IDENTIFICATION OF BEST PRACTICES IN SUPPLIER SELECTION AND SUPPLIER QUALITY MANAGEMENT

by

KRISTIN L. P. H. FLETCHER

Submitted to the Alfred P. Sloan School of Management and the School of Engineering in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN THE MANAGEMENT OF TECHNOLOGY

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 1992

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May 8, 1992

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ABSTRACT

The competitive global economy of the 1990's requires that organizations integrate Total Quality Management into every aspect of their operations in order to compete. Strategic supplier quality management is an important aspect of any comprehensive quality program.

This study seeks to identify a range of reportedly successful supplier management practices in use in organizations in the United States, and to identify the conditions and constraints under which such practices are most successful and most appropriate. A chapter is devoted to supplier quality management in the United States Navy.

The path of industry toward a global standard for supplier quality management is also discussed.

Thesis Supervisor: Henry S. Marcus
Title: NAVSEA Professor of Ship Acquisition
ACKNOWLEDGEMENT

The author gratefully acknowledges the support and resources made available to her by Hank Marcus, the NAVSEA Professor of Ship Acquisition.

I would also like to thank all the managers from the companies studied in this paper who so generously provided data and taught me about Supplier Quality Management. I am inspired by all your good efforts.
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CHAPTER 1
INTRODUCTION

What are the best methods for selecting high quality, high value suppliers? What are the most important criteria for supplier selection? How can suppliers be motivated to improve the quality of their products and services? How can ongoing relationships of trust and integrity be built with suppliers? These questions are being asked throughout the United States by organizations attempting to improve the value of their products and services by increasing the quality of raw materials and interim products and services which they procure and utilize in their operations. Organizations are working to reduce unwieldy bases of thousands of suppliers to a manageable few high quality suppliers.

1.1 Why is Supplier Quality Management Important?

With the advent of Total Quality Management in the United States, Supplier Quality Management has become a significant issue for many U.S. organizations. Juran's Quality Control Handbook offers the following enumeration of reasons supplier quality management is important:

1. "Amount of purchased product" embodied in the parent company's product.

2. "High costs associated with poor quality supplier items."
3. "Interdependence of buyers and suppliers" with respect to facilities, technology, business, etc.

4. "Other internal factors at the buyer's organization" such as "just-in-time" inventory, incoming inspection costs, etc. ¹

While this list is rather brief, it nonetheless provides an overview of the rationale for giving significant attention to supplier management. The overall objective of supplier management should be "to create a relationship with a supplier that assures that the product will meet fitness-for-use needs with a minimum of incoming inspection or corrective action." ²

1.2 Baldrige Award Criteria for Supplier Quality

Much of the quality movement in the United States today is being driven by activities revolving around the Malcolm Baldrige National Quality Award. In its administration of this award the Department of Commerce stresses the importance of partnerships and information sharing among organizations seeking to improve the quality of their products and services. With regard to customer-supplier relationships, one of the key award concepts specifically addresses supplier management: "Companies need to communicate quality requirements to suppliers and work to elevate supplier quality performance." ³

The award examination criteria explicitly outline requirements for Supplier Quality:

² Ibid., 15.3.
a. approaches used to define and communicate the company's specific quality requirements to suppliers. Include: (1) the principal quality requirements for the company's most important suppliers; and (2) the principal quality indicators the company uses to communicate and monitor supplier quality.

b. methods used to assure that the company's quality requirements are met by suppliers. Methods may include audits, process reviews, receiving inspection, certification, and testing.

c. strategy and current actions to improve the quality and responsiveness of suppliers. These may include partnerships, training, incentives and recognition, and supplier selection.  

and for Supplier Quality Results:

a. trends and current levels for the most important indicators of supplier quality

b. comparison of the company's supplier quality with that of competitors and/or with benchmarks. Such comparisons could include industry averages, industry leaders, world leaders, principal competitors in the company's key markets, and appropriate benchmarks. Describe the basis for comparisons.  

The issues raised in these criteria extend far beyond the traditional singular concern with cost of materials and services as the factor used to distinguish between suppliers of similar commodities. These criteria have opened a new venue of quality management with great potential for improvement for any customer willing to make efforts in supplier quality management.

All of the general methods cited in these Baldrige Award criteria are used by organizations in the United States. But specific criteria and procedures to support these methods vary. This thesis describes a number of supplier management systems in place at a variety of organizations. With one exception which will be duly noted, all of the systems described are successful as

4 Ibid., 14.
5 Ibid., 15.
reported by the organizations which use them. Components which are common
to many or all of the systems are identified. An evaluation of the reasons for
differences among systems is made, as well as an evaluation of the conditions
and constraints within which each of these organizations operates which may
affect the quality systems they develop.

1.3 A Walk Through the Chapters

Chapter 2 describes the methodology used for this research, and
presents general results. Chapter 3 analyzes generally the variety of
components of supplier management programs studied in this paper. The
major differences between components of supplier quality management
programs are identified. Chapters 4 through 7 describe in detail each of four
groupings of supplier quality management components, ranging from product-
oriented components to process-oriented components. The types of
components in each of these groupings are described, and examples are
provided.

Chapter 8 analyzes a test program of supplier quality management being
implemented in the Navy. Its advantages and disadvantages, in light of the
information provided in previous chapters, are identified and described.

Chapter 9 describes the importance of the development of standards for
supplier quality management, and the evolution of industry toward a universal
international standard, namely ISO 9000.
Chapter 10 presents conclusions of the study.
CHAPTER 2
GENERAL RESULTS

This chapter describes the methodology used for data collection and presents the general data which form the basis of this study. Once these data are presented, more detailed analyses will follow in Chapters 3 through 8.

2.1 Methodology

Seventeen organizations were identified either as organizations with progressive supplier quality management programs, or as organizations attempting to make inroads in supplier management in previously untouched industries. These organizations were identified through literature searches, as well as by Massachusetts Institute of Technology faculty and students with familiarity with the subject organizations. Information on supplier quality management was obtained from each organization through several mediums including personal interviews, phone interviews, published articles, and corporate manuals or brochures. Three of the organizations identified were either non-responsive, or did not provide meaningful or complete information. The minimal information obtained regarding these three organizations is not reported in this study.

In acquiring information from organizations, requests were purposefully open-ended. Respondents were asked to describe their organization's supplier
management programs and/or to provide information describing the programs. It was assumed that any respondent who felt that his organization had a strong supplier quality management program would also state that the program included, for example, ‘Strong Lines of Communication’. Rather than asking explicitly whether or not the program included ‘Strong Lines of Communication’, then, open-ended questions were asked that would lead a respondent to describe or supply information regarding the major components of the organization’s program. It was felt that if ‘Strong Lines of Communication’ or any other component was a significant feature of any program, it would be evident in the response, assuming that meaningful and reasonably complete information was obtained from the respondent. For all but one of the organizations, supporting organizational documents were obtained, allowing confirmation of the programs and issues stressed at these organizations.

The focus of this study is external suppliers, suppliers to an organization’s manufacturing process which are physically and legally separate from the organization. While some of the systems described herein may be applicable to internal as well as external suppliers, this study does not explicitly address internal suppliers.

2.2 Organizations Surveyed

The organizations from which meaningful data was obtained include the following:

- Aluminum Company of America
  Pittsburgh, Pennsylvania
- Bose Corporation  
  Framingham, Massachusetts
- Campbell Soup Company  
  Camden, New Jersey
- Digital Equipment Corporation  
  Northborough, Massachusetts
- General Motors Purchasing Activities  
  Detroit, Michigan
- Hewlett-Packard Company  
  Medical Products Group  
  Waltham, Massachusetts
- International Business Machines Corporation  
  Corporate Purchasing Staff  
  Purchase, New York
- L.L. Bean Apparel and Footwear  
  Freeport, Maine
- Motorola, Inc.  
  Schaumburg, Illinois
- Naval Material Quality Assessment Office  
  Portsmouth, New Hampshire
- Raytheon Company  
  Lexington and Bedford, Massachusetts
- Rockwell International Corporation  
  Defense Electronics Headquarters  
  Anaheim, California
- Tennant Company  
  Minneapolis, Minnesota
- Varian Associates, Inc.  
  Medical Equipment  
  Palo Alto, California

Where a specific corporate division is not indicated on the above list, systems applicable to the entire corporation or organization were surveyed. It is
possible in these cases that individual divisions of the corporations have different or more extensive systems of supplier quality management.

The organizations surveyed produce a wide variety of products in a wide variety of markets. Purchased product costs constitute a significant portion of total costs for all of the surveyed organizations. All are generally considered successful, and all promote their supplier quality management programs as successful.

2.3 Major Components of Supplier Management Programs

Figure 2.1 lists each of the organizations surveyed and major components of each organization’s supplier quality management program. General descriptions of each class of components are provided in Table 2.2. It is important to note that only major components of each organization’s program are identified. It is possible that the organizations surveyed have some minor aspects of other components in their supplier management programs. The intention of Figure 2.1 is to identify the significant thrusts of each program, and the major drivers behind the implementation of each program. No attempt has been made to identify every aspect of every organization’s program.

The components which are analyzed in Figure 2.1 are generally components that are common to a significant number of the organizations analyzed and which are considered critical components of these programs. It is a list of commonly recurring components used by these organizations to
### Figure 2.1

**Matrix of Major Components of Supplier Quality Management Programs**

<table>
<thead>
<tr>
<th></th>
<th>ALCOA (a)</th>
<th>BOSE (b)</th>
<th>CAMPBELL-SOUP (c)</th>
<th>DIGITAL (d)</th>
<th>GM (e)</th>
<th>HEWLETT-PACKARD (f)</th>
<th>IBM (g)</th>
<th>LL. BEAN (h)</th>
<th>MOTOROLA (i)</th>
<th>NIXON (j)</th>
<th>RAYTHEON (k)</th>
<th>ROCKWELL (l)</th>
<th>TENNANT (m)</th>
<th>VARLAN (n)</th>
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<td><strong>RESPONSIVENESS TO INQUIRIES</strong></td>
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<td><strong>ROCKWELL INDEX (OR SIMILAR ESTIMATE OF TOTAL COST)</strong></td>
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<td><strong>MINIMUM QUALITY REQUIREMENT</strong></td>
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<td><strong>OUTSTANDING SUPPLIER RECOGNITION</strong></td>
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<td><strong>SUPPLIER CERTIFICATION</strong></td>
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<td><strong>STRONG LINES OF COMMUNICATION</strong></td>
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<td><strong>SUPPLIER INVOLVEMENT IN PRODUCT DEVELOPMENT</strong></td>
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<td><strong>GOOD CUSTOMER PROGRAM</strong></td>
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<td><strong>BROAD RESPONSIBILITY FOR PROGRAM IMPLEMENTATION</strong></td>
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Footnotes for Figure 2.1:


e General Motors Corporation, GM Purchasing Activities, Supplier Development Administration, Part Certification Procedure GP-8 (Detroit: General Motors Corporation, 1991), 1-2; General Motors Corporation, Targets for Excellence, General Motors Corporation Standard for Supplier Performance Evaluation and Reporting (Detroit: General Motors Corporation, 1990), 1, 2-11, 3-20, 3-28, 3-30, 3-31, 4-11, and 5-3.


g IBM News, "IBM and Solectron Corporation Announce Study to Form Manufacturing Relationship" (IBM News), 6 February 1992; Richard Moore, International Business Machines Program Manager on Procurement Staff, phone interview by author, 5 March 1992, Purchase, New York.


Louis P. Geoffrion, Raytheon Manager of Corporate Quality Assurance, interview by author, 3 January 1992, Lexington, Massachusetts; Klaus Lasch, Raytheon Missile Systems Division Deputy Director of Quality, phone interview by author, 7 January 1992, Bedford, Massachusetts; Raytheon Corporation, Total Quality Management Through Transition From Development to Production (Raytheon Corporation, 1991), 5-5-5-7.


<table>
<thead>
<tr>
<th><strong>Historical Data:</strong></th>
<th>Compiled from historical records of customer-supplier relationship. Such data is usually maintained on a commodity basis.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Yield at Incoming Inspection</td>
<td>Percentage of lots of acceptable quality as a fraction of lots inspected.</td>
</tr>
<tr>
<td>• Delivery Performance</td>
<td>Percentage of lots received on time as a fraction of lots ordered. [Penalties may be applied for late or early delivery.]</td>
</tr>
<tr>
<td>• Post-Acceptance Reliability</td>
<td>Reliability of product through the manufacturing process and the life of the customer's product.</td>
</tr>
<tr>
<td>• Responsiveness to Inquiries</td>
<td>Supplier's responsiveness to requests for information and to changes in customer requirements.</td>
</tr>
<tr>
<td><strong>Rockwell Index</strong></td>
<td>Index developed and publicized by Rockwell International Corporation which considers historical non-productive costs of doing business with a supplier, providing an estimate of the total cost of doing business with the supplier. Index is usually maintained on a commodity basis.</td>
</tr>
<tr>
<td><strong>Minimum Quality Requirement</strong></td>
<td>Specification of a minimum requirement for product quality which suppliers must meet in order to be eligible to supply product to the customer. [Note: Many organizations that have supplier certification programs set a minimum requirement for certification; this metric suggests a minimum quality requirement used as a prerequisite to business.]</td>
</tr>
<tr>
<td><strong>Outstanding Supplier Recognition</strong></td>
<td>Systematic public recognition of high performing suppliers on a regular basis.</td>
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<td><strong>TABLE 2.2 (Continued)</strong></td>
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<tr>
<td><strong>Supplier Certification</strong></td>
<td>Systematic certification of suppliers with a proven, long-standing history of high quality, on-time, high integrity performance. Certified suppliers are generally preferred for subsequent contract awards for the subject commodity and often ship product directly to the customer without any requirement for inspection. Just-in-time delivery programs may be incorporated into such agreements.</td>
</tr>
<tr>
<td><strong>Quality and/or Process Audits</strong></td>
<td>Audits performed by the customer of the supplier's process compliance with quality management principles. Appropriate use of Statistical Process Control is often a subject of such audits.</td>
</tr>
<tr>
<td><strong>Supplier Training</strong></td>
<td>Customer provides training for suppliers in process improvement. [Not just training in the customer's supplier management program.] Training may be formal or informal, generic in nature, or tailored to the supplier.</td>
</tr>
<tr>
<td><strong>Strong Lines of Communication</strong></td>
<td>Customer systematically communicates expectations and feedback with respect to each supplier's standing, progress, and possibly strengths and weaknesses. Strong lines of communication between customer and supplier are established and maintained. Communication is often performed in person.</td>
</tr>
<tr>
<td><strong>Supplier Involvement in Product Development</strong></td>
<td>Customer solicits input and participation from suppliers during product design. This type of partnership requires a high level of trust and respect in the full scope of the customer-supplier relationship.</td>
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<td><strong>TABLE 2.2 (Continued)</strong></td>
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<td><strong>Good Customer Program</strong></td>
<td>Systematic self-assessment by the customer of the customer's role as a &quot;good customer&quot;. Such a program includes efforts to survey suppliers as to their perceptions of the customer. Assessment generally includes evaluation of the level of communication with suppliers, and of the constructive quality of this communication.</td>
</tr>
<tr>
<td><strong>Broad Responsibility for Program Implementation</strong></td>
<td>Responsibility for implementation of supplier quality management program is shared among divisions of the company or organization. Program is not purely a &quot;Quality&quot; Program.</td>
</tr>
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</table>
distinguish between suppliers of various levels of quality, to monitor the quality of products and services purchased, and to motivate suppliers to improve the quality of their products and services. Two exceptions (‘Minimum Quality Requirement’ and ‘Good Customer Program’) are included because the author feels that the presence or absence of these components in any program is significant. (This point will be elaborated later in this study.)

The components included in this list do not include issues which are used to establish the basic acceptability of suppliers. For example, most suppliers look at the compliance of a supplier’s product with technical specifications or at least the potential of the supplier to meet technical specifications as a prerequisite to establishing a relationship with a supplier. Existing or planned plant capacity is also generally considered a prerequisite to business. Further, customers usually consider the ‘financial stability’ or ‘good business practices’ of a supplier (e.g., the metric used may be the supplier’s Dun and Bradstreet rating) prior to considering doing business with the supplier. For the purposes of this study, such prerequisites, or minimum requirements will not be discussed. This study focuses instead on issues considered and systems used as means to compare the quality of nominally qualified suppliers’ products, to stimulate suppliers to improve the quality of their products and services, and to establish ongoing relationships with high quality suppliers.

Finally, “Price” is not included as a component to be studied in this thesis except as it is incorporated into several of the quality rating systems discussed. Most customers use price as a means of selecting suppliers, but its relationship to the quality of supplied products is neither consistent nor clear.
CHAPTER 3
A CONTINUUM OF COMPONENTS

This chapter analyzes generally the variety of components of supplier management programs studied in this paper. The major differences between programs are identified. Once these differences are described, specific types of programs will be analyzed more fully in subsequent chapters.

3.1 Beyond Price

All of the supplier quality management programs investigated in this paper establish criteria by which to select and motivate suppliers other than the traditional criterion of purchase price. A universal judgement has been made by the participants in this study that purchase price alone does not provide a suitable judgement gage for selection of suppliers. It is further recognized that purchase price may have little relationship to the quality of the purchased service or part. The fourth of Dr. Deming’s “14 Points for Management” elaborates on this point: “End the practice of awarding business on the basis of price tag alone. ... The purchasing department must change its focus from lowest initial cost of material purchased to lowest total cost.”

In concert with this recommendation, several of the programs that were analyzed attempt to assess the total cost to the customer of purchasing a particular part from a particular supplier. The scope of these programs extends well beyond simply collecting the prices of items. Further, through the process of analyzing and collecting data on suppliers, a great deal is learned about each supplier which would not be obtained through price quotes alone. Such systems will be discussed further in Chapter 4.

3.2 The Scope of Supplier Quality Management Programs

Nearly all of the supplier management programs studied here were first applied either to large, high volume purchases, or to purchases of components considered “key” or critical to the customer’s business. While several of the programs have explicit goals that eventually all purchases will fall under the purview of the program, most establish criteria for purchases which must be made within the auspices of the program. Such criteria include:

- Hewlett-Packard first applies its program to parts which are common to many divisions of the company. The selection of suppliers for such parts is usually done by a central corporate procurement group. Divisional procurement groups then select and motivate suppliers of divisional “key commodities” according to the corporate supplier quality management program. 2

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• IBM applies its supplier quality management program to suppliers from which it purchases parts more than once per year.  

• Varian applies its supplier quality management program to vendors that supply parts worth more than 250 thousand dollars per year.  

• Motorola identifies "critical purchased commodities, ...where purchasing dollars are concentrated," and focuses its supplier selection and quality improvement efforts on purchases of these commodities.  

Since the administrative cost of many supplier quality management programs is significant, it is usually necessary to make some type of cost-benefit analysis, even if the analysis is relatively qualitative. The cost of many of these programs is dependent on the program's degree of involvement with the supplier. This cost may be quantifiable in terms of cost per supplier or commodity analyzed in the program.

Whether or not a particular company's supplier management program relies on historical data, such data should be kept for as many purchases as possible in a systematic, easily accessible system. The cost of collection and compilation of historical data is relatively low. Such data is critical for identification of weaknesses and problems in the system, as well as for supplier evaluation. This point will be discussed further in Chapter 4.

Another factor which must be considered in the determination of the scope of a supplier management program is the ability of the customer to

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5 Ken Stork, "Survival of the Fittest" (Ken Stork, n.d.).
influence and affect the quality of the suppliers' products and processes. Some of the criteria for supplier management program scope described above are actually qualitative attempts to identify the suppliers from which it is most advantageous to seek improvement, as well as the suppliers which are most likely to respond and be receptive to the concerns of the customer because the supplier’s volume of business from the customer is relatively large. The issue here is one with a high level of uncertainty.

Some companies include receptivity and responsiveness of suppliers as a component of their selection criteria. The most general comment on this receptivity issue came from Ken Stork, Motorola’s Corporate Director of Materials & Purchasing, who said that a supplier will respond to customer efforts to improve quality if the supplier-customer relationship is such that “the supplier feels economic benefit from it.” Mr. Stork went on to explain that the supplier may see such potential benefit if the volume of business from the customer is high, or if the supplier sees that the customer is able to help the supplier improve its processes through training or other incentives. 6 The second of these possibilities leaves the relative sizes of the corporations involved as well as the volume of business as secondary determinants of the receptivity of suppliers to supplier quality management programs.

Motorola has established Motorola University which offers mandatory and optional courses for Motorola suppliers at a nominal fee. 7 Such an opportunity may provide incentive for suppliers to become involved in business

relationships with Motorola. The Tennant Company, a small Minneapolis-based floor-cleaning equipment producer, has been surprised at how receptive large companies have been to working with Tennant at improving quality. Tennant was able to establish a strong relationship with the Ford Motor Company starting in the early 1980's by meeting with company executives in person and explaining Tennant's commitment to quality, its intention to reduce its supplier base, and the problems Tennant was having with Ford engines. Ford was impressed with Tennant's commitment to quality, and, according to a Ford power products manager, Tennant played a key role in getting Ford involved in quality. Ford and Tennant have an ongoing commitment to one another. 8

Finally, in determining the scope of supplier management programs, some companies may consider the trade-off between reduction of the supplier base and encouraging competition between suppliers. Some organizations focus on the importance of establishing long-term relationships with a few suppliers. Others feel that it is important to allow competitive market pressures to motivate suppliers to improve. Even among those who express the importance of supplier competition, reduction of the supplier base to a manageable number is generally a stated objective of supplier quality management programs.

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8 Roger L. Hale, Ronald E. Kowal, Donald D. Carlton, and Tim K. Sehnert, Made in the USA: How one American company helps satisfy customer needs through Strategic Supplier Quality Management (Minneapolis: Tennant Company, 1991), 31-35.
3.3 Implementation of Supplier Management Programs

Several factors are common to the implementation of most successful supplier quality management programs. Perhaps the most important of these is that responsibility for program implementation is shared broadly in the organization. It is important that the program is not perceived purely as a quality program that is the "Quality", or "Quality Assurance" Department's responsibility. Figure 2.1 shows that eleven of the fourteen organizations studied have delegated broad responsibility for their supplier quality management programs.

Rockwell's purchasing and quality assurance departments have equal control of Rockwell's Supplier Rating and Incentive Program. This sharing is cited as "the real key to SRIP's success. ... This isn't a quality program, it's a business program with direct daily involvement by purchasing and quality assurance." 9 This idea is in agreement with Total Quality Management literature abundant today which stresses the importance of total company involvement in quality activities and of cross-functional teams in the implementation of quality activities. 10

Most systems collect information and rate suppliers on a commodity basis - e.g., a supplier that supplies two commodities to a customer with a supplier quality management system may have a high quality rating on one

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9 Tom Stundza, “Can supplier ratings be standardized?” Purchasing, 8 November 1990, 60.
commodity but a low or unacceptable quality rating on the other. These results are not mixed, and there is no attempt to create an overall rating for the supplier's products in general. Supplier certification programs generally certify suppliers, but only after all of the suppliers' products meet the certification requirements. Supplier certification will be discussed further in Chapter 5.

Many of the organizations surveyed centralize supplier management for diverse divisions at a central corporate office. General Motors and Digital have both established corporate supplier databases which all divisions must use for supplier selection. ¹¹

3.4 Product-Oriented versus Process-Oriented

In Figure 3.1 common components of supplier quality management programs are arranged on a continuum with components that focus on products supplied at one end and components that focus on the suppliers' processes at the other end. This distinction is very important and very evident in the tone of the programs of which these components are a part.

Product-oriented components focus internally on the impact that suppliers' components have on the processes and products of the customer. Programs based on product-oriented components often rely on historical data

Continuum of Components of Supplier Quality Management Programs

Figure 3.1
on product quality based on incoming inspection and other product-related metrics. While the success of any supplier quality management program is dependent on the manner in which it is implemented, systems which rely on inspection and product-focus run the danger of acting as barriers to customer-supplier relationships if communication between the two parties is not well established and maintained.

Process-oriented components, by contrast, are based on the assumption that if suppliers' processes are well managed, balanced, and in control, high product quality will automatically follow. Programs which focus on process-oriented components often stress communication with suppliers, and supplier and customer involvement in one another's processes in lieu of inspection. Campbell Soup Company, which has a relatively process-based supplier quality management program, has moved personnel from positions in incoming inspection to positions visiting with suppliers to analyze their processes. 12 Motorola has also moved personnel from incoming inspection to positions working with suppliers. 13 Such transfers increase customer-supplier communication dramatically.

Programs which focus on process-oriented components seek to establish long-term trusting relationships with suppliers, in which employees from both supplier and customer are encouraged to be involved with one another across organizational boundaries.

CHAPTER 4
HISTORICAL DATA

This chapter presents two examples of supplier quality rating systems which primarily utilize historical data for supplier selection. The limitations of historical data are discussed, and the importance of historical data for identification of problem areas in supplier management is also discussed.

4.1 The Case of Raytheon

The Raytheon Corporation uses historical data from past purchases to select suppliers for future purchases. The metrics by which suppliers are judged include:

1. Yield at Incoming Inspection
   \[ \text{Yield} = \frac{\text{Lots Accepted}}{\text{Lots Inspected}} \]

2. Delivery Performance
   \[ \text{Delivery Performance} = \frac{\text{Number of Lots Received on Time}}{\text{Number of Lots on Order}} \]

Notes: There is no penalty for early shipment.
There is a small tolerance within which lots are considered "on time". This tolerance is not communicated to the suppliers.
3. Post-Acceptance Reliability:

This metric focuses on the performance of the product throughout the manufacturing process and the life of the product. This metric is assigned either '0' or '1' for each supplier depending on whether or not there is deemed to be a performance problem with the supplier's product.

4. Responsiveness to Inquiries:

This metric assesses the supplier's responsiveness to informational inquiries and to changes in Raytheon's requirements. This metric is assigned either '0' or '1' for each supplier depending on whether or not there is deemed to be a problem with the supplier's responsiveness.

- All data are collected for twelve months of performance prior to the time at which the rating is made. ¹
- Suppliers are also expected to demonstrate their quality effectiveness to Raytheon, including the use of Statistical Process Control (SPC) techniques. ²
- Supplier ratings on the above factors are considered confidential between Raytheon and the subject supplier. Ratings are shared among Raytheon Divisions. ³

Raytheon also has a supplier certification program based on these historical metrics:

¹ Klaus Lasch, Raytheon Missile Systems Division Deputy Director of Quality, phone interview by author, 7 January 1992, Bedford, Massachusetts.
² Louis P. Geoffrion, Raytheon Manager of Corporate Quality Assurance, interview by author, 3 January 1992, Lexington, Massachusetts.
³ Lasch, phone interview.
If during the previous twelve months a supplier has achieved a 100 percent product yield (metric 1), the supplier is certified. The remaining three metrics are only considered when the yield is less than 100 percent.

Once a supplier is certified, Raytheon and the supplier sign a “Memorandum of Agreement” (MOA). This MOA allows Raytheon to perform on-site, unannounced inspection of the supplier’s manufacturing facilities and requires that the supplier continue to employ SPC techniques.  

Products of certified suppliers are not subject to incoming inspection upon receipt at Raytheon. Further, the cost of receipt inspection for non-certified suppliers is factored into purchase decisions, providing a competitive advantage for certified suppliers.  

4.2 The Rockwell System

In the mid-1980's Rockwell International Corporation developed a supplier quality rating system based on a metric which estimates the total cost of doing business with each supplier. Rockwell has extensively publicized this system, so that many other companies use versions of "the Rockwell System". During recent years Rockwell has expanded its supplier quality management system to include other components focused on the importance of communication and partnership with suppliers.

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4 Ibid.
5 Geoffrion, phone interview.
Rockwell's supplier quality management program consists of four efforts:

1. Creation and maintenance of a supplier performance history.
2. Analysis and evaluation of the history.
3. Education and support of the suppliers.
4. Motivation through reward and recognition of the superior performers.  

The base of Rockwell's supplier quality management program is its Supplier Rating and Incentive Program. In this program, Rockwell uses a "Quality Cost Index" for each supplier to estimate the true total cost of doing business with a specific supplier. The quality cost index is calculated as follows:

\[
\text{Quality Cost Index} = \frac{\text{Purchased Cost} + \text{Non-Productive Costs}}{\text{Purchased Cost}} 
\]

Non-productive costs are those costs caused by resolution of unacceptable conditions caused by the supplier. Common causes of non-productive costs include:

- Rejection of material
- Inspection (If suppliers continuously ship acceptable product, inspection is not necessary.)
- Rework of defective material
- Acceptance of non-conforming material
- Late/Early delivery
- Discrepancies in order quantity

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By estimating the costs to each Rockwell activity associated with each of these discrepancies, an estimate of the non-productive cost per occurrence is developed for each of these and other common discrepancies.

At the end of each analysis period (e.g., 6 months), a summary is compiled of each supplier’s performance with respect to each commodity during the period, enumerating the number of times during the period that the supplier’s performance caused non-productive costs as a result of any of the common non-productive causes. The total cost of these incidents of non-compliance is calculated by multiplying the standard cost of each common cause of non-compliance by the number of times that cause occurred during the period. With this information and the total purchased cost of the commodity from the subject supplier during the period, the Quality Cost Index can be calculated. (It is important to note that a Quality Cost Index is calculated for each commodity of each supplier; a supplier may perform well with respect to one commodity, but poorly with respect to another commodity.) An illustration of a Quality Cost Index calculation is shown in Figure 4.1.

Occasionally, a supplier may perform in such a manner that is deemed exceptional and above and beyond any normal expectations (e.g. rapid turn-around of a critical order that was not forecasted by Rockwell). In such a case, ‘bonus points’ may be awarded to the supplier to offset some of the non-productive costs in the calculation of that supplier’s Quality Cost Index.

Once Quality Costs Indices have been calculated for each supplier of a commodity, these indices can be multiplied by the quoted prices on any common bid package to estimate the actual total cost of awarding the
### Figure 4.1

**Rockwell Quality Cost Index Calculation** *

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receipt or purchased cost</td>
<td></td>
<td>$150,690</td>
</tr>
<tr>
<td><strong>Non-productive costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return to supplier</td>
<td>2 @ 275</td>
<td>$550</td>
</tr>
<tr>
<td>Accept with repair</td>
<td>0 @ 260</td>
<td>$0</td>
</tr>
<tr>
<td>Accept non-conforming material</td>
<td>4 @ 140</td>
<td>$560</td>
</tr>
<tr>
<td>Material late</td>
<td>6 @ 120</td>
<td>$720</td>
</tr>
<tr>
<td>Material early</td>
<td>1 @ 75</td>
<td>$75</td>
</tr>
<tr>
<td>Excessive material</td>
<td>0 @ 70</td>
<td>$0</td>
</tr>
<tr>
<td>Short material</td>
<td>0 @ 155</td>
<td>$0</td>
</tr>
<tr>
<td>Bonus points</td>
<td>1 @ 275</td>
<td>$275</td>
</tr>
<tr>
<td><strong>Total non-productive costs</strong></td>
<td></td>
<td>$1,630</td>
</tr>
</tbody>
</table>

Purchased plus non-productive costs $152,320

Quality Cost Index 1.011

contract to that supplier. The result is that an estimate of the “best buy” to Rockwell can be made. 7

- New suppliers are assigned Quality Cost Indices equal to the average of all Quality Cost Indices for the commodity. Rockwell reports that this system for rating new suppliers has worked well in practice. Rockwell’s Project Manager for Procurement Quality Assurance further noted that within this system, “it would be more unfair to do anything else.” 8

- Rockwell maintains a maximum “red line” value for the Quality Cost Indices, above which suppliers are not eligible for receiving purchase orders or bid proposals. This “red line” value is periodically reduced as an incentive for continuous improvement. 9

- Rockwell states that it is vitally important that the use of Quality Cost Indices be well communicated to suppliers prior to awarding contracts as a result of their use. Suppliers should be periodically informed of their Quality Control Indices for each commodity, and of where they stand with respect to their competition in each commodity (without identifying the competition). 10

- As mentioned in Chapter 3, Rockwell insists that one of the most important aspects of the implementation of the Supplier Rating and Incentive Program is that it is administered jointly by the Material and Procurement Quality

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7 Ibid., 5-10.
9 Tom Stundza, “Can supplier ratings be standardized?” Purchasing, 8 November 1990, 60.
10 Rockwell International Corporation, Increasing Productivity Through Supplier Performance, 11.
Assurance divisions. Any changes in the system require joint approval. This program, then, is not a "Quality" program, but rather an operational, systems-oriented business function.  

- Rockwell recognizes the outstanding supplier in each commodity each period with appropriate awards and publicity.  

- Rockwell has established a supplier certification program. Suppliers with excellent quality histories and who pass a Supplier Product Integrity Audit are granted a Most Valued Performer Award, and Rockwell eliminates requirements for receiving inspection on the supplier's materials.  

- Rockwell also recognizes its responsibilities to be a good customer. It has instituted a Supplier Involvement Steering Council, consisting of four representative supplier executives, chartered to provide Defense Electronics with guidance in supplier communication.  

Rockwell has achieved the following results with its supplier quality management program:

- Receiving inspection rejections have been reduced from approximately fifteen percent to approximately five percent.

- Replacement material costs have been cut by more than half.  

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11 Stundza, 60.
12 Rockwell International Corporation, Increasing Productivity Through Supplier Performance, 11.
14 Ibid.
• Rockwell’s Defense Electronic Headquarters has reduced its supplier base from approximately 3500 to approximately 600 since the program was implemented in 1986. 16

4.3 Limitations of Historical Data

Both of the quantitative systems just described offer advantages. Both are simple. The criteria of each system may be easily described to and understood by existing and potential suppliers. The results are clear and verifiable. Nevertheless, both systems also offer disadvantages. Rockwell notably has supplemented it use of the “Quality Cost Index” with a number of other initiatives, including its supplier certification program and the Supplier Involvement Steering Council, which address many of the limitations of the quantitative system.

Several important limitations of historical data will be described in the following paragraphs.

4.3.1 What’s Behind the Numbers?

Motorola uses a modified version of the Rockwell System in its supplier quality management program. Ken Stork of Motorola cites the importance of letting “the winners win, and ... the losers lose” through such a system. 17

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16 Kirsanoff, phone interview.
17 Ken Stork, “Survival of the Fittest” (Ken Stork, n.d.).
While it is true that any such system must be implemented with commitment, and used as planned in order to achieve efficiency and functionality, it is also important that the customer have some understanding of the people and processes that exist behind the numbers assigned to a supplier. Juran’s Quality Control Handbook expands upon this theme: “Supplier ratings should be used as a servant, not as a master for decision making. The single index hides important details; the decision maker should understand what is hidden.” Juran goes on to describe the context within which quantitative ratings are appropriate: “Supplier rating is an important defect prevention device if it is used in an atmosphere of interdependence between supplier and customer.”

While it is evident that both Motorola and Rockwell make significant efforts to understand the details behind their suppliers’ numbers, it is not particularly evident that Raytheon makes such efforts. This may be a shortcoming of Raytheon’s program.

4.3.2 The Minimum Requirement

It is notable that only one of our sampled supplier quality management programs includes a “minimum requirement” rating below which suppliers may not bid on procurement orders. (See Figure 2.1.) Rockwell’s “red line” is the only such requirement in the programs surveyed. There is a danger in setting a minimum requirement that once a supplier meets the requirement, there will not

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be incentive for the supplier to improve further. 19 Rockwell’s system compensates for this potential problem in two ways:

- Rockwell’s “red line” value is periodically reduced as an incentive for continuous improvement by suppliers.

- Within the quality minimum, Rockwell’s application of its Quality Cost Indices provides incentive for suppliers to improve in attempts to reduce their own Quality Cost Indices so as to ultimately receive more business from Rockwell.

However, any supplier selection system that sets a minimum quality requirement that suppliers must meet in order to bid, but that simply uses price as the criterion for selection among the “qualified” suppliers, provides little motivation for suppliers to improve.

Supplier Certification Programs often set a minimum quality requirement suppliers must meet in order to become certified. The minimum requirements set for such certifications are normally extremely high, ensuring that only truly exceptional suppliers are certified. Nonetheless, it is important that within such programs, certification is reevaluated periodically (e.g., at least yearly) in order to ensure that suppliers are motivated to improve continuously, and to evaluate changes resultant of evolutionary changes in supplier processes. Supplier certification will be discussed further in Chapter 5.

19 Don P. Clausing, Bernard M. Gordon Adjunct Professor of Engineering Innovation and Practice, Massachusetts Institute of Technology, interview by author, 23 January 1992, Cambridge, Massachusetts.
4.3.3 The Difficulty of New Supplier Selection

Any supplier management system which relies on historical data on the customer-supplier relationship has a problem when faced with the issue of how to judge new suppliers relative to existing suppliers. As mentioned earlier, Rockwell assigns new suppliers a Quality Cost Index equal to the average of the Quality Cost Indices of all suppliers on record for the commodity being purchased. Within this system, indeed, "it would be ... unfair to do anything else." 20 This solution, however, essentially provides an arbitrary rating for new suppliers which is bound to both punish and discourage high quality new suppliers, and to reward low quality new suppliers. The result may ultimately be an inconsistent system for rewards.

The Naval Material Quality Assessment Office (NMQAO) has a Red/Yellow/Green Program by which it assesses the relative levels of risk to the Navy of receiving non-conforming products from suppliers based on historical data. 21 In this system new suppliers for whom there is not sufficient historical data are assumed to be low risk (equivalent to "Green") suppliers. 22 While as an "innocent until proven guilty" rule, this solution is perhaps fair to new suppliers, it nonetheless entails a level of risk, and by nature rewards low quality suppliers on occasion. The Red/Yellow/Green Program will be discussed in more detail in Chapter 9.

20 Kirsanoff, phone interview.
22 Ibid., 6.
The risk to the customer of adopting either of these methods for assessing new suppliers within a historical data supplier quality management system is clearly dependent on the size of the procurement at issue. While assignment of relatively arbitrary ratings may be appropriate for small purchases, for larger purchases it may very well behoove organizations to become involved with their potential suppliers and to make some evaluation of their quality potential based on their processes. Juran's Quality Control Handbook suggests the following criteria be used to evaluate new suppliers:

- "The reputation of the supplier."
- "Information derived from buyers who have had experience with this supplier on similar products."
- "Qualification tests of the supplier's design."
- "Survey of the supplier's manufacturing facility."
- "Information from data banks."  

Quality and process audits provide one means of collecting the type of information necessary for a detailed assessment of a supplier's quality potential. Quality and process audits will be discussed in detail in Chapter 6.

**4.3.4 Competition Versus Relationships**

Both of the historical data systems described in sections 4.1 and 4.2 are dependent on the maintenance of relationships with a number of suppliers of each commodity. Each system is dependent on competition among suppliers to

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23 Juran and Gryna, ed., 15.18.
motivate suppliers to increase their quality performance and earn increased levels of business. Such dependency implies that reduction of the supplier base can only be achieved to a point that still allows significant levels of competition. Perhaps more importantly, this reliance on competition for system effectiveness may provide a barrier to the establishment of long-term, trusting relationships with suppliers. Supplier certification programs such as Raytheon’s program, which eliminate incoming inspection for suppliers with outstanding quality histories on supplied commodities, may appropriately compensate for this potential barrier to customer-supplier relationships. Supplier certification programs will be discussed in detail in Chapter 5.

4.4 The Importance of Historical Data

Historical data as a tool for selection and management of suppliers has a number of limitations, several of which have been described here. Nonetheless, historical data is vitally important as a tool for diagnosing problem areas in a supplier quality management system. Any system whose goal is improved quality requires that the “vital few problems” which cause the most significant cost in terms of quality be identified and resolved. This may be accomplished with a Pareto analysis. Many systems attempt to generally address all quality problems rather than attacking these vital few. 24 Further, maintenance of historical data allows assessment and verification of the progress of any quality program.

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24 Ibid., 15.35.
As a supplier to IBM and Hewlett-Packard, Analog Devices Semiconductor has been the subject of the supplier quality management programs of these two companies. Art Schneiderman, Vice President of Quality and Productivity at Analog, notes that the objective data used as a basis for these programs create a common language on which the customer-supplier relationship can be based. Mr. Schneiderman notes that such data are important because they are specific and verifiable. On the basis of these data, issues in the customer-supplier relationship can be clarified, and opportunities for improvement can be identified.  

The Tennant Company reports that it maintains data on “accepted incoming lots, zero defects, reliability, and on-time delivery” for its suppliers. Every six months Tennant compiles the data into a performance report for each supplier. These data are a “valuable trouble-shooting tool,” and provide a base of discussion for the customer-supplier relationship. 

Indeed, it is notable that twelve of the fourteen organizations surveyed in this study use some type of historical data as an important component of their supplier quality management programs.

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25 Art Schneiderman, Analog Devices Semiconductor Vice President of Quality and Productivity, phone interview by author, 17 March 1992, Wilmington, Massachusetts.
26 Roger L. Hale, Ronald E. Kowal, Donald D. Carlton, and Tim K. Sehnert, Made in the USA: How one American company helps satisfy customer needs through Strategic Supplier Quality Management (Minneapolis: Tennant Company, 1991), 41.
This chapter discusses recognition of outstanding suppliers as well as certification of outstanding suppliers. Five of the fourteen organizations surveyed in this study have programs of outstanding supplier recognition; nine have supplier certification programs. While outstanding supplier recognition programs are not necessarily indicative of strong customer-supplier relationships, supplier certification and attendant elimination of incoming inspection is indicative of movement toward trust and commitment in customer-supplier relationships. With supplier certification we begin to move toward the relationship-focus end of the supplier quality management component continuum (Figure 3.1.).

5.1 Outstanding Supplier Recognition

Many organizations communicate with suppliers on quality issues only when they have poor product quality. Supplier management efforts are concentrated on identifying poor performers and motivating them to improve, while providing little meaningful communication on quality issues with suppliers that are performing acceptably. The Red/Yellow/Green system used by the Naval Material Quality Assessment Office falls into this category. It classifies suppliers as "Red" (high risk), "Yellow" (moderate risk), or "Green" (low risk), and uses these classifications in procurement decisions. Suppliers classified
as “Red” or “Yellow” are notified of their classifications, but suppliers classified as “Green” receive no feedback on their quality status. ¹ The Navy’s Red/Yellow/Green system will be discussed in detail in Chapter 8.

While such systems which “push” poor suppliers to improve are apparently effective, coupling such a system with outstanding supplier recognition as a motivational “pull” may multiply the effects of any supplier management system. As mentioned in Chapter 4, Rockwell periodically recognizes outstanding suppliers for each commodity purchased. Other supplier recognition programs include:

- Campbell Soup Company awards and publicizes suppliers that reach its “Select Supplier” status. ²

- General Motors honors outstanding suppliers with “Mark of Excellence” and “Targets for Excellence” Awards. ³

- IBM has recently initiated a supplier recognition award titled “IBM’s Market-Driven Quality” Supplier Award. ⁴

- Tennant Company awards outstanding suppliers with publicity and personal ceremonies. ⁵

³ General Motors Corporation, Targets for Excellence, General Motors Corporation Standard for Supplier Performance Evaluation and Reporting (Detroit: General Motors Corporation, 1990), 1.
In all of these programs, recognition is made publicly. Suppliers may occasionally advertise their receipt of such awards.

5.2 Supplier Certification

Supplier certification programs are very common in progressive supplier quality management programs. More than half of the programs surveyed here include supplier certification programs.

As noted in Chapter 3, most supplier quality management systems collect and analyze data on a commodity basis - i.e., if a supplier supplies several commodities to a customer, the supplier’s performance will be measured for each commodity. Supplier certification, however, is generally done on the basis of the supplier; either the supplier’s processes are analyzed generally, or all of the supplier’s parts must meet the certification criteria. Varian Medical Equipment, for example, certifies suppliers, but in the certification process, certifies every part supplied to Medical Equipment by the subject supplier. 6 L.L. Bean provides an exception to this procedure: L.L. Bean certifies products of suppliers, and has yet to certify all of a supplier’s products, thus certifying the supplier. 7

Some supplier certification systems are product-oriented, and some are process-oriented. Some include both product- and process-oriented

6 Varian Radiation Division Medical Group, Medical Equipment Quality Procedure QP 115, “Requirements for Purchased Part Certification,” Varian Radiation Division Medical Group, 1931, 4-5.

7 Elizabeth Spaulding, L.L. Bean Director of Product Sourcing and Quality for Apparel and Footwear, interview by author, 3 March 1992, Freeport, Maine.
components. Raytheon's supplier certification program, described in Chapter 4, is relatively product-oriented. The criteria by which suppliers are selected for certification are nearly entirely product-related. ("Responsiveness to Inquiries," as one of these criteria is not product-related, but neither is it process-related.) Once a supplier is certified, Raytheon has the option of performing inspections of the supplier's manufacturing facilities, but prior to this point, some competency in Statistical Process Control techniques is the only process-oriented criterion.

Rockwell's system has both product-oriented and process-oriented components. Candidates for certification are selected on the basis of excellent Supplier Rating and Incentive Program (Quality Cost Index) ratings and an excellent quality and delivery history. A Supplier Product Integrity Audit is performed which assesses the supplier's business system as well as the supplier's ability to produce compliant product. If found acceptable, the supplier is certified. 8

Varian Medical Equipment's certification program also has product- and process-oriented components. Varian uses historic data on defective parts as a criteria for selecting suppliers as candidates for certification; suppliers must have a defect rate of less than two percent for twelve months. Once selected as a candidate for certification, Varian conducts a process evaluation survey of the supplier's plant to analyze the supplier's quality process controls. If found acceptable, the supplier is subsequently certified. 9

9 Varian Radiation Division Medical Group, Medical Equipment Quality Procedure QP 115, 4-5.
Some of the more process-oriented systems focus not on specific commodities, but on suppliers' manufacturing processes in general. Alcoa identifies key suppliers as candidates for certification. Alcoa assigns a Supplier Quality Associate from Alcoa to work with each candidate supplier to assess and bring the supplier's processes into conformance with Alcoa's quality expectations. Alcoa has developed a detailed and extremely well defined set of audit guidelines which are ultimately used to certify outstanding suppliers. A list of Alcoa's audit criteria is shown in Table 5.1. For each of these criteria, Alcoa has developed an in-depth expectation of performance from the supplier, as well as a quantitative and qualitative rating scale. Prior to the final audit by an Alcoa team, however, the supplier is expected to perform a self-audit, and the supplier and Alcoa's Supplier Quality Associate perform a Trial Audit. Audits and certifications are performed on a specific facility, rather than for the entire company. 10 This certification process is rigorous and demanding. It takes at least one and one-half to two years for a supplier to become certified once the supplier is chosen as a candidate. 11

Whether an organization's supplier certification program is product-oriented or process-oriented appears to be highly dependent on the types of other components that the organization's supplier quality management program has in place. Product-oriented programs have product-oriented supplier certification programs. Process-oriented programs have process-oriented supplier certification programs. Broad-based programs include product- and process-oriented components in the supplier certification programs.

Table 5.1
Alcoa Audit Statement Index *

<table>
<thead>
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5.3 Elimination of Incoming Inspection

Once a supplier is certified, most organizations do not require that parts from that supplier be inspected upon receipt. Varian Medical Equipment signs a Supplier Certification Program Agreement with certified suppliers which includes a reduced inspection plan. Certified suppliers are required to maintain an in-process sample inspection program, and are required to submit first article components for inspection to Varian whenever a new part is delivered or a specification change is made. 12

Rockwell Defense Electronics trains supplier representatives to inspect components to be shipped to Rockwell at the source. Inspected product is then shipped directly to Rockwell’s warehouse. 13

While such programs make a leap of trust and faith in the supplier-customer relationship, they establish the groundwork for both customer and supplier to work toward a long-term mutually beneficial relationship.

12 Varian Radiation Division Medical Group, Medical Equipment Quality Procedure OP 115, 4-5; and Varian Radiation Division Medical Group, "Supplier Certification Program Agreement," Varian Radiation Division Medical Group, n.d., 2-4.
13 Albaugh and Kirsanoff.
This chapter discusses the use of quality and process audits in supplier quality management programs. Nearly all of the organizations surveyed in this study use quality and/or process audits as major components of their supplier quality management programs. In Chapter 5 we noted several cases in which organizations use quality and process audits as tools for supplier certification. In Chapter 4 we suggested quality and process audits as a means of assessing a new supplier’s quality potential in cases in which the procurement is large or critical to the organization. Quality and process audits may also be used for monitoring and assessment of suppliers with which an organization has an ongoing relationship. Hewlett-Packard Company’s Medical Products Group’s Waltham Division relies particularly heavily on a variety of audits in its supplier quality management system. Through such audits and a high level of communication, this group becomes intimately involved with a few of its key suppliers. This group’s supplier quality management system is indeed process-oriented and relationship-oriented.

6.1 The Case of Hewlett-Packard

The following is a summary of the Hewlett-Packard Company’s Medical Product Group’s Waltham Division’s Supplier Management Process:
When choosing suppliers for a new commodity, Hewlett-Packard (H-P) sends a questionnaire to potential suppliers which asks for report of such factors as:

- Location
- Utilization of Capacity
- State of labor relations, unionization, etc.  

After an initial cut based on these factors, H-P visits the most attractive suppliers and performs a Supplier Quality Audit. This audit consists of both a Quality System Audit and a Process Control Audit.  

The criteria for these audits are shown in Tables 6.1 and 6.2. Quality system requirements are largely derived from the requirements of the ISO 9001 standard. H-P has also added several requirements to those required by ISO 9001.  

Audits are judged largely on a qualitative basis. There is no minimum requirement for the results of these audits; H-P looks instead for a willingness on the part of the supplier to improve, to work with H-P in mutual engineering throughout H-P product life cycles, and to establish a long-term mutually beneficial relationship.  

Supplier Quality Profiles are compiled as a result of the audits for those suppliers with whom H-P chooses to do business. These profiles are used to provide constructive recommendations for supplier improvement.  

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4 Nardizzi, interview.
### Table 6.1

**Hewlett-Packard**

**Supplier Quality System Audit Criteria** *

1.0  Management Responsibility
2.0  Quality System
3.0  Contract Review
4.0  Design Control
5.0  Documentation Control
6.0  Purchasing
7.0  Customer Supplied Product
8.0  Product Traceability
9.0  Process Control
10.0 Inspection and Testing
11.0 Test and Measurement Equipment
12.0 Inspection/Test Status
13.0 Non-Conforming Product
14.0 Corrective Action
15.0 Handling, Storage, Packaging, and Delivery
16.0 Quality Records
17.0 Internal Quality Audits
18.0 Training
19.0 Servicing
20.0 Statistical Techniques
21.0 Safety
22.0 Electrostatic Discharge Control
23.0 Continuous Improvement
24.0 Quality Planning
25.0 Product Reliability

Table 6.2
Hewlett-Packard
Supplier Process Control Audit Criteria *

1.0  Statistical Process Control (SPC) Plan
2.0  SPC Training Program
3.0  Automation
4.0  SPC Documentation
5.0  Test to Process Feedback
6.0  Test and Measurement Equipment Variabilities
7.0  Critical Processes
8.0  Statistical Process Control
9.0  Process Capability

There is a great deal of focus in H-P's supplier management program on communication with suppliers. Supplier performance expectations are outlined very clearly, and strong and consistent lines of communication are established with ongoing suppliers to communicate where the suppliers stand in H-P's rating system. H-P defines future key procurement needs, and communicates these to appropriate suppliers.  

Supplier Performance Expectations are outlined clearly by H-P's "TQRDC" program. Specific areas in which expectations are defined are:
- Technology
- Quality
- Responsiveness
- Delivery
- Cost of Ownership
- Financial Stability.  

At least annually and as often as quarterly, suppliers which have ongoing relationships with H-P and which supply "key commodities" or "corporate commodities" are assessed on the basis of a TQRDC Review. A commodity is rated as a key commodity based either on volume of use or technical importance to H-P's final products. "Corporate commodities" are commodities that are ordered by numerous divisions of H-P. H-P's corporate office performs the TQRDC reviews for "corporate commodities". The criteria and metrics used in this review are summarized in Table 6.3.

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6 Nardizzi, interview.
7 Hewlett-Packard Company, Supplier Performance Expectations (Hewlett-Packard Company, 1989).
8 William E. Bagley, interview by author, 14 February 1992, Waltham, Massachusetts.
Table 6.3
Hewlett-Packard Criteria and Metrics
for TQRDC Reviews *

**Technology Expectations:**
- New Technology (Leading Edge and Timely Introductions)
- Mutual Engineering
- Strong Commitment to R&D

*Metrics:*
- TQRDC Supplier Performance Survey
- Manufacturing Technology Audit
- Investment in R&D

**Quality Expectations:**
- Process Control (including SPC)
- Demonstrated Product Reliability By Test/When Requested
- Documentation
- Responsive to Alerts & Corrective Actions Requests

*Metrics:*
- TQRDC Supplier Performance Survey
- Parts per million defects
- Process Quality Index
- Quality System Audit Scores
- Alerts

**Responsiveness Expectations:**
- High Level Commitment to H-P (including timeliness)
- Effective Worldwide Factory & Field Support For All H-P Entities
- Long-Term Product Support
- Flexibility to Changes

*Metrics:*
- TQRDC Supplier Performance Survey
- Consistent Worldwide Service
- Process Change Notifications
- Product Discontinuance Notifications
- Business Audit

**Delivery Expectations:**
- On-Time Delivery
- Lead Time
- Packaging
- Backup Shipment Strategy
**Table 6.3 (continued)**

**Delivery Expectations (continued):**

*Metrics:*
- TQRDC Supplier Performance Survey
- On-time Delivery Performance (3 days early/0 days late)
- Supplier Lead Times
- Evaluation of Performance to other Delivery Expectations
- Supplier On-time Shipment Performance

**Cost of Ownership Expectations:**
- Worldwide Price Leadership
- Cost Reductions
*Metrics:*
- TQRDC Supplier Performance Survey
- Full Supplier Participation in Cost Analysis of Targeted Parts
- Unsolicited Cost Reductions Submitted to H-P
- Quotes with Best Worldwide Prices

**Financial Stability is determined by:**
- D&B Credit Ratings
- Financial Questionnaires
- Output from Financial Stability Models

In addition, a Supplier Quality Profile based on Quality System Audits may be completed for each supplier which rates the supplier numerically as a means of comparison of competing suppliers.  

H-P's Medical Products Group has started to sign a "Mutual Agreement of Objectives" with each supplier during the TQRDC Reviews. The Mutual Agreement of Objectives establishes goals and priorities for the next period for the supplier's improvement.  

During the last four years H-P's Medical Products Group's Waltham Division has decreased its supplier base from approximately 1500 suppliers to 392 suppliers. This division of H-P sometimes maintains just one supplier for a commodity. Often, though, H-P will establish a relationship with a dominant and preferred supplier, but continue to award some small level of business to an alternate qualified supplier in order to mitigate the risk associated with single supplier procurement.  

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9 Hewlett-Packard Company, "Supplier Quality Profile."  
10 Bagley, interview.  
11 Nardizzi, interview.
In the emerging global economy it is becoming increasingly important for organizations to cooperate in order to improve the quality of goods and services and survive the competition. A supplier quality management system which alienates suppliers by imposing unnecessary or poorly understood requirements on suppliers will stand in the way of such ends. Managers of the most progressive supplier quality management systems recognize the potential dichotomy a supplier management program may create. These managers integrate tools into their supplier quality management systems specifically designed to strengthen customer-supplier relationships, and in some cases, to pro-actively aid suppliers in the improvement of their product quality. This chapter describes several such tools, and their use in supplier quality management programs.

7.1 Supplier Training

Eight of the fourteen organizations surveyed in this study perform some type of supplier training beyond simple training in the organization’s supplier quality management system. The range of training activities varies: Raytheon has taught a “Basics of Statistical Process Control” to suppliers. \(^1\) Motorola

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\(^1\) Louis P. Geoffrion, Raytheon Manager of Corporate Quality Assurance interview by author, 3 January 1992, Lexington, Massachusetts.
has established Motorola University with its own dean and faculty to teach a variety of courses to employees and suppliers. Some of the courses are required for suppliers. 2

Alcoa’s training is tailored specifically to individual key suppliers. As part of its certification process, Alcoa assigns an Alcoa employee, a Supplier Quality Associate, to each supplier. The Supplier Quality Associate is responsible to work with suppliers toward constant and continuous quality improvement by developing quality systems internal to the supplier which fit the supplier’s unique needs and processes. 3

Supplier training is one of the means through which suppliers may feel economic benefit from a customer-supplier relationship, even if the the volume of business transacted between the customer and the supplier is relatively small. 4 Customer benefits from supplier training may be closer relationships with suppliers, a higher quality of product from suppliers, and an increased level of understanding and trust in the customer-supplier relationship.

7.2 Strong Lines of Communication

Several of the organizations surveyed in this study stated that communication with suppliers was the key to their supplier quality management

programs. 5 Strong communication requires that communication be continuous, that performance feedback be provided, and that communication occur more frequently and consistently than only when quality problems occur.

Communication is perhaps the best method to motivate suppliers to seek continuous improvement. The indication that the customer cares about the quality of products and services is one key to this motivation. Feedback which identifies specific areas where improvement would be most beneficial to the customer can provide assurance that the customer is truly concerned about each specific supplier, and that the customer is expending some effort to help the supplier in specific areas, rather than generally demanding improved quality. Hewlett-Packard provides such feedback in its TQRDC reviews which are held at least annually, and often twice per year with key suppliers. In a further enhancement of this process, H-P signs a "Mutual Agreement of Objectives" with suppliers during these reviews. 6

The Tennant Company also stresses the importance of communication, but Tennant’s system for communication is less formal than Hewlett-Packard’s system. Tennant makes opportunities for person-to-person visits with suppliers. Tennant visits with top management of supplier companies early in the


relationship. Tennant encourages worker-to-worker communication. Tennant celebrates achievements with suppliers regularly. 7

Communication which is unreasonably demanding and one-sided can be detrimental to the customer-supplier relationship. Suppliers may lose motivation and become discouraged as a result of such communication. 8 General Motors' (GM) communications with its suppliers appears to fall into this category. GM’s written documentation states the importance of communication, but focuses on one-way communication from the supplier back to GM. 9 Further, GM’s major communications program is a “Problem Reporting and Resolution Process” which is used to resolve issues of nonconformance. GM apparently recognizes its lack of positive communication, as the corporation is currently developing a “Supplier Performance Indicators Reporting System” which will summarize and communicate to suppliers “key performance indicators in the areas of product quality, delivery and responsiveness. Communicating these key indicators provides measurement/feedback on current performance and highlights opportunities for improvement.” 10

7 Hale and others, 38-40, 67-68.
9 General Motors Corporation, Targets for Excellence, General Motors Corporation Standard for Supplier Performance Evaluation and Reporting (Detroit: General Motors Corporation, 1990), 5-9.
10 Ibid., 3-30 - 3-31.
7.3 Supplier Involvement in Product Development

Seven of the organizations included in this study involve some suppliers in product development. The scope of this involvement varies among companies:

The Tennant Company periodically invites groups of suppliers to meet and discuss product development at Tennant. During such meetings Tennant describes research which is often proprietary, and Tennant's specific needs for new products which the suppliers may be able to meet. In return, suppliers often share information on their own product development, on the newest technology, and on cost-effective components. Such sharing allows Tennant "to design with an eye to the future rather than the past." 11

Both Hewlett-Packard and Digital Equipment Corporation seek to identify suppliers willing to participate in mutual engineering early in their product life cycles. 12 It is important for organizations to recognize that mutual engineering involves significant risk for the suppliers, as commitment of capital and energy must often be made without any volume commitment, and without any assurance of product success. Digital tries to award suppliers willing to make such commitments with increased levels of ongoing business. Digital also allows the suppliers to amortize their development costs for products over the first year of sales. 13

11 Hale and others, 61, 69.
13 Yedavalli, interview.
The ultimate example of supplier involvement in new product development is provided by the Bose Corporation. Bose has developed a system titled “JIT II” \(^{14}\) by which it invites major suppliers to place a representative in Bose manufacturing facilities full time. The supplier representatives are empowered both to place orders on their own companies (eliminating the requirement for a Bose buyer and a supplier salesperson to interact), and to work with Bose on product development and product improvement. Supplier representatives have access to Bose data, Bose people, and Bose processes. \(^{15}\) (The only exceptions to this open flow of information are trade secrets and information on competitors.) Bose has established such a relationship with seven suppliers who have a total of ten in-plant personnel at Bose. Bose claims that the mutual engineering resultant of such relationships occurs much more frequently and is much more valuable than mutual engineering with outside suppliers. Relationships with suppliers who have in-plant representatives are strong and trusting. \(^{16}\)

Bose and its in-plant suppliers sign long-term contracts which guarantee sales for the supplier, and a stable price for Bose. \(^{17}\) Bose invites suppliers with the following characteristics to participate in the “JIT II” system:

- Bose must already have a trusting relationship with the supplier.
- The supplier must have a history with Bose of supplying high quality parts on time with good support and at good cost levels. \(^{18}\)

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\(^{14}\) “JIT II” is a registered service mark of Bose.

\(^{15}\) Lance E. Dixon, Bose Corporation Director of Purchasing and Logistics, “JIT II” (Summary document, Framingham, Massachusetts, 1992), 1.

\(^{16}\) Dixon, speech.

\(^{17}\) Ibid.

\(^{18}\) Dixon, “JIT II.”
• The dollar volume with the supplier must be over one million per year. Otherwise "the arrangement will not pay off for either company." 19

• There must be a large number of purchase order transactions each year. 20

"JIT II" is not recommended when an organization has little need for mutual engineering. 21

Customer-supplier involvement in one another's new product development requires a high level of mutual trust and commitment. The organizations surveyed in this study which involve suppliers in new product development find that when they entrust key suppliers with proprietary information and seek their assistance, trust and commitment are provided in return. Trust and strong relationships are both a requirement and an outcome of supplier involvement in new product development.

7.4 Being a Good Customer

Two of the organizations surveyed in this study have programs which specifically recognize the importance of being a good customer. Motorola and Rockwell each have programs which systematically require the organization to be introspective about its role in the customer-supplier relationship.

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19 Bill Warren, "JIT II: Just in time sounds even better at Bose, where they're trumpeting a new system for purchasing and transportation," American Shipper (December 1991): 44.
20 Dixon, "JIT II."
Rockwell’s Supplier Involvement Steering Council was briefly described in Chapter 4. The council consists of four representative supplier executives who meet quarterly to provide Rockwell Defense Electronics with guidance in supplier communication. In addition, in 1989 Rockwell Defense Electronics hosted a Supplier Executive Review for the top executives of 50 key suppliers. In preparation for the meeting, the executives completed questionnaires rating Rockwell as a customer.  

Rockwell recognizes that “Our suppliers are also our customers; they receive our specifications, requirements, and our schedules. If we don’t provide our suppliers with good input, they can not be successful in providing us with good product.”  

Motorola also solicits supplier feedback. It has a Supplier Advisory Board of executives of supplier firms who “are chosen for their candor.” In addition, Motorola’s business segments send out quarterly questionnaires inviting anonymous critiques of Motorola as a customer.  

Ken Stork, Corporate Director of Materials and Purchasing for Motorola, states that as marketing preaches that corporations should differentiate themselves as suppliers, Motorola feels that corporations should differentiate themselves as customers. This will allow corporations to attract the best suppliers.  

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23 Ibid.
24 Sheridan, 30.
supplier bases today, suppliers will be reducing their customer bases in the future - eliminating customers that are either too small, too demanding, or too difficult. 26

These "Good Customer" programs provide the most progressive examples in this study of supplier quality management tools designed to enhance and develop customer-supplier relationships.

26 Sheridan, 25-27.
The Navy has developed a supplier quality management system intended to evaluate and mitigate the risk associated with receipt of non-conforming materials. This Red/Yellow/Green Program has been in operation on a test basis at a number of Naval field activities since mid-1989. This chapter describes and evaluates the Red/Yellow/Green Program in light of the information provided in previous chapters on progressive supplier quality management systems.

8.1 The Red/Yellow/Green Program

Red/Yellow/Green (RYG) assesses the degree of risk associated with awarding a material contract to a contractor based on the contractor's product quality history in transactions with the Navy. Based on a contractor's history, an assessment is made of whether a contractor is high risk ("Red"), moderate risk ("Yellow"), or low risk ("Green"). Assessment is done by Federal Supply Classification (FSC), so each contractor has a RYG classification for each FSC for which it supplies product to the Navy.

For many years the Navy has maintained a database of contractor histories as part of its Contractor Evaluation System, one facet of the Navy's
Product Deficiency Reporting and Evaluation System. ¹ The database assimilates information from several Navy reporting systems which report on product quality of materials used to build and maintain the Navy’s fleet. The database standardizes the following types of information:

- Acquisition History
- Contractor Plant Visits
- Product Deficiency Reporting & Feedback
- Waiver/Deviation Requests
- First Article Inspection
- Test Production Lot Testing
- Technical Receipt Inspection Results

In addition to its use in the RYG Program, this database has been used for many years by Navy procurement activities to reduce and eliminate the receipt of non-conforming or substandard materials. ² Bi-annually, major Navy quality and procurement activities meet to identify problem contractors as candidates to be included on the Navy’s “VDAR” (Vendor Data Analysis Report) list. Candidates are chosen based on negative data trends, ³ lack of responsiveness to Quality Deficiency Reports (QDR’s) or corrective action requests, process quality deficiencies identified as a result of on-site plant reviews, deception or fraud. ⁴ Prior to being placed on the VDAR list, contractors are issued two letters over the course of one year informing them that they may be placed on the list if significant quality improvements are not

² Department of the Navy, Office of the Assistant Secretary of the Navy (Shipbuilding and Logistics), Reliability, Maintainability and Quality Assurance Directorate, Product Deficiency Reporting and Evaluation Program (Washington, D.C.: Department of the Navy, n.d.).
⁴ Product Deficiency Reporting and Evaluation Program.
made. Once on the list, the contractor and local congressmen are notified that the contractor is on the list. 5 The VDAR list is sent to government contracting officers and quality assurance activities. The VDAR list does not debar contractors from competing for Navy contracts; it is rather intended to alert contracting officers and quality assurance activities that the contractor has had quality problems in the past, and that additional surveillance or inspection of the contractor’s activities and products may be warranted. 6

The Red/Yellow/Green Program was developed to establish a more systematic method for contractor evaluation in procurement awards than the VDAR list, while using the same database used for selection of VDAR candidates. A contractor’s classification for each FSC is determined by results of pre-award surveys, product-oriented surveys, quality systems reviews, and first article tests, as well as high reject rates, a high number of Quality Deficiency Reports, or identification of other major deficiencies. 7 A list of classification criteria for each risk category is shown in Table 8.1. Reject rate is the most commonly used criterion for RYG classification. 8

RYG classifications are used in two ways in Navy procurements: the Technical Evaluation Adjustment (TEA) Method, and the Greatest Value/Best Buy (GV/BB) Method. The TEA Method is used in small and major purchase procedures. The GV/BB Method is used primarily in major purchase procedures.

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6 Product Deficiency Reporting and Evaluation Program.
8 Eaton, interview.
| Table 8.1 | RYG Classification Criteria *

**RED:**
- On current Navy VDAR
- Method C, D, and/or E Corrective Action Listings in effect
- Latest quality Pre-Award Survey in last two years no award
- Latest Product-Oriented Survey in last two years unacceptable
- Latest Quality Systems Review in last two years unacceptable
- Latest Special Survey in last two years unacceptable
- Reject rate 15% or more for two or more rejected lots in last two years
- Latest two First Article Tests in last two years unsatisfactory
- Two or more Category I QDR's in last two years
- Six or more Category II action QDR's in last two years
- On Defense Logistics Agency Contractor Alert List for major deficiencies

**YELLOW:**
- Issued VDAR Letter of Concern
- Latest quality Pre-Award Survey in last two years award with findings
- Latest Product-Oriented Survey in last two years acceptable with corrections
- Latest Quality Systems Review in last two years acceptable with corrections
- Latest Special Survey in last two years acceptable with corrections
- Reject rate 6-14% for two or more rejected lots in last two years
- Latest First Article Test in last two years unsatisfactory
- One Category I QDR in last two years
- Three to five Category II action QDR's in last two years
- On Defense Logistics Agency Contractor Alert List for minor deficiencies
- Previously red - no rejects for five or more lots in last six months

**GREEN:**
- Latest quality Pre-Award Survey in last two years award with no findings
- Latest Product-Oriented Survey in last two years acceptable
- Latest Quality Systems Review in last two years acceptable
- Latest Special Survey in last two years acceptable
- Reject rate less than 6% for five or more lots in last two years
- All First Article Test in last two years satisfactory
- Zero to two Category II action QDR's and reject rate less than 6% for five or more lots in last two years
- Previously yellow - no rejects for five or more lots in last six months

A TEA is an estimate of the cost to the Navy of additional quality activities necessary to ensure that material procured from "risky" contractors is acceptable for use in the fleet. TEA's are added to a risky ("Red" or "Yellow") contractor's bid to make an estimate of the total cost to the Navy of procuring from the contractor. TEA's are estimated for activities such as pre-award surveys, post-award orientations, product-oriented surveys, government source inspection, or receipt inspection. The assumption is made that such quality evaluations are not necessary for contractors classified as "Green". The concept behind the use of TEA's is very similar to the Rockwell system described in Chapter 4, which estimates the total cost of doing business with a supplier.

The Greatest Value/Best Buy Method is used for major purchases in which the differences in bidder's prices are likely to be so large as to make the use of TEA's ineffective. Under this method, an activity develops a contractor evaluation plan for each procurement on a case-by-case basis, using price and RYG classification as evaluation criteria. Price must be assigned a minimum evaluation weight of 40 percent.

Contractors for whom there is not adequate data to make a classification are labeled "Insufficient data". TEA's are not assessed for "Insufficient data" contractors. Under the GV/BB Method, "Insufficient data" contractors are

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10 Ibid., 1-2, 16-18.
11 Ibid., 2.
12 Gebhart, 19.
considered solely under the assumption of "lowest price, technically acceptable". 13

RYG classifications are updated monthly. Contractors classified as “Yellow” or “Red” are notified of their classifications and are given one month to challenge before the classifications are used in procurement selections. 14

8.2 Advantages of Red/Yellow/Green

The Red/Yellow/Green Program offers a number of advantages over the VDAR Program for Navy procurements. It is relatively simple. It is systematic and can be applied to a large percentage of Navy procurements, as long as data are available on the subject contractors. While the VDAR list identifies contractors with very poor quality histories, RYG provides a less extreme method of warning contractors whose quality is falling (i.e., a “Yellow” classification).

The database used to make RYG classifications exists. As a tool it may be used as a basis - a common language - for relationships with contractors. Based on a low number of challenges received from contractors who are notified that their classification is “Yellow” or “Red”, the database is considered accurate. 15

13 “Product Deficiency Reporting and Evaluation Program Contractor Evaluation System Red/Yellow/Green Program Procedures,” 4, 6, and 11.
14 Eaton, interview; and “Product Deficiency Reporting and Evaluation Program Contractor Evaluation System Red/Yellow/Green Program Procedures,” 2.
15 Gebhart, 15-16.
Red/Yellow/Green and the VDAR list do allow identification of the "vital few problems" which cause the most significant cost in terms of quality. Unfortunately, this identification may not be used effectively by the Navy to eliminate or reduce quality problems with incoming material. The reasons for this lack of effectiveness will be discussed in the next two sections.

8.3 Problems with the Red/Yellow/Green System

This section will discuss problems with the Red/Yellow/Green system as a supplier quality management system, including problems resultant from the legal context within which defense procurements are administered. The next section will discuss problems in the implementation of Red/Yellow/Green that have limited its effectiveness.

Use of Red/Yellow/Green is not imposed consistently or completely on or by procurement contracting officers. Use of the system is voluntary, and the manner in which the database is used is not mandated. While the tests of Red/Yellow/Green at a number of Naval activities are generally considered successful, the Program has not been mandated for all Navy procurement activities.

For legal reasons, quality assessments such as those made in the RYG Program can not be used to establish the technical acceptability of a contractor. Quality assessments can be used as a means of comparison, but not as a

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determination of responsibility or technical acceptability. 17 As a result, the Red/Yellow/Green Procedures and General Policy explicitly state, "RYG does not eliminate the requirement to make a determination of responsibility for every prospective contractor prior to award, and the requirement to include all documentation supporting the determination in the contract file. A contractor's FSC classification alone is not sufficient to determine that a contractor is or is not responsible, without further consideration of the standards in FAR [Federal Acquisition Regulation] 9.104." 18 While a necessary legal condition, this clarification may act to discourage contracting officers from using Red/Yellow/Green. The RYG Program may be seen as additional work not absolutely necessary for contract awards, particularly by individuals skeptical about Total Quality Management. Further, procurement officers are not provided with consistent incentives to use the RYG Program. Their incentives may encourage contract awards based on lowest price, not best value. No funding or incentive programs have been provided to encourage the use of RYG.

The criteria used to classify contractors as "Red", "Yellow", or "Green" are very limited and relatively parochial. On-time delivery is not considered, although NMQAO is considering incorporating some measure of timely delivery into the Program in the future. 19

17 Krista Ann Hagmann, "An Evaluation of the Navy's Red/Yellow/Green Program and How This Program is Intended to Improve the Selection of Quality Contractors" (M.S. Thesis, Naval Postgraduate School, 1989), 67-70.
19 Eaton, interview.
As with other programs that use historical data, the treatment of new bidders for whom there is no historical data (those labeled "Insufficient data") is somewhat arbitrary. During the test period of the program, 134 low offerer "Red" or "Yellow" bidders have been displaced. Of these, 72 were displaced by contractors with "Insufficient Data", 9 were displaced by "Yellow" contractors, and 53 were replaced by "Green" contractors in the subject FSC code. These figures are rather disturbing; the value of replacing a "Red" or "Yellow" vendor with a vendor for whom there is not sufficient quality history to make a judgement is questionable. 20

The problem of "Insufficient Data" contractors also highlights the importance of maintaining a complete and up-to-date quality history for as many suppliers as possible. This is possible for a centralized Navy office such as NMQAO only with the support of the field activities. If field activities are not using or do not recognize the value of the RYG Program, they are unlikely to provide good support of the Program's database. The effectiveness of the Red/Yellow/Green Program is directly related to the existence of accurate contractor history in the PDREP CES database. 21

NMQAO systematically communicates only with poor quality suppliers. This communication is primarily in the form of letters informing the contractors that they are classified "Red" or "Yellow" and that they have thirty days to challenge the classification. This communication could hardly be described as constructive. This is just one symptom of a supplier quality management system

which is oriented toward poor quality performers, rather than toward high quality performers. The Program looks from the "Green" performers, who are basically performing "as expected", down to the poor performers, focusing on the latter. No attempts are made to differentiate between "Green" contractors, between those with, for example, a four percent reject rate over the last two years and those who have delivered perfect product on-time for the last two years. There is no incentive for "Green" contractors to improve or to maintain perfect quality performances.

There is very little interaction between NMQAO, which classifies contractors in the RYG Program, and the contractors. (There may be more interaction between the field activities and the contractors.) With only 35 employees, NMQAO can not possibly maintain relationships with a significant percentage of the 18,000 contractors included in the PDREP database. In most cases, then, NMQAO has little understanding of what's behind the quality history numbers for a given supplier. Further, even the procedures used by the field activities suggest that audits or supplier system reviews are a tool to be used only with problem contractors. Viewed more positively, such tools could be used to improve supplier-customer relationships and understanding, and as a means to assess the quality performance of new contractors.

Red/Yellow/Green relies on competition among contractors for success. There is no incentive in Red/Yellow/Green for the Navy to reduce its contractor base to a manageable number. The advantage provided to new contractors may actually result in a contractor base of increasing size. Further, the

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Competition in Contracting Act of 1984 requires that the Navy use "full and open" competition in procurement procedures except under a number of enumerated extenuating circumstances. 23 This Act essentially precludes the Navy from establishing long-term relationships with small number of suppliers, as recommended by Deming 24 and others. The Competition in Contracting Act does allow the use of multi-year contracts in Defense acquisitions; 25 this is one way that Navy activities may establish long-term relationships with suppliers, but it obviously has its limitations.

Finally, ethical considerations in defense contracting inhibit communication between government representatives and suppliers. Both government and contractor representatives are cautioned against activities which might even have the appearance of a conflict of interest.

The Navy operates within a number of different constraints from those in which most private organizations operate. Some of the best practices in supplier quality management identified in previous chapters would be either impractical or impossible within these constraints. Nonetheless, a number of the limitations of Red/Yellow/Green are not the result of these constraints, but rather of system problems identified here which are not related to legal issues, or the result of the manner in which Red/Yellow/Green has thus far been implemented.

8.4 Problems with Red/Yellow/Green Implementation

Red/Yellow/Green has been implemented in its limited scope as a "Quality" program administered by the people at NMQAO. Broad responsibility for Program implementation has not been established. In Chapter 3 we discussed the importance of establishing broad-based responsibility for quality programs. Red/Yellow/Green does not enjoy this advantage.

Perhaps more importantly, Red/Yellow/Green has not received consistent or strong support from top management in the Navy. At this time the Program has not progressed beyond its test stage. The Program can not be successful if it is not used consistently by procurement activities. Top management could mandate its use, or could provide incentives for procurement officers to use the system. Top management has not made either of these efforts.

Red/Yellow/Green has not always been received well by contractors. (This is not surprising considering the tone of the communications associated with the Program.) One of the reasons for this is the manner in which the Quality Deficiency Report (QDR) system is implemented. The QDR system is one of the sources of data for the PDREP database used as a basis for RYG. According to industry sources, QDR's are sometimes written for parts of poor quality or parts that are not functioning properly without confirmation of the cause of the defect. It is assumed that the problem is the fault of the supplier, when the piece may instead have been handled improperly, or used in a

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system for which it was not designed. NMQAO may then receive such unconfirmed QDR’s, and use them to the detriment of blameless suppliers.

NMQAO has no reasonable means of verifying cause for a QDR it receives. The problem here is not with NMQAO’s Red/Yellow/Green system, but rather with the way in which the QDR system is implemented. 27 NMQAO’s database is accurate, but the data on which it is based is sometimes inappropriately represented. The result is that contractors sometimes perceive that Red/Yellow/Green is inconsistent, or unfair.

Further, the Program may not be well understood by contractors, and because it is only used by a few field activities, it does not send a consistent message to existing and potential contractors.

8.5 Conclusions

Red/Yellow/Green as a system is by no means doomed to failure, but it desperately needs high level support in the Navy. Other problems, such as the existence of a complete high quality database, would naturally improve if top management actively supported NMQAO in its efforts. If top management advocated the use of RYG and delegated shared responsibility for some aspects of RYG to procurement officers, field activities would naturally respond both with consistent use, and with good data for the PDREP database.

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27 The Navy has an effective system of Spares and Repairs which establishes cause and fault of parts which malfunction in order to prevent recurrence and establish responsibility for the problem. QDR’s should only be written in cases in which the contractor is clearly at fault; this would improve the QDR system, provide more accurate data for Red/Yellow/Green, and enhance contractors’ trust in their customer, the Navy.
Further, if the Navy consistently and appropriately used the Red/Yellow/Green Program, contractors would receive a consistent message from the Navy that quality is an important priority, and that contractors must continuously improve their quality in order to continue to obtain high value contracts with the Navy.

While the involvement of NMQAO with its numerous contractors is a problem which perhaps cannot reasonably be resolved within the limitations of current legal requirements, the negative reaction of contractors to the Red/Yellow/Green Program probably can be improved. Steps should be taken to ensure that quality reporting systems in the Navy, particularly those that feed the PDREP database, are accurate and consistent. Further, communications with contractors should be more positive and constructive. Letters can be sent to “Green”, as well as “Yellow” and “Red” contractors, describing the program, informing them of their classifications, and asking them to continue their good quality efforts toward continuous improvement.

Because of the limitations of the historical data on which Red/Yellow/Green is based, the Program should not be used as the sole quality criterion on which major purchase decisions are made. Ideally, field activities should visit and become involved with potential contractors for major procurements.

Finally, Red/Yellow/Green may be the beginning of a high integrity supplier quality management system in the Navy. Red/Yellow/Green is a necessary, but not sufficient component of such a system. Unfortunately,
before the Navy can begin to expand its supplier quality management program toward the process-oriented end of the component continuum, Red/Yellow/Green must be implemented fully and consistently. Red/Yellow/Green implementation could be an excellent first step toward a comprehensive supplier quality management system for the Navy.
This chapter discusses the importance of standards for supplier quality management, and the migration of industry toward a universal standard.

9.1 The Importance of Standards

As Supplier Quality Management becomes an ever more pervasive and important phenomenon, suppliers are increasingly pressured to meet the requirements of a variety of diverse and only partially overlapping supplier quality management programs. Customers often visit suppliers as a prerequisite to doing business, requesting that suppliers invest time and effort to adapt their processes to the unique requirements of each important customer. ¹ Further, customers often expect to make additional supplier visits during the execution of their contracts in order to ensure that quality requirements are maintained. Suppliers can not possibly meet the requirements of every customer, and yet many will try under the pressures of today's quality movement. Juran's Quality Control Handbook offers four elements which would reduce this burden on suppliers:

1. A standard specification of the element(s) of a quality system.

2. Individual assessors who are trained and qualified by a competent body.

3. An independent third party to operate a service of supplier assessment.

4. The publication of details of the firms who have been successfully appraised.”

Good national and international standards and third party assessment bodies could decrease the pressure on suppliers and still allow identification of good suppliers. In England, the British Standards Institution has for many years provided a comprehensive quality system standard, a qualification system for assessors, and a supplier assessment service, including periodic publication of assessed firms. In the United States, the Coordinating Agency for Supplier Evaluation (CASE) has been effective in reducing redundant supplier assessments, but is used by companies only on a limited basis, often as a supplemental system of supplier evaluation. (Norie of the organizations surveyed in this study included CASE ratings as an important component of their supplier quality rating systems.)

9.2 Military Standards

Two primary military specifications have been imposed on defense contractors since 1963 to control the quality of supplies and services purchased. These include MIL-Q-9858A, “Quality Program Requirements,”

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3 Ibid.
and MIL-I-45208A, "Inspection System Requirements." 5 MIL-Q-9858A requires "An effective and economical quality program, planned and developed in consonance with the contractor's other administrative and technical programs." 6 The specification outlines general guidelines for quality programs, but provides little specific guidance. While the generic nature of these requirements allows contractors to develop quality systems which meet their unique characteristics, the standards err in allowing such latitude that little guidance or verifiability can be gleaned from them. As a result, these standards provide a relatively superficial set of quality requirements for defense contractors. 7

9.3 The ISO 9000 Series

In 1987 the ISO 9000 series of standards and an accompanying terminology standard (ISO 8402) were published by the International Organization for Standardization. 8 This series of standards is modeled on that of the British Standards Institute, mentioned earlier. 9

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9.3.1 Description of the ISO 9000 Series

The ISO 9000 standard describes the concepts of quality management and quality assurance, and provides guidelines for selection and use of specific standards within the ISO 9000 series. Each of the subsequent three standards provides a model of specific guidelines for a quality system. The stringency of the specific standard used for a supplier depends on the "functional and organizational capability" required of the supplier for the product or service being supplied. Guidance for use of the specific standards is as follows:

" a) ISO 9001: for use when conformance to specified requirements is to be assured by the supplier during several stages which may include design/development, production, installation and servicing.

b) ISO 9002: for use when conformance to specified requirements is to be assured by the supplier during production and installation.

c) ISO 9003: for use when conformance to specified requirements is to be assured by the supplier solely at final inspection and test."  

ISO 9001 is the most stringent of the three model standards. This standard provides quality criteria in the areas listed in Table 9.1. Criteria for ISO 9002 and 9003 are somewhat less stringent.  

11 The ISO 9001 standard is very systematic. It requires internal audit and verification, periodic management review, and extensive documentation of all aspects of the quality program elements listed in Table 9.1.  


Table 9.1

ISO 9001

Quality System Requirements *

1. Management responsibility
2. Quality system
3. Contract review
4. Design control
5. Document control
6. Purchasing
7. Purchaser supplied product
8. Product identification and traceability
9. Process control
10. Inspection and testing
11. Inspection, measuring and test equipment
12. Inspection and test status
13. Control of nonconforming product
14. Corrective action
15. Handling, storage, packaging and delivery
16. Quality records
17. Internal quality audits
18. Training
19. Servicing
20. Statistical techniques

The ISO 9000 series has a number of limitations. The series represents a minimum requirement for an effective quality system. As a result (and as discussed in Chapter 4), the series includes no requirement for continuous improvement. The series' criteria also do not include customer satisfaction.  

The criteria for ISO 9000 series qualification are weighted heavily toward documentation of quality systems in place. Documentation is stressed more in these standards than any specific quality system requirements. The result is that "a poor quality product and manufacturing process could meet the standard as long as the required quality system elements were well documented." 

The series provides no specific requirements for specific commodities; it is generic in nature. While this provides a desirable level of universality for the standards, it compromises the overall impact of the standards on product quality. It is notable that the next revision of the standards, slated for implementation in the mid-1990's, is being written to include specific criteria for each of four broad product categories: hardware, software, processed materials, and services. 

The International Standards Organization has attempted to create a series of quality standards that are universally acceptable and flexible for a wide variety of products. The result is that the criteria are often insufficient to meet specific needs, and may be limited in their ability to raise the general

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14 Meckstroth, 14.
15 Ibid.
16 Ibid.
17 Marquardt and others, 27, 30.
18 Ibid., 26.
quality of products manufactured. Nonetheless, the ISO 9000 series is an excellent starting point for a universal quality system standard. 19 It provides some structure for quality systems, it is reasonably comprehensive in scope if not in depth, and it provides a range of models for quality systems (i.e., those represented by ISO 9001, 9002, and 9003). 20

9.3.2 Adoption of the ISO 9000 Series Standards

The most strong and significant adoption of the ISO 9000 series to date has been by the European Community (EC), which is using ISO 9000 as a universal framework for quality across member states. While quality assurance certification is not absolutely required for a company doing business in the EC, its broad endorsement and wide use there are expected to make ISO 9000 series certification a “de facto” condition of transacting business in the EC. 21 It is estimated that 13,500 firms are currently certified to ISO 9000 in the United Kingdom alone. Further, it is clear that all other factors being equal, a firm with ISO 9000 certification competing for business in the EC will have a competitive advantage over a firm that is not certified. 22

The ISO 9000 series has been adopted as the United States’ national quality system standard. 23 The Series has also been adopted by NATO. 24

20 Meckstroth, 7.
21 Ibid., 12.
22 Ibid., 13.
23 Ibid., 7.
24 Hockman.
the United States, its use has been limited. The Navy is flirting with the idea of applying the standard to supplier certification. 25 The majority of U.S. organizations that have sought ISO 9000 certification have done so in order to compete for business in the EC.

9.3.3 Third Party Certification

The European Community's use of the ISO 9000 series standards encourages third party qualification of suppliers. In order to standardize such certification across EC boundaries, the EC requires that third party registrars be accredited to a European standard for testing and certification agencies (the EN 45000 series). 26

The United States is following the EC's lead toward encouragement of third party certification to ISO 9000, although at a somewhat slower pace. The American Society for Quality Control has recently established a Registrar Accreditation Board to qualify registrars to certify organizations to ISO 9000. 27 At this time, however, U.S. boards and registrars are not recognized as qualified in the EC. The U.S. and the EC Council are discussing this issue. Some EC-approved registrars have established offices in the U.S. to certify companies that wish to do business in the EC with the benefit ISO 9000 certification. At least one U.S. registrar (Underwriters Laboratory) has signed a

26 Meckstroth, 10.
memorandum of agreement with a European registrar (the British Standards Institute) allowing EC certification of any company certified by the U.S. registrar.  

Registration to ISO 9000 requires an in-depth review of each supplier's quality processes. This includes review of written documentation and a comprehensive on-site review of quality processes. Areas requiring corrective action are identified during the on-site visit. Once corrective actions have been taken and verified, the supplier may be certified.  

This process may take 18 months or more and cost 200 to 300 thousand dollars per plant. The certification is valid for three years, subject to verification every six months.

9.4 Conclusion

The ISO 9000 series is an excellent start toward the establishment of a universal, comprehensive quality standard for supplier certification. Its use in the European Community, and the incentive EC use provides for non-EC firms (including U.S. firms) to become certified, is creating a momentum for this standard which is very hopeful. Certification to ISO 9000 will become increasingly commonplace as firms appreciate the benefit of ISO 9000 certification in trade with EC nations.

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28 Meckstroth, 11-12.  
29 Lofgren, 35-36.  
30 Meckstroth, 9.  
31 Lofgren, 37.  
32 Tatum and Heller, 56.
It is likely that increased use of ISO 9000 certification for supplier quality verification will decrease the number of second party audits being conducted at suppliers' plants. However, in cases in which organizations require quality verification beyond the limited requirements of the ISO 9000 series, supplemental audits may still be performed. The overall result of this combination is that suppliers certified to ISO 9000 should be subject to less frequent, more focused audits. 33

Certification to common or universal standards provides little relief for suppliers or customers hoping to establish long-term trusting relationships with their counterparts. These parties may be able to focus on relatively important and unique issues in customer-supplier relationships under the assumption that minimum quality requirements have been verified by the subject standard. But long-term mutually beneficial relationships will still require that trust be established through good ongoing communication and significant efforts on both sides of the customer-supplier relationship.

33 Burr, 22.
Most of the organizations surveyed in this study use a variety of components in their supplier quality management programs. Most systems include components from both ends of the product- to process-oriented spectrum. Motorola and Rockwell have a particularly wide range of components in their supplier quality management programs.

Some organizations attempt to apply the same system to all purchases chosen to be analyzed within the system. Others attempt to identify the most critical purchases, and apply process-oriented components to those purchases, while using more traditional product-oriented components for the remainder of the purchases. For example, as mentioned in Chapter 3, Motorola identifies “critical purchased commodities, ...where purchasing dollars are concentrated,” and focuses its supplier selection and quality improvement efforts on purchases of these commodities. ¹

For low-priced standard purchases, IBM uses purchase price as the primary criterion for supplier selection; purchases of commodities considered important to the quality of IBM’s final product and high value purchases are subject to additional scrutiny, and more process-oriented criteria. ²

¹ Ken Stork, “Survival of the Fittest” (Ken Stork, n.d.).
At each of the organizations where different selection criteria are used for different types of purchases, the organizations have made qualitative cost-benefit analyses of the benefits of using particular quality management tools for a given type of purchase relative to the costs of these actions, tailoring the choice to the criticality of the subject purchase. Because components located on the process-oriented end of the supplier quality management component continuum (Figure 3.1) generally require more personal involvement with suppliers, these components also tend to be more expensive to employ with a given supplier.

An ideal supplier quality management system for a corporation which purchases a wide variety of supplies would employ a variety of supplier quality management components, both product-oriented and more expensive process-oriented types of components. The types of management tools used for a given purchase would be tailored to the criticality of the purchase, and the choice of tools would take into consideration the potential quality benefits and cost savings likely as a result of such actions. Figure 10.1 suggests criteria by which these judgements might be made in such a system.

A small variety of supplier quality management components may be appropriate at organizations where a small variety or range of supplies is purchased. For example, as described in Chapter 6, the Waltham Division of the Hewlett-Packard Company's Medical Products Group relies very heavily on audits of key components in its supplier quality management program. Hewlett-Packard uses these audits as opportunities to develop constructive and ongoing working relationships with suppliers of critical components. These constructive audits are appropriate for this division's supplier management
Figure 10.1

Continuum of Components of Supplier Quality Management Programs

- Historical Data
- Rockwell Index
- Outstanding Supplier Recognition
- Supplier Certification
- Quality and Process Audits
- Supplier Training
- Strong Lines of Communication
- Supplier Involvement in Product Development
- Good Customer Program

Maintain Historical Data for All Purchases

Increasing Need for Concurrent Engineering

Low-Value Purchases

High-Value Purchases
program, both because of the nature of the supplies being purchased, as well as the nature of the final product being manufactured at this division, medical products on which human lives depend. There are other cases in which it is appropriate to focus a supplier quality program on a particular type of management component. This may be particularly true for small companies or specialized divisions of large corporations.

As noted in Chapter 4, historical data should be maintained for all purchases as a means of assessing the likely quality of future purchases from a supplier with whom the organization has a history of business, and as a method to identify the problem areas in the supplier quality management system. Historical data should be used as a primary purchase criterion for purchases of standard items as well as low-priced non-critical components.

At the other end of the continuum are supplier quality management components that require the development of trusting long-term relationships with suppliers and relatively intensive (and expensive) efforts on the part of the supplier and the customer. These types of components should be used in cases in which concurrent engineering by customer and supplier is likely to yield significant benefits, in cases in which non-standard parts are being used and/or developed, and for high-value purchases in which the potential losses as a result of low quality are high. One clear example of the types of purchases which should use components at this process-oriented end of the spectrum are purchases from suppliers identified by Bose as candidates for "JIT II". As described in Chapter 7, these suppliers have long-standing high integrity relationships with Bose, and sales of more than one million dollars per year with Bose; the supplier-customer relationship includes a large number of
transactions, and the need for concurrent engineering and coordination is high. If these criteria are not met, according to Bose, "JIT II" will not be cost effective for customer or supplier.

Organizations should take care not to become enamored with any particular supplier quality management component. All of the components identified in this study have benefits for some types of purchases; none are universally applicable or cost effective for all types of purchases. An ideal supplier quality management program would include components from each end of the component continuum, applying these components to specific purchases such that the benefits outweigh the costs.

Finally, any supplier quality management program should be developed with the primary goal of identifying those vital few purchases in which purchasing dollars are concentrated, and in which the greatest potential risk as a result of poor quality exists. Supplier quality management programs should be concentrated toward these purchases, with additional efforts for less critical purchases addressed by the system as feasible and as cost-effective.
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