

IDA DOCUMENT D-1842

INDUSTRY USE OF ADVANCED QUALITY PRACTICES

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May 1996

Prepared for
Office of the Director
Test, Systems Engineering, and Evaluation

Approved for public release; distribution unlimited.



INSTITUTE FOR DEFENSE ANALYSES
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PREFACE

This document reports some of the findings from work performed by the Institute for Defense Analyses (IDA) under the task "Advanced Quality and Best Practices for DoD." The work was performed for the Office of the Director Test, Systems Engineering, and Evaluation under the technical cognizance of the Army Armament Research, Development, and Engineering Center, Product Assurance Directorate.

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INTRODUCTION

This document presents the results of a questionnaire developed by the Advanced Quality Subpanel of the Government & Industry Quality Liaison Panel to elicit responses from industry about advanced quality practices. The subpanel originally distributed its questionnaire to members of the Aerospace Industries Association (AIA) and the National Security Industry Association (NSIA), and the Institute for Defense Analyses (IDA) later distributed a slightly revised questionnaire to elicit responses from a wider audience and try to get commercial industry feedback.

The questionnaire was not designed scientifically, and the responses received thus far were not subjected to detailed statistical analysis. Because of the informal nature of the questions, there was much overlap. Respondents often answered different questions with the same answer, or, in the authors' opinion, answered one question with a response that fit more appropriately under another question. Recognizing these variances, the authors focused analysis on the total set of answers and present it in a format useful to DoD.

GOAL

The questionnaire was intended to aid the subpanel in deliberating how government could motivate industry to use advanced quality practices (AQPs) beyond the basic quality management system required to do business with the government.

Goal

Seek industry perspective on issues concerned with implementing and improving advanced quality practices (AQPs).

QUESTIONNAIRE DISTRIBUTION

IDA mailed the questionnaire to quality assurance professionals identified from previous work, such as those involved with the task on elimination of acceptable quality levels (AQLs) from government standards and specifications (IDA Paper P-2991). IDA also used lists of attendees from conferences where participants were from commercial as well as defense industries, such as the Manufacturing Technology Conference at the National Institute of Standards and Technology (NIST). In addition, IDA set up a home page on the world wide web.

Questionnaire Distribution

- **AIA and NSIA Distribution**
- **World Wide Web Page**
- **86 Direct Mail Letters**
 - **Companies and associations involved in DoD study on Acceptable Quality Levels**
 - **NIST and other conference attendee lists (for commercial companies)**
 - **Auto industry POCs for QS9000**

WORLD WIDE WEB PAGE

At the Web address shown in the first bullet on the chart, the home page included a letter requesting participation and explaining the sponsor and development of the questionnaire, directions for completing and submitting the questionnaire, the questionnaire itself, and a direct e-mail response capability. Links to other pertinent home pages were requested, and other home pages "found" this one and provided links themselves. For example, the American Productivity and Quality Center provides the following hotlink:

An Opportunity to Participate

The Institute for Defense Analyses is assisting the Government/Industry Quality Liaison Panel in a study of the use of Advanced Quality concepts and practices in commercial industry. The panel . . . has widespread government agency and industry involvement. The task force is looking for assistance in deepening its understanding of issues concerned with implementing and improving advanced quality concepts. They have developed a questionnaire to solicit detailed industry input on advanced quality concepts. The questionnaire and further information on the project has been posted to the following web site: <http://socrates.ida.org/quality>.

World Wide Web Page

- **URL—<http://socrates.ida.org/quality/>**
- **Links**
 - **Quality Resources On-Line**
 - **American Productivity and Quality Center**
- **Links Requested**
 - **ASQC**
 - **The Benchmarking Exchange**
 - **Computer-Aided Manufacturing-International (CAM-I)**

RESPONDENTS

This chart shows the respondents to date to the questionnaire. It clearly shows the heavy defense industry participation. IDA continues to try to get responses from commercial industry, but there seems to be a lack of motivation. Government isn't their customer.

Respondents

- * Abbott Laboratories
- AAI Corporation
- Bell Helicopter Textron
- Boeing Defense & Space Group
- * Eastman Chemical
- EDO Corp, Govt Systems Div
- * Electronic Ind. Quality Registry
- GE Aircraft Engines
- GenCorp Aerojet
- Harris Corp, Air Traffic Control Systems Division
- Hughes Space & Comm.
- Loral Space Systems
- Newport News Shipbuilding
- Lockheed Martin
 - Aeronautical Systems
 - Astronautics
 - Defense Systems
 - Govt. Electronic Systems
- Northrop Grumman
- Orbital Sciences
- Parker Aerospace Group
- * Raytheon
- Rockwell
- Rockwell International
- Sundstrand Corporation
- United Tech. Hamilton Std.
- Westinghouse Electric
- * Majority of sales commercial.

AREAS OF EMPHASIS

IDA grouped the 16 questions from the initial format of the questionnaire into three broad areas of interest: internal practices, supplier relationships, and customer relationships. We deliberately avoided defining or calling out any specific AQPs in the questionnaire with the rationale that industry respondents would define what they considered to be AQPs.

Regarding the use of AQPs within their company, respondents were asked:

- What were the significant lessons learned in the development of your basic quality system? How did you determine what worked and what didn't?
- What factors have been significant in defining the priority that your company places on the effectiveness of your quality process?
- To what extent do incentive or penalty mechanisms motivate you to improve the effectiveness of your quality practices or quality management system?
- How does your organization define or recognize advanced quality practices?
- How do you assess the risk or potential benefit from the use of a proposed advanced quality practice?
- What metrics do you use to capture the effectiveness of advanced quality practices?
- How do you measure the effectiveness of advanced quality practices or otherwise recognize their payoff?
- How do warranties impact your decision on whether or not to implement an advanced quality practice?

Regarding subcontractor relationships, respondents were asked:

- How do you motivate the performance of your subcontractors?
- To what extent do you use incentives or penalty mechanisms to motivate your subcontractors?
- How do you encourage your subcontractors to pursue advanced quality practices?
- How do you value subcontractor implementation of advanced quality practices?

Regarding market share and customer relationships, respondents were asked:

- How do you identify customer expectations and how do you translate these into expectations of your quality system?
- To what extent do you tailor your quality system to meet these expectations?
- What key indicators do you use to measure customer satisfaction?
- How do you perceive quality as a factor in obtaining market share?

Areas of Emphasis

- **Internal Practices**
 - Motivation for improving quality system
 - Definition, measurement, priority for AQPs
- **Supplier Relationships**
 - Motivating supplier performance
 - Encouraging supplier use of AQPs
 - Value of subcontractor use of AQPs
- **Customer Relationships**
 - Identifying customer expectations
 - Tailoring quality system
 - Measuring customer satisfaction

INTERNAL PRACTICES

INTRODUCTION TO INTERNAL PRACTICES

The questions in this section dealt with the internal quality system and the use of advanced quality practices in the respondent's own organization. Selected responses follow.

Our current quality system reflects policy for all functional and product entities of the company. As we developed this system, we found that it was important to prescribe clear policy, but allow flexible implementation that suits the different function business areas so that effectiveness and efficiency are optimized. Also, our policy was established by senior managers from all disciplines; this assured us the buy-in, understanding of the system, and familiarity necessary for flow-down training.

The quality system was "Quality Control" oriented. As a result, the ownership of quality was very functionalized. Development projects were transitioned into production poorly, as that is where most of the problems were manifested. Advanced techniques, like TQM and ISO 9000, promote quality across all participants of the business, from development through production. Quality becomes inbred into every process, and the responsible party held responsible.

Traditional corrective action did not always address processes or systemic problems. Corrective action was focused on an individual part number or problem. While the immediate problem may have been corrected, it might show up again at a later date or in another area. Therefore, we believed that we must implement advanced quality methods to determine the capability of processes and the interaction of factors or process parameters.

When we first implemented advanced quality methods, our teams tended to focus on trying to correct problems they received from their suppliers (internal and/or external). We learned that we must learn to focus first on improving our own processes.

In flowing down advanced quality requirements to our external suppliers, we learned that we can be most effective if we first educate the internal customers about their own key characteristics, statistical methods, and methods for flowing down key characteristics.

Each team monitors the cost and effect of their process improvement cycles. Early in developing the team's charter, the team states their "expected results." These expectations may be in the form of reducing variation, defects, costs, and actual time involved in the process. They may also expect to improve internal or external customer satisfaction.

Upon completion of an improvement cycle, the team may review costs and effects, or benefits of the activities, or tasks that were accomplished by the team. The costs and effects fall into four basic categories: cost, time, quality, and customer satisfaction. Cost and time expenditures or benefits may be either nonrecurring or recurring.

WHAT WERE THE SIGNIFICANT LESSONS LEARNED IN THE DEVELOPMENT OF YOUR BASIC QUALITY SYSTEM?

The majority of responses to this question are reflected in the accompanying chart and the following representative responses:

The single most important lesson learned is the importance of a top-down management commitment to the quality system. This is also stressed in the ISO 9000 quality system standard. The next most important lesson is meeting requirements in a manner that serves your own needs whenever possible.

Too often, the quality system was overdocumented. There was a huge tendency to spell out exactly how to do something rather than what should be done. The system became very bureaucratic and did not allow flexibility to deal with different situations. As a consequence, different systems or procedures sprang up. The rigidity did not permit wholesale improvements across the business, or allow the implementation of new techniques.

Our procedures tended to be written at too high a level of understanding with subtler documents referenced for clarification. Attainment of the desired outcome was more appropriate when the procedures were documented to the level of the user to the extent necessary to allow consistent implementation.

Responses differed on whether a common process was needed across the facility and whether it should be tailored. The following comments illustrate this point.

Less is better, and promote a single quality system for all organizations, products, and customers. Our prior Burger-King approach (infinite program variation) was a continuous audit trap and a communication nightmare.

You have to tailor the basic system to meet the specific rewards of the program, and you need to emphasize early product and process characterization and control through statistical methods.

Critical processes must be uniformly practiced across business areas with tailoring for unique programs and a requirement approval by the process owner.

What Were the Significant Lessons Learned in the Development of Your Basic Quality System?

- **Top management commitment is essential**
- **Quality is everyone's responsibility—not a department**
- **Keep it basic, simple, and consistent—less is better—don't overdocument**
- **Train, train, train**
- **Inspection does not assure all requirements will be met**

HOW DID YOU DETERMINE WHAT WORKED AND WHAT DIDN'T?

Responses to this question fell within 4 categories: customer feedback, implementation team feedback, no choice (regulatory requirement), the ever popular trial and error, and the more analytical measurement and data. Selected responses demonstrate these categories:

Our quality system has grown up over a period of 40 years and, as a result, has many arms and legs. It is almost easier to start from scratch, and redefine a system if a company is small enough. Have gone through reams of procedures over the years and found out whether they worked or not by performing them and getting input from employees.

What worked and what did not was to a degree driven by our customers. Their feedback was generally incorporated to change our quality system.

It had to meet the customer (and regulatory agency, i.e., FAA, JAA, DCMAO) requirements, and be compatible with the manufacturing operations.

Evolving from a simple inspection system to a defect correction system, and then to a defect prevention/avoidance system, required the integration of new methods, and the involvement/acceptance of responsibility by various disciplines. The procedure generally used to implement changes was as follows: preview the program, train the trainer, empower the employee, change course as soon as it doesn't work, listen to feedback.

We pick a system and put teams together to ensure that it gets the appropriate attention.

Trial and error. Adjustments made based on measured results or output.

The current quality system has evolved over the past 40-plus years. Strong customer input, DoD, etc., has shaped the current system. Other regulatory agencies, FAA, JAA, OSHA, etc., have also been instrumental in forcing change. Technology changes, materials, processes, etc., have also forced change. Empirical data has determined if the changes were effective.

What works is determined by implementation accompanied by constant measurement of results.

How Did You Determine What Worked and What Didn't?

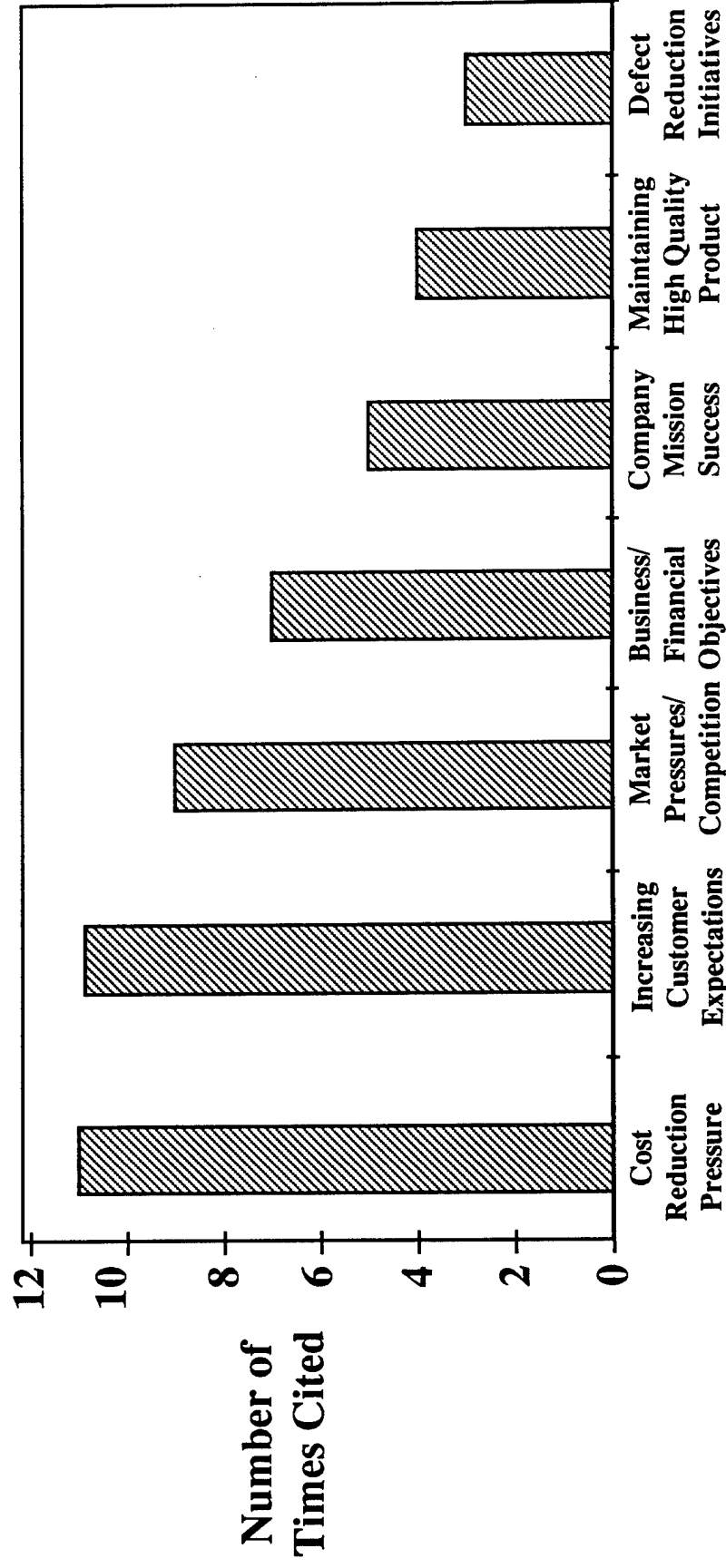
- **Customer feedback**
- **Implementation team feedback**
- **No choice—regulatory requirements**
- **Trial and error**
- **Measurement of results**

WHAT FACTORS HAVE BEEN SIGNIFICANT IN DEFINING THE PRIORITY THAT YOUR COMPANY PLACES ON THE EFFECTIVENESS OF YOUR QUALITY PROCESS?

Responses to this question fell within the categories shown on the facing page. Market pressures were paramount—specifically from increased customer expectations, competitive pressures, or cost reduction needs. Next came the companies' internal objectives, which, of course, are also driven by market pressures. These objectives included the company mission success, business and financial objectives, and the goal of maintaining a high quality product and reducing defects. One commercial company, structured entirely of teams, states:

We have four foundation documents that define the corporate culture goals. These documents are hung on the walls throughout the company. They are statements of the company policies and methods to achieve the strategic goals. During team meetings, members refer to the documents to see where they are linking into the success of the company overall.

What Factors Have Been Significant in Defining the Priority That Your Company Places on the Effectiveness of Your Quality Process?



TO WHAT EXTENT DO INCENTIVE OR PENALTY MECHANISMS MOTIVATE YOU TO IMPROVE THE EFFECTIVENESS OF YOUR QUALITY PRACTICES OR QUALITY MANAGEMENT SYSTEM?

Answers to this question varied from "none at all" to "a great deal." The following comments illustrate the range of comments received:

To a great deal. Certain contracts apply incentives to the number of MRB-type actions; this compels us to control MRB activity by identifying root causes for problems and preventing recurrence. Incentives applied to delivery dates compel us to maintain high quality standards to build things right the first time, and develop new ways to reduce cycle time.

We do not have incentive or penalty mechanisms in our contracts to improve the effectiveness of our quality practices or quality management system; rather, we are motivated to improve quality practices so we can reduce costs and meet corporate performance goals.

Penalty mechanisms or incentives are not flowed down to the functional areas. Therefore, money is not a factor in improving quality. Cost effect on Quality is a result of the quality programs being effective.

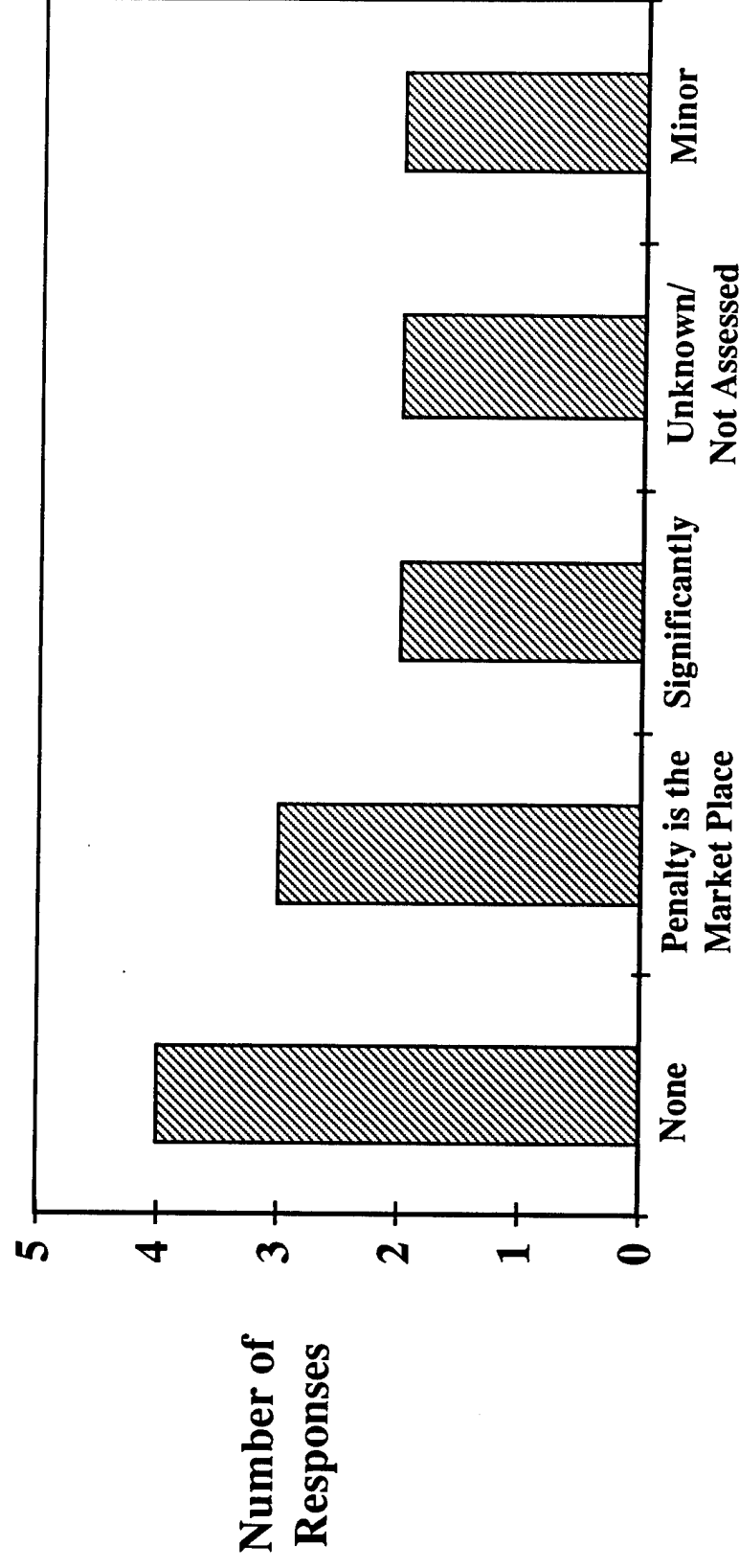
The ultimate goal for products/services we produce/provide is customer satisfaction. While incentives or penalties derived from producing these products/services do influence continual improvement of policies, procedures and practices, we believe these influences to be minor, and our goal will be accomplished with or without them.

Many comments focused not on contract incentives but on recognition and rewards of the employees:

Continuous improvement is a companywide initiative. The incentive for improving the effectiveness of quality practices resides in the "pay-for-performance" merit review system. Corporate and company strategies/goals, including quality improvement, cascade throughout the company, resulting in stretch goals for and accountability by every employee.

High level of positive incentives involving public recognition of exceptional performance. Examples include quality recognition program, AEGIS excellence awards, corporate honors nights, nights on the town, family days, evenings of excellence, etc. Employees at all levels understand the penalties that the market place will assess if performance does not constantly improve.

To What Extent Do Incentives or Penalties Motivate You to Improve Your Quality Practices or Management System?



HOW DOES YOUR ORGANIZATION DEFINE ADVANCED QUALITY PRACTICES?

Of the three respondents who made no distinction of AQPs, one response was a flat “we don’t,” one sounded as if the company just had not gotten to that point yet, and one made no distinction because of the nature of the product:

We don’t use and train for, nor do we distinguish, advanced quality practices.

We have not yet established an effort to define or recognize “advanced quality” concepts or practices.

We do not make a distinction between our standard business practices and quality system and “advanced” quality concepts or practices due to the nature of our product. Our product is long-life (operational lifetime up to 15 years), highly reliable spacecraft and communications systems.

One company made the following significant point:

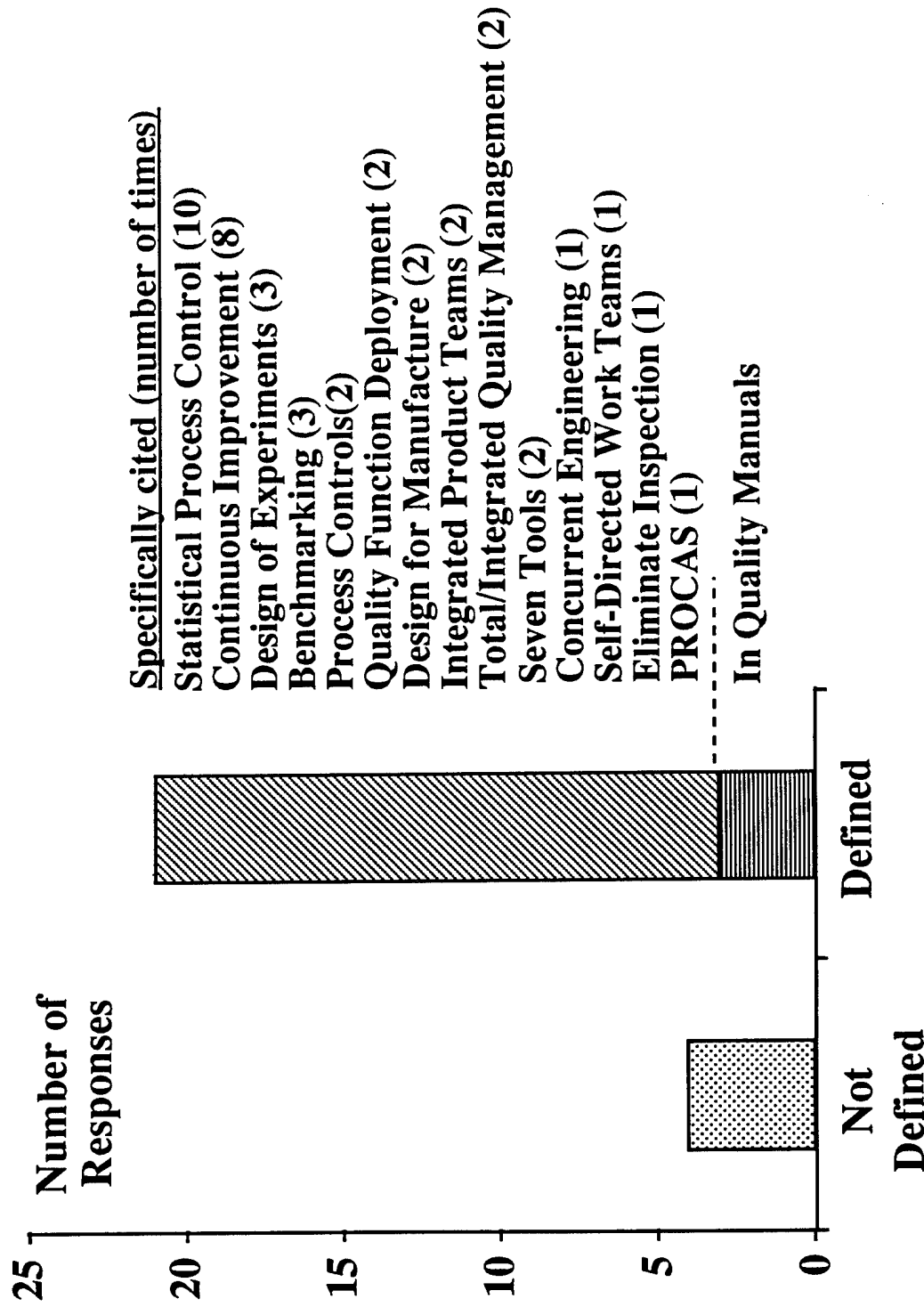
Three factors need to be considered as an integral aspect of an examination of advanced quality practices. First, advanced quality practices change as the state-of-the-art progresses; therefore, what is advanced today will not be in the future. For example, quality circles were considered to be advanced in the early 1980s, and Taguchi methods were advanced in the early 1990s. Neither of these practices are generally considered to be advanced today. Second, the rate of new practice development has increased dramatically; thus that time between when a practice is advanced and when it is routine is shortening. Finally, advanced quality practices need to be considered within an organizational context, not as a stand-alone evaluation, because what may be advanced for a design or low rate production enterprise may not be for a commodity manufacturer, and vice versa. Because of these factors, any definition of advanced quality practices must be time and contextually sensitive. This would defeat the purpose of trying to compare organizations based on their application of some arbitrary list of what may be advanced quality practices, or they may be a passing fad. Therefore, it is difficult to have a precise definition of advanced quality practices; rather, [industry] should continually scan the environment for new techniques, pilot those that appear to fit the mission, and adopt those that prove to be effective.

Key characteristics were also mentioned:

Functional organizations define key quality characteristics of their products and processes. These are tracked and reported to upper management as required.

We also flowdown key characteristics to suppliers.

How Does Your Organization Define AQPs?



HOW DOES YOUR ORGANIZATION RECOGNIZE ADVANCED QUALITY PRACTICES?

“Recognition” here seemed to be interpreted either as “finding them out” or as recognition of the people doing the work. The general comments are summarized on the facing page, and the following comments illustrate the variety of answers received.

Advanced Quality concepts are recognized anywhere within the business. Suggestions for consideration are given to the responsible management. Teams may be set up to evaluate the feasibility and return for implementation of the concept. If deemed appropriate for a particular project, a procedure defining the concept and approach would be prepared and supplement the baseline quality system for that project. If the concept were deemed a “best practice,” it would be included by procedure into the baseline system for universal application.

Advanced Quality concepts are identified through benchmarking industry practices, incorporate information sharing via Executive Quality Council and participation in appropriate industry/government committees establishing policy. When an advanced concept is identified, internal policy is revised to provide implementation. Development and implementation of new policy is the responsibility of an executive Continuous Improvement Council.

Constantly looking for better ideas from any source—our people, our customers, our competitors, and world class organizations (benchmarking).

We encourage all employees to search for innovative ways to improve quality, reduce costs, and perform at or ahead of schedules. We recognize individual and group efforts.

How Does Your Organization Recognize AQPs?

- **Constantly searching for new ideas**
 - **Employees, customers, intercorporate information sharing**
- **Training and internal performance assessment**
- **Recognizing individual and group efforts**
 - **Standup meetings, printed publications, electronic news network**
- **Management support and commitment**
 - **Establish corporate policies, procedures, handbooks**

HOW DO YOU ASSESS THE RISK OR POTENTIAL BENEFIT FROM THE USE OF A PROPOSED ADVANCED QUALITY PRACTICE?

Responses to this question ranged from pilots before implementation to analysis and real assessment to no assessment at all. In the "taken as a given" category, typical responses were:

We anticipate real benefits from the use of AQS concepts. We believe there will be a reduction in our cost of quality ratios, there will be more certified suppliers, and a greater use of operator verification where processes are characterized and statistical controls are utilized.

The risk is believed to be minimal.

In some companies, the benefits are surmised as part of the continuous improvement program or by gut feel:

The only way we can achieve our company vision is to improve continuously. Therefore, we have adopted continuous improvement using advanced quality methods as a way of doing business. We do not assess the risk or potential benefit for each and every use of an advanced quality practice.

Risk is analyzed prior to introduction of any process change; benefits are usually estimated by gut feel and experience.

For some the benefit had to be proven:

An Advanced Quality policy is not adopted unless there is clear evidence of its effectiveness. Once adopted, metrics are established to measure its effectiveness.

Advanced quality practices must provide a benefit, i.e., improved quality, lower cost. Each pilot program is assessed by the pilot team and their management as to expectations and risk. Risk may be contained by the size of the pilot program.

Real risk assessments also occur:

Assess the risk or benefit of a proposed practice by understanding the process in question and analyzing available data to determine the cause and effect of the proposed change. In order to do this effectively, multifunctional teams are often established if the proposed practice is significant so that all risks and benefits can be addressed. Special metrics could then be used to monitor the change when implemented.

However, some people either left this blank, stated that they did not understand the question, or flat out said that no risk assessment was done at this time.

How Do You Assess the Risk or Potential Benefit From the Use of Proposed AQP's?

- **Benefit taken as a given (no assessment)**
- **Part of continuous improvement philosophy—don't measure individually**
- **Pilot programs, trial run, or study period prior to implementation**
- **Management review/evaluation**
- **Cost and risk assessment**
- **Analysis—cause and effect**

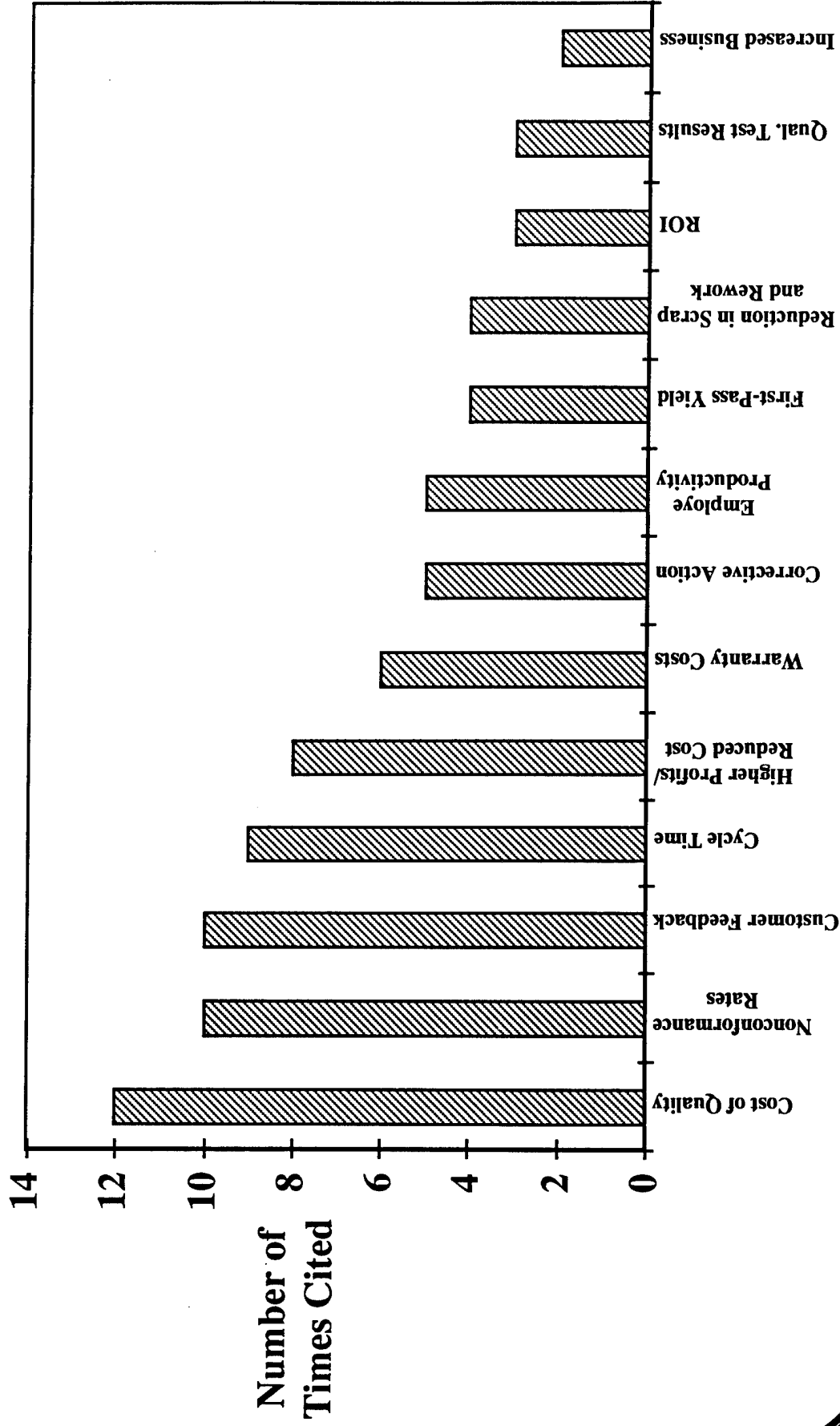
WHAT METRICS DO YOU USE TO CAPTURE THE EFFECTIVENESS OF ADVANCED QUALITY PRACTICES?

The facing page shows the types of metrics generally reported by the respondents. How the metrics are used is illustrated by the following comments:

Metrics are collectively decided by the team and its customer. The focus is on the rate of change from last period to current period. Goals are based on tenfold improvement and Six Sigma company status by year 2000.

The metrics will vary according to the practice being measured. Advanced concepts are implemented in the design process to improve quality; the metrics include monitoring design changes and causes for the errors. Advanced concepts are implemented in the area of corrective action evolving from simple correction of a deficiency to root cause determination to prevention of repetitions; the metrics include monitoring the overall customer failure trend for potential corrections to continuously improve the customer satisfaction. A more general but key measurement throughout the process is the cost of quality which, if properly defined and measured, can provide valuable information on the effectiveness of the quality system.

What Metrics Do You Use to Capture the Effectiveness of AQPs?



HOW DO YOU MEASURE THE EFFECTIVENESS OF ADVANCED QUALITY PRACTICES, OR OTHERWISE RECOGNIZE THEIR PAYOFF?

This was another question where "recognition" was interpreted as awards (Malcolm Baldrige, state productivity awards, business journal recognition, etc.). Other responses provided more analytical answers.

In order to increase communication and provide a forum for the discussion of quality issues, a regular monthly meeting attended by the senior representatives of both the company and the resident customer is held. Specific data from various areas of the total quality system are presented and the trends analyzed. The purpose is to mutually assess the effectiveness of the quality system. If a shortfall is observed, projects are initiated to enhance or improve the system.

Intangibles—customer satisfaction index, design team satisfaction ratings, suggestion program (as an indicator of morale), etc.

Effectiveness of advanced quality is measured by the team and team's sponsors. Identified savings are considered as returned money to the programs, and return on investments are realized real time.

We measure the effectiveness of our practices and/or changes to those practices through financial, reliability, and quality tradeoff studies. These studies are validated by tracking budgetary performance, nonconformance rates, cycle times, etc.

We measure their effectiveness by comparing the performance of the unit piloting the new practice with either their past performance or the performance of a control group.

We measure their effectiveness by their collective impact on the cost of quality whereby we measure, virtually real time, the cost of compliance and noncompliance.

Analysis preferably statistical.

By the improvement in our metrics, product acceptance rates, and bottom line.

Benefit is determined by reductions in defect rate.

If required by customer, increased customer satisfaction; if self-implemented, reduced costs.

How Do You Measure the Effectiveness or Recognize Payoffs of AQPs?

- **Outside recognition, awards**
- **Customer and/or design
team satisfaction**
- **Statistical and other types of
analysis**
- **Improvement in bottom line**

HOW DO WARRANTIES IMPACT YOUR DECISION ON WHETHER TO IMPLEMENT AN ADVANCED QUALITY PRACTICE?

No responses were received on implementation of specific advanced quality practices. Answers were given as overall implementation of advanced quality practices. Given that, there was a direct dichotomy in the answers to this question. Respondents said warrantees either did or didn't have an impact. There were few answers in between. To those who said that warranties had no impact, the following was typical:

Warranty claims and costs are continuously monitored and evaluated. A multidisciplinary reliability board with primary responsibility for reliability issues evaluates data, sets priorities, and initiates actions including advanced quality practices. Analysts monitor warranty costs and component life cycles to categorize/establish infant mortality rates.

Warranties are a way of life in our contracts. However, advanced quality practice is driven from the pressure of competition, as opposed to the fear of failure.

The decision to implement advanced quality practices was based not on warranty claims but on the desire to produce a quality product at a reasonable price.

Advanced quality (continuous improvement) is our way of doing business and is required by our customers. Warranties do not impact the decision.

Those who said warranties have an impact often downplayed it:

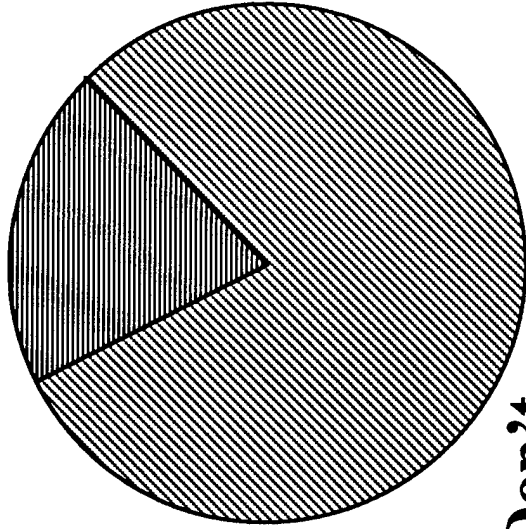
While the performance against warranties is certainly affected by the quality of the product, other factors also affect warranty performance such as the design margins, inherent reliability of the product, and organizational strategy to provide rapid warranty service.

Warranties have little *direct* impact on our use of advanced quality practices since our products have always exhibited extremely high reliability with excellent customer satisfaction. However, advanced quality techniques improve production rates and costs, and a percentage of savings is shared with our major customer.

One defense industry respondent thought that warranties were very important in commercial sector, not much in defense. However, one commercial company said that warranties were not applicable in their decisions on whether to implement an advanced quality practice.

How Do Warranties Impact Your Decision on Whether To Implement an AQP?

**Only Indirectly
(3 Responses)**



**They Don't
(12 Responses)**

SUPPLIER RELATIONSHIPS

INTRODUCTION TO SUPPLIER RELATIONSHIPS

This section addresses relationships with suppliers and the effects on the supplier's quality system and use of advanced quality concepts. Throughout, answers stressed sharing, partnering, and teaming in an atmosphere of mutual trust. Selected comments follow.

Suppliers are regularly advised of their performance rating and comparison to their peers. Those suppliers with excellent ratings are pursued for long-term procurement agreements, and are also allowed to self-release product without scheduling procurement oversight inspections. Suppliers who cannot improve are penalized due to additional oversight requirements which affect their ability to deliver at will and, ultimately, these suppliers are eliminated if improvement is not realized.

We have placed substantial emphasis on partnering with suppliers who complement our core competencies with technology access, risk sharing, responsiveness, adherence to schedule with exceptional product/service quality, environmental consciousness, electronic communication capabilities, and innovation. We are currently working to establish stronger relationships with key suppliers through enhanced communication, up-front involvement in integrated process teams, total supply chain measurement and feedback, awards based on total value/cost, and training both internally and with our supplier partners. We have provided our vision of the future to our suppliers of an optimized supplier base structured as an extension of our company, connected electronically, economically, and with a common goal. Part of this vision includes our preferred supplier process which provides overall process measurement and feedback, supplier/CAD improvement teams, and technical support. Our key supplier partners recognize the criticality of continuous improvement to continued business success of both our businesses, and they are anxious to participate in these joint activities which result in improved requirements, understanding, and joint process improvements.

We do not have a formal program to encourage subcontractors to pursue advanced quality concepts/practices; however, it is done informally between our Supplier Quality personnel and the subcontractors. There is a lot of one-on-one communication, exchanging ideas, and suggesting improvements. The practice of working together as a team is also encouraged.

Over the years, we have attempted to establish working partnerships with our supplier community. New quality concepts are often discussed with suppliers, and teams set up to implement them. If the concept is more general across many potential suppliers, our company has sponsored symposia to convey the message and strategy to the supplier community to foster buy-in and implementation. We have offered training to the suppliers or assistance in implementation at their facilities to facilitate incorporation.

HOW DO YOU MOTIVATE THE PERFORMANCE OF YOUR SUBCONTRACTORS?

The majority of responses listed supplier ratings and certification programs as the motivating factor for supplier performance. One example follows.

Subcontractor performance is motivated through communications and with our use of a vendor rating system which assigns a numerical rating to all subcontractors. The rating, called the "Total Cost Factor," includes defects found during our receipt inspection, defects at the subcontractor's facility, and delivery performance. Good ratings impact the prospect that a subcontractor will be awarded a contract.

Next was the promise of future business and actual teaming and partnering with the suppliers.

We expect suppliers to supply 100 percent acceptable material. We offer them help, take them on as partners, award high quality indicator suppliers with more business by giving them a bidding advantage and, finally, we put them on our "excluded supplier list" if they do not comply with our requirements and fail to correct their performance. We do not require them to operate in any particular way as long as their output remains high quality. However, most suppliers find that the use of some advanced quality concepts gives them a market advantage.

Direct feedback is a result of all the preceding categories, but was called out in a few cases without mention of a formal program. Less oversight is also the result of many of these motivation factors, but again it was specifically called out in a few cases.

A "preferred supplier" program recognizes continuing good performance and offers rewards such as extended audit intervals and reduced recurring inspection. Parts from exemplary suppliers may go directly to stock upon receipt.

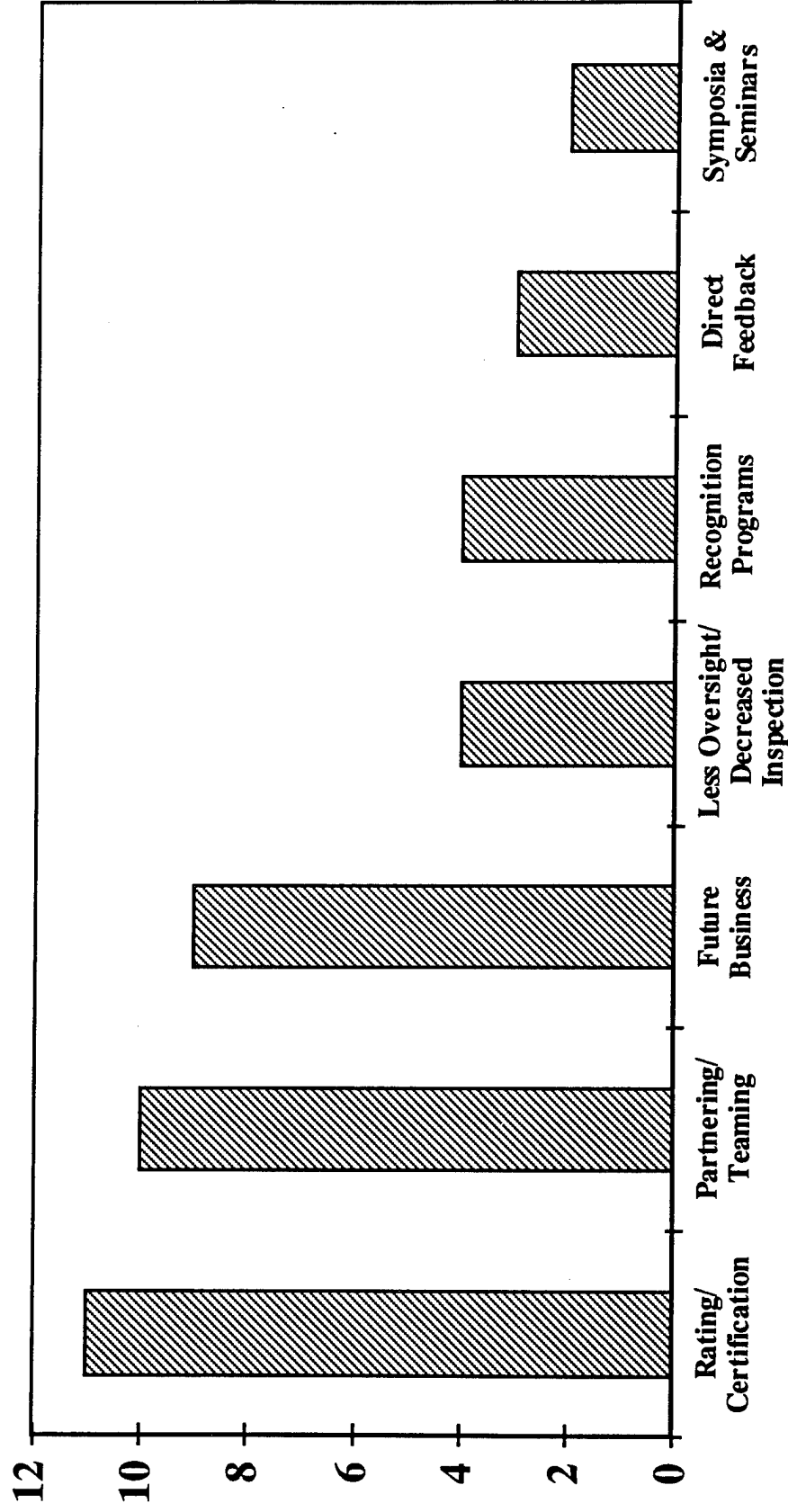
The Certified Supplier Program or CSP, allows a certified supplier to deliver material dock-to-stock without contractor oversight. The desire to eliminate redundant inspections and source appraisals, and to appreciate the corresponding cost reductions is real. The motivation to meet and maintain the stringent CSP requirements is evident. Retention in the CSP allows reduced operating cost, improved competitiveness, and greater potential for future follow-on business, extremely critical in times of decreased defense spending.

Recognition programs and symposia and seminars were also noted. Some responses were very blunt.

If no SPC program, then no work.

Penalty threats considered counterproductive and absorb resources.

How Do You Motivate the Performance of Your Subcontractors?



TO WHAT EXTENT DO YOU USE INCENTIVES OR PENALTY MECHANISMS TO MOTIVATE YOUR SUBCONTRACTORS?

As the accompanying chart shows, companies either used incentives or penalties a great deal or not at all. Many used incentives but still believed that penalties were counterproductive. A few selected answers follow.

Motivation of our subcontractors is mostly in the form of negative incentive. Poor performance (quality wise) will impact their quality rating and, if bad enough, will cause them to go to a RED status. This rating will preclude them from receiving new orders until the trend is reversed.

We primarily motivate suppliers with penalty mechanisms.

We mostly use incentives based upon delivery dates or improvements thereto. Penalty mechanisms are almost never used.

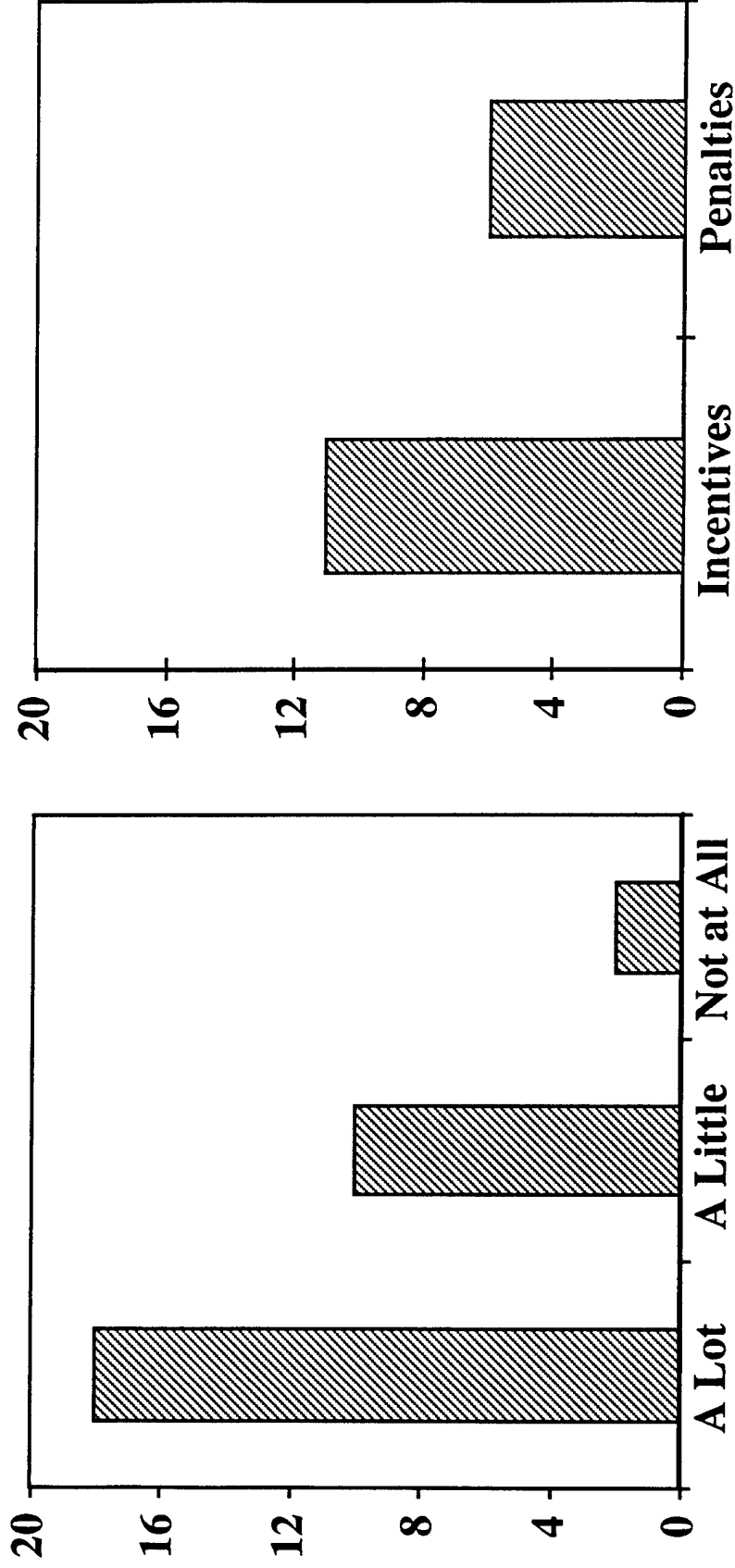
Neither incentives nor penalties are a part of our subcontracts. Our prior experience indicates that both are only negative motivators.

No penalty mechanisms for failure by subcontractor to implement advanced quality concepts are in place at this time. If the requirement to implement an advanced quality concept/practice is required by our customer to be flowed-down to the subcontractor, the penalty for failure to implement the concept/practice by the subcontractor is subcontractor disqualification.

And again the blunt answer that industry has no trouble in making:

Our motivation/penalty mechanism is simple. If the supplier does not use SPC techniques, we look for a new supplier that will.

To What Extent Do You Use Incentives or Penalty Mechanisms to Motivate Your Subcontractors?



HOW DO YOU ENCOURAGE YOUR SUBCONTRACTORS TO PURSUE ADVANCED QUALITY PRACTICES?

Many respondents used the same answer here as to the question "How do you motivate the performance of your subcontractors?" For example, the following response was received for that question, but here we place emphasis is on the italics, causing the reader to conclude that advanced quality practices are not a requirement.

We expect our suppliers to supply 100 percent acceptable material. We offer them help, take them on as partners, award high quality indicator suppliers with more business by giving them a bidding advantage and, finally, we put them on our "excluded supplier list" if they do not comply with our requirements, and fail to correct their performance. *We do not require them to operate in any particular way as long as their output remains high quality. However, most suppliers find that the use of some advanced quality concepts gives them a market advantage.*

Many others also used business drivers for motivation.

Show suppliers they will no longer be competitive without it.

By sharing our success with the implementation of these concepts and the improvement to their bottom line.

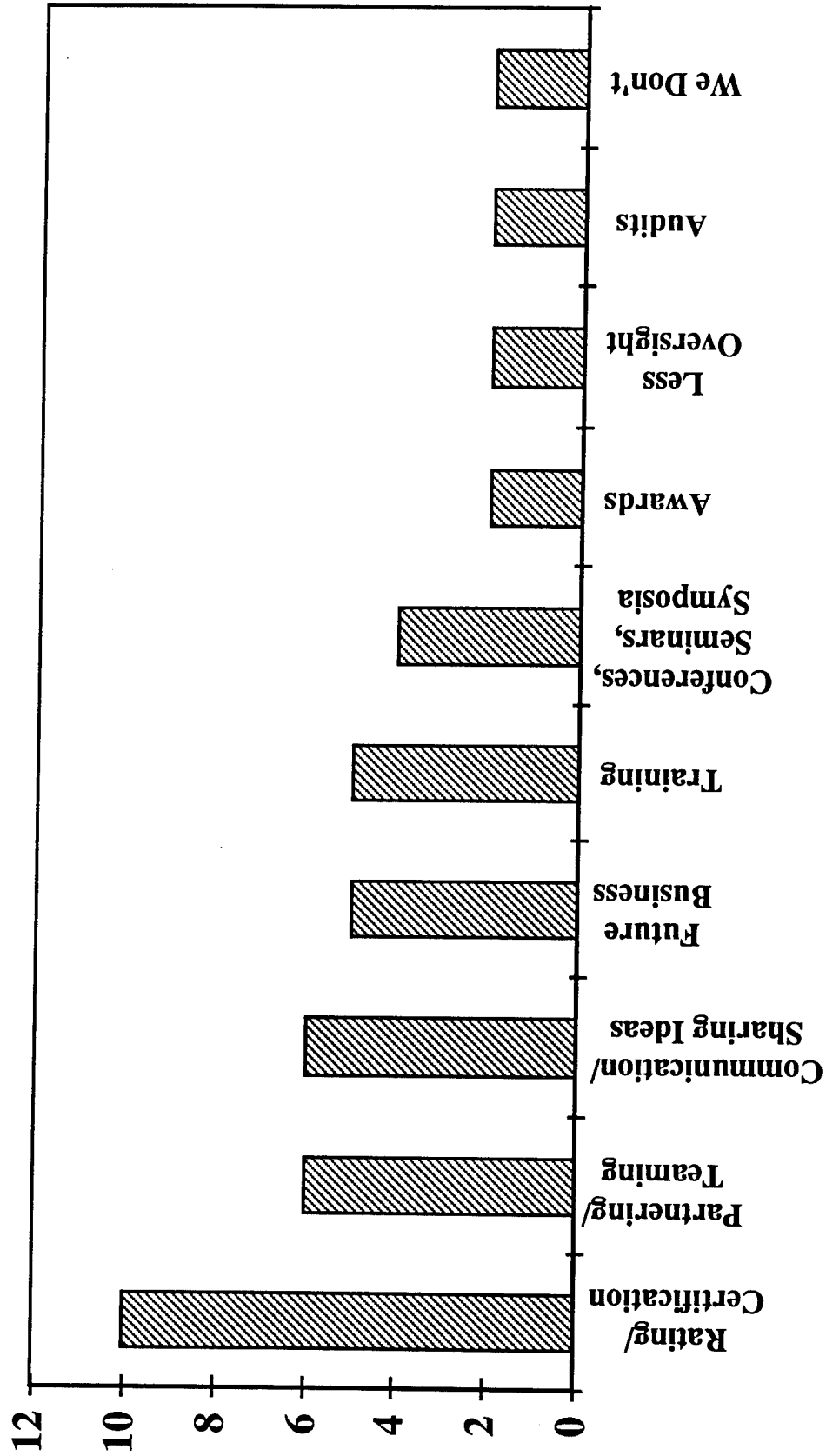
Other responses talked about the difficulties encountered.

We are not, as a company, currently pursuing any advanced quality initiatives with our subcontractors. There may be isolated cases whereby a subcontractor has taken some initiatives on their own and we are generally supportive. We have attempted to promote initiatives with our subcontractors in the recent past only to be met with reluctance or outright resistance. Almost without exception, our supplier community sees these initiatives as out of scope and want to negotiate cost. In our current environment of fixed price contracts, renegotiation is generally not feasible.

But again, some were very specific:

To be fair to our suppliers, we have decided that everyone must have an SPC program, certified by us, working to monitor the process output for these processes which control key characteristics as defined by the supplier. This should give each supplier a level field for our contracts. Those suppliers that make the biggest improvements in reducing scrap, rework and repair, and those that have improved the quality level of their product, should have a competitive edge over his competition that have not realized the savings from proper implementation of SPC.

How Do You Encourage Your Subcontractors to Pursue Alps?



HOW DO YOU VALUE SUBCONTRACTOR IMPLEMENTATION OF ADVANCED QUALITY PRACTICES?

The majority of respondents said they valued the use of advanced quality practices by their suppliers. Answers such as the following show that it is integral to their business processes.

The performance of subcontractors is integral to our ability to meet customer commitments. Management of our supplier resources through partnership development, continuous product and performance improvement, and strategic alliances forms the foundation of the supplier management process.

Implementation of advanced quality practices at subcontractors is critical for the subcontractor to meet the quality/cost/productivity challenges for continued business.

Implementation of advanced quality practices is mandatory for the future of our supplier partnerships. While we do not mandate what form the quality process takes in our suppliers' processes, continuous improvement in some form is becoming a requirement.

Implementation of appropriate advanced quality practices at our subcontractors is very important if it results in improved performance and lower cost.

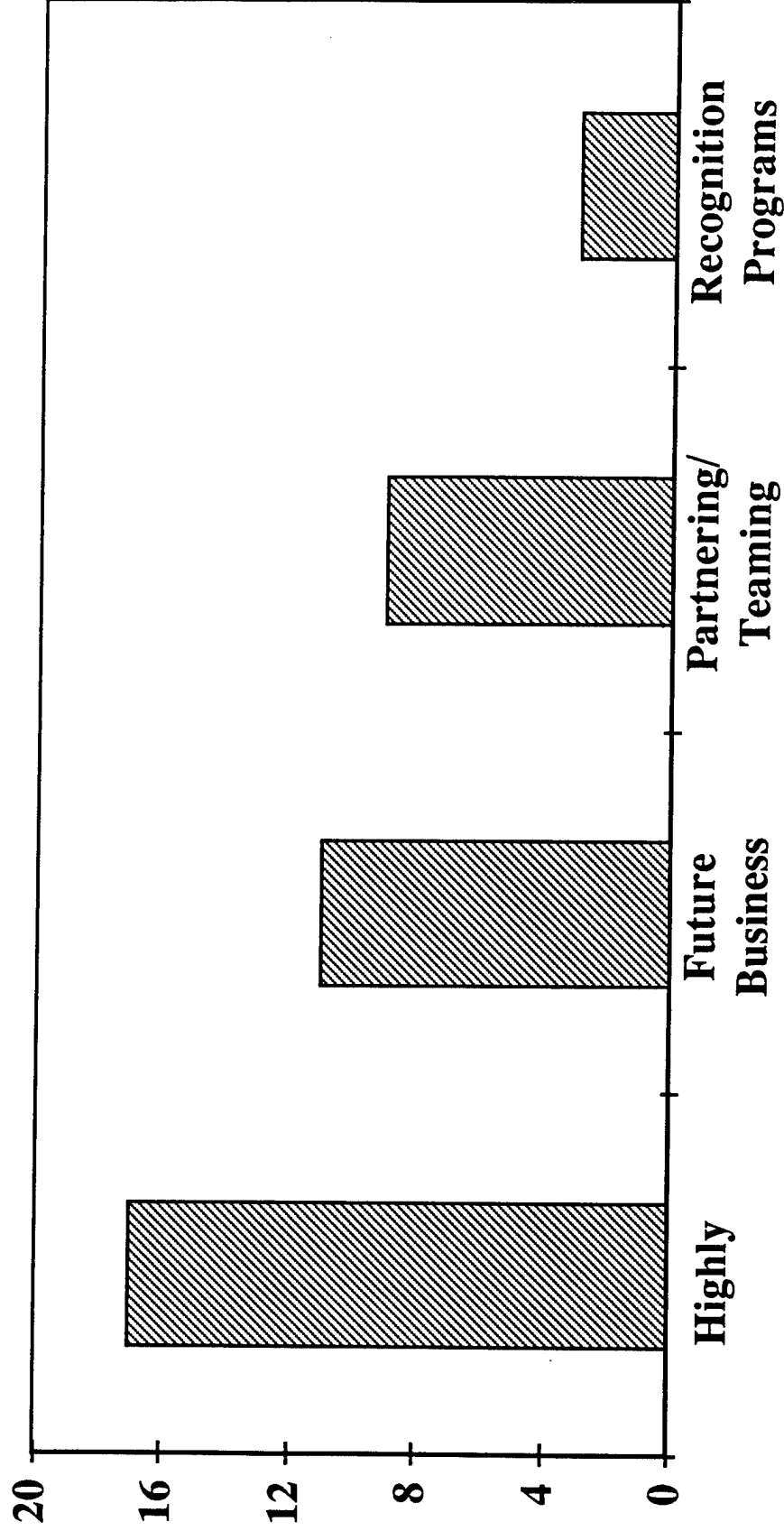
Then there were those that insisted on its use.

Highly valued. So much so that many advanced techniques are required for participation in our certification program. New changes are encouraged often via a value engineering sharing scheme.

Since 70 percent of our base is subcontracted, a quality system is mandatory at our suppliers.

Again, many people used the same answers given to previous questions and interpreted "how do you value" not on a ranking basis but on a "how do you do it" type of reaction.

How Do You Value Subcontractor Implementation of AQPs?



CUSTOMER EXPECTATIONS

INTRODUCTION TO CUSTOMER EXPECTATIONS

This section focuses on an organization's relationship with its customers and how quality relates to market share. The sharing and teaming concept was not quite as prevalent here, except for the commercial industry responses. In the defense world, the integrated product and process development (IPPD) and performance specification initiatives are just beginning to incorporate the government customers on the teams. Industry still relies heavily on contract requirements, as the following comments illustrate.

Since the majority of our business is still with the government, customer expectations on production programs are communicated through the contract. In the product development areas, our marketing will identify the customer drivers.

Customer expectations are identified through various forms such as contracts, award fees, verbal communication, and customer rating systems. In addition, we have teaming arrangements with various customer levels.

Customer specifies "acceptable" quality (and delivery) performance in the contract and issues periodic performance measurement data.

Contract requirements also drive system requirements.

Customer expectations are received in contractual documents for the basic quality requirements.

Company strategies are directed to meet/exceed customer requirements and expectations. Cost control and continuous quality improvement are inherent in these strategies—knowledge of customer satisfaction/expectations is essential for tailoring the quality system.

Times are changing, however, as these comments show:

The customer also was aware of our successes in implementing advanced quality concepts and expected application of them to this program.

Customers expect product to meet and exceed the performance of the specifications. We assure our process and quality system achieves their expectations.

Market share in future domestic and international markets will be increasingly determined by highest quality, together with best price. Both demand effective quality systems, and neither is achievable alone.

HOW DO YOU IDENTIFY CUSTOMER EXPECTATIONS?

The majority of responses, since the majority of respondents were from the defense industry, said that the customer expectations were spelled out in the contract. A typical response follows.

Since the majority of our business is still with the government, customer expectations on production programs are communicated through the contract. In the product development areas, our marketing will identify the customer drivers.

Formal surveys were also used, particularly at commercial companies.

A comprehensive Customer Satisfaction Assessment Program (CSAP) in which external and internal customers are interviewed quarterly and every six months, respectively. Customers are asked to rate organization units on quality, responsiveness, schedule performance, technical competence, and value. In addition, there are other factors which may be rated, and customers may pick their own if they wish. Ratings are averaged over all customers interviewed.

Customer expectations are identified through surveys, customer forums, product support representatives, air shows, delivery audits, etc. Customer expectations of quality are defined in terms of problems/lessons learned, and actions are taken to prevent recurrence and to modify the existing system when required.

Benchmarking was cited as a popular activity and Quality Function Deployment was used frequently.

We organize our product centers around customers wherever possible. We regularly solicit input from our customers as part of our benchmarking, and have our customers be part of our policy development.

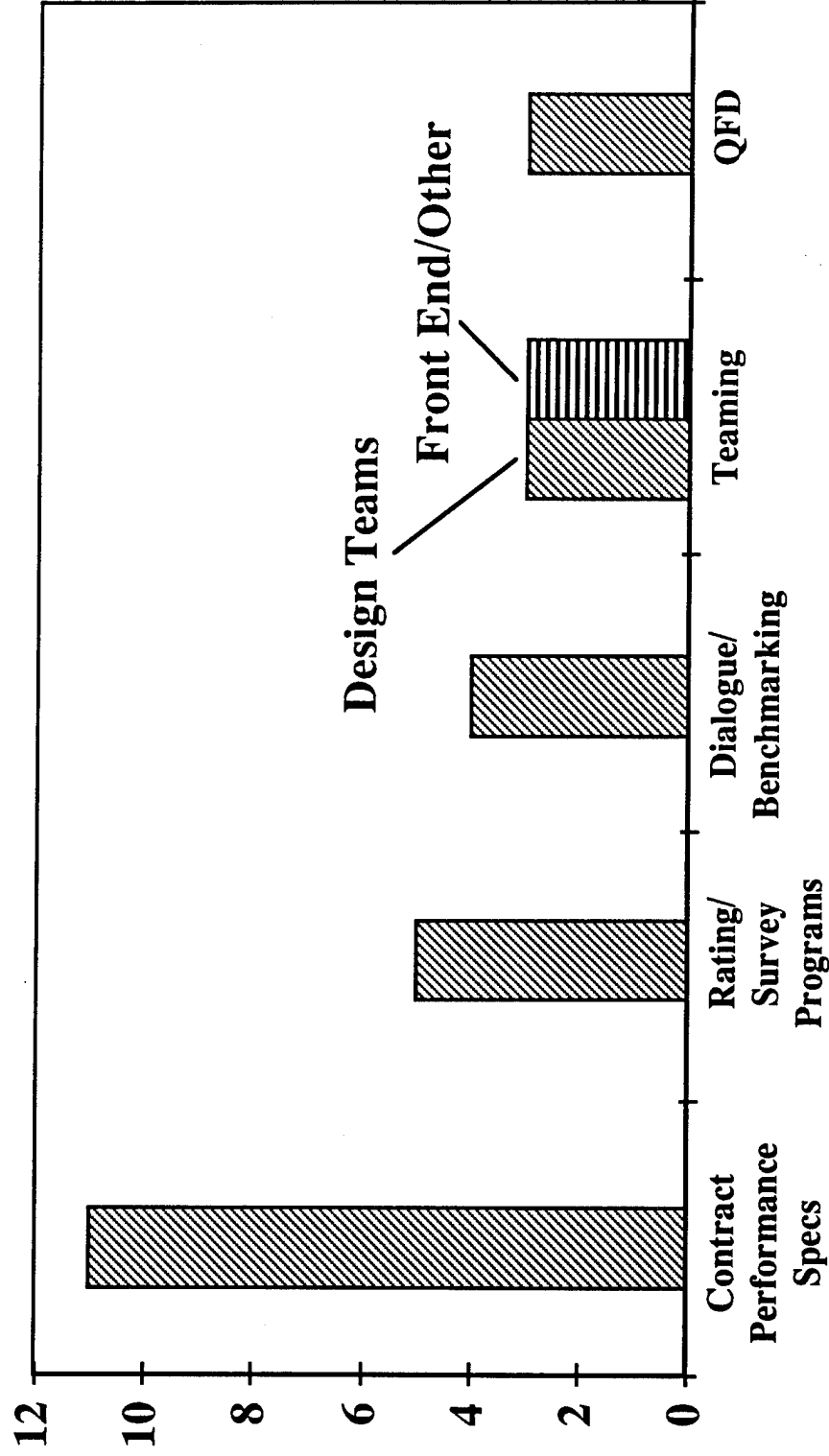
Quality functional deployment (QFD) is also used as a tool to align and translate customer expectations into our systems. Teams were used not only with suppliers but also with customers.

Design build teams are multifunctional and include members from both our external customer and suppliers. The customer expectations are clearly defined.

We work closely with our customers during the front end of the business, and promote our proven quality processes.

Whenever possible, customer participation on our product development teams is encouraged.

How Do You Identify Customer Expectations?



HOW DO YOU TRANSLATE CUSTOMER EXPECTATIONS INTO EXPECTATIONS OF YOUR QUALITY SYSTEM?

The most common approach was to flow down requirements, the second most common was to develop a quality plan, and the third was to incorporate expectations in the strategic plan. The following comments were typical:

These requirements are then flowed down to the procurement and manufacturing organizations, via procedures, standards, and engineering data. The control of this is monitored by the quality system.

These requirements are reflected in all internal work orders and used as the basis for design reviews and product acceptance.

Customer expectations were translated to include key characteristics on the drawings, with requirements for minimum variability.

These requirements are flowed down to the supplier via the purchase order.

In our company, contracts are reviewed by representatives from all functions. The requirements are identified and compared with the company's capability. Gaps are identified and procedures developed to accommodate the new item. All requirements are identified in a "quality plan" which describes how the system is applied to this particular project. The plan is then communicated to all affected parties.

The contractual requirements are consolidated into a quality plan for each customer's program. The quality plan is then implemented via program-specific directives modifying our standard quality system for any unique situations.

Customer expectations are an integral portion of our strategic plan.

When the rating is finished, each unit develops an improvement plan. There are goals for improvement. These assessments are overseen by our Executive Council.

The heritage of our quality system is expressly in response to their expectations.

When expectations weren't directly translated into quality system, a team approach was used :

The customer expectations are not per se translated into the quality system, however, key quality personnel are members of the teams.

How Do You Translate Customer Expectations into Expectations of Your Quality System?

- **Flowdown of requirements**
 - Procedures, standards, engineering data
 - Key characteristics
 - Internal work orders
 - Purchase orders to suppliers
- **Part of strategic plan or quality plan**
- **Quality personnel as members of team**

TO WHAT EXTENT DO YOU TAILOR YOUR QUALITY SYSTEM TO MEET CUSTOMER EXPECTATIONS?

The most common response to this question was that the quality system is tailored as necessary to meet customer expectations, often depending on the contract requirements. Some respondents seemed to have interpreted tailoring as a "downward" thrust. Some people made the distinction that their *system* was not tailored but the *plan* was; and others bluntly responded that the system was designed to meet their own internal requirements, which were seen to be above those of their customers. And some remarked on the effect of standards.

To the extent that our quality system is not compliant with customer requirements and contract.

Customers sometimes require great variation in their quality requirements. We promote our single standard system to the extent possible. However, our system does, and must, respond to the unique needs of each customer. Customer satisfaction is always the overriding criteria.

The quality system is not tailored to meet customer expectations. The system is established to meet our own internal standards and expectations which often exceed the customer desires.

As much as possible to reduce costs and cycle time without sacrificing established "best methods."

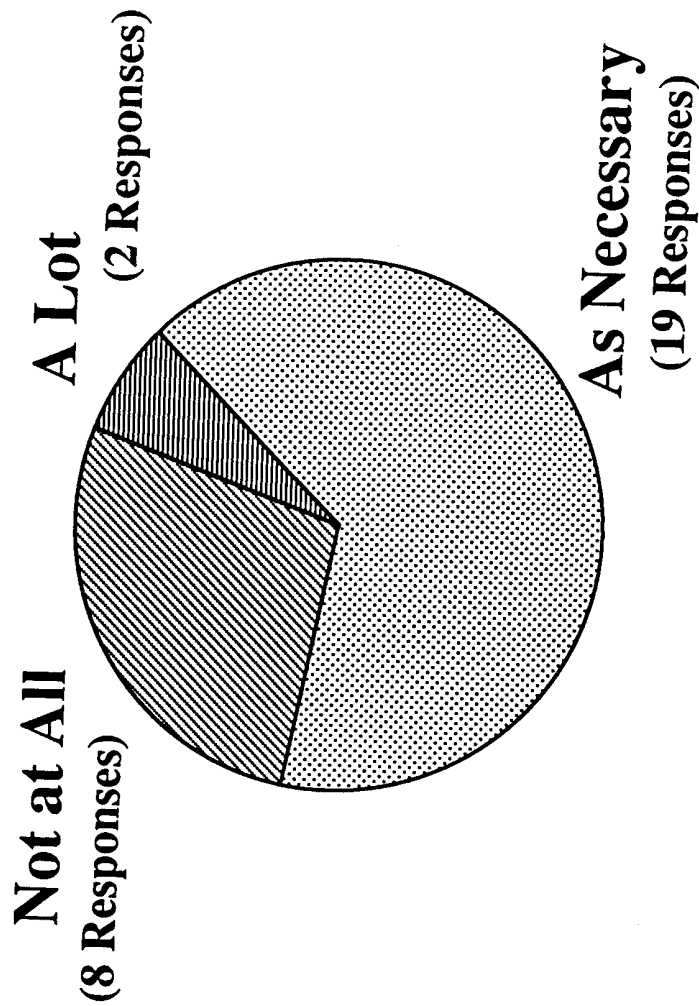
Quality plans are written for each product. The quality system is stable for all products.

The quality system is generally robust enough to satisfy requirements. Tailoring may be done if necessary to meet a particular program/customer requirement.

The basic quality system is not tailored to meet individual items. The system is designed such that specific requirements can be defined for individual product without altering the entire system.

Our quality policy and system is uniform throughout the company. Unique customer requirements are tailored at the implementation level for the process or product affected by documented procedures. Tailoring is becoming less prevalent as customers recognize the benefits of advanced practices, such as those prescribed in ISO 9000 and DI-9000.

To What Extent Do You Tailor Your Quality System to Meet Customer Expectations?



WHAT KEY INDICATORS DO YOU USE TO MEASURE CUSTOMER SATISFACTION?

The key indicators that the respondents listed fell into the following categories: formal surveys, comments/feedback after delivery, repeat business and sales, warranty claims and corrective action requests. Some specific measures are included in the following comments.

Field returns, field complaints, warranty costs, notification to customer of problems (escapes), field actions required, customer audit results, cost, delivery.

We consistently use three measures: customer discrepancy notices, quality escapes, and award fee ratings. When available, we also use supplier performance ratings from our customers.

Customer satisfaction is measured by daily contact, customer ratings, award fees, and most of all, repeat contracts.

Repeat business, including modifications and/or extensions to existing contracts. Feedback through informal and contractual communication channels.

Several metrics are used to measure customer satisfaction. Among them are customer acceptance rate, customer reliability trends, performance to schedule, customer ratings.

Customer satisfaction report, defect per 1000 parts, supplier quality index.

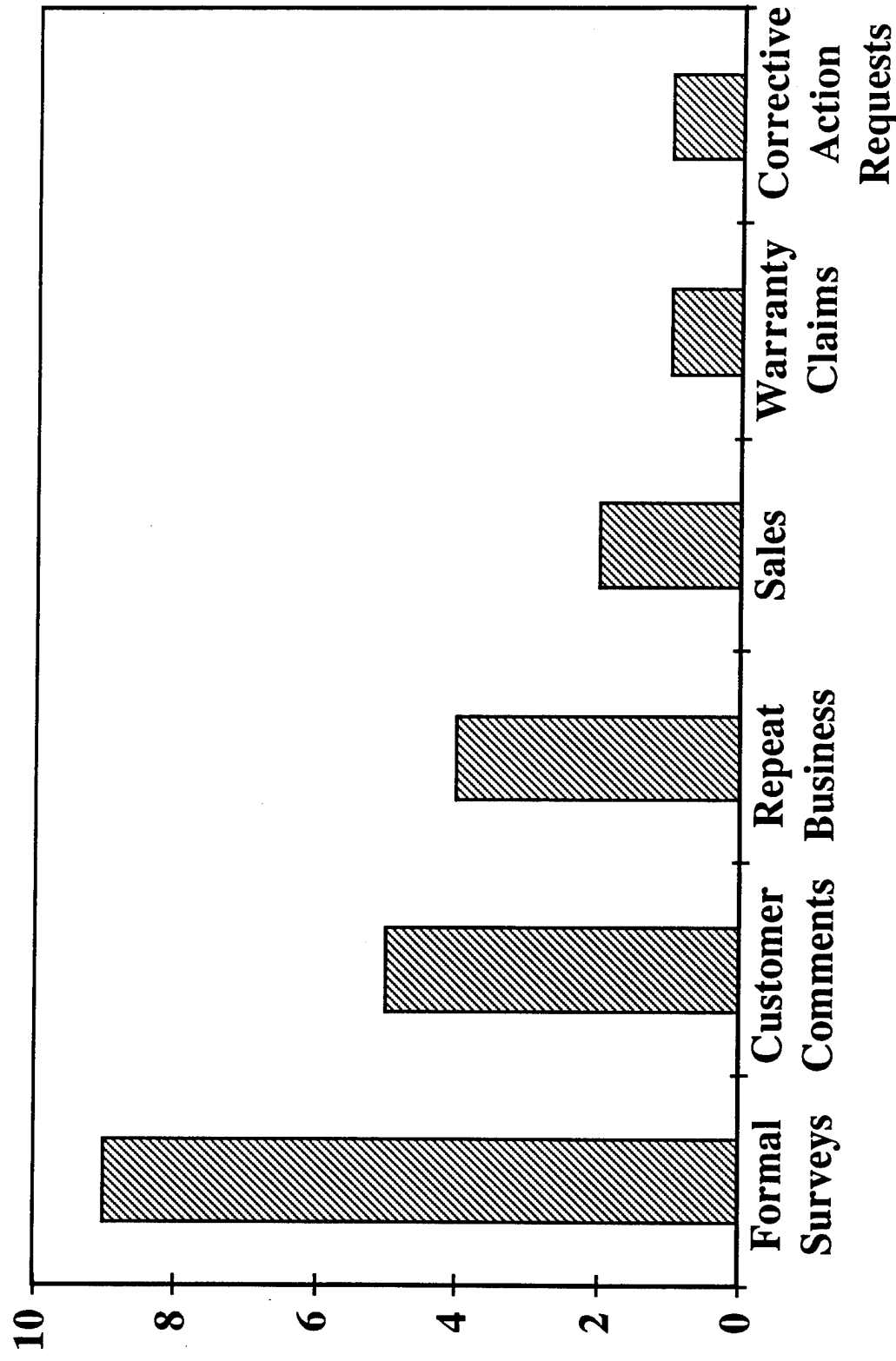
Reduced warranty claims, reduced field problems, reduction in customer complaints, and an increase in sales.

Self-assessment to Malcolm Baldrige National Quality Award criteria, metrics reported to corporate offices regarding total quality implementation progress, repeat business, CAR frequency, return rates.

We include the customer in a number of review processes (i.e., design review, failure review, parts review, etc.). Additionally, we formally survey for specific customer response. We closely track our satellite in-orbit performance for its relationship to ongoing programs.

Continued/increased business and satisfaction metrics based on customer expectations.

What Key Indicators Do You Use to Measure Customer Satisfaction?



HOW DO YOU PERCEIVE QUALITY AS A FACTOR IN OBTAINING MARKET SHARE?

Most respondents believe that quality is a significant factor or even essential in obtaining market share. However, as is the trend today, some respondents see quality as a "given"—taken for granted by the customers—and so market share depends on something beyond it. Some respondents still maintain that cost is the driving factor for market share, but cost as *the* factor is increasingly being tied to the type of product or service produced and the industry sector involved. Respondents who said that quality is not a factor have been dealing with DoD, whose standard driver has been cost, cost, cost and schedule. Selected comments follow.

No company will achieve market share in the 1990s unless their products and/or services are high quality, and their costs are competitive. "Zero defects" is coming back, only in a different form—it now comes as an unstated customer requirement.

One of the keys to market leadership is developing the capability to respond quickly with affordable products and innovative solutions. Integrated product/process teams, using advanced quality tools, have been critical to obtaining new programs, and providing high quality and low-cycle time. Integrated product/process development is critical to customer satisfaction and operating efficiencies.

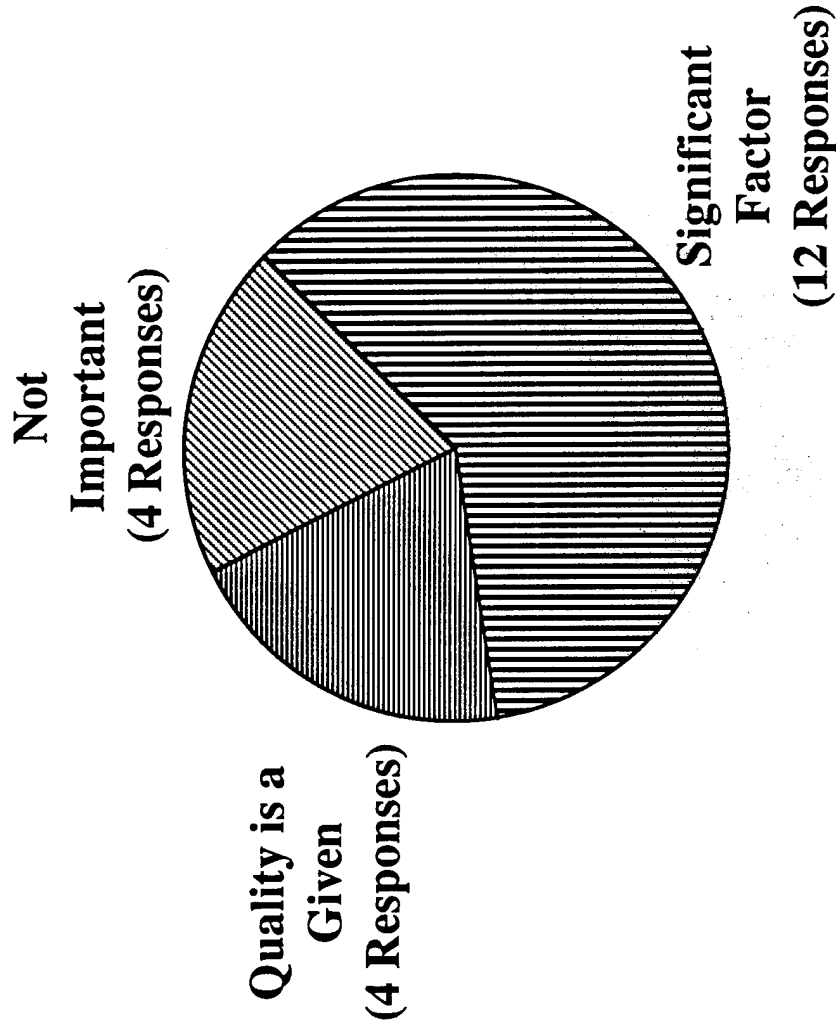
A cost-effective, efficient quality system will reduce the product cost. Lower product costs permit us to be more competitive at all points in the quote, manufacture, sale, delivery, and after-market for our product. Initial sale and after market excellence then equate to market share.

Our customers expect compliance with contractual requirements as a standard practice. We feel that perceived quality from the customers' perspective has only a limited impact on obtaining contracts. Limited impact from a positive perspective, major impact from a negative perspective.

A significant factor now; however, price, delivery, and technology have been, and probably still are, the dominant factors used by our customers to assess their potential subcontractors. They are therefore a factor in increasing our market share. In our market segment, high quality is relatively constant between the competing companies.

Quality is perceived to be a huge factor in attaining new business, particularly when branching out into potential international and commercial markets. In the past, many customers and contractors have been hurt by low-priced quality programs where the total life-cycle cost of the product was not considered. An effective and efficient quality system will ensure that things are done right the first time.

How Do You Perceive Quality as a Factor in Obtaining Market Share?



CONCLUSIONS

From the answers documented in this booklet, it seems clear that advanced quality practices are recognized and highly valued in industry. Industry respondents had no trouble including the many practices and initiatives shown on page 23 under the umbrella of advanced quality practices, and they didn't worry about which practice belonged to which function. These best practices contribute to the quality of the product above and beyond what would be expected under a basic quality system. It does appear that advanced quality may be an evolving concept in how it is valued, subject to the organizational context, the type of product, and the industry sector that each company is in.

Although quality is seen as an important factor in obtaining market share, companies appear to be moving beyond quality considerations in their own organizations (assuming they are at a very high quality level) and realizing that future market share will depend on how well they manage their supply chains and how good their subcontractors' products are. Quality focus will shift to the small and medium-size businesses that make up the supply chains of the prime contractors or systems integrators.

Conclusions

- **Advanced quality practices are widely recognized in industry**
- **Advanced quality is a high priority in the business environment**
- **Supplier AQPs are important in the source selection process**

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