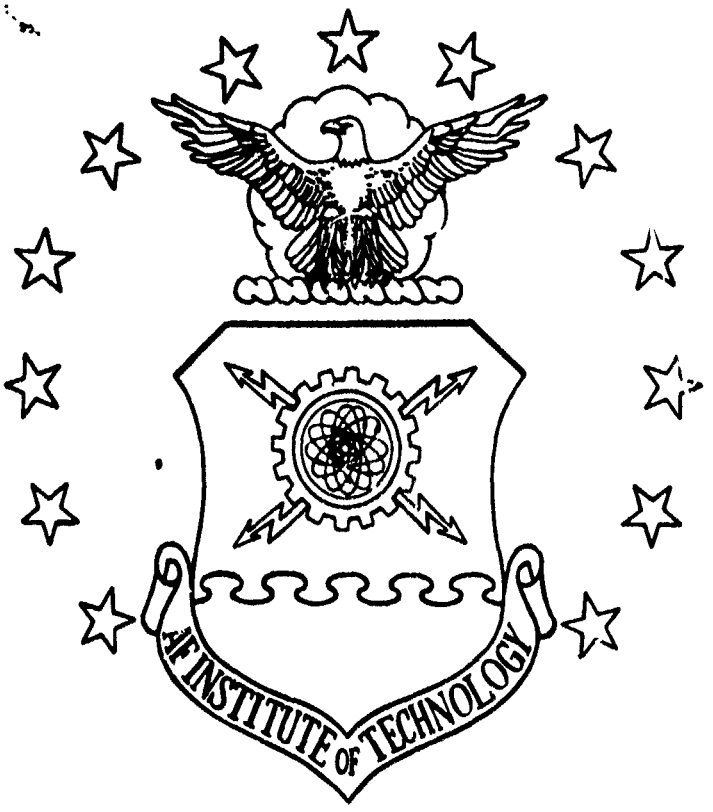

MATERIAL REQUIREMENTS PLANNING (MRP) WITHIN THE DEFENSE INDUSTRY: THE LINKAGE TO MULTIYEAR PROCUREMENT (MYP)

Douglas W. Edgar, Captain, USAF

LSSR 71-83

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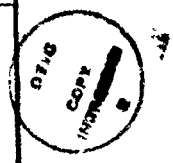

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Material Requirements Planning (MRP) is the consensus for a material management system in a dependent demand environment. Critics speculate that Government procurement practices, specifically annual funding and annual contracting, preclude the use of MRP and other strategic management techniques and contribute significantly to weapon system acquisition costs. Revised multiyear procurement (MYP) policies were implemented in fiscal year 1982 to incentivize defense contractor utilization of MRP and other strategic management techniques. The objectives of this research project were to determine the status of MRP utilization within the defense industry and to ascertain the influence that the revised MYP policies exerted on the decision to acquire or enhance an MRP system. A survey of 25 defense contractors was used to accomplish the research objectives. Data analysis revealed no significant differences between defense industry and overall U.S. industry's utilization of MRP. The revised MYP policies had minimal influence on the decision to acquire an MRP system. However, the receipt of a multiyear contract would exert a stronger influence on a defense contractor's decision to enhance an existing MRP system.

LSSR 71-83

MATERIAL REQUIREMENTS PLANNING (MRP) WITHIN THE DEFENSE INDUSTRY: THE LINKAGE TO MULTIYEAR PROCUREMENT (MYP)

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

Douglas W. Edgar, BS
Captain, USAF

September 1983

This thesis, written by

Capt Douglas W. Edgar

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT

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Donald L. Brechtel

COMMITTEE CHAIRMAN

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CHAPTER 1

THE RESEARCH PROBLEM

Introduction

"Cost growth and large cost overruns on many military programs in recent years have generated severe criticisms in the public press and in Congress [7:1]." Jacques Gansler notes that the costs of modernizing our defense systems (i.e., replacing outdated equipment with new technology equipment) have escalated as much as threefold from original equipment purchase costs (15:17). While inflation and an expanding technology are increasing the costs of weapon systems, the Government's methods of funding also introduce many cost problems into the weapon systems acquisition process (6:4; 7:1).

Background

The primary method of funding Government programs is annual funding[1] (6:4). Annual funding coupled, with the Department of Defense's (DOD) full-funding policy, results in year-by-year contracting even for programs that stretch over many years (12; 29:1576). The year-by-year contracting approach effectively limits a contractor's planning horizon to one year thus inhibiting the use of long range planning systems and the associated potential cost savings (6:5).

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[1] Refer to Appendix A for the definition of annual funding and other key terms.

General Alton D. Slay, former Commander of Air Force Systems Command (AFSC), cited the following example:

> We receive an annual authorization bill from the Congress which indicates, for example, the maximum number of F-16s we will be allowed to procure this year, say 180, or 15 per month. Later, we receive an appropriations bill which may fund the number of aircraft previously authorized or may fund a lesser number, say 120, or 10 per month. Once we have all other necessary approvals, we ask the prime contractor for his proposal for these 120 aircraft, review his projected costs, negotiate a price, and award a contract. Then, the contractor will order most of the materials and components for these 120 and eventually start manufacturing [24:VII-29].

Additionally, many times programs are slipped or stretched out in order to allocate funds to all programs (24:V13, V15). The General Accounting Office (GAO) presented the following on the problem:

> The weapons also may be produced at a limited rate, because sufficient funds are not available in the DOD budget to produce a greater number in a given year. Whatever the reason for limiting production of an item to less than the optimum rate, the effect of this action is a loss of productivity and an increase in the cost of major weapons [9:11].

The short-range planning horizon imposed on defense contractors impacts weapon system costs in two ways -- production efficiency and material acquisition efficiency (23:52). Production efficiency is impacted because plant and equipment are, in the short run, a fixed factor of production (16:179). Thus, while the Government's requirements

may vary from year-to-year, the contractor's capability to produce will not vary substantially. Unless the quantity required by the Government happens to be the quantity that the contractor can produce most efficiently in the short run, the Government usually pays more for each unit of production than under a long-range planning horizon (16:190). A long-range planning horizon would allow manipulation of all factors of production to achieve maximum production efficiency (16:191-3).

Material costs for major weapon systems are estimated to represent from 57 percent to 60 percent or more of the total costs of production (19:7; 20:4; 27:777). Limiting defense contractors to short-run planning horizons effectively precludes the utilization of material management systems that would minimize material and material-related costs (6:5). "Few contractors would be willing to incur such investment expenditures without Government commitment to fund and pay such costs as they occur...[23:48]."

The pervading deficiencies of year-by-year contracting for multiyear programs have long been recognized by both the Department of Defense and the defense industry (23:39-53). Multiyear procurements were used extensively during the Vietnam conflict until early in 1970 when Congress, in an effort to regain control of the "purse strings," enacted legislation that virtually eliminated the use of multiyear procurements (23:47; 28:34-35).

Both the Department of Defense and the defense industry have sought reenactment of revised multiyear procurement (MYP) policies to counter the rising costs of defense weapon systems (23). Two of the principal benefits of MYP were stated as: (1) reduced material costs and (2) an enlarged planning horizon (23:43).

In 1981, Congress authorized the implementation of revised and revitalized multiyear procurement policies for use by DOD in the acquisition of major weapon systems (30). Section 909 of the 1982 Department of Defense Authorization Act includes the following four major revisions to MYP policy:

1. MYP may be used for major systems acquisition.
2. Advance procurements may be made to obtain economic lot prices.
3. Cancellation ceilings may include recurring and nonrecurring costs.
4. Notification to Congress is required for ceilings over $100 million [18:55].

The Department of Defense acted quickly to implement MYP by awarding a four-year contract for F-16 production to General Dynamics Corporation in January 1982 and proposing thirteen MYP programs in the Fiscal Year 1983 DOD budget (5:1).

Problem Statement

While the Congressionally-implemented multiyear procurement (MYP) policies have enlarged Government contractors'

planning horizons and provided specific incentives for improved material management, the capability of the defense industry to fully exploit the new MYP policy revisions is unknown. Virtually all sources of information regarding material management systems recommend the use of a Material Requirements Planning (MRP) system in an environment such as the defense industry (2;3;8;14;17;19;20;32). The extent of MRP system utilization within the defense industry and the anticipated effects of revised MYP policies on the defense industry's acquisition of MRP systems are unknown. A knowledge of MRP usage within the defense industry is necessary to assess the impact of the revised MYP policies on weapons system acquisition costs.

Justification For Research

No research has been conducted to date regarding the status of MRP systems within the defense industry nor of the defense industry's inclination to acquire such material management systems. The magnitude of the potential material savings from MRP usage for defense programs justifies such research. Air Force Systems Command estimates that from 40 percent to 85 percent of the savings from a MYP program can be realized in material costs (25:Atch 3). The projected material savings would amount to between $104 million and $221 million on the F-16 production program alone and between $1.5 billion and $3.2 billion on all current MYP contracts and candidates for future MYP contracts (10:292;31).

Literature Review

The linkage of multiyear contracting to MRP utilization within the defense industry is currently just a matter of speculation. The previous period of concentrated MYP utilization (i.e., pre-1970) was at a point in time when MRP utilization within the defense industry was in its infancy stage (4:17; 23:47; 28:34-5). However, recent studies have indicated that, during the pre-1970 MYP intensive period, defense contractors utilized the available material management strategies and techniques that were suited to the multiyear contracting environment (23:42).

The relevant literature that links multiyear procurement (MYP) to Material Requirements Planning (MRP) is very limited. This research project will integrate the related literature throughout the remainder of the author's thesis.

Comparison of Material Requirements Planning (MRP) and Non-MRP Approaches

The benefits of MRP system utilization are not as apparent as many sources on the subject suggest. A comparison of the effects of both a non-MRP and an MRP approach in a simplified material requirements scenario is provided below.

A Non-MRP Approach. A simplistic but often used approach for determining material requirements before a production run is as follows (3:523):

Net Requirements = Components Required - Components On Hand

An examp e of material requirements determination for 5,000 air compressors using the simplistic approach for the "engine assembly" of an air compressor is set forth in Table 1.1 (See Figure 1.1 for a partial Bill of Materials breakout).

TABLE 1.1

A NON-MRP APPROACH

(Adapted from 3:523)

Components	Number of Components Required to Meet a Demand for 5000 Air Compressors	-	On Hand	=	Net Requirements
Engine Assembly	5000	-	1800	=	3200
Air Cleaner Subassembly	5000	-	1000	=	4000
Filter Housing Subassembly	5000	-	2000	=	3000

The above non-MRP approach, however, recognizes neither the "time phasing" of requirements (i.e., when subassemblies are needed to avoid delays in production) nor the possibility of subassembly quantity dependency on end-item quantities (3:523). As such, the non-MRP approach cannot fully exploit the opportunity for material savings offered by multiyear procurements.

An MRP Approach. An MRP system requires three inputs: (1) the Master Production Schedule, (2) the end-item Bill

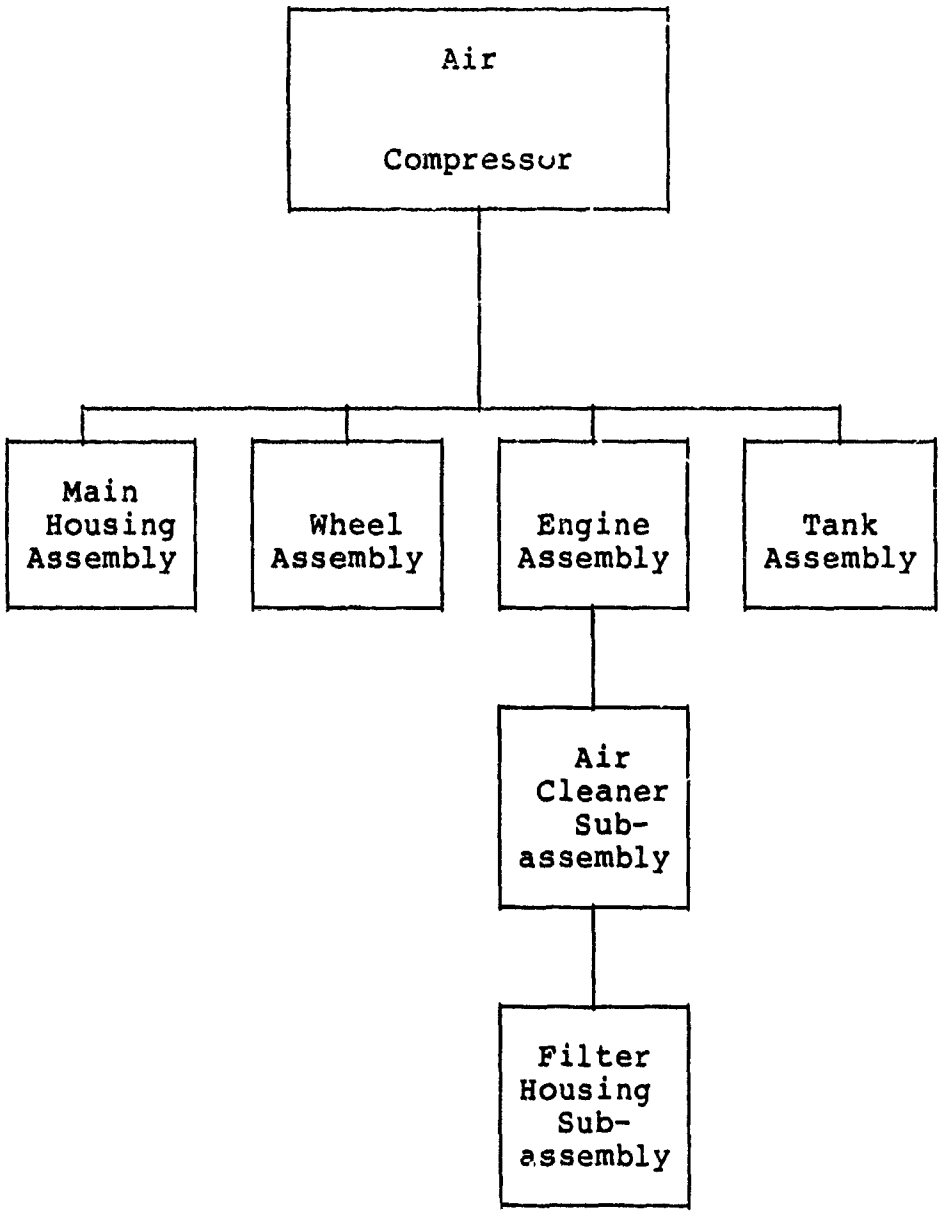


Figure 1.1. A Partial Bill of Materials for the Air Compressor

(Adapted from 3: Fig 12.6)

of Materials, and (3) the Inventory Records File (See Figure 1.2) (8:518). Utilizing the three inputs, the MRP system reconciles the differences between required and existing inventories and schedules make-or-buy quantities for net inventory requirements. The result is a system which, while minimizing inventory and inventory-related costs, helps insure that components are on hand when the components are needed in the production schedule (8:524). A simplified example of an MRP system application is provided below using the air compressor information:

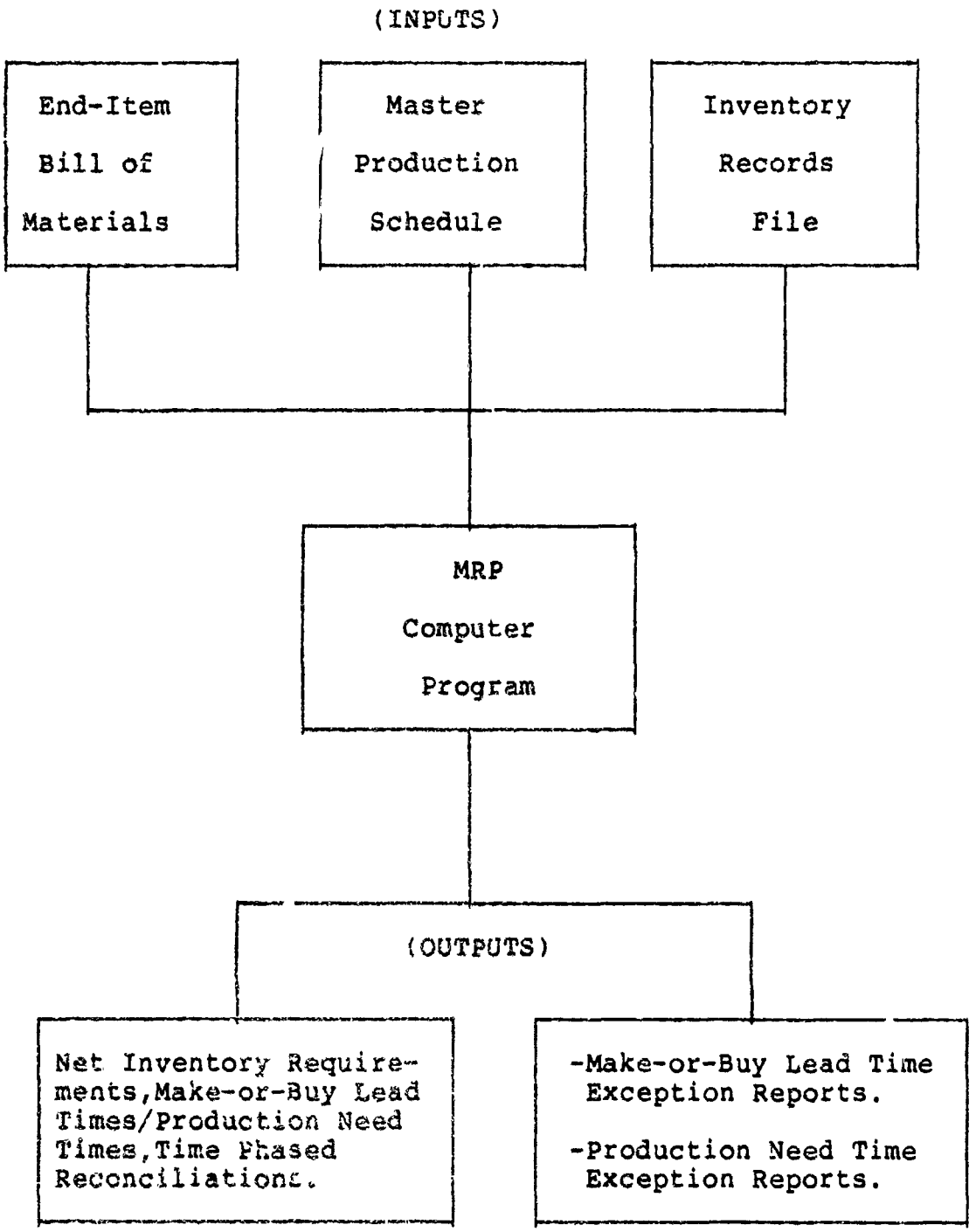
TABLE 1.2

AN MRP APPROACH

(Adapted from 3:524-5)

Components	Number of Components Required to Meet a Demand for 5000 Air Compressors	-	On Hand	=	Net Requirements
Engine Assembly	5000	-	1800	=	3200
Air Cleaner Subassembly	3200	-	1000	=	2200
Filter Housing Subassembly	2200	-	2000	=	200

Although the net requirement for engine assemblies (3,200) is the same under both systems, the initial simplistic non-MRP approach made no attempt to account for possible dependency of subassembly demand on end-item quantity. The MRP system considers the dependency, hence "the net requirement of the higher assembly becomes the gross requirement for the next lower subassembly [3:524]."



Inputs and Outputs of an MRP System

Figure 1.2.

(Adapted from 8· Exhibit 16.3)

An MRP system's "time phasing" for the air compressor information is depicted in Figure 1.3. The lead time for a higher assembly drives the order times for all lower subassemblies. To keep the illustration simple, all subassembly quantities are assumed to be required "on hand" before production of the next higher assembly can begin. For example, the lead time for the engine assembly is eight weeks, thus the need time for the next lower subassembly (the air cleaner subassembly) becomes the engine assembly need time minus the engine assembly lead time (i.e., 20 weeks - 8 weeks which equals 12 weeks). The need time minus the lead time for the air cleaner subassembly becomes the need time for the filter housing subassembly (i.e., 12 weeks - 2 weeks = 10 weeks and so on).

MRP System Availability

Material Requirements Planning (MRP) is a generic name for a material management system that possesses the attributes set forth in the definitions of key terms (See Appendix A). Such an MRP system can either be developed in-house or purchased commercially as a computer package. Some material management systems that embody the attributes of an MRP system and are available commercially include the following:

1. The Production and Information Control System (PICS) is an International Business Machines (IBM) package developed to centralize and computerize the information

Item		Week							
		4	6	...	10	11	12	...	20
Engine Assembly	Gross Rqmt								5000
	On-hand								1800
Lead Time: 8 weeks	Net Rqmts						...	....	3200
	Order Release						3200		
Air Cleaner Sub-assembly	Gross Rqmt						3200		
	On-hand						1000		
Lead Time: 2 weeks	Net Rqmts				...	....	2200		
	Order Release				2200				
Filter Housing Sub-assembly	Gross Rqmt				2200				
	On-hand				2000				
Lead Time: 4 weeks	Net Rqmts		...	....	.200				
	Order Release		200						

Figure 1.3. An MRP Time-Phasing Example

(Adapted from 8: Exhibit 16.15)

system in fabrication and assembly plants. While encompassing the attributes of an MRP system, PICS also addresses job scheduling and shop loading (8:539-41).

2. The Communication Oriented Production Information and Control System (COPICS) is also an IBM package extending the PICS system into a dynamic, on-line manufacturing control system (8:542-4). As such, COPICS also encompasses the attributes of an MRP system.

3. The Manufacturing Resource Planning II (MRP II) system does to basic MRP what COPICS did to PICS (29). As such, MRP II also encompasses the attributes of an MRP system.

Status of MRP Utilization

While this research project was an exploratory study regarding the status of MRP system utilization within the defense industry, a similar study has been accomplished for all United States industries. Anderson, Schroeder, and others (4) indicate that approximately 64 percent of the companies within all U.S. industries are utilizing MRP systems. Anderson and Schroeder observed that as the manufacturing process becomes more complex, that is, when manufacturing includes assembly and fabrication and when a combination of processes are involved, the greater the commitment to MRP (4:11-12).

The respondents to Anderson and Schroeder's study (4) were from U.S. industry as a whole and may have, in fact,

included some defense contractors. Anderson and Schroeder made no attempt to distinguish between defense and non-defense oriented firms. Of the respondents to Anderson and Schroeder's study, 67.1 percent of the firms had annual sales of $50 million or less and 62.9 percent of the respondents were "single-plant" firms. However, 83.2 percent of the respondents to Anderson and Schroeder's study were engaged in make-to-stock production (4). Although there were some obvious and inherent differences between the populations of respondents in Anderson and Schroeder's study and the author's research project, the substantial similarities between U.S. industry as a whole and the defense industry warrant comparisons of the author's research results to the results of Anderson and Schroeder's study. Anderson and Schroeder's study was utilized extensively in the development and direction of the author's research project.

Research Objectives

This research project concentrated on the following objectives:

1. Survey defense contractors to ascertain the current status of MRP system utilization within the defense industry.

2. Survey defense contractors' attitudes and opinions regarding the anticipated effects of the revised MYP policies on the acquisition or enhancement of MRP system capability within the defense industry.

3. Survey defense contractors' opinions as to the magnitude of projected material savings that may be realized from MRP system utilization within the defense industry as a direct result of multiyear procurement.

Research Questions

The specific research questions that guided this research project are stated below:

1. What is the current status of MRP system utilization by prime contractors within the defense industry?

2. Does the extent of MRP system utilization differ between defense oriented and non-defense oriented industries?

3. Will revised multiyear procurement (MYP) policies influence the acquisition of new MRP systems or enhancement of existing MRP systems by defense contractors that are awarded MYP contracts?

4. What percentages of actual or anticipated MYP savings are material or material-related savings?

5. Does MRP system utilization influence material costs on non-MYP contracts?

Summary List of Assumptions

1. Defense contractors are economic entities and, as such, will act in a rational manner when confronted with alternatives and opportunities. That is, every opportunity to increase production efficiency and reduce costs will be exploited to the fullest extent possible.

2. The data used for this research project were assumed to accurately reflect the attitudes and opinions of the firms that responded to the survey instrument utilized for data collection.

Summary List of Limitations

1. Material management systems are essentially faced with two demand situations: (1) independent demand where the demand for an item is independent of the demand for all other items, and (2) dependent demand where the demand for an item is linked to the demand for an end-item for which the item is a component (8:401-507). The nature of the market for components for new major weapon systems is a "dependent demand" situation. Therefore, the material management systems that are utilized in independent demand situations (e.g., the Economic Order Quantity model) were not considered in this research project (8:401-507).

2. The survey instrument was administered through the Air Force's Education With Industry (EWI) program. Survey response accuracy, especially in regard to Research Objectives 2 and 3, was based on the attitudes and opinions of the key contractor personnel with which the EWI students interacted. Additionally, as multiyear procurement (MYP) has not yet been implemented to its fullest potential, most responses regarding Research Objectives 2 and 3 were anticipated results rather than actual experience.

3. As participation in the Air Force's Education With Industry (EWI) program was a prerequisite for inclusion in the data base for this research project, the sample was necessarily finite and limited in size.

Summary

The Congressionally-authorized implementation of revised multiyear procurement provisions has presented the potential for substantial savings in major weapon systems acquisitions. Air Force Systems Command estimates that from 40 to 85 percent of the potential savings from MYP are based on material and material-related costs. The capability of the defense industry to exploit the potential savings opportunities through Material Requirements Planning (MRP) system utilization is unknown. The purpose of this research project was to analyze both the status of MRP utilization within the defense industry and the potential material cost savings that may result from increased utilization of Material Requirements Planning (MRP) systems on multiyear procurement (MYP) programs. The specific research methodology that served as the general framework for conducting this research project is described in the next chapter.

CHAPTER 2

THE RESEARCH METHODOLOGY

Introduction

This chapter describes the universe, population, and sample from which data were collected for the author's research project. Additionally, the techniques employed in data collection and the statistical tests in data analysis are outlined in this chapter.

Description of the Universe, Population, and Sample

The universe for this research project consisted of all businesses engaged in the production or supply of goods and/or services for new major weapon systems being acquired by the Department of Defense. The universe included both prime contractors[2] and subcontractors. The population of interest was defense industry prime contractors since 1 January 1980 (see Figure 2.1).

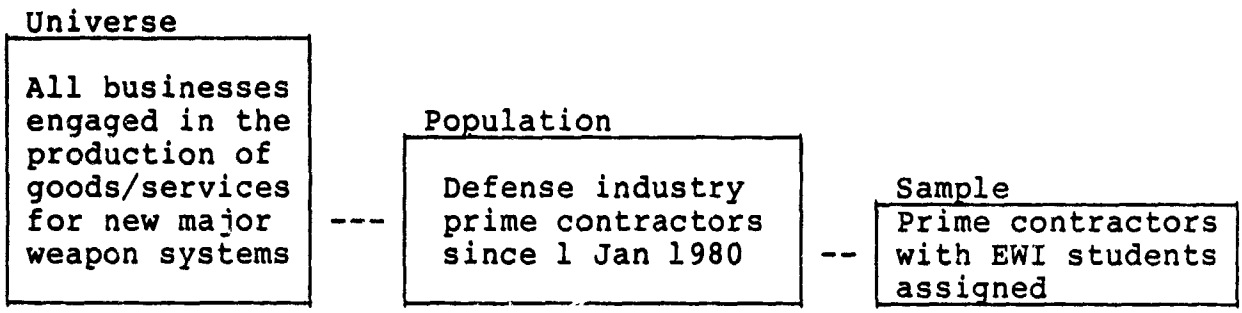


Figure 2.1. The Universe, Population, and Sample

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[2] The contractors with which DOD has a written and signed contract; see Appendix A for the definition of a "prime contractor" and other key terms.

The research sample included the defense industry prime contractors that were participants in the Air Force's Education With Industry (EWI) program (1).

Since virtually all of the sampled contractors were included among the top 50 defense contractors that accounted for nearly 50 percent of the defense acquisition expenditures in 1982 (see Appendix B for a listing of the top 50 defense contractors for 1982), generalization of the results of the author's study to the universe was considered valid (13:37; 26).

The sample used in this research project included the defense contractors that presently have or have had a prime contractor relationship with DOD at least once since 1 January 1980. The sampled contractors also had EWI students assigned to the contractors' facilities. The 1 January 1980 date was selected to allow for the cyclical nature of defense acquisitions and the recent increase in the acquisition of new defense systems by the Reagan administration (15:9). Contractors that did not fall within the above category were excluded from the sample data.

Data Collection Plan

Three alternative data collection methods were considered for this research project: (1) on-site interviews, (2) mail survey, and (3) telephone survey. While on-site interviews are the most flexible, the interviews are also the most expensive data collection method

with regard to time and money. Mail surveys are good for well-structured research that can be condensed into a few pages but often have response rates of only 10 to 20 percent. Telephonic interviews provide fast and reasonably high levels of responses but should be used when a few, simple questions are being asked (4:5).

After considering the three alternative plans for data collection, the mail survey was selected as the best data collection method for the author's research project. The mail survey provided a relatively large sample at a low cost and provided an opportunity to ask a comprehensive set of questions. The traditional response rate problem of mail surveys was overcome by utilizing Education With Industry (EWI) students located at participating defense contractor facilities. During this research project, the EWI program sponsored 138 military students at 72 defense contractor plants throughout the United States (1:1). Previous research projects that have used mail surveys conducted through EWI students have achieved response rates greater than 60 percent (5:118).

Each EWI student was mailed one survey instrument that was completed during an interview session with the "most appropriate" contractor executive involved with defense contracts. The "most appropriate" executive was one with knowledge regarding both Material Requirements Planning (MRP) and Multiyear Procurement (MYP) as related to defense

contracts. In the event two or more EWI students were assigned to the same sample element (i.e., to the same division of the firm), instructions were included soliciting only one response. When two or more responses from a sample element were received, the most complete response from that sample element was included in the sample data. The author included only one response from each sample element in the data analysis.

The guarantee of anonymity for the survey respondents was a major factor for incentivizing survey participation. The surveyed firms that did volunteer their identity are listed in Appendix C.

The overall relationships among the research objectives, research questions, survey instrument sections, and survey instrument questions are provided in Figure 2.2.

The survey instrument used for data collection in this research project consisted of four sections (see Appendix D). The first section of the survey was demographic in nature. The demographics defined the management level, experience, and background of the survey respondents.

Section II of the survey instrument addressed the current extent of MRP system utilization within the defense industry (Research Objective #1). The survey responses addressed yes/no, fill-in-the-blank, multiple choice, and seven-point Likert scale questions. A seven-point Likert

Research Objectives	Research Questions	Survey Instrument	
		Section #	Questions
Demographics	N/A	I	1 through 16
#1. MRP system utilization within the defense industry.	1 and 2	II	17 through 30
#2. Effects of MYP on MRP.	3	III	31 through 40
#3. Magnitude of savings from MRP utilization.	4 and 5	IV	41 through 50

Figure 2.2. Research Outline

scale was chosen because it offered more reliability than smaller scales and less complexity than larger scales (5:22).

Section III of the survey instrument covered the anticipated effects of the revised Multiyear Procurement (MYP) policies on the acquisition or enhancement of MRP systems within the defense industry (Research Objective #2). The responses in Section III addressed multiple choice and seven-point Likert scale questions. Again, a seven-point Likert scale was chosen, because it offered more reliability than small scales and less complexity than larger scales (5:22).

Section IV of the survey instrument addressed Research Objective #3, the magnitude of projected material savings that may be realized from MRP utilization within the defense industry as a direct result of multiyear procurement (MYP). All responses to Section IV questions were seven-point Likert scale responses for the same reasons set forth in the descriptions of Sections II and III of the survey instrument.

Statistical Analysis Plan

The Statistical Package for the Social Sciences (SPSS) was used in the data analysis (22). The SPSS statistical analysis programs are included in Appendix E. The survey instrument responses were transferred to computer data files. Frequency distributions were obtained from each section of the survey instrument to verify the accuracy of the

data transfer and to ensure that the distributions could be approximated, where appropriate, by the normal distribution. Approximately 43 responses were anticipated (i.e., 60 percent of the 72 EWI participating defense contractors). However, since only 25 responses were received, the "t" distribution was utilized to approximate the normal distribution (21:166-9).

Both parametric and nonparametric statistical techniques were employed in the analysis of the collected data. While the solicited responses were "ordinal" in nature, the design of the response scales was, to the extent practical, mutually exclusive and as close to "interval" as possible. Thus, while the median provided a valid statistical analysis, a parametric analysis also provided some insight into the characteristics of the sample (13:120-6).

Analysis of Section I Responses

Means and frequency distributions were computed for the responses to Section I (questions 1-16) of the survey instrument. A comparison of the demographics of the respondents in this research project to the demographics of the respondents in the study by Anderson and Schroeder (4) was also accomplished. The computation of arithmetic means was accomplished using the formula below (21:46):

$$\bar{X} = \frac{\sum X_i}{n} .$$

where $\bar{X}$ = the arithmetic mean,

X_i = the response from the ith element, and

n = the number of respondents.

Analysis of Section II Responses

A sample proportion ($\bar{p}$) of the form shown below was computed for the responses to question #17 of the survey (21:215, 295):

$$\bar{p} = \frac{X}{n}$$

where: X = the number of respondents utilizing MRP systems, and

n = the number of respondents.

The hypotheses set forth below were used to test for differences in MRP system utilization between defense and non-defense industries at a 95 percent confidence level (21:301-2):

H_o: $p \geq p_i = .64$

H_a: $p < p_i = .64$

where p = the proportion of respondents utilizing MRP systems (approximated by the computed value of $\bar{p}$), and

p_i = the proportion of manufacturing industry as a whole utilizing MRP systems (4).

The null hypothesis, H_o, stated that the defense industry's extent of utilization of MRP systems is equal to or greater than the extent of MRP system utilization by manufacturing industry as a whole. The alternate hypothesis, H_a, was that there is a lesser extent of MRP system utilization in the defense industry than in the manufacturing industry as a whole.

Frequency distributions, means, and medians were computed for the remaining responses to Section II (questions 18-30) of the survey instrument. A comparison of the responses to questions 18 and 22 through 27 of this research project to similar questions in Anderson and Schroeder's study (4) was also accomplished. As Anderson and Schroeder (4) utilized a four-point Likert scale in their study and a seven-point Likert scale was used in this research project, a conversion of the responses was necessary. Table 2.1 represents the conversion methodology employed for comparative purposes.

TABLE 2.1

ANDERSON AND SCHROEDER'S FOUR-POINT TO EDGAR'S SEVEN-POINT CONVERSION

Anderson and Schroeder's Terminology	Anderson and Schroeder's Scale	Edgar's Scale
None	1	1
Some	2	2,3
Much	3	4,5
Very Much	4	6,7

Analysis of Section III Responses

Arithmetic means, medians, and frequency distributions were computed for the responses to Section III (questions 31-40) of the survey instrument. No comparisons were made between the responses in Section III to Anderson and Schroeder's study (4), because Anderson and Schroeder's study contained no questions regarding multiyear procurement (MYP).

Analysis of Section IV Responses

Arithmetic means, medians, and frequency distributions were computed for the responses to Section IV (questions 41-50) of the survey. A comparison of the responses to question #49 of the author's research project to similar questions in Anderson and Schroeder's study (4) was also accomplished. Again, as Anderson and Schroeder (4) utilized a four-point Likert scale and a seven-point Likert scale was used in this research project, a conversion of the responses was necessary. Table 2.1 represents the conversion methodology employed in the author's study.

Summary

A target population consisting of EMT participating prime contractors within the defense industry was selected from the universe of all defense industry contractors. The sample included the contractors that currently have or have had a prime contractor relationship with DOD at least once

since 1 January 1980 and have EWI students assigned to their respective contractor facilities.

Each sample element was surveyed by a resident EWI student for responses to three categories of interest:

1. The current extent of MRP system utilization within the defense industry,

2. The anticipated effects of the revised MYP policies on the acquisition or enhancement of MRP systems within the defense industry, and

3. The magnitude of projected material savings that may be realized from MRP system utilization within the defense industry as a direct result of multiyear procurement.

The survey response data were subjected to computerized data analysis, the results of which are outlined in Chapter 3 of this research report.

CHAPTER 3

DATA SUMMARY AND ANALYSIS

Introduction

This research project was designed to ascertain the utilization of Material Requirements Planning (MRP) systems within the defense industry and to determine the impacts of Multiyear Procurement (MYP) on the defense industry's usage of MRP. This chapter provides a summary of the data collected and the analysis of the data gathered from survey respondents.

Survey Results

One hundred and thirty-eight (138) survey instruments were distributed to 138 Education With Industry (EWI) students assigned to 72 defense contractors throughout the United States. Of the 138 survey instruments mailed, 59 surveys were returned for a return rate of 42.8 percent. Of the 59 responses, 30 were not completed for a variety of reasons, such as "the political climate is not conducive to divulgence of the information at this time," "the information requested appears to be proprietary," and "the firm does not work in an area where MRP is applicable." Two respondents had no prime contractor relationship with the Government, and two respondents duplicated two earlier responses. Twenty-five usable responses were left, which

provided an effective return rate of 18.1 percent for analysis. While the 18.1 percent effective return rate was less than anticipated, it is well within the 10 to 20 percent response rate characteristic of mail surveys. The strict limitations imposed by the author on the acceptance of a response for analysis and the perceived sensitivity of the requested data impacted otherwise excellent response rate. Respondent anonymity was a major incentive for respondent participation. However, as all of the respondents that volunteered their firm's identity were ranked among the top 50 defense contractors for 1982 (see Appendix B for a listing of the top 50 defense contractors for 1982 and Appendix C for a listing of the responding firms), the sample was considered representative of the target population. The survey responses used in data analysis are provided in Appendix F.

Section I Analysis

Section I of the survey instrument (questions 1-16) dealt with the demographics of the research sample. The demographics and other sections of the survey are summarized and compared, where appropriate, with Anderson and Schroeder's study (4) in Appendix G. Briefly, 28 percent of the respondents were executive managers, and 84 percent were middle managers or above. Of the 25 respondents, 52 percent

worked directly in a "materials" area, 24 percent worked in "production" or a related discipline, and 84 percent had greater than seven years experience in the defense industry.

Section II Analysis

Section II of the survey instrument (questions 17-30) dealt with the utilization of MRP systems by the defense industry. The responses to question #17 indicated that 68 percent of the responding firms are currently utilizing an MRP system. The hypotheses relative to the responses to question #17 were as follows:

H_o: $p \geq p_i = .64$

H_a: $p < p_i = .64$

where p = the proportion of respondents utilizing MRP systems,

and p_i = the proportion of industry contractors as a whole utilizing MRP systems (4).

As the proportion of the respondents for this research project that were utilizing MRP systems was 68 percent, the null hypothesis, H_o, for question #17 was not rejected at the 95 percent confidence level. The defense industry's utilization of MRP systems was the same or greater than the extent of MRP system utilization in U.S. manufacturing industry as a whole.

In response to questions #18 and #19 of the survey, 12 of the responding contractors currently utilizing an MRP system (70.6 percent) developed their MRP system "in-house."

Of the 12 contractors that have developed an "in-house" MRP system, no firms have introduced their "in-house" MRP system into the marketplace as a commercial venture. Of the five contractors that acquired commercially available MRP systems for either "off-the-shelf" implementation or company-specific adaptation, two firms had acquired the IBM Production and Information Control System (PICS), one firm had acquired a "MAC-PAC" system, the origin and nature of which was not stated, and two contractors did not identify the brand name of their commercially-acquired MRP system.

In response to survey question #20, only one of the respondents that had acquired a commercially available MRP system revealed the system's "acquisition" and "implementation" costs. The stated acquisition cost of the commercially-acquired MRP system was $40,000. The stated implementation cost of the commercially-acquired MRP system was $3,000,000.

In response to question #21 of the survey instrument, 17.6 percent of the responding firms that are currently utilizing an MRP system used the MRP system "predominantly" on Government contracts, 29.4 percent of the firms utilized the MRP system "only" on Government contracts, and 52.9 percent of the respondents utilized the MRP system "equally" on both Government and commercial contracts. None of the respondents used the MRP system "only" or "predominantly" on commercial contracts.

In response to survey question #22, 35.3 percent of the responding firms that are currently utilizing an MRP system classified their MRP system as a "Class A" system, 23.5 percent of the firms classified their MRP system as a "Class B" system, 23.5 percent classified their MRP system as a "Class C" system, and 17.6 percent of the firms classified their MRP system as a "Class D" system. A stratification of system classification by annual sales is set forth in Table 3.1. Some respondents did not classify their MRP system.

TABLE 3.1

SYSTEM CLASSIFICATION BY SALES

Sales	Classification	Percentage of Firms
Under $10M	A	0.0%
	B	100.0%
	C	0.0%
	D	0.0%
$11-50M	A	28.6%
	B	19.0%
	C	14.3%
	D	9.5%
	Not Classified	28.6%
$51-100M	A	0.0%
	B	0.0%
	C	33.3%
	D	33.3%
	Not Classified	33.3%
Over $100M	A	21.1%
	B	15.8%
	C	21.1%
	D	15.8%
	Not Classified	26.3%

The responses to survey question #23 indicated that 50 percent of the responding firms defined MRP in a "broad" sense, 33 percent defined MRP in a "narrow" sense, and 17 percent defined MRP other than "broad" or "narrow."

The responses to questions #24 and #25 of the survey instrument regarding the "accuracy of data" are provided in Table 3.2. The responses (based on a scale of 1 to 7; 1 = poor, 7 = excellent) indicated that a relatively high degree of accuracy exists for all categories of data in both the commercial and the defense activities of the responding firms. However, such data accuracy was anticipated for on-going firms within both commercial and Government marketplaces.

TABLE 3.2

GOVERNMENT AND COMMERCIAL DATA ACCURACY

Data Type	Commercial Data Mean	Commercial Data Median	Government Data Mean	Government Data Median
Inventory Records	6.1	6.0	6.1	6.2
Bill of Materials	6.0	6.2	5.9	6.1
Market Forecasts	5.2	4.8	5.1	5.3
Master Production Schedule	5.9	6.1	5.6	6.2
Production Lead Times	5.9	6.1	5.3	5.6
Vendor Lead Times	5.7	5.5	5.3	5.3
Shop Floor Control Data	5.7	5.9	5.0	5.0
Capacity Plan	5.6	5.9	5.1	5.0

The responses to survey questions #26 and #27 regarding the "status" of the elements of a firm's material management system are set forth in Tables 3.3 and 3.4. The responses indicated a significant difference in the "status" of the elements of a firm's material management system with the Government (defense) activity having significantly more computerization. However, the large percentage of "unknown" responses for the commercial activities may have masked some information that could not be ascertained in the author's study.

TABLE 3.3

COMMERCIAL MATERIAL MANAGEMENT SYSTEM ELEMENT STATUS

	Commercial Material Management System		
System Element	Manual(%)	Computerized(%)	Unknown(%)
Forecasting End Items	24.0	24.0	52.0
Bill of Materials	0.0	56.0	44.0
Inventory System	8.0	48.0	44.0
Master Prod'n Schedule	12.0	40.0	48.0
Parts Explosion	16.0	40.0	44.0
Order Release	12.0	44.0	44.0
Purchasing	8.0	48.0	44.0
Capacity Planning	16.0	28.0	56.0
Operation Scheduling	20.0	36.0	44.0

TABLE 3.4

GOVERNMENT MATERIAL MANAGEMENT SYSTEM ELEMENT STATUS

	Government Material Management System		
System Element	Manual(%)	Computerized(%)	Unknown(%)
Forecasting End Items	48.0	36.0	16.0
Bill of Materials	8.0	92.0	0.0
Inventory System	24.0	76.0	0.0
Master Prod'n Schedule	24.0	72.0	4.0
Parts Explosion	24.0	72.0	4.0
Order Release	24.0	76.0	0.0
Purchasing	24.0	76.0	0.0
Capacity Planning	40.0	40.0	20.0
Operation Scheduling	40.0	56.0	4.0

The responses to survey question #28 regarding the "integration" of the elements of the material management systems are provided in Table 3.5. The responses (based on a scale of 1 to 7; 1=0-13 percent, 7=84-100 percent with an approximate interval distribution among responses) indicated a high degree of integration (interaction) among the elements of material management systems in both commercial and Government activities. Again, the high degree of system integration was not surprising for on-going firms.

TABLE 3.5

DEGREE OF SYSTEM ELEMENT INTEGRATION

System Type	Degree of Integration Mean	Median
Commercial	5.3	5.9
Government	4.9	5.4

The reasons provided by the eight defense industry contractors responding to survey question #29 for not utilizing an MRP system are depicted in Table 3.6. The responses (based on a scale of 1 to 7; 1=none, 7=very much) indicated that the predominant reason for not utilizing an MRP system was "lack of top management support."

TABLE 3.6

REASONS FOR NON-UTILIZATION OF MRP WITHIN DEFENSE INDUSTRY

Reasons	Degree of Influence Mean	Median
The high acquisition cost of an MRP system.	4.6	4.8
The high implementation cost of an MRP system.	4.8	5.0
Lack of top management support for acquisition of an MRP system.	5.3	5.7
A "better" system is currently in place.	4.2	4.3
Unaware that MRP existed.	3.4	2.0

Survey question #30 addressed the utilization of an MRP system on commercial contracts but not on Government contracts. Only one firm responded to question #30, and the respondent provided no rationale as to why the MRP system was utilized on commercial contracts but not on Government contracts.

Section III Analysis

Section III of the survey instrument (questions #31 through #40) dealt with the impact of the revised multiyear procurement (MYP) policies on the acquisition or enhancement of an MRP system by a defense contractor.

The responses to survey questions #31 and #32 regarding the impact of the receipt of a multiyear contract on the acquisition of an MRP system are depicted in Table 3.7. The responses (based on a scale of 1 to 7; 1=no influence, 7=total influence, and 4=tie-breaker in the decision of whether or not to acquire an MRP system) indicated that the receipt of a multiyear contract has historically had and would continue to have little influence on a firm's decision to acquire an MRP system.

TABLE 3.7

EFFECT OF MYP ON MRP ACQUISITION BY DEFENSE CONTRACTORS

Condition	Degree of Influence Mean	Median
Actual impact on MRP acquisition	1.9	1.2
Anticipated impact on MRP acquisition	2.2	1.2

The responses to survey questions #33 and #34 regarding the impact of the receipt of a multiyear contract on the enhancement of an existing MRP system are provided in Table 3.8. The responses (based on a scale of 1 to 7; 1=no influence, 7=total influence, and 4=tie-breaker in the decision of whether or not to enhance an existing MRP system) indicated a much stronger, both actual and anticipated, tendency for respondents to enhance an existing MRP system if awarded a multiyear contract. This empirical finding reinforces one of the assumptions upon which this research project was based. That is, defense contractors are economic entities and, as such, will act in a rational manner when confronted with alternatives and opportunities to increase production efficiencies and reduce costs, thereby maximizing the profits of the firm. The rationality of contractors' behavior was demonstrated by the acquisition of the material management system (i.e., MRP) recommended by virtually all

credible sources regarding material management in a dependent demand type of environment, whether or not a multiyear contract has been awarded (2;3;8;14;17;19;20;32).

TABLE 3.8

EFFECT OF MYP ON MRP ENHANCEMENT

Condition	Degree of Influence Mean	Median
Actual impact on MRP enhancement	2.8	2.0
Anticipated impact on MRP enhancement	3.8	4.5

The responses to question #35 of the survey instrument regarding the actual influence that the attributes of MYP had on a firm's decision to acquire an MRP system are set forth in Table 3.9. The responses (based on a scale of 1 to 7; 1=no influence, 7=total influence, and 4=tie breaker in the decision of whether or not to acquire an MRP system) reinforced the basic assumption of rationality of behavior on the part of responding firms. The attributes of MYP, whether a contractual arrangement or not, exhibited some influence on the respondents' decisions to acquire an MRP system. In fact, the only attribute unique to an MYP contractual arrangement, the "inclusion of material costs in the cancellation ceiling," had the least influence of the stated MYP attributes on the acquisition of an MRP system.

TABLE 3.9

ACTUAL INFLUENCE OF MYP ON ACQUISITION OF MRP

Attribute	Degree of Influence Mean	Median
1. Firmer requirements.	4.4	5.0
2. Long range planning opportunities.	4.7	5.0
3. Advance material buys.	4.5	4.5
4. Inclusion of material costs in the cancellation ceiling.	3.9	4.0

The responses to survey question #36 regarding the probable influence that the attributes of MYP would have on a firm's decision to acquire an MRP system are depicted in Table 3.10. The responses (based on a scale of 1 to 7; 1=no influence, 7=total influence, and 4=tie-breaker in the decision of whether or not to acquire an MRP system) indicated, to those that are not currently utilizing an MRP system, that the receipt of a multiyear contract would have some influence on the decision of whether or not to acquire an MRP system. Of particular significance was the fact that the only attribute unique to an MYP contractual arrangement, the "inclusion of material costs in the cancellation ceiling," would have the least influence on the decision of whether or not to acquire an MRP system. This empirical finding was contrary to the expectations and stated opinions of most MYP authorities (23).

TABLE 3.10

PROBABLE INFLUENCE OF MYP ON ACQUISITION OF MRP

Attribute	Degree of Influence Mean	Median
1. Firmer requirements.	5.0	5.5
2. Long range planning opportunities.	5.5	6.0
3. Advance material buys.	5.0	5.5
4. Inclusion of material costs in the cancellation ceiling.	3.0	2.5

The responses to question #37 of the survey regarding the actual influence that the attributes of MYP had on a firm's decision to enhance an existing MRP system are provided in Table 3.11. The responses (based on a scale of 1 to 7; 1=no influence, 7=total influence, and 4=tie-breaker in the decision of whether or not to enhance an MRP system) again reinforced the basic assumption of rationality of behavior on the part of the responding firms. The attributes of MYP, whether or not in a contractual arrangement, exhibited a stronger influence on the respondents' decisions to enhance existing MRP systems. Again, the only attribute unique to an MYP contractual arrangement, the "inclusion of material costs in the cancellation ceiling," had the least influence of the stated MYP attributes on MRP system enhancement.

TABLE 3.11

ACTUAL INFLUENCE OF MYP ON ENHANCEMENT OF MRP

Attribute	Degree of Influence Mean	Median
1. Firmer requirements.	4.6	5.3
2. Long range planning opportunities.	4.8	5.8
3. Advance material buys.	4.6	5.0
4. Inclusion of material costs in the cancellation ceiling.	3.6	3.8

The responses to survey question #38 regarding the probable influence that the attributes of MYP would have on a firm's decision to enhance an MRP system are depicted in Table 3.12. The responses (based on a scale of 1 to 7; 1=no influence, 7=total influence, and 4=tie-breaker in the decision of whether or not to enhance an MRP system) indicated that all of the stated attributes of MYP would bear heavily on the decision of whether or not to enhance an existing MYP system.

TABLE 3.12

PROBABLE INFLUENCE OF MYP ON ENHANCEMENT OF MRP

Attribute	Degree of Influence Mean	Median
1. Firmer requirements.	5.5	6.1
2. Long range planning opportunities.	5.0	6.0
3. Advance material buys.	4.3	4.2
4. Inclusion of material costs in the cancellation ceiling.	4.0	4.3

The responses to survey questions #39 and #40 regarding the most influential attribute of MYP on a firm's decision to acquire or enhance an MRP system are set forth in Table 3.13 (where the responses were based on a scale of 1 to 4; 1=Firmer requirements and 4=Inclusion of material costs in the cancellation ceiling). The mean responses indicated that the most influential of the attributes provided in Table 3.12 was essentially a toss-up between "long range planning opportunities" and the opportunity for "advance material buys." However, the more appropriate response in this case, the median, clearly favored "long range planning opportunities" as the most influential attribute of MYP.

TABLE 3.13

MOST INFLUENTIAL ATTRIBUTE OF MYP REGARDING MRP

Decision	Attribute Mean	Median
To Acquire MYP System.	2.5	2.0
To Enhance Existing MRP System.	2.4	1.9

Section IV Analysis

Section IV of the survey instrument (questions #41 through #50) dealt with the savings potential resulting from MRP system utilization directly attributable to MYP implementation.

The responses to survey questions #41 and #42 regarding the "actual" percentage of MYP-related savings that are material-related savings and the percentage of the material-related savings that resulted from MRP system utilization are depicted in Table 3.14. The responses (based on a scale of 1 to 7; 1=0-13 percent, 7=84-100 percent with approximately an interval distribution among responses) indicated that approximately 31 percent of actual MYP resultant savings were material-related savings. Of the MYP material-related sa· ıgs, approximately 18 percent were directly related to MRP system utilization.

TABLE 3.14

MYP AND MRP RELATED MATERIAL SAVINGS

Category of MYP Savings	Response Mean	Median
MYP-related savings that are material-related.	3.2	2.8
Material-related savings that resulted from MRP utilization.	2.3	2.0

The responses to questions #43 and #44 of the survey regarding the "anticipated" percentage of MYP-related savings that would be material-related savings and the percentage of the material-related savings that would result from MRP system utilization are provided in Table 3.15. The responses (based on a scale of 1 to 7; 1=0-13 percent, 7=84-100 percent with approximately an interval distribution among responses) indicated that approximately 30 percent of the anticipated MYP savings would be material-related savings. Of the anticipated MYP material-related savings, approximately 25 percent were anticipated to be directly related to MRP system utilization.

TABLE 3.15

ANTICIPATED MYP AND MRP RELATED MATERIAL SAVINGS

Category of MYP Savings	Response Mean	Median
MYP-related savings that would be material-related.	3.2	2.5
Material-related savings that would result from MRP utilization.	2.9	2.5

The responses to survey questions #45 and #46 regarding the impact of the "acquisition" of an MRP system on material costs for non-multiyear Government contracts are depicted in Table 3.16. The responses (based on a scale of 1 to 7; 1=0-13 percent, 7=84-100 percent with approximately an interval distribution among responses) indicated that the acquisition of an MRP system resulted in an actual savings of approximately 15 percent for material-related costs, even for non-MYP contracts. Anticipated material-related savings on future non-MYP contracts were estimated at 19 percent.

TABLE 3.16

EFFECTS OF MRP ACQUISITION ON NON-MYP CONTRACTS

Condition	Response Mean	Median
Actual impact of MRP acquisition on material costs on non-MYP contracts.	2.1	1.4
Anticipated impact of MRP acquisition on material costs on non-MYP contracts.	2.4	1.8

The responses to survey questions #47 and #48 regarding the impact of the "enhancement" of an MRP system on material costs for non-multiyear Government contracts are provided in Table 3.17. The responses (based on a scale of 1 to 7; 1=0-13 percent, 7=84-100 percent with approximately an interval distribution among responses) indicated that the enhancement of an existing MRP system reduced material-related costs on non-MYP contracts by approximately 12 percent. Anticipated material-related cost reductions from MRP system enhancements were estimated at 24 percent.

TABLE 3.17

EFFECTS OF MRP ENHANCEMENT ON NON-MYP CONTRACTS

Condition	Response Mean	Median
Actual impact of MRP enhancement on material costs for non-MYP contracts.	1.9	1.3
Anticipated impact of MRP enhancement on material costs on non-MYP contracts.	2.7	2.3

The responses to survey questions #49 and #50 regarding the actual and anticipated "achievements" of MRP system benefits are provided in Table 3.18. The responses (based on a scale of 1 to 7; 1=none, 7=very much) indicated that the utilization of an MRP system significantly improved the degree of achievement of stated material management system benefits. Of particular interest was that both the

actual and anticipated responses selected "better production scheduling" and "better control of inventory" as the elements that benefited most from MRP system utilization. In addition, the anticipated benefits from MRP system utilization emphasized "improved customer satisfaction" and "better cost estimating."

TABLE 3.18

ACHIEVEMENTS OF MRP SYSTEM BENEFITS

Condition/Benefit	Degree of Improvement Mean	Median
A. Actual Achievements:		
1. Improved competitive position.	4.1	4.0
2. Improved customer satisfaction.	5.0	5.0
3. Better production scheduling.	5.6	5.9
4. Improved plant efficiency.	5.1	5.0
5. Better cost estimating.	5.2	5.1
6. Better control of inventory.	5.8	6.1
B. Anticipated Achievements:		
1. Improved competitive position.	5.7	5.8
2. Improved customer satisfaction.	6.0	6.0
3. Better production scheduling.	6.7	6.8
4. Improved plant efficiency.	5.3	5.0
5. Better cost estimating.	6.3	6.3
6. Better control of inventory.	6.3	6.5

Summary

The responses to the EWI administered survey were analyzed with respect to three categories of interest:

1. The extent of MRP system utilization within the defense industry,

2. The anticipated effects of the revised MYP policies on the acquisition or enhancement of MRP systems within the defense industry, and

3. The magnitude of projected material savings that may be realized from MRP system utilization within the defense industry as a direct result of the revised MYP policies.

The conclusions, implications, and recommendations resulting from the data analysis are contained in Chapter 4 of this research report.

CHAPTER 4

CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

This chapter provides a summary of the research project and conclusions. First, a summary of the background, objectives, and methodology of the research project is presented. The research summary is followed by the conclusions and implications regarding the three research objectives and five research questions. Finally, the recommendations for implementation and future research are discussed.

Summary of Background, Objectives, and Methodology

"Cost growth and large cost overruns on many military programs in recent years have generated severe criticisms in the public press and in Congress [7:1]." While inflation and an expanding technology are increasing the costs of weapon systems, the Government's methods of funding also introduce many cost problems into the weapon systems acquisition process (6:4; 7:1). Annual funding, coupled with the DOD full-funding policy, results in year-by-year contracting even for programs that stretch out over many years (12; 29:1576). The year-by-year contracting approach effectively limits a defense contractor's planning horizon to one year, thus inhibiting the use of long-range planning systems with

the associated potential cost savings (6:5). The short-range planning horizon imposed on defense contractors impacts weapon system costs in two ways--production efficiency and material acquisition efficiency (23:52). Material costs for major weapon systems are estimated to represent from 57 percent to 60 percent or more of the total costs of production (19:7; 18:4; 27:777). Limiting defense contractors to short-range planning horizons effectively precludes the utilization of material management systems that would minimize material costs (6:5).

In 1981, Congress authorized the implementation of multiyear procurement (MYP) policies to counter the rising costs of weapon system acquisitions (30). Two of the principal benefits of MYP were stated as: (1) reduced material costs and (2) an enlarged planning horizon (23:43).

The capability of the defense industry to fully exploit the new MYP policies was unknown prior to the author's research project. Virtually every source of information regarding material management systems recommended the use of Material Requirements Planning (MRP) systems in the environment in which defense contractors operate (2; 3; 8; 14; 17; 19; 20; 32). The current status of MRP system utilization within the defense industry and the effects of the newly implemented MYP policies on the defense industry's acquisition of new MRP systems or enhancement of existing MRP systems were unknown prior to the author's research study.

The objectives of this research project were threefold:

1. To ascertain the current status of MRP system utilization within the defense industry,

2. To ascertain defense contractors' attitudes and opinions regarding the anticipated effects of the implemented MYP policies on the acquisition or enhancement of MRP system capability within the defense industry, and

3. To ascertain defense contractors' attitudes and opinions regarding the magnitude of material savings that may be realized from MRP system utilization as a direct result of multiyear procurement.

The three research objectives were accomplished through the use of the following five research questions:

1. What is the current status of MRP system utilization by prime contractors within the defense industry?

2. Does the extent of MRP system utilization differ from defense oriented to non-defense oriented industries?

3. Will the revised MYP policies influence the acquisition of new MRP systems or enhancement of existing MRP systems by defense industry contractors that are awarded MYP contracts?

4. What percentage of actual or anticipated MYP savings are material or material-related savings?

5. What percentage of actual or anticipated MYP material or material-related savings are a direct result of MRP system utilization?

The data used to address the five research questions were obtained from a survey instrument administered by Education With Industry (EWI) students located at various defense contractor facilities throughout the United States (see Figure 4.1 for the relationships among the research objectives, the research questions, and the survey questions). Both parametric and nonparametric statistical techniques were employed in the analysis of data. The statistical analyses were primarily descriptive in nature. Additionally, frequency distributions were developed for the responses to all survey questions.

Research Conclusions

This research project succeeded in accomplishing the three research objectives. As depicted in Figure 4.1, research questions were designed to help accomplish the three research objectives. The research conclusions associated with each research objective will be discussed followed by a description of the answers to the associated research questions. Although the author's study results should be considered preliminary and warrant further study and validation, the research findings supported the author's stated conclusions.

Research Objectives	Research Questions	Survey Instrument	
		Section #	Questions
Demographics	N/A	I	1 through 16
#1. MRP system utilization within the defense industry.	1 and 2	II	17 through 30
#2. Effects of MYP on MRP.	3	III	31 through 40
#3. Magnitude of savings from MRP utilization.	4 and 5	IV	41 through 50

Figure 4.1. Research Outline

Research Conclusion 1

Many defense industry contractors are presently utilizing Material Requirements Planning (MRP) systems for material management. There are no significant differences between the defense industry and overall U.S. industry's utilization of MRP systems.

Survey Response to Research Question #1. Approximately 68 percent of the responding defense industry contractors were presently utilizing MRP systems. Of the 32 percent of the firms not utilizing MRP systems, "lack of top management support" was the most frequently cited reason for not employing an MRP system.

Survey Response to Research Question #2. The extent of the defense industry's MRP system utilization (68%) did not differ significantly from overall U.S. manufacturing industry's utilization of MRP systems (64%), as reported in Anderson and Schroeder's study (4) (see Appendix G for a tabular comparison of the demographics and responses to similar questions between the author's research project and Anderson and Schroeder's study).

Research Conclusion 2

Defense industry contractors that currently do not utilize an MRP system are of the attitude or opinion that the receipt of a multiyear contract would not significantly influence their decision to acquire an MRP system. Defense

industry contractors that currently utilize an MRP system are of the opinion that the receipt of a multiyear contract would influence the decision to enhance existing MRP systems.

Survey Response to Research Question #3. The eight defense industry contractors that responded to the survey and are not currently utilizing an MRP system felt that the award of an MYP contract would influence the decision to acquire an MRP system on an average of 2.2 on a scale of 1 to 7 (where 1=no influence, 7=total influence, and 4=tie-breaker in the decision of whether or not to acquire an MRP system). The median response from the responding defense industry contractors that were not currently utilizing an MRP system indicated that the award of an MYP contract would influence the decision to acquire an MRP system by a rating of 1.2 on a scale of 1 to 7 (where 1=no influence, 7=total influence, and 4=tie-breaker in the decision of whether or not to acquire an MRP system).

The 17 defense industry contractors that responded to the survey and were currently utilizing an MRP system were of the attitude or opinion that the award of an MYP contract would influence the decision to enhance the existing MRP system on an average of 3.8 on a scale of 1 to 7 (where 1=no influence, 7=total influence, and 4=tie-breaker in the decision of whether or not to enhance the existing MRP system). Fifty percent of the responding defense contractors that

were currently utilizing an MRP system were of the opinion that the award of an MYP contract would influence the decision to enhance the existing MRP system by a rating of 4.5 or more on a scale of 1 to 7 (where 1=no influence, 7=total influence, and 4=tie-breaker in the decision of whether or not to enhance the existing MRP system).

Research Conclusion 3

Defense industry contractors are of the opinion that an average of 30.7 percent of MYP savings are actually or projected to be material-related savings. Of the material-related savings, 21.9 percent are projected to be the direct result of MRP system utilization.

Survey Response to Research Question #4. The 25 defense industry contractors that responded to the survey were of the opinion that an average of 30.7 percent of MYP savings are or would be material-related savings. Fifty percent of the responding defense industry contractors were of the opinion that 20.5 percent or more of MYP savings are or would be material-related savings.

Survey Response to Research Question #5. The 25 defense industry contractors that responded to the survey were of the opinion that an average of 21.9 percent of actual or projected MYP material-related savings are or would be the direct result of MRP system utilization. Fifty percent of the responding defense industry contractors were

of the opinion that 15.7 percent or more of the actual or projected MYP material-related savings are or would be the direct result of MRP system utilization.

Implications of This Study

The results from the author's research project support one of the assumptions upon which this study was based. That is, defense industry contractors are economic entities and, as such, will act in a rational manner when confronted with alternatives and opportunities to increase production efficiencies and reduce costs, thereby maximizing the profits of the firm. While MYP, as a contractual arrangement, appeared to exhibit little influence in a defense industry contractor's decision to acquire an MRP system, the attributes of MYP in conjunction with the defense contractor's rational behavior have resulted in MRP system utilization within the defense industry that is comparable to that of U.S. industry as a whole.

However, the observation by Anderson and Schroeder (4) that the commitment to MRP becomes greater as the complexity of manufacturing increases was not exhibited within the defense industry. Of the responding defense industry contractors, 82.6 percent had annual sales over $100 million, 84.0 percent operated multiple plants, and 91.7 percent engaged in both assembly-line and fabrication types of manufacturing. Conversely, of the respondents to Anderson and Schroeder's study (4), 15.7 percent had annual

sales over $100 million, 35.7 percent operated multiple plants, and 83.2 percent engaged in both assembly-line and fabrication types of manufacturing. If Anderson and Schroeder's (4) observation had held within the defense industry, the extent of MRP system utilization within the defense industry would have been significantly greater than the extent of MRP system utilization within U.S. industry as a whole.

While the receipt of an MYP contract had little influence on a defense contractor's decision to acquire an MRP system, the receipt of an MYP contract did (and would) have a stronger influence on a defense contractor's decision to enhance an existing MRP system. It appears that the rationality of behavior dictates the acquisition of, at least, a basic MRP system (approximately 65 percent of the respondents had less than a "Class A" system). Then, the receipt of an MYP contract stimulates contractor investment and thus the willingness to enhance an existing MRP system.

Recommendations for Implementation

Based on the author's overall assessment of the research results, the following recommendations for implementation are provided:

1. While the receipt of an MYP contract has little influence on a defense contractor's decision to acquire an MRP system, MYP does have a stronger influence on the decision to enhance an existing MRP system. Therefore, MYP

should be implemented to the fullest extent possible to facilitate the increased material-related cost savings and production efficiencies that would result from MRP system enhancements.

2. Material Requirements Planning (MRP) systems, in one form or another, are in the defense industry to stay. Yet, the MRP educational opportunities for DOD personnel who must deal with defense contractors are minimal. Students within the Graduate Contracting and Manufacturing Management Option of the Logistics Management Program offered by the School of Systems and Logistics, Air Force Institute of Technology (AFIT), currently receive only an MRP orientation as a part of one production management course. Furthermore, no AFIT Professional Continuing Education (PCE) or Extension Course Institute (ECI) courses are available regarding MRP. The development of MRP-related education courses should be given consideration if the Government is to maximize the potential benefits of MYP implementation and MRP system utilization by defense contractors.

Recommendations for Future Research

In performing this research project, several areas warranting further study were identified. The following four areas highlight topics in need of additional research. The first research area is a complete replication of the

author's study, and the other three areas for future research involve a replication of the author's study with some modifications to the basic research methodology.

Replication of This Study

The author's study was not overwhelmingly supportive of the popular belief that MYP would produce significant cost savings in the acquisition of major weapon systems. Replication of the author's research project would provide additional rationale for major policy revisions regarding the acquisition of major weapon systems.

Replication of Study With Methodology Modifications

The author suggests that this study be replicated after making the following two revisions to the research methodology:

1. Change the data collection plan to include the direct survey of defense contractors for the purpose of obtaining a larger sample size, and

2. Utilize personal interviews instead of EWI administered mail surveys to reduce the subjective interpretation levels involved in the collection of data.

Replication of Study With Expanded Population

Replication of the author's study should be conducted utilizing an expanded population to include all defense subcontractors with which the DOD does not have a direct contractual arrangement. The expanded target population

should include the entire defense industry, thus revealing empirical results for the defense industry as a whole, including both defense prime contractors and subcontractors.

Replication of Study Within Industry As A Whole

This study should be replicated within industry as a whole in concert with the American Production and Inventory Control Society (APICS), the sponsors of Anderson and Schroeder's study (4), with provisions for differentiation between defense and non-defense intensive firms to ascertain and confirm differences and similarities.

Concluding Observations

The empirical evidence from the author's research project did not support the position espoused by Jacques Gansler (15) that the environment created by the Government through its regulations and funding procedures is not conducive to cost effective weapon system acquisitions. Defense contractors appear to act in a rational manner when confronted with alternatives and opportunities to maximize profits. While MYP has little influence on a contractor's decision to acquire a new MRP system, MYP does exhibit a stronger influence on the contractor's decision to enhance an existing MRP system. With material costs ranging from 57 to 60 percent of the costs of a major weapon system, the enhancement of MRP systems resulting from the receipt of MYP contracts has significant potential for reducing the costs of major weapon systems in the future.

APPENDICES

APPENDIX A

DEFINITIONS OF KEY TERMS

Advance Procurement	Procurement of material and components in advance of the fiscal year in which the end-item will be procured (6:125).
Annual Funding	This is the current procedure for funding most programs. The authorizations and appropriations are limited to one fiscal year at a time. The yearly budgets prepared by the DOD reflect this policy by specifically requesting those funds which are intended for the upcoming fiscal year's programs (6:125).
Cancellation	Applies solely to multi-year contracts and is not synonymous with termination. It is the right of the Government to discontinue a multi-year contract at the end of a fiscal year and for all subsequent fiscal years (6:125).
Cancellation Ceiling	The maximum amount that the Government will pay the contractor for costs which the contractor would have recovered through the unit price had the multi-year contract been completed (6:125).
Full Funding	All funds required to cover the total estimated cost to deliver a given quantity of usable end-items that must be available at the time of contract award. The full funding policy prohibits any DOD agency from procuring an entire program for which production may span several years by paying for the program as costs are incurred. This policy was adopted to preclude instances where acquisition programs are started without sufficient funds available for completion, leaving subsequent Congresses and administrations the necessity

Full Funding (cont)	of funding completion or terminating the program prior to completion (6:25-26).
Material Management	Material management is the planning, directing, controlling, and coordinating of all those activities concerned with material and inventory requirements from the point of inception to the introduction into the manufacturing process. Material management begins with the determination of material quality and quantity and ends with the material's issuance to production in time to meet customer demands on schedule and at the lowest cost (17:89).
Material Requirements Planning (MRP) Systems	A set of priority planning techniques for planning the acquisition of component items below the product or end-item level. MRP utilizes the manufacturing build schedule (master production schedule), which determines what components should be ordered and when the components should be ordered. Taking this information, MRP produces a schedule of specific component needs in a sequence that plans for each component to be available when needed for the next level of assembly (17:182).
Multi-year Contract	A contract which utilizes multi-year procurement procedures (6:126).
Multi-year Contracting	A method of acquiring DOD planned requirements for up to a five-year period without having total funds available at the time of contract award (6:30).
Multi-year Funding	This type of funding is in contrast to annual funding. It is the practice by which Congress authorizes and appropriates

Multi-year Funding (cont)	funds for programs in excess of one year. Multi-year funding refers to longer term funds appropriated by Congress for the purpose of funding program requirements for periods in excess of one year. Multi-year funding and multi-year contracting are not synonymous terms (6:27).
Multi-year Procurement	A generic term which describes procedures for acquiring needed items over several years through one contract. The intent is to lower costs through economies of scale (6:126).
Prime Contractor	An individual, company, firm, or corporation which enters into a written agreement with the Government to perform work or furnish supplies (11:538).
Nonrecurring Costs	Production costs which are incurred on a one-time basis and amortized over the period of the multi-year contract (6:126).
Recurring Costs	Production costs which enter into the product, such as material and labor costs (6:126).

Rank	Company	Value of Contracts
1.	General Dynamics	$5,891,101,000
2.	McDonnell Douglas	5,630,104,000
3.	United Technologies	4,208,293,000
4.	General Electric	3,654,097,000
5.	Lockheed	3,498,550,000
6.	Boeing	3,238,796,000
7.	Hughes Aircraft	3,140,735,000
8.	Rockwell International	2,690,518,000
9.	Raytheon	2,262,290,000
10.	Martin Marietta	2,008,354,000
11.	Grumman	1,900,489,000
12.	Northrop	1,598,194,000
13.	Westinghouse Electric	1,491,700,000
14.	FMC	1,370,675,000
15.	Litton Industries	1,316,603,000
16.	Honeywell	1,217,205,000
17.	International Business Machines	1,196,831,000
18.	Sperry	1,149,399,000
19.	RCA	995,947,000
20.	Ford	896,726,000
21.	TRW	868,771,000
22.	Tenneco (Newport News Shipbuilding)	844,594,000
23.	Exxon	840,535,000
24.	Texas Instruments	838,977,000
25.	American Telephone and Telegraph	752,645,000
26.	General Motors	689,515,000

APPENDIX B

TOP 50 DEFENSE CONTRACTORS OF 1982

Rank	Company	Value of Contracts
27.	Congoleum (Bath Iron Works)	675,757,000
28.	AVCO	667,895,000
29.	Motor Oil Hellas	633,336,000
30.	General Tire & Rubber (Aerojet)	625,417,000
31.	Standard Oil of California (Chevron)	603,983,000
32.	Bendix	592,696,000
33.	Teledyne	590,274,000
34.	Textron	583,692,000
35.	GTE	567,100,000
36.	Singer	549,127,000
37.	LTV	548,055,000
38.	Phibro Salomon (Derby)	520,524,000
39.	American Motors	473,516,000
40.	International Telephone & Telegraph	442,527,000
41.	Guam Oil & Refining	436,396,000
42.	Goodyear Tire & Rubber	423,748,000
43.	Summa (Hughes Helicopters)	420,825,000
44.	North American Phillips (Magnavox)	409,158,000
45.	Todd Shipyards	404,255,000
46.	You One Construction	371,652,000
47.	First Colony Farms (United States Lines)	369,152,000
48.	Soberbio	355,256,000
49.	Eaton	336,634,000
50.	Du Pont (Conoco, Remington Arms)	326,895,000

Source: U.S. News & World Report, 4 April 1983, p. 46.

APPENDIX C

THE LIST OF SURVEYED FIRMS THAT VOLUNTEERED IDENTITY ON SURVEY INSTRUMENT

Aerojet General, Solid Propulsion Division

Boeing VERTOL Company

General Dynamics/Convair Division

General Dynamics/Ft Worth Division

General Electric Company, Aircraft Engine Business Group/Evendale, Military Engine Projects Operation Division

Hercules Incorporated, Aerospace Division, Bacchus Works

Hughes Aircraft Company/Ground Systems Group

Isotopic, Nuclear Chemistry Division

ITT Defense Communications Division

Lockheed Missile & Space Company/Missile Systems Division

Lockheed Sunnyvale/SSD

Martin-Marietta Denver Aerospace

McDonnell Aircraft

McDonnell-Douglas Astronautics Company/Material Subdivision

RCA Missiles and Surface Radar

Rockwell International Corp/Autonetics Strategic Systems Division

United Technologies/Sikorsky Aircraft

Vought Corporation

Westinghouse Electric Corporation/Integrated Logistics Support Division

APPENDIX D

SURVEY INSTRUMENT

LSP (Capt Brechtel, Autovon 785-3944)

Material Requirements Planning (MRP) Interview Guide

Education With Industry (EWI) Students

1. The attached survey is part of an Air Force Institute of Technology research project studying Material Requirements Planning (MRP). The purpose of this survey is to gather information concerning contractor opinions and experience regarding MRP system utilization and the impact of multiyear procurement (MYP) on contractor MRP systems.

2. This survey is authorized by USAF survey control number USAF SCN 83-38. The report that results from this research will be available through the Defense Technical Information Center.

3. The success of this research effort is totally dependent on your cooperation. The completed surveys are needed not later than 10 June 83. Please take a few minutes from your schedule to assist us in this endeavor.

LARRY L. SMITH, Col, USAF
Dean
School of Systems and Logistics

2 Atch
1. Interview Guide
2. Return Envelope

SCN Expiration Date: 30 Jun 83

CI

Survey of Education With Industry (EWI) Students

LS

I fully support the Material Requirements Planning (MRP) survey proposed by Capt Brechtel's research project at AFIT/LS. He has briefed me on the methodology and expected results.

JAMES H. HAVEY, Col, USAF
Dean
Civilian Institution Programs

PRIVACY STATEMENT

In accordance with paragraph 8, AFR 12-35, the following information is provided as required by the Privacy Act of 1974:

a. Authority:

(1) 5 U.S.C. 301, Departmental Regulations;

(2) 10 U.S.C. 8012, Secretary of the Air Force, Powers, Duties, Delegation by Compensation;

(3) DOD Instruction 1100.13, 17 Apr 68, Surveys of Department of Defense Personnel; and

(4) AFR 30-23, 22 Sep 76, Air Force Personnel Survey Program.

b. Principal purposes. The survey is conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and DOD.

c. Routine uses. The survey data will be converted to information for use in research of management related problems. Results of the research, based on the data provided, will be included in written master's theses and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or presented orally, will be unlimited.

d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

SPECIAL INSTRUCTIONS

1. All of the questions in this survey are designed to be answered by the Material Manager, Production or Operations Manager, Material Control Manager, Inventory Control Manager, or other person most familiar with the material management system of the company to which you are assigned. When completing the survey questions, please take care to interview the most appropriate person meeting the above characteristics that you have access to.

2. Please circle or fill-in the appropriate response(s) on the survey itself.

3. Relevant definitions are set forth at the end of the survey.

4. Questions regarding this survey and/or the research project should be addressed to Captain Donald L. Brechtel, Autovon 785-3944 or commercial 513-255-3944.

5. Return the completed surveys in the enclosed self-addressed envelope or address and return to:

Captain Donald L. Brechtel
AFIT/LSP
Wright-Patterson AFB OH 45433

6. Your assistance in this research project is appreciated.

Please indicate the company/division to which you are assigned:

_____

SECTION I

Instruction for EWI Students

In this section you (the EWI student) are to ask questions concerning the background and experience of both the respondent and the respondent's company.

Questions for the Respondent

1. Which of the following most nearly describes your area of responsibility within the firm?

   a. Production (Manufacturing)/Operations Management
   b. Financial Management
   c. Contracts
   d. Engineering/Research and Development
   e. Inventory Management
   f. Materials/Subcontract Management
   g. Other, _____ (please specify)

2. Which of the following best describes your position within the firm?

   a. Executive Management
   b. Middle Management
   c. Foreman/Line Supervisor
   d. Non-supervisory/Worker
   e. Other, _____ (please specify)

3. Title of respondent:_____

4. How many years have you been in your present position?

   a. Less than 1 year
   b. More than 1 year but less than 3 years
   c. More than 3 years but less than 5 years
   d. More than 5 years but less than 7 years
   e. More than 7 years but less than 10 years
   f. More than 10 years but less than 15 years
   g. More than 15 years but less than 25 years
   h. Over 25 years

5. How many years have you been employed by your firm?

   a. Less than 1 year
   b. More than 1 year but less than 3 years
   c. More than 3 years but less than 5 years
   d. More than 5 years but less than 7 years
   e. More than 7 years but less than 10 years
   f. More than 10 years but less than 15 years
   g. More than 15 years but less than 25 years
   h. Over 25 years

6. How many years have you been employed in the defense industry?

   a. Less than 1 year
   b. More than 1 year but less than 3 years
   c. More than 3 years but less than 5 years
   d. More than 5 years but less than 7 years
   e. More than 7 years but less than 10 years
   f. More than 10 years but less than 15 years
   g. More than 15 years but less than 25 years
   h. Over 25 years

7. Your firm's major product area(s) are: _____

   _____

8. Annual Sales (in Million $, circle the most appropriate response):

   Total Company:

Under			Over
a. $10 M	b. $11-50M	c. $51-100M	d. $100M

   Your facility or division:

Under			Over
a. $10 M	b. $11-50M	c. $51-100M	d. $100M

9. Your total (overall) company consists of (check the most appropriate response):

   a. Single Plant _____ b. Multiple Plants _____

   c. Other _____ (Please Describe _____)

10. Type of production at your facility or division:

    On Commercial contracts:
    a. Make-to-order b. Make-to-stock c. Both d. None

    On Government contracts:
    a. Make-to-order b. Make-to-stock c. Both d. None

11. Type of Manufacturing at your facility or division:

On Commercial contracts:
a. Assembly b. Fabrication c. Both d. None

On Government contracts:
a. Assembly b. Fabrication c. Both d. None

12. Type of production process at your facility or division:

On Commercial contracts:
a. Job-shop b.Continuous-process c. Assembly-line

On Government contracts:
a. Job-shop b.Continuous-process c. Assembly-line

13. Number of employees at your facility or division? _____

14. Number of employees in Production and Inventory Control at or that support your facility or division? _____

_____

15. What percentage of your firm's total business (sales) is defense oriented?

For Your Total Company _____%

For Your Facility or Division _____%

16. Has your facility or division served as a "prime contractor" with the Department of Defense (DoD) since 1 Jan 1980?

a. Yes (To what extent? _____% of the time)
b. No

SECTION II

Instruction for EWI Students

Material Requirements Planning (MRP) is a material management system that, through the use of the Master Production Schedule, Bill of Materials, and current inventory status, provides a time-phased (what part is needed when) listing of net inventory requirements that allows material managers to minimize material and material-related costs and production delays caused by non-receipt of needed materials or components. A further definition, tree diagram, and simplified example of an MRP system are provided as Attachment #1. Please provide the attachment to the respondent for review prior to answering the below listed questions.

An MRP system can either be developed "in-house" or acquired commercially. Some examples of commercially available systems that embody the attributes of an MRP system are as follows:

1. The Production and Information Control System (PICS) is an IBM package developed to centralize and computerize the information system in fabrication and assembly plants. While encompassing the attributes of an MRP system, it also addresses job scheduling and shop loading.

2. The Communication Oriented Production and Information Control System (COPICS) is also an IBM package extending the PICS into a dynamic, on-line manufacturing control system. As such, it also encompasses the attributes of an MRP system.

3. The Manufacturing Resources Planning II (MRP II) system by Oliver Wight does to basic MRP what COPICS does to PICS. As such, it also encompasses the attributes of an MRP system.

Questions for the Respondent

17. Does your firm utilize an MRP system for the management of material and material-related costs?

    a. Yes (What year was it acquired? _____)
    b. No

NOTE: If the respondent provides a "NO" answer to question #17, go to question #23. Otherwise, continue with question #18.

18. If the answer to question #17 was "Yes," was the MRP system being utilized:

    a. Developed in-house
    b. Acquired commercially
    c. A modified adaptation of a commercial system

19. If the answer to question #18 was "Developed in-house," is the system now being marketed commercially?

    a. Yes (Commercial Name _____)
    b. No

20. If the answer to question #18 was "Acquired commercially," what is (was):

    The Commercial Name _____
    The Source _____
    The cost of acquisition $_____
    The cost of implementation $_____

21. If the answer to question #17 was "Yes," is the MRP system being utilized:

    a. Predominantly on Government Contracts (_____%)
    b. Predominantly on Commercial Contracts (_____%)
    c. Only on Government Contracts
    d. Only on Commercial Contracts
    e. Equally on both Government and Commercial contracts

22. If the answer to question #17 was "Yes," which of the following categories best describes the status of MRP in your facility:

a. Class A: Closed-loop system used for both priority and capacity planning. The Master Production Schedule (MPS) is leveled and used by top management to run the business. Most deliveries are on time, inventory is under good control, and little or no expediting is done.

b. Class B: Closed-loop system with capability for both priority planning and capacity planning. However, MPS is somewhat inflated. Top management does not give full support. Some inventory reductions have been obtained, but capacity is sometimes exceeded and some expediting is needed.

c. Class C: Order launching system with priority planning only. Capacity planning is done informally with a probable inflated MPS. Expediting is used to control the flow of work. A modest reduction in inventory has been achieved.

d. Class D: The MRP system exists mainly in data processing. Many records are inaccurate. The informal system is largely used to run the company. Little benefit is obtained from the MRP system.

23. How is the term "MRP" used in your company?

a. _____ In the "broad" sense, as a closed-loop manufacturing control system.

b. _____ In the "narrow" sense, as parts explosion and order launching.

c. _____ Other (specify _____)

24. What is the accuracy of the following types of data used in your firm's commercial business (circle the most appropriate response)?

	Poor ----- Excellent	Unknown
a. Inventory Records	1 2 3 4 5 6 7	x
b. Bill of Materials	1 2 3 4 5 6 7	x
c. Market Forecasts	1 2 3 4 5 6 7	x
d. Master Production Schedule	1 2 3 4 5 6 7	x
e. Production Lead Times	1 2 3 4 5 6 7	x
f. Vendor Lead Times	1 2 3 4 5 6 7	x
g. Shop Floor Control Data	1 2 3 4 5 6 7	x
h. Capacity Plan	1 2 3 4 5 6 7	x
i. Not applicable - no commercial business.		

25. What is the accuracy of the following types of data used in your firm's Government business (circle the most appropriate response)?

	Poor ----- Excellent	Unknown
a. Inventory Records	1 2 3 4 5 6 7	x
b. Bill of Materials	1 2 3 4 5 6 7	x
c. Market Forecasts	1 2 3 4 5 6 7	x
d. Master Production Schedule	1 2 3 4 5 6 7	x
e. Production Lead Times	1 2 3 4 5 6 7	x
f. Vendor Lead Times	1 2 3 4 5 6 7	x
g. Shop Floor Control Data	1 2 3 4 5 6 7	x
h. Capacity Plan	1 2 3 4 5 6 7	x

26. What is the current status of the following elements of the material management system used in your firm's commercial business (check the most appropriate response)?

	Manual	Computer-ized	Un-known
a. Forecasting End-items			
b. Bill of Materials			
c. Inventory System			
d. Master Production Schedule			
e. Parts Explosion			
f. Order Release			
g. Purchasing			
h. Capacity Planning			
i. Operation Scheduling			

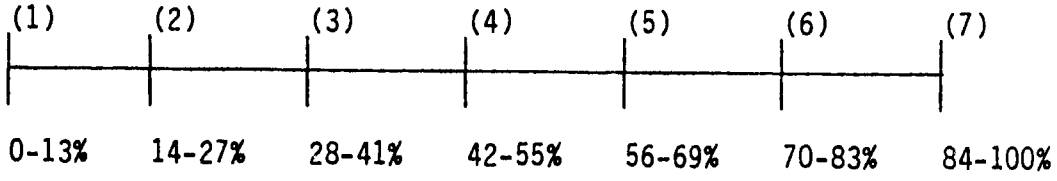
j. Not applicable - no commercial business

27. What is the current status of the following elements of the material management system used in your firm's Government business (check the most appropriate response)?

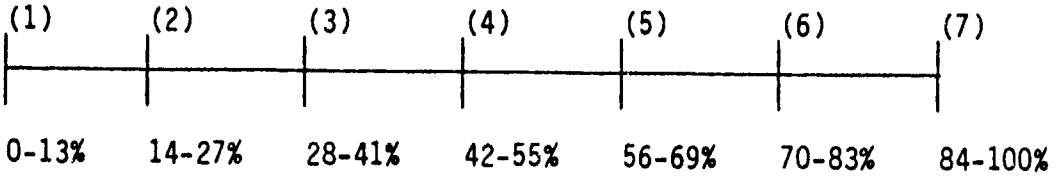
	Manual	Computer-ized	Un-known
a. Forecasting End-items			
b. Bill of Materials			
c. Inventory System			
d. Master Production Schedule			
e. Parts Explosion			
f. Order Release			
g. Purchasing			
h. Capacity Planning			
i. Operation Scheduling			

28. How much integration have you achieved between the elements set forth in questions 26 & 27 above (circle the most appropriate response)?

Commercial Business (skip if no commercial business):



Government Business:



29. If your firm does NOT employ an MRP system, which of the following best describe the reason(s) for not employing an MRP system (circle the most appropriate response)?

		Degree of Influence None-----Very Much	Unknown
a.	The high acquisition cost of an MRP system.	1 2 3 4 5 6 7	x
b.	The high implementation cost of an MRP system.	1 2 3 4 5 6 7	x
c.	Lack of top management support for acquisition of an MRP system.	1 2 3 4 5 6 7	x
d.	A "better" system is currently in place (Please describe the current system _____ _____)	1 2 3 4 5 6 7	x
e.	Unaware tnat MRP existed.	1 2 3 4 5 6 7	x
f.	Other (Please specify _____ _____)	1 2 3 4 5 6 7	x

30. If your firm employs an MRP system on commercial contracts and NOT on Government contracts, which of the following describe the reason(s) for not employing MRP on Government contracts (circle the most appropriate response)?

		Degree of Influence None-----Very Much							Unknown
a.	The funding methods on Government contracts are too restrictive to permit the long-range planning benefits of MRP.	1	2	3	4	5	6	7	x
b.	The administrative and reporting requirements on Government contracts inhibit effective utilization of MRP.	1	2	3	4	5	6	7	x
c.	The proportion of DOD business to the firm's total business does not warrant the effort or expense required to employ MRP on Government contracts.	1	2	3	4	5	6	7	x
d.	The highly cyclical nature of defense spending inhibits the firm from capital investment for a strategic management system such as MRP.	1	2	3	4	5	6	7	x
e.	Other (Please Specify) _____ _____	1	2	3	4	5	6	7	x
f.	Not applicable - no commercial business								

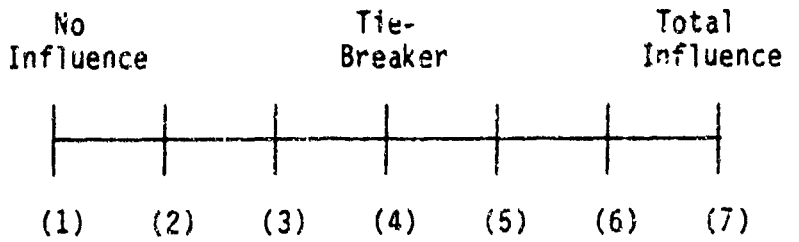
SECTION III

Instructions for EWI Students

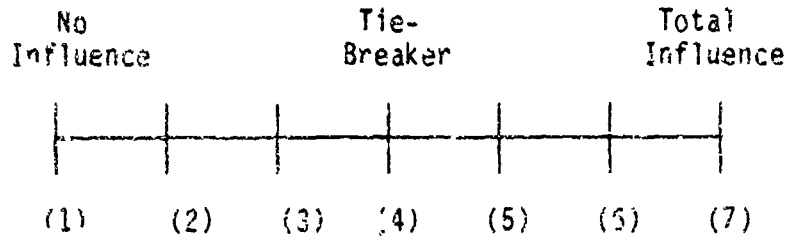
The Department of Defense Authorization Act of 1982 implemented revised and revitalized multiyear procurement (MYP) policies which allow for the inclusion and funding of recurring costs such as material and material-related costs as well as the inclusion of material costs in the cancellation ceiling for Government contracts. The following questions are to be answered by the respondent in view of the revised MYP policies.

Questions for the Respondent

31. To what extent has the receipt of a multiyear contract influenced the acquisition of an MRP system (circle the most appropriate response number)?



32. To what extent would the receipt of a multiyear contract influence the acquisition of an MRP system (circle the most appropriate response number)?



33. If your firm currently utilizes an MRP system on Government contracts, to what extent has the receipt of a multiyear contract influenced the enhancement of the existing MRP system (circle the most appropriate response)?

No Influence			Tie-Breaker			Total Influence
(1)	(2)	(3)	(4)	(5)	(6)	(7)

34. If your firm currently utilizes an MRP system on Government contracts, to what extent would the receipt of a multiyear contract influence the enhancement of the existing MRP system (circle the most appropriate response)?

No Influence			Tie-Breaker			Total Influence
(1)	(2)	(3)	(4)	(5)	(6)	(7)

35. What attributes of multiyear procurement (MYP) influenced your firm's decision to acquire an MRP system (circle the most appropriate response for each attribute)?

	Degree of Influence None-----Very Much	Unknown
a. Firmer Requirements	1 2 3 4 5 6 7	x
b. Long Range Planning Opportunities	1 2 3 4 5 6 7	x
c. Advance Material Buys	1 2 3 4 5 6 7	x
d. Inclusion of Material Costs in the Cancellation Ceiling	1 2 3 4 5 6 7	x
e. Other (Please Specify_____)	1 2 3 4 5 6 7	x

36. What attributes of multiyear procurement (MYP) would influence your firm's decision to acquire an MRP system (circle the most appropriate response for each attribute)?

	Degree of Influence None-----Very Much	Unknown
a. Firmer Requirements	1 2 3 4 5 6 7	x
b. Long Range Planning Opportunities	1 2 3 4 5 6 7	x
c. Advance Material Buys	1 2 3 4 5 6 7	x
d. Inclusion of Material Costs in the Cancellation Ceiling	1 2 3 4 5 6 7	x
e. Other (Please Specify _____) _____	1 2 3 4 5 6 7	x

37. What attributes of multiyear procurement (MYP) influenced your firm's decision to enhance the existing MRP system (circle the most appropriate response for each attribute)?

	Degree of Influence None-----Very Much	Unknown
a. Firmer Requirements	1 2 3 4 5 6 7	x
b. Long Range Planning Opportunities	1 2 3 4 5 6 7	x
c. Advance Material Buys	1 2 3 4 5 6 7	x
d. Inclusion of Material Costs in the Cancellation Ceiling	1 2 3 4 5 6 7	x
e. Other (Please Specify _____) _____	1 2 3 4 5 6 7	x

38. What attributes of multiyear procurement (MYP) would influence your firm's decision to enhance the existing MRP system (circle the most appropriate response for each attribute)?

	Degree of Influence None-----Very Much	Unknown
a. Firmer Requirements	1 2 3 4 5 6 7	x
b. Long Range Planning Opportunities	1 2 3 4 5 6 7	x
c. Advance Material Buys	1 2 3 4 5 6 7	x
d. Inclusion of Material Costs in the Cancellation Ceiling	1 2 3 4 5 6 7	x
e. Other (Please Specify _____)	1 2 3 4 5 6 7	x

39. What attribute of multiyear procurement (MYP) does (did) your firm consider THE most important in the decision to acquire an MRP system (circle the most appropriate response)?

a. Firmer Requirements

b. Long Range Planning Opportunities

c. Advance Material Buys

d. Inclusion of Material Costs in the Cancellation Ceiling

e. Other (Please Specify _____)

40. What attribute of multiyear procurement (MYP) does (did) your firm consider THE most important in the decision to enhance the existing MRP system (circle the most appropriate response)?

a. Firmer Requirements

b. Long Range Planning Opportunities

c. Advance Material Buys

d. Inclusion of Material Costs in the Cancellation Ceiling

e. Other (Please Specify _____
_____)

SECTION IV

Instruction for EWI Students

Two of the major benefits of the revised multiyear procurement (MYP) policies are viewed as being (1) the inclusion of and funding for advance procurement of materials and (2) an expanded planning horizon which allows for the utilization of longer range techniques that permit more efficient management, thus increased savings, on multiyear programs. Have the respondent answer the following questions in view of actual or anticipated savings resultant from multiyear contracting.

Questions for the Respondent

41. What percentage of the actual savings on Government contracts resultant from MYP are material or material-related savings (circle the most appropriate response number)?

(1)	(2)	(3)	(4)	(5)	(6)	(7)
0-13%	14-27%	28-41%	42-55%	56-69%	70-83%	84-100%

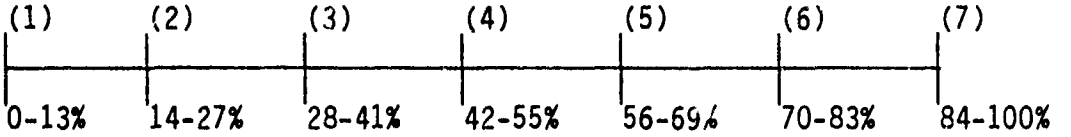
42. What percentage of the savings in question #41 are actually a direct result of MRP system utilization (circle the most appropriate response number)?

(1)	(2)	(3)	(4)	(5)	(6)	(7)
0-13%	14-27%	28-41%	42-55%	56-69%	70-83%	84-100%

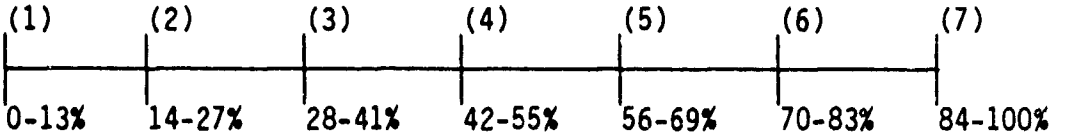
43. What percentage of the anticipated savings on Government contracts resultant from MYP will be material or material-related savings (circle the most appropriate response number)?

(1)	(2)	(3)	(4)	(5)	(6)	(7)
0-13%	14-27%	28-41%	42-55%	56-69%	70-83%	84-100%

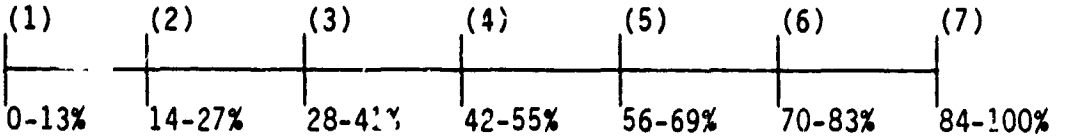
44. What percentage of the savings in question #43 are anticipated to be a direct result of MRP system utilization (circle the most appropriate response number)?



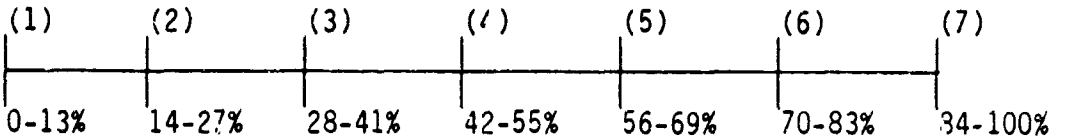
45. To what extent has the acquisition of an existing MRP system decreased material and material-related costs on non-MYP Government contracts (circle the most appropriate response number)?



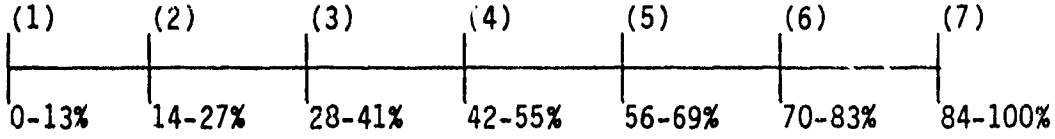
46. To what extent do you anticipate the acquisition of an MRP system will decrease material and material-related costs on non-MYP Government contracts (circle the most appropriate response number)?



47. To what extent has the enhancement of an existing MRP system decreased material and material-related costs on non-MYP Government contracts (circle the most appropriate response number)?



48. To what extent do you anticipate the enhancement of an existing MRP system will decrease material and material-related costs on non-MYP Government contracts (circle the most appropriate response number)?



49. With respect to your firm's Government contracts, to what degree has your firm achieved the following benefits from your MRP system?

	Degree of Improvement None --- Very Much	Unknown
a. Improved Competitive Position	1 2 3 4 5 6 7	x
b. Improved Customer Satisfaction	1 2 3 4 5 6 7	x
c. Better Production Scheduling	1 2 3 4 5 6 7	x
d. Improved Plant Efficiency	1 2 3 4 5 6 7	x
e. Better Cost Estimating	1 2 3 4 5 6 7	x
f. Better Control of Inventory	1 2 3 4 5 6 7	x

50. With respect to your firm's Government contracts, to what degree do you anticipate that your firm will achieve the following benefits from your MRP system?

		Degree of Improvement None --- Very Much	Unknown
a.	Improved Competitive Position	1 2 3 4 5 6 7	x
b.	Improved Customer Satisfaction	1 2 3 4 5 6 7	x
c.	Better Production Scheduling	1 2 3 4 5 6 7	x
d.	Improved Plant Efficiency	1 2 3 4 5 6 7	x
e.	Better Cost Estimating	1 2 3 4 5 6 7	x
f.	Better Control of Inventory	1 2 3 4 5 6 7	x

ADDITIONAL COMMENTS:

ATTACHMENT #1

A Non-MRP Approach

A simplistic but often used approach for determining material requirements before a production run is as follows (3:523):

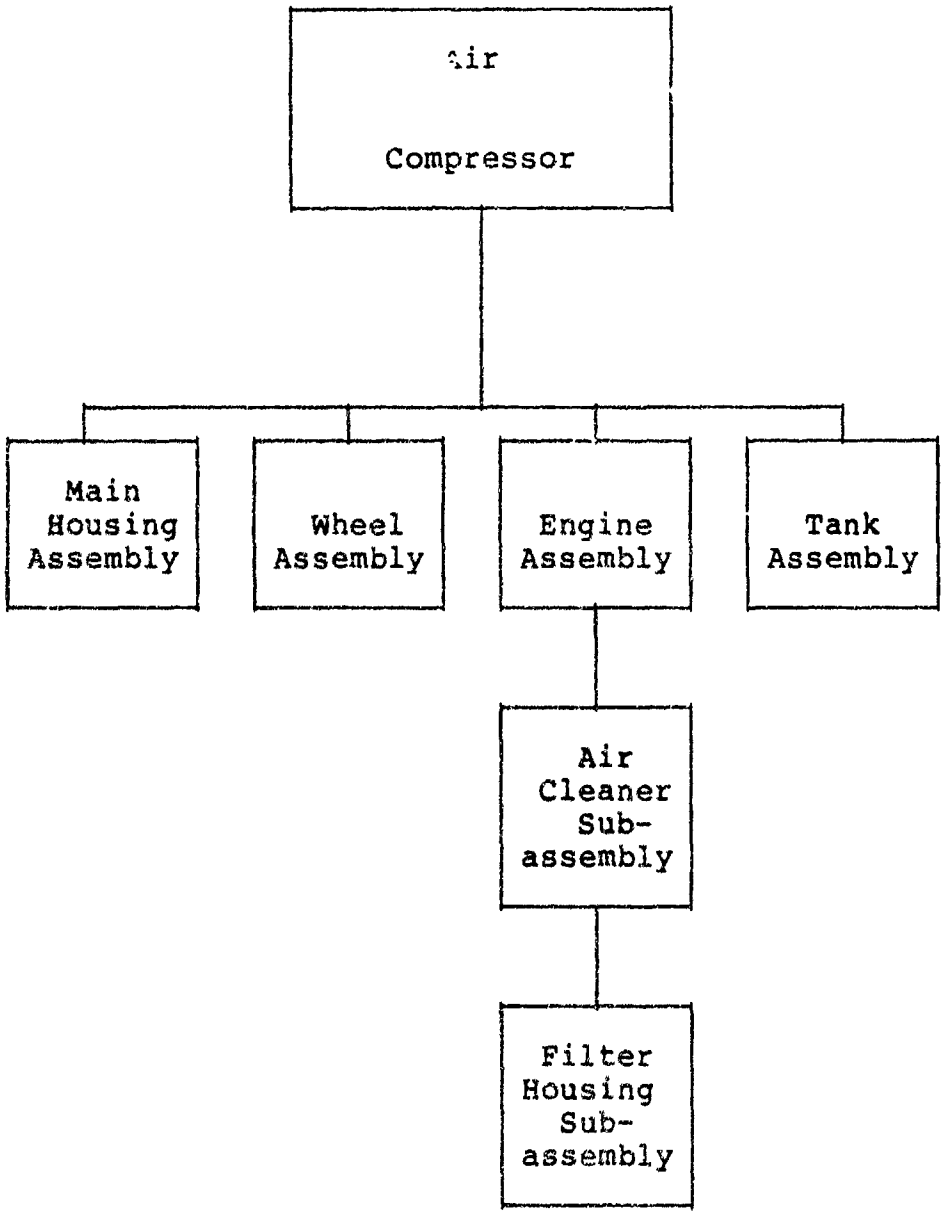
Net Requirements = Components Required - Components On Hand

An example of material requirements determination for 5,000 air compressors using the simplistic approach for the "engine assembly" of an air compressor is set forth in Table 1.1 (See Figure 1.1 for a partial Bill of Materials breakout).

TABLE 1.1
A NON-MRP APPROACH
(Adapted from 3:523)

Components	Number of Components Required to Meet a Demand for 5000 Air Compressors	-	On Hand	=	Net Requirements
Engine Assembly	5000	-	1800	=	3200
Air Cleaner Subassembly	5000	-	1000	=	4000
Filter Housing Subassembly	5000	-	2000	=	3000

The above non-MRP approach, however, recognizes neither the "time phasing" of requirements (i.e., when subassemblies are needed to avoid delays in production) nor the possibility of subassembly quantity dependency on end-item quantities (3:523). As such, the non-MRP approach cannot fully exploit the opportunity for material savings offered by multiyear procurements.



A Partial Bill of Materials for the Air Compressor

Figure 1.1.

(Adapted from 3: Fig 12.6)

An MRP Approach. An MRP system requires three inputs: (1) the Master Production Schedule, (2) the end-item Bill of Materials, and (3) the Inventory Records File (See Figure 1.2) (8:518). Utilizing the three inputs, the MRP system reconciles the differences between required and existing inventories and schedules make-or-buy quantities for net inventory requirements. The result is a system which, while minimizing inventory and inventory-related costs, helps insure that components are on hand when the components are needed in the production schedule (8:524). A simplified example of an MRP system application is provided below using the air compressor information:

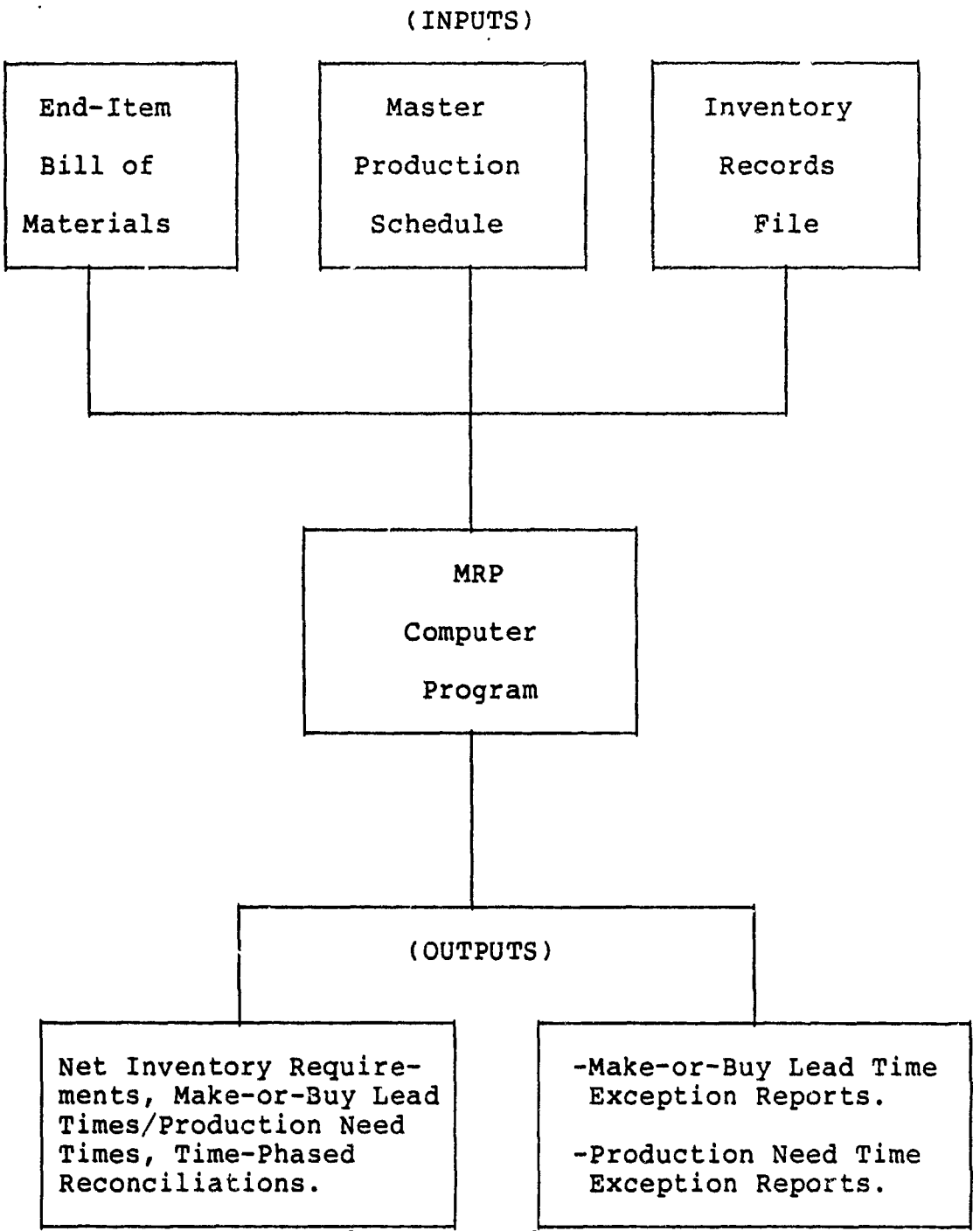
TABLE 1.2

AN MRP APPROACH

(Adapted from 3:524-5)

Components	Number of Components Required to Meet a Demand for 5000 Air Compressors	-	On Hand	=	Net Requirements
Engine Assembly	5000	-	1800	=	3200
Air Cleaner Subassembly	3200	-	1000	=	2200
Filter Housing Subassembly	2200	-	2000	=	200

Although the net requirement for engine assemblies (3,200) is the same under both systems, the initial simplistic non-MRP approach made no attempt to account for possible dependency of subassembly demand on end-item quantity. The



Inputs and Outputs of an MRP System

Figure 1.2.

(Adapted from 8: Exhibit 16.3)

MRP system considers the dependency, hence "the net requirement of the higher assembly becomes the gross requirement for the next lower subassembly [3:524]."

An MRP system's "time phasing" for the air compressor information is depicted in Figure 1.3. The lead time for a higher assembly drives the order times for all lower subassemblies. To keep the illustration simple, all subassembly quantities are assumed to be required "on hand" before production of the next higher assembly can begin. For example, the lead time for the engine assembly is eight weeks, thus the need time for the next lower subassembly (the air cleaner subassembly) becomes the engine assembly need time minus the engine assembly lead time (i.e., 20 weeks - 8 weeks which equals 12 weeks). The need time minus the lead time for the air cleaner subassembly becomes the need time for the filter housing subassembly (i.e., 12 weeks - weeks = 10 weeks and so on.

Item		Week							
		4	6	...	10	11	12	...	20
Engine Assembly Lead Time: 8 weeks	Gross Rqmt								5000
	On-hand								1800
	Net Rqmts						...	....	3200
	Order Release						3200		
Air Cleaner Sub-assembly Lead Time: 2 weeks	Gross Rqmt						3200		
	On-hand						1000		
	Net Rqmts				...	....	2200		
	Order Release				2200				
Filter Housing Sub-assembly Lead Time: 4 weeks	Gross Rqmt				2200				
	On-hand				2000				
	Net Rqmts		...	....	.200				
	Order Release		200						

Figure 1.3. An MRP Time-Phasing Example

(Adapted from 8: Exhibit 16.15)

Advance Procurement	Procurement of material and components in advance of the fiscal year in which the end-item will be procured (6:125).
Annual Funding	This is the current procedure for funding most programs. The authorizations and appropriations are limited to one fiscal year at a time. The yearly budgets prepared by the DOD reflect this policy by specifically requesting those funds which are intended for the upcoming fiscal year's programs (6:125).
Cancellation	Applies solely to multi-year contracts and is not synonymous with termination. It is the right of the Government to discontinue a multi-year contract at the end of a fiscal year and for all subsequent fiscal years (6:125).
Cancellation Ceiling	The maximum amount that the Government will pay the contractor for costs which the contractor would have recovered through the unit price had the multi-year contract been completed (6:125).
Full Funding	All funds required to cover the total estimated cost to deliver a given quantity of usable end-items that must be available at the time of contract award. The full funding policy prohibits any DOD agency from procuring an entire program for which production may span several years by paying for the program as costs are incurred. This policy was adopted to preclude instances where acquisition programs are started without sufficient funds available for completion, leaving subsequent Congresses and administrations the necessity

Full Funding (cont)	of funding completion or terminating the program prior to completion (6:25-26).
Material Management	Material management is the planning, directing, controlling, and coordinating of all those activities concerned with material and inventory requirements from the point of inception to the introduction into the manufacturing process. Material management begins with the determination of material quality and quantity and ends with the material's issuance to production in time to meet customer demands on schedule and at the lowest cost (17:89).
Material Requirements Planning (MRP) Systems	A set of priority planning techniques for planning the acquisition of component items below the product or end-item level. MRP utilizes the manufacturing build schedule (master production schedule), which determines what components should be ordered and when the components should be ordered. Taking this information, MRP produces a schedule of specific component needs in a sequence that plans for each component to be available when needed for the next level of assembly (17:182).
Multi-year Contract	A contract which utilizes multi-year procurement procedures (6:126).
Multi-year Contracting	A method of acquiring DOD planned requirements for up to a five-year period without having total funds available at the time of contract award (6:30).
Multi-year Funding	This type of funding is in contrast to annual funding. It is the practice by which Congress authorizes and appropriates

Multi-year Funding (cont)	funds for programs in excess of one year. Multi-year funding refers to longer term funds appropriated by Congress for the purpose of funding program requirements for periods in excess of one year. Multi-year funding and multi-year contracting are not synonymous terms (6:27).
Multi-year Procurement	A generic term which describes procedures for acquiring needed items over several years through one contract. The intent is to lower costs through economies of scale (6:126).
Prime Contractor	An individual, company, firm, or corporation which enters into a written agreement with the Government to perform work or furnish supplies (11:538).
Nonrecurring Costs	Production costs which are incurred on a one-time basis and amortized over the period of the multi-year contract (6:126).
Recurring Costs	Production costs which enter into the product, such as material and labor costs (6:126).

APPENDIX E

STATISTICAL ANALYSIS PROGRAMS

Program #1

```
RUN NAME          CRITICAL VARIABLE CHECK
VARIABLE LIST     X1 TO X121
INPUT MEDIUM      CARD
INPUT FORMAT      FREEFIELD
FREQUENCIES       GENERAL = 20
OPTION            *
STATISTICS        ALL
READ INPUT DATA
FINISH
```

Program #2

```
RUN NAME          DATA CHECK
VARIABLE LIST     A
INPUT MEDIUM      CARD
INPUT FORMAT      FREEFIELD
CONDESCRIPTIVE    ALL
STATISTICS        ALL
READ INPUT DATA
FINISH
```

VOGELBACK COMPUTING CENTER
NORTHWESTERN UNIVERSITY

S P S S - - STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

VERSION 8.0 -- JUNE 18, 1979

```
RUN NAME        KFP YES
VARIABLE LIST   X1 TO X123
INPUT MEDIUM    CARD
INPUT FORMAT    FREEFIELD
SELECT IF       (X20 EQ 1)
FREQUENCIES     GENERAL = ALL
OPTION          8
STATISTICS      ALL
READ INPUT DATA

FREQUENCIES - INITIAL CM ALLOWS FOR  13.5 VALUES
              MAXIMUM CM ALLOWS FOR 1519 VALUES

END OF FILE ON FILE DAT1
AFTER READING     25 CASES FROM SUBFILE NONAME
1KRP YES                                  06/17/83  10.24.44.     PAGE     2

FILE - NONAME   (CREATED - 06/17/83)

X1
```

CATEGORY LABEL	CODE	ABSOLUTE FREQ	RELATIVE FREQ (PCT)	ADJUSTED FREQ (PCT)	CUM FREQ (PCT)
	0	1	5.9	5.9	5.9
	1.	3	17.6	17.6	23.5
	4.	1	5.9	5.9	29.4
	5.	7	41.2	41.2	70.6
	6.	3	17.6	17.6	88.2
	7.	2	11.8	11.8	100.0
	TOTAL	17	100.0	100.0	

FILE - NONAME (CREATED - 06/17/83)

APPENDIX F

METHODOLOGY OF DATA TRANSFER AND COMPUTER DATA FILES

The following methodology was employed during the transfer of survey responses into computer data files:

Survey Question	Response	File Entry	Program Variable
1	a	1	X1
	b	2	
	c	3	
	d	4	
	e	5	
	f	6	
	g	7	
	None	0	
2	a	1	X2
	b	2	
	c	3	
	d	4	
	e	5	
	None	0	
3	N/A	N/A	N/A
4	a	1	X3
	b	2	
	c	3	
	d	4	
	e	5	
	f	6	
	g	7	
	h	8	
	None	0	
5	a	1	X4
	b	2	
	c	3	
	d	4	
	e	5	
	f	6	
	g	7	
	h	8	
	None	0	

Survey Question	Response	File Entry	Program Variable
6	a	1	X5
	b	2	
	c	3	
	d	4	
	e	5	
	f	6	
	g	7	
	h	8	
	None	0	
7	N/A	N/A	N/A
8A	a	1	X6
	b	2	
	c	3	
	d	4	
	None	0	
8B	a	1	X7
	b	2	
	c	3	
	d	4	
	None	0	
9	a	1	X8
	b	2	
	c	3	
	None	0	
10A	a	1	X9
	b	2	
	c	3	
	d	4	
	None	0	
10B	a	1	X10
	b	2	
	c	3	
	d	4	
	None	0	

Survey Question	Response	File Entry	Program Variable
11A	a	1	X11
	b	2	
	c	3	
	d	4	
	None	0	
11B	a	1	X12
	b	2	
	c	3	
	d	4	
	None	0	
12A	a	1	X13
	b	2	
	c	3	
	None	0	
12B	a	1	X14
	b	2	
	c	3	
	None	0	
13	Actual #	Actual #	X15
14	Actual #	Actual #	X16
15A	Actual %	Actual %	X17
15B	Actual %	Actual %	X18
16	a	1	X19
	b	2	
	None	0	
17	a	1	X20
	b	2	
	None	0	

Survey Question	Response	File Entry	Program Variable
18	a	1	X21
	b	2	
	c	3	
	None	0	
19	a	1	X22
	b	2	
	None	0	
20A	Actual $	Actual $	X23
	None	0	
20B	Actual $	Actual $	X24
	None	0	
21	a	1	X25
	b	2	
	c	3	
	d	4	
	e	5	
	None	0	
22	a	1	X26
	b	2	
	c	3	
	d	4	
	None	0	
23	a	1	X27
	b	2	
	c	3	
	None	0	
24A	1-7	1-7	X28
	Unknown	8	
	None	0	
24B	1-7	1-7	X29
	Unknown	8	
	None	0	

Survey Question	Response	File Entry	Program Variable
24C	1-7	1-7	X30
	Unknown	8	
	None	0	
24D	1-7	1-7	X31
	Unknown	8	
	None	0	
24E	1-7	1-7	X32
	Unknown	8	
	None	0	
24F	1-7	1-7	X33
	Unknown	8	
	None	0	
24G	1-7	1-7	X34
	Unknown	8	
	None	0	
24H	1-7	1-7	X35
	Unknown	8	
	None	0	
24I	i	9	X36
	None	0	
25A	1-7	1-7	X37
	Unknown	8	
	None	0	
25B	1-7	1-7	X38
	Unknown	8	
	None	0	
25C	1-7	1-7	X39
	Unknown	8	
	None	0	

Survey Question	Response	File Entry	Program Variable
25D	1-7 Unknown None	1-7 8 0	X40
25E	1-7 Unknown None	1-7 8 0	X41
25F	1-7 Unknown None	1-7 8 0	X42
25G	1-7 Unknown None	1-7 8 0	X43
25H	1-7 Unknown None	1-7 8 0	X44
26A	M,C,U	1,2,0	X45
26B	M,C,U	1,2,0	X46
26C	M,C,U	1,2,0	X47
26D	M,C,U	1,2,0	X48
26E	M,C,U	1,2,0	X49
26F	M,C,U	1,2,0	X50
26G	M,C,U	1,2,0	X51
26H	M,C,U	1,2,0	X52

Survey Question	Response	File Entry	Program Variable
26I	M,C,U	1,2,0	X53
26J	j None	3 0	X54
27A	M,C,U	1,2,0	X55
27B	M,C,U	1,2,0	X56
27C	M,C,U	1,2,0	X57
27D	M,C,U	1,2,0	X58
27E	M,C,U	1,2,0	X59
27F	M,C,U	1,2,0	X60
27G	M,C,U	1,2,0	X61
27H	M,C,U	1,2,0	X62
27I	M,C,U	1,2,0	X63
28A	1-7 None	1-7 0	X64
28B	1-7 None	1-7 0	X65
29A	1-7 Unknown None	1-7 8 0	X66
29B	1-7 Unknown None	1-7 8 0	X67

Survey Question	Response	File Entry	Program Variable
29C	1-7	1-7	X68
	Unknown	8	
	None	0	
29D	1-7	1-7	X69
	Unknown	8	
	None	0	
29E	1-7	1-7	X70
	Unknown	8	
	None	0	
29F	1-7	1-7	X71
	Unknown	8	
	None	0	
30A	1-7	1-7	X72
	Unknown	8	
	None	0	
30B	1-7	1-7	X73
	Unknown	8	
	None	0	
30C	1-7	1-7	X74
	Unknown	8	
	None	0	
30D	1-7	1-7	X75
	Unknown	8	
	None	0	
30E	1-7	1-7	X76
	Unknown	8	
	None	0	
30F	f	9	X77
	None	0	

Survey Question	Response	File Entry	Program Variable
31	1-7	1-7	X78
	None	0	
32	1-7	1-7	X79
	None	0	
33	1-7	1-7	X80
	None	0	
34	1-7	1-7	X81
	None	0	
35A	1-7	1-7	X82
	Unknown	8	
	None	0	
35B	1-7	1-7	X83
	Unknown	8	
	None	0	
35C	1-7	1-7	X84
	Unknown	8	
	None	0	
35D	1-7	1-7	X85
	Unknown	8	
	None	0	
35E	1-7	1-7	X86
	Unknown	8	
	None	0	
36A	1-7	1-7	X87
	Unknown	8	
	None	0	
36B	1-7	1-7	X88
	Unknown	8	
	None	0	

Survey Question	Response	File Entry	Program Variable
36C	1-7	1-7	X89
	Unknown	8	
	None	0	
36D	1-7	1-7	X90
	Unknown	8	
	None	0	
36E	1-7	1-7	X91
	Unknown	8	
	None	0	
37A	1-7	1-7	X92
	Unknown	8	
	None	0	
37B	1-7	1-7	X93
	Unknown	8	
	None	0	
37C	1-7	1-7	X94
	Unknown	8	
	None	0	
37D	1-7	1-7	X95
	Unknown	8	
	None	0	
37E	1-7	1-7	X96
	Unknown	8	
	None	0	
38A	1-7	1-7	X97
	Unknown	8	
	None	0	
38B	1-7	1-7	X98
	Unknown	8	
	None	0	

Survey Question	Response	File Entry	Program Variable
38C	1-7	1-7	X99
	Unknown	8	
	None	0	
38D	1-7	1-7	X100
	Unknown	8	
	None	0	
38E	1-7	1-7	X101
	Unknown	8	
	None	0	
39	a	1	X102
	b	2	
	c	3	
	d	4	
	e	5	
	None	0	
40	a	1	X103
	b	2	
	c	3	
	d	4	
	e	5	
	None	0	
41	1-7	1-7	X104
	None	0	
42	1-7	1-7	X105
	None	0	
43	1-7	1-7	X106
	None	0	
44	1-7	1-7	X107
	None	0	
45	1-7	1-7	X108
	None	0	

Survey Question	Response	File Entry	Program Variable
46	1-7 None	1-7 0	X109
47	1-7 None	1-7 0	X110
48	1-7 None	1-7 0	X111
49A	1-7 Unknown None	1-7 8 0	X112
49B	1-7 Unknown None	1-7 8 0	X113
49C	1-7 Unknown None	1-7 8 0	X114
49D	1-7 Unknown None	1-7 8 0	X115
49E	1-7 Unknown None	1-7 8 0	X116
49F	1-7 Unknown None	1-7 8 0	X117
50A	1-7 Unknown None	1-7 8 0	X118
50B	1-7 Unknown None	1-7 8 0	X119

Survey Question	Response	File Entry	Program Variable
50C	1-7	1-7	X120
	Unknown	8	
	None	0	
50D	1-7	1-7	X121
	Unknown	8	
	None	0	
50E	1-7	1-7	X122
	Unknown	8	
	None	0	
50F	1-7	1-7	X123
	Unknown	8	
	None	0	

Computer Data Files

```
1 1 3 8 3  4 4 2 3 3
3 3 3 3 4300  240  35  75 1
1 1 2 0 3  5 1 1 6 6 3
6 6 5 6 5  0 6 6 1 6 6 5
6 5 2 2 2  2 2 2 2 2 2 0
2 2 2 2 2  2 2 2 2 6 6
0 0 0 0 3  0 0 0 0 0 0 0
1 1 1 5 0  0 0 0 0 0 0 0 0
0 0 0 0 0  0 6 4 6 6 0 0
0 0 0 5 6  2 0 0 2 3 5
6 5 5 6 3  5 6 6 6 7
4 4 1 1 5  3 1 2 3 3
3 3 3 3 6000  200  70  75
1 1 1 2 0  0 5 2 1
6 7 4 4 6  6 5 6 0 6 6 6 7 7 7
6 5 2 2 2  2 1 2 2 2 0 0
2 2 2 2 1  2 2 2 2 4 4
0 0 0 0 0  0 0 0 0 0 0 0
4 0 4 0 3  5 6 6 0
0 0 0 0 0  5 6 7 7 0
6 7 7 7 0  2 1 5 3 4
4 3 3 4 3  4 5 5 3 5 4
4 5 3 5 4  4
6 3 2 3 3  3 2 3 1 1
3 3 3 3 9000  700  0 0 1 2
0 0 0 0 0  0 1 5 5 5
6 6 6 4 4  0 5 5 6 6 6 6
5 5 1 2 1  2 1 2 1 1 2 0
1 2 1 2 1  2 1 1 2 7 7
5 5 6 4 1  0 0 0 0 0 0 0
0 0 0 0 0  0 0 0 0
0 0 0 0 0  0 0 0 0 0
0 0 0 0 0  0
0 6 0 6 0  0
6 0 6 0 0  0 0 0 0
0 0 0 0 0  0
5 2 2 7 7  4 4 2 1 1
3 3 1 1 12000  100  0 50 1
1 1 2 0 0  5 3 2
5 7 3 7 6  5 3 3 0 5 7 3
7 6 5 3 3  0 2 1 2 2 2 2
1 1 3 0 2  1 2 2 2 2 1 1 0
0 0 0 0 0  0 0 0 0 0 0 0
0 0 0 0 0  0 0 0 0 0 0 0 0
0 0 0 0 0  0 0 0 0 0 0
0 0 0 0 0  0 0
8 5 5 5 5  5 0 0 0 0 0 0
5 1 6 7 6  4 4 2 1 1
3 3 3 3 4200  135  35  55
1 1 1 2 0  0 6 1 1
7 7 8 7 7  7 7 7 0 7 7
```

NOTE:

The data are provided for the 123 variables (i.e., X1 through X123) for each respondent from left to right then top to bottom, starting with the 123 variables for the first respondent and ending with the 123 variables for the last respondent.

```
8 7 7 7 7 7 0 2 2 2 2 2
2 2 2 0 0 2 2 2 2 2 2 2 2
7 7 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 6 1 1 1 1 0
0 0 0 0 0 0 0 0 0 0
6 6 6 7 0 0 5
5 2 5 5 2 0 0 1
5 5 6 3 4 7 0 0 1 0 0 0
1 1 2 5 6 4 4 2 4 1
0 3 0 3 1300 70 100 0
1 1 2 0 4000000 3000000 3
4 1 0 0 0 0 0 0 0 0 9
5 6 5 4 4 4 5 4
0 0 0 0 0 0 0 0 0 0
1 2 1 1 2 2 2 1 1 0 5
0 0 0 0 0 0 0 0 0 0 0 9
2 5 2 5 8 6 9 8 8
5 6 3 4 0 8 8 8 8 8
5 6 4 4 4 2 2 0 0 0
0 0 0 0 0 8 8 8 8 8
5 6 5 5 4 4
5 2 2 6 6 4 4 2 1 1
3 3 3 3 10000 125 50 40
1 1 1 2 0 0 5 2 3
7 7 5 6 7 7 6 6 0
7 7 6 6 7 7 6 7
2 2 2 2 2 2 2 2 2 0
2 2 2 2 2 2 2 2 2
5 5 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 4 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 8 0 1 1 0 0 1
0 0 6 5 1 0 0 1
4 7 5 5 7 7 7 7 5 5 7 7
1 3 1 7 8 4 4 2 0 1
0 1 0 1 6300 227 52 100
1 1 1 2 0 0 3 2 2
0 0 0 0 0 0 0 0 9 7 6 5
7 5 5 3 4 0 0 0 0 0 0 0 0 0
3 0 2 2 2 2 2 2 1 0
0 6 0 0 0 0 0 0 0 0 0 0 0 9
0 0 0 6 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 7 1 1 1 0 0 0
0 0 0 0 5 0 1 1 9 8
7 8 0 7 8 8 8 8 8 8
5 2 2 7 8 4 4 3
3 1 4 3 0 1 4500 190
1 99 1 1 1 2 0 0 3
3 1 0 0 0 0 0 0 0 0 9
6 4 8 4 5 4 4 4
0 0 0 0 0 0 0 0 0 3
```

```
1 2 1 1 2 1 1 1 1 0 2
0 0 0 0 0 0 0 0 0 0 0 9
1 1 1 1 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0
0 0 0 0 0 5 5 1 1 0 0 1 2 1 1
1 6 8 8 8 8 3 5 4 4 2 7
7 1 5 8 4 4 4 2 3 1
3 3 3 3 1 4 0 0 0 7 0 0 0 30
1 0 0 1 2 0 2 0 0 0
0 1 6 7 6 7 7 7 6 6 0
7 7 6 7 7 7 7 7
2 2 2 2 2 2 2 2 2 0
2 2 2 2 2 2 2 2 2
6 7 8 8 8 5 5 0
8 8 8 8 8 0
4 7 7 7 7 7 5 5 0
7 7 7 7 0 6 7 6 7 0
6 6 7 7 0 1 1 2 2 1
1 1 1 1 1
8 7 7 6 6 7 6 7 7 7 7 7
5 2 2 7 7 4 4 2
4 1 4 3 0 2 4 2 0 0 5 0 0
95 100 1 1 1 2 0 0 3
4 1 0 0 0 0 0 0 0 0 9
5 6 3 5 2 2 3 4
0 0 0 0 0 0 0 0 0 3
1 2 2 2 2 1 1 1 1 0 5
0 0 0 0 0 0 0 0 0 0 0 0
6 6 6 6 6 7 4 4 0
6 7 4 4 0 6 7 4 4 0
6 7 4 4 0 2 2
2 1 2 2 1 2 1 2
4 4 4 4 4 4 6 6 6 6 4 6
5 3 1 7 7 4 4 2 1 1
3 3 3 3 2 0 0 0 0 5 0 0 8 1 0 3
1 1 1 2 0 0 1 1 2
0 0 0 0 0 0 0 0 0 9
7 7 8 7 7 7 6 8
0 0 0 0 0 0 0 0 0 3
2 2 2 2 2 2 2 0 2 0 5
0 5 3 0 0 0 0 0 0 0 0 0
1 1 0 0 0 0 0 0
3 4 5 3 0 0 0 0 0 0
0 0 0 0 0 0 0 2 0 2
2 0 2 0 0 0 0 0 0 0
0 0 0 0 0 0
5 2 5 8 3 4 4 2 4 1
4 3 0 3 1 6 0 0 0 3 5 0 0 5 100
1 2 0 0 0 0 0 0 3
0 0 0 0 0 0 0 0 9
5 5 4 3 5 5 4 4
0 0 0 0 0 0 0 0 0 3
```

```
0 2 2 2 2 2 2 1 1 0 3
0 0 0 0 0 0 0 0 0 0 0 9
1 1 1 3 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 5 5 5 1 1
1 1 2 1 1 0 0 0 0 0
6 6 7 4 6 7
1 2 2 7 7 4 2 2 1 1
3 3 1 1 3000 300 90 95
1 2 0 0 0 0 0 0 3
6 5 2 1 3 3 2 1
6 5 2 1 3 3 2 1 1 2 2 1 1 1
2 1 2 0 1 2 2 1 1 1 2 1 2 6 6
0 0 0 0 0 7 0 0 0 0 0 9 1 1
0 0 0 0 0 0 0 7 7 7 1 0
0 0 0 0 0 0 0 0 0 0 0 0
5 0 5 0 0 2 0 0
0 0 0 0 0 0 0 0 0 0 0 0
6 2 3 3 3 4 4 2 1 1
3 3 1 1 5000 100 80 95
1 2 0 0 0 0 0 0 3
5 3 8 9 4 5 6 6 0
5 3 8 8 4 5 0 8
1 2 2 1 2 1 1 0 1 0
1 2 2 1 2 1 1 0 1
1 1 4 4 6 2 5 0
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1
1 1 1 1 0 1 1 1 1 0 1 1 1 1 0
5 5 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
5 2 2 5 0 4 0 2 3 3
3 3 3 3 2600 200 0 0
1 1 2 0 0 0 5 1 1
7 6 3 6 5 5 5 6 0
7 6 3 6 5 5 5 6
2 2 2 2 2 2 2 2 2 0
2 2 2 2 2 2 2 2 2 7 7
0 0 0 0 0 0 0 0 0 0 0 0
5 6 5 6 6 4 6 5 0
6 5 6 4 0 6 4 5 6 0
6 5 4 6 0 1 1 3 5 4
4 5 3 5 5 4 3 6 6 5 6
4 4 6 5 5 6
1 2 5 8 6 4 4 2 1 1
4 3 0 1 25000 118 98 100
1 2 0 0 0 0 0 0 2
0 0 0 0 0 0 0 0 9
7 7 0 6 4 4 0 4
0 0 0 0 0 0 0 0 0 3
2 2 2 2 2 2 2 2 2
```

```
0 7 0 0 6 0 0 0
0 0 0 0 0 0 1 2 0 0
5 5 7 5 0 0 7 0 0 7
0 0 0 0 0 0 0 0 0 0 0 0
3 0 2 2 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0
7 2 1 2 5 4 4 2 3 1
3 3 3 3 12000 500 0 25
1 1 1 2 0 0 5 3 2
6 5 4 5 6 5 6 6 0
6 7 6 7 6 5 8 8
1 2 2 2 2 2 2 0 1 0
1 2 2 2 2 2 2 0 1
6 6 1 1 4 6 1 0
0 0 0 0 0 0 1 1 5 0
5 7 7 1 0 0 0 0 0 0
5 7 7 1 0 0 0 0 0 0 0 2
6 4 6 4 0 0 2 2
5 7 7 8 8 6 5 7 7 8 8 6
6 2 2 7 7 4 4 2 1 1
3 3 1 3 70000 0 50 50
1 1 1 2 0 0 1 2 1
8 8 8 8 8 8 8 8 0
7 6 5 5 6 7 5 5
0 0 0 0 0 0 0 0 0 0
2 2 2 2 0 2 1 2 2
0 4 0 0 0 0 0 0 0 0 0 0 0 0
1 1 4 4 8 8 8 8 8
7 7 7 6 0 6 6 6 6 0
7 7 7 6 0 0 2 2 0
2 0 0 0 0 0
3 3 6 5 6 6 5 5 6 5 6 6
6 1 1 7 7 4 4 3 1 1
3 3 1 1 3000 100 50 90 1
1 2 0 0 0 3 4 2 0 0 0 0 0 0 0 0 0
5 3 1 1 2 2 2 1 0 0 0 0 0 0 0 0 0 3
1 1 1 1 1 1 2 1 1 0 1
0 0 0 0 0 0 0 0 0 0 0 0 9
1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1
0 0 1 1 1 1 1 2 1 2 1 1 1 1 1 1
3 6 6 4 5 5
7 2 2 7 7 4 4 2 3 3 3 3
2 2 3100 160 15 97 1
1 3 2 0 0 5 3 1
6 6 5 5 6 6 6 6 0 5 6 5 5 6 6 5 5
2 2 2 1 1 1 2 2 1 0 1 2 2 2 1 2 2 2 0
2 2 0 0 0 0 0 0 0 0 0 0 0 0
2 0 2 0 5 5 3 4 0 0 0 0 0 0
5 5 3 4 0 0 0 0 0 0
1 1 1 3 1 3 1 3 1 2
```

```
5 5 6 6 5 6 6 6 6 6 6 6
6 2 7 7 3 4 4 2 0 1
4 3 0 1 3000 78 15 100 1
1 1 2 0 0 1 1 1 0 0 0 0 0 0 0 0 9
7 7 0 7 7 7 5 5 0 0 0 0 0 0 0 0 5
2 2 2 2 2 2 2 2 2 0 7 0 0 0 0 0 0
0 0 0 0 0 0 1 1 1 1 0 0 0 0 0
0 0 0 0 0 7 7 7 1 1 7 7 7 0 0 5 5
0 0 1 1 1 1 1 1 1 5 7 4 1 7
0 0 0 0 0 0
0 0 0 4 0 0 0 2 0 0 0 0 0 0
7000 2700 0 0 1 1 3 0 0 0 5
1 2 5 5 0 6 6 5 5 5 0 6 6 0 6 5 6 5 6
1 2 2 2 2 2 2 1 2 0 1 2 2 2 2 2 2 0 2
6 6 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 1 1 1 1 1 0 1 1 1 1 0
1 1 1 1 0 1 1 3 1 0 2 2
0 0 0 0 0 0 0 0 1 1 3 3 3 4
8 8 8 8 8 8
1 1 2 7 7 3 3 1 4 1
4 2 0 2 600 275 100 100
1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5
7 6 4 7 6 5 4 6 0 0 0 0 0 0 0 0 0 3
1 1 1 1 1 1 1 1 1 0 3 5 6 4 4 2 0
0 0 0 0 0 9 1 1 6 6 6 8 8 8 8
0 0 0 0 0 6 6 5 6 0 0 0 0 0 0
0 0 3 0 3 0 0 0 0 0 5 0 6 6 6 6
0 0 0 0 0 0
2 1 2 7 7 4 4 2 3 3 3 3
3 3 15000 4000 55 27 1
2 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1 2 2 0 2 2 2 0 1 0
1 2 2 0 2 2 2 0 1 6 0
0 0 0 0 0 0 0 0 0 0 0 0 1 1
1 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 0 5 5 6 5 6 5
```

APPENDIX G

EDGAR TO ANDERSON & SCHROEDER COMPARISON

This appendix contains a tabular comparison of responses to the same or similar questions asked by both the author's research project and Anderson and Schroeder's study (4). While both projects were similar in nature, the author's research project was more specifically oriented towards the defense industry. Therefore, only the questions that were common to both the author's research project and Anderson and Schroeder's study (4) are provided below.

Edgar's Question/Subject	Edgar's Response	Anderson and Schroeder's Response
8. Annual sales:		
Total Company:		
Under $10M:	0.0%	16.8%
$11 - $50M:	0.0%	29.9%
$51 -$100M:	12.5%	14.2%
Over $100M:	87.5%	39.1%
Responding Facility:		
Under $10M:	4.3%	23.4%
$11 - $50M:	8.7%	43.7%
$51 -$100M:	4.3%	17.2%
Over $100M:	82.6%	15.7%
9. Plant characteristics:		
Single plant:	4.0%	62.9%
Multiple plants:	84.0%	35.7%
Other:	12.0%	1.4%

Edgar's Question/Subject	Edgar's Response	Anderson and Schroeder's Response
10. Type of products:		
Commercial perspective:		
Make-to-order:	45.5%	16.3%
Make-to-stock:	0.0%	13.3%
Both:	36.4%	70.4%
No commercial business:	18.2%	N/A
Government perspective:		
Make-to-order:	79.2%	N/A
Make-to-stock:	0.0%	N/A
Both:	20.8%	N/A
11. Type of manufacturing:		
Commercial perspective:		
Assembly-line:	0.0%	7.1%
Fabrication:	0.0%	9.7%
Both:	72.7%	83.2%
No commercial business:	27.3%	N/A
Government perspective:		
Assembly-line:	4.2%	N/A
Fabrication:	4.2%	N/A
Both:	91.7%	N/A

Edgar's Question/Subject	Edgar's Response	Anderson and Schroeder's Response
12. Type of process:		
Commercial perspective:		
Job-shop:	31.3%	41.3%
Continuous-process:	6.3%	11.5%
Assembly-line:	62.5%	22.8%
Combination:	N/A	24.4%
Government perspective:		
Job-shop:	33.3%	N/A
Continuous-process:	12.5%	N/A
Assembly-line:	54.2%	N/A
13. Average number of employees at the responding facility:	10,684	957
14. Average number of employees in Production and Inventory Control at the responding facility:	786	17
18. The MRP system was:		
Developed in-house:	70.6%	42.0%
Acquired commercially, not modified:	17.6%	10.0%
Acquired commercially, but modified:	11.8%	48.0%

Edgar's Question/Subject	Edgar's Response	Anderson and Schroeder's Response
22. The class of MRP systems being utilized:		
Class A:	35.3%	9.5%
Class B:	23.5%	29.2%
Class C:	23.5%	48.6%
Class D:	17.6%	12.7%
23. MRP defined in the:		
Broad sense:	50.0%	27.4%
Narrow sense:	33.3%	48.2%
Other:	16.7%	24.4%
24./25. Accuracy of MRP type information:		
MRP Companies:		
Commercial perspective:		
Inventory records:	3.7	2.7
Bill of materials:	3.7	3.2
Market forecasts:	2.6	2.0
Production schedule:	3.7	2.7
Production lead times:	3.9	2.6
Vendor lead times:	3.5	2.5
Floor control:	3.5	2.0
Capacity planning:	3.5	2.0
Composite (32 possible)	28.1	19.7

Edgar's Question/Subject	Edgar's Response	Anderson and Schroeder's Response
Government perspective:		
Inventory records:	3.7	N/A
Bill of materials:	3.7	N/A
Market forecasts:	2.6	N/A
Production schedule:	3.5	N/A
Production lead times:	3.5	N/A
Vendor lead times:	3.2	N/A
Floor control:	3.1	N/A
Capacity planning:	3.1	N/A
Composite (32 possible)	26.4	N/A
Non-MRP Companies:		
Commercial perspective:		
Inventory records:	3.5	2.1
Bill of materials:	3.0	2.4
Market forecasts:	3.0	2.3
Production schedule:	3.0	2.0
Production lead times:	3.3	2.2
Vendor lead times:	3.3	2.3
Floor control:	3.0	1.9
Capacity planning:	2.7	1.9
Composite (32 possible)	24.8	17.1
Government perspective:		
Inventory records:	3.6	N/A

Edgar's Question/Subject	Edgar's Response	Anderson and Schroeder's Response
Bill of materials:	3.3	N/A
Market forecasts:	3.0	N/A
Production schedule:	3.2	N/A
Production lead times:	3.3	N/A
Vendor lead times:	3.1	N/A
Floor control:	3.0	N/A
Capacity planning:	3.0	N/A
Composite (32 possible)	25.5	N/A

26./27. The percentage of computerization of MRP type information:

	Edgar's Response		Anderson and Schroeder's Response	
	MRP Firms	Non-MRP Firms	MRP Firms	Non-MRP Firms
Commercial perspective:				
Forecasting end-items:	71.4	20.0	42.5	15.7
Bill of materials:	100.0	100.0	86.7	38.5
Inventory records:	88.9	80.0	84.4	54.4
Production schedule:	88.9	50.0	52.2	15.9
Parts explosion:	77.8	60.0	86.9	40.9
Order release:	88.9	60.0	49.6	17.6
Purchasing:	100.0	60.0	43.1	8.9
Capacity planning:	75.0	33.3	37.7	6.1
Scheduling:	66.7	60.0	35.0	8.5

Edgar's Question/Subject	Edgar's Response		Anderson and Schroeder's Response	
	MRP Firms	Non-MRP Firms	MRP Firms	Non-MRP Firms
Government perspective:				
Forecasting end-items:	50.0	28.6	N/A	N/A
Bill of materials:	94.1	87.5	N/A	N/A
Inventory records:	76.5	75.0	N/A	N/A
Production schedule:	82.4	57.1	N/A	N/A
Parts explosion:	81.3	62.5	N/A	N/A
Order release:	82.4	6_.5	N/A	N/A
Purchasing:	82.4	62.5	N/A	N/A
Capacity planning:	57.1	33.3	N/A	N/A
Scheduling:	62.5	50.0	N/A	N/A

Edgar's Question/Subject	Edgar's Response	Anderson and Schroeder's Response
49. Degree of MRP benefits achievement:		
Improved competitive position:	2.2	2.1
Improved customer satisfaction:	2.7	2.5
Better production scheduling:	3.4	2.7
Improved plant efficiency:	2.8	2.4
Better cost estimating:	2.8	2.2
Better control of inventory:	3.5	3.0

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