

# An Overview of Supplier Rating, Certification and Selection Systems in the Defense Aircraft Industry

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## 1. Introduction

In this paper, we report on the status of supplier rating, certification and selection systems in the US Defense Aircraft Industry. Our findings result from a range of information gathering activities over the past eighteen months including: Site visits to companies; a one day review session at Lockheed Fort Worth Company on February 7, 1994 in which 10 companies made presentations of their systems; the study of documents received from over a dozen companies pertaining to rating, certification and selection systems; and, responses to the Survey of Supplier Systems and Relationships.

The purposes of this report are:

- To identify and review current practices with respect to supplier rating, certification and selection systems based on our current state of knowledge;
- To discuss the extent to which these systems support the process of supplier base optimization.

## 2. Central Questions

Several questions need to be addressed as we review supplier rating, certification and selection systems.

**How are supplier rating, certification and selection systems differentiated with respect to the commodity being purchased, the stage of the life cycle of the contractor's system of which the commodity is a component, and the contractor's position in the overall supplier network?**

An implication of this question is that, in order to evaluate rating, certification and selection systems, we require a taxonomy of the commodities in a total system being acquired by the Air Force. Acquisition of off-the-shelf fasteners for cockpit panels for the third production lot of F-22's will not require the same overall scrutiny as that of a mission computer for the prototype of a new aircraft.

Figure 1 is an overview of McDonnell Douglas Aircraft's breakdown of commodities into commodity categories. Separate teams are assigned to managing the acquisition of commodities in each of these categories. Depending on the nature of the acquisition, the teams are comprised of personnel specializing in engineering, production, quality control, procurement, contracts and finance.

**What are the connections among supplier rating, certification and selection systems?**

As we shall discuss, all three types of systems seek to identify "best value" acquisitions based on objective data about a supplier's performance with respect to quality and on-time delivery, and subjective data about responsiveness and business viability.

**How do supplier rating, certification and selection systems reflect the long-term objectives of the contractor?**

Over the long term, the contractor seeks a supplier base that will optimally covers its needs. Since the future is uncertain, especially for the Defense Aircraft Industry, the contractor needs to hedge his supplier portfolio. On the one hand, the contractor seeks to establish a broad and enduring base of certified suppliers. On the other hand, the contractor may be forced to devote considerable resources to improving supplier relationships and performance for commodities for which its current base is weak. The issue of optimizing the supplier base is discussed in greater detail in Section 7 of this paper.

**What are the suppliers' and customers' views of the effectiveness of the contractors rating, certification and selection system?**

Although metrics associated with a rating, certification or selection system might indicate to the contractor that the system has proven effective, further study is required to evaluate the longer term impact on the supplier base, and therefore, on the customer. Overly stringent standards might lead to better short-term performance, but have the effect of driving some suppliers out of the defense business, or out of business completely.

### **3. Supplier Rating Systems**

Most prime contractors and major sub-contractors have developed best value supplier rating systems that incorporate historical information about a supplier's quality and delivery performance. Figure 2 summarizes results from the Survey of the percentages of contractors with formal rating systems. Additional information from these and other companies is required to explain the disparity in use of rating systems between airframe companies and electronics companies.

Supplier rating systems are based on estimates of non-productive costs that inflate the effective total cost to the contractor of doing business with the supplier. Non-productive costs can include those resulting from early delivery, late delivery, extra shipment, incorrect supporting documents, unplanned event rejection, overdue trouble report-corrective action request, scrap notice, return to vendor, and other deficient behaviors.

For a typical rating system, the various non-productive costs are transformed to a single number, called, for example, the **Supplier Performance Index (SPI)**, which is a multiplicative factor greater than or equal to 1.00. Thus, a supplier with a perfect performance record receives a rating of 1.00; all others receive a rating greater than 1.00. In principle, when assessing a supplier's bid, the contractor adjusts the bid price by multiplying it by the SPI and the supplier with the lowest adjusted price wins the award. In practice, source selection is a more complex and judgmental process than that implied by the contractor's rating system.

Ratings are updated regularly (e.g., each month), usually based on a rolling average of the previous 12 months performance. Where necessary or appropriate, adjustments in the SPI are made to normalize differences in supplier volume to the contractor. First-time suppliers with no performance history receive an initial SPI based on the average of all suppliers in their commodity.

In addition to providing contractors with information about best value bids, rating systems provide an important mechanism for feedback to and control of their suppliers. Supplier ratings are distributed on a regular basis (e.g., quarterly) to the suppliers. Those with unacceptably high ratings (e.g., more than one standard deviation above the average SPI for their class of commodity) are put on notice that they must improve their performance or risk losing business with the contractor. If a supplier's poor rating persists, they may be dropped from the approved supplier list. Such an action can only be reversed by the supplier's demonstration that they have remedied their deficiencies in performance. This typically will involve considerable time and effort on the part of the supplier.

This use by large contractors of rating systems as **report cards** provides a potentially insightful point of comparison of practices in the US Defense Aircraft Industry and the Japanese Automobile and Aircraft Industries. According to Friedman and Samuels [1992], a major reason that the Japanese Industries have been highly successful is that large Japanese contractors are nurturant of suppliers, even those whose performance is sub-par. Velocci [1994] suggests that large contractors in the US Defense Aircraft Industry are using a "carrot-and-stick" approach to obtaining higher levels of performance from lower-tier suppliers. The carrot is the promise of long-term agreements between the contractor and the supplier; the stick is total loss of business with the supplier. Further study of the report card aspect of rating systems in the Industry is required to understand the extent to which low grades lead to supportive or punitive interactions of large contractors with their suppliers.

Contractors with supplier rating systems such as the one described above include AIL, Boeing, and Rockwell International, to name only a few. It is generally agreed that most rating systems were derived from the Rockwell International system originally developed in the 1980's. The similarity among systems suggests that **standardized rating systems**, including supporting computer software, could be developed and disseminated throughout the Industry. The use of standardized software would promote the sharing of data among large and medium sized defense contractors.

Three important assumptions are implicit in the calculation and use of the SPI in the rating systems as described above. One is that non-productive costs associated with a supplier's deficient behavior can be accurately measured. Since many non-productive costs must surely depend on the commodities acquired from the supplier, a further assumption is that the non-productive costs can be differentiated by commodity. This differentiation is not reflected in the rating systems. The third assumption is that consolidation of all non-productive costs into a single number (the SPI) is truly reflective of the supplier's performance.

In summary, the SPI has the advantage of simplicity, but for the purposes of supplier evaluation it may be overly so. Additional analysis of supplier performance data and its impact on the contractor's costs and performance is needed to better understand the validity of current rating systems. Such analysis should be possible because many contractors with rating systems maintain detailed data bases on which their SPI's are based.

## 4. Supplier Certification

Virtually all prime and first tier defense aircraft companies have some form of supplier certification program. Their development was stimulated by the contractors' desire to improve quality and by the willingness of the Air Force and other defense agencies to invest in their creation. The primary objective of a certification program is to create and maintain a base of suppliers that provide the contractor with dependable **quality and on-time delivery**. At the same time, an important secondary objective for the contractor is to reduce the size of the base to levels below those of the recent past. Supplier performance with respect to, **business practices, and responsiveness** are also considered to be important factors in the certification process. Responsiveness is a multi-discipline and somewhat subjective assessment that includes: engineering, procurement, quality, product support, manufacturing-systems contracting.

The Survey results clearly reveal the Industry's commitment to supplier certification programs. Figure 3 shows the marked increase in the number of certified suppliers over the past 4 years as a function of the size of the contractor. Figure 4 displays the same information as a function of the different sectors in which the contractors fall. The percentage or number of suppliers not yet certified but who should be certified is not known.

Most companies have three or four levels of certified suppliers. The standards for each certification level are mainly objective but the certification process is not as quantitative and mechanistic as the rating systems discussed above. Suppliers in the highest or higher categories are judged to be sufficiently dependable with respect to quality and other attributes that they are invited to participate in design processes and Long Term Arrangements. Often, large contractors will treat in-house product centers as notional suppliers and seek to certify them follow processes similar to those used for outside suppliers.

Consistently high supplier quality has several benefits to the contractor and the supplier. The total costs of acquisition for the contractor can be significantly reduced by eliminating rework due to low quality commodities from the supplier. Costs of inspection are also significantly reduced. Closer and more effective working relationships between a contractor and the suppliers usually results in reduced inventories. For the supplier, reduced inspection due to certification also reduces their costs. Moreover, certified suppliers are given preferred status by the supplier for follow on and new business. The certified supplier may also profit due to their enhanced reputation in the industry.

The emphasis on quality in the certification process is reflected by the requirement that suppliers use **Statistical Process Control (SPC)** in their own processes. The leader in promoting the use of SPC is Boeing Defense & Space Group. Boeing's Advanced Quality System (AQS) is a de facto industry standard, as well as their approach to certification.

The increased reliance on certification programs in the Industry reflects the more widespread movement throughout US industry in general to closer relationships between contractors and their suppliers (e.g., see Magnet [1994]). Companies now expect greater supplier participation in design and engineering change efforts, and in coordinating manufacturing plans with those of their suppliers. To an extent not fully understood, the desire and need for greater coordination between a prime contractor and its suppliers is

a result of advances in information technology such as EDI, CAD, and so on. These advances make it possible to achieve greater coordination, and at the same time, force contractors to seek closer coordination to achieve competitive advantage.

The rapid expansion of certification programs has been accompanied by a dramatic reduction in the number of suppliers in the **supplier base**. Figure 5 displays results from the Survey as a function of the size of the contractor. Figure 6 displays the dramatic reduction in the production supplier base that has taken place at McDonnell Douglas Aircraft. Velocci [1994] lists similar reductions at Douglas Aircraft, Lockheed Ft. Worth, and Pratt & Whitney. One linkage between certification and reduction of the supplier base is the following. Increased certification leads to a more reliable core of suppliers who can be given a greater percentage of the contractor's out-sourced business, which in turn reduces the need to maintain a large supplier base.

The extent to which reduction of the supplier base is a process of making a virtue out of necessity is not clear. Velocci [1994] states that, by 1997, the number of companies supplying parts and services will shrink by at least 60% compared with 1991, with losses especially among suppliers in the lower tiers. Moreover, many vendors will shift to industries requiring less demanding quality, scheduling and manufacturing processes. Others will simply go out of business with the greatest impact among suppliers with yearly sales under \$50 Million.

## 5. Supplier Selection

Source selection criteria and processes depend on the size of the acquisition, the stage of the overall system development (e.g., EMD or production), and whether or not the acquisition is for a new part or component, or a follow-on. An overview of a typical selection process for a major acquisition is shown in Figure 7, which was prepared by the Lockheed Fort Worth Company. Many or most companies in the Industry have formal source selection processes that follow a decision flow similar to the one in the Figure. Since details of source selection are proprietary, our information about them is less complete than information on rating and certification systems.

Much of the historical information about suppliers' performance required by source selection is similar to that required by rating and certification systems. In addition, source selection is concerned with details about the specific acquisition such as the cost proposal of each supplier and the supplier's capabilities to make the commodity. It might well be that the historical performance of a supplier would count for only 30% of the total evaluation points in a major acquisition. Nevertheless, many or most companies attempt to maintain a best value approach to source selection.

Source selection processes are also differentiated as **traditional** or **collaborative**. A traditional source selection is one in which the RFP is developed by the contractor and sent to potential suppliers without discussion or interaction with these suppliers. A collaborative source selection is one in which the contractor develops the RFP in a proactive manner. A collaborative source selection may be suitable for more complex and costly acquisitions for which there may be a smaller number of viable suppliers and for which design differences in addition to cost may be significant in determining the best value supplier.

An important aspect of source selection as indicated in Figure 7 is **risk analysis**. Qualitatively, there are four categories of risk: Technical risk, production/schedule risk,

cost growth risk, financial condition risk. Figure 8 provides a matrix describing typical guidelines describing degrees of risk in these four categories. Except for financial condition risk, the higher levels of risk arise in situations where the factors usually measured in certification procedures are partially or totally irrelevant. Thus, for example, source selection involving state of the art technology or developments with highly uncertain costs may require the contractor to select new, uncertified suppliers on the basis of capabilities beyond those valued highly in the contractor's certification program.

## **6. Metrics**

Metrics associated with supplier rating and certification systems, and with supplier management in general, include: Quality, on-time delivery, cost (including decreasing cost over time), number of suppliers, supplier flexibility and responsiveness. The first three metrics are considered to be the most important. Figure 9 depicts improvements in quality at Lockheed Fort Worth Company over the period 1991 – 1993 as the result of widespread implementation of rating and certification systems.

Recorded improvements in quality and on-time delivery among large contractors are impressive and important to superior supplier management. Nevertheless, additional processes are needed to achieve even greater improvements in supplier-contractor relations and management. The metrics listed above are, after all, only aggregate summaries of historical supplier performance. As such, they are useful for detecting degradation in this performance. They do not provide mechanisms for measuring supplier performance in depth, especially indirect supplier costs that are passed on to the contractor. Nor do they provide mechanisms for coordinating supplier and contractor activities. These points are discussed in greater detail in the following section.

## **7. Optimizing the Supplier Base**

The expression "optimizing the supplier base" is often used by contractors to describe the underlying purpose of supplier rating and certification systems. It implies that the contractor seeks a supplier base that provides and will continue to provide high quality commodities that are delivered on-time at low or reasonable total cost. Certainly, the use of rating and certification systems, along with increased use of Long Term Agreements, have contributed significantly to the more effective use of supplier networks. Nevertheless, four important aspects of supplier base optimization are not addressed by supplier rating and certification systems.

### **1. Tactical Make-or-Buy Decisions.**

As the Defense Aircraft Industry downsizes, contractors whose business is exclusively or mainly defense related are caught between opposing forces regarding tactical make-or-buy decisions. These are make-or-buy decisions over planning horizons of one to three years. On the one hand, contractors can reduce the impact on their company of downsizing by making larger proportions of their products in-house. On the other hand, they can make their operations leaner by eliminating in-house production and engineering resources that are inefficient, or less efficient than those outside the company. The choice is mainly an economic one, but one that must also take into account union contracts and negotiations aimed at retaining jobs in the company.

Due to government regulations on costs and contracts, a purely economic analysis of a make-or-buy decision in a defense company may be more distorted than such decisions in the commercial sector. This point is analyzed in detail by Rogerson [1992] who demonstrates that government approved schemes for allocating indirect costs may lead contractors to make commodities in-house even when there are suppliers who could make them for much less. In addition, economic analysis of a make-or-buy decision requires the development and use of accurate and complete activity based costing models of the contractor's product design and manufacturing environments. This issue is the next one to be discussed.

## **2. Activity Based Costing of Design, Manufacturing, Service and Administrative Activities.**

An increasing number of companies in the commercial sector are developing and using activity based costing models of their manufacturing activities. These models relate activity levels of independent factors, called **cost drivers**, to different categories of costs. Typically, manufacturing costs are broken down into: Product sustaining costs, process sustaining costs, facility sustaining costs, and business unit sustaining costs. The models are useful in determining accurate unit costs for the company's products and in revealing hidden and unnecessary costs that can be eliminated from the company's supply chain. Very recently, companies have also begun developing activity based costing models of their design, service and administrative activities. The purpose of these new applications is the same as those in manufacturing; namely, to achieve an in-depth understanding of the cost drivers and cost structure of these activities.

To the best of our knowledge, companies in the defense aircraft industry have avoided the development and use of activity based costing models of their manufacturing activities and, in general, of their entire operations. Despite the proven merits of activity based costing, it has apparently been eschewed by defense companies because they believe its application will reveal costs and practices that the government will use to reduce contract payments or awards.

This deficiency has a potentially detrimental effect on achieving lean management of a defense contractor's supply chain. According to Womack and Jones [1994; p. 102]:

"Once companies in the (value) stream, including the team leader, accept a clear set of principles (governing relationships between the leader and the suppliers), the next step is mutual verification. The activities of each company must be transparent so that the upstream and downstream collaborators can verify that all tasks are being performed adequately. One way to do this is a continuing process "audit" ...which must be conducted jointly in both directions: customer-supplier and supplier-customer. This means the end of secrecy in product development and production operations and suggests the need to even further with activity based costing so that the indirect costs of all activities are fully understood and dramatically reduced."

Womack and Jones admit that these principles are ideals yet to be widely attained, even in the commercial sector. Defense contractors are further behind companies in the commercial sector because contract-costing methods in the defense industry inhibit the openness they recommend.

Activity based costing models provide important insights but, as discussed in Shapiro [1994], to evaluate capacity plans, they need to be extended to decision models for capacity planning. Specifically, these are mathematical optimization models that use activity based costing relationships as inputs to determine optimal resource levels and optimal allocations of resources to production activities. Shapiro [1994] demonstrates how economics of make-or-buy decisions are heavily dependent on these resource decisions, which cannot be optimally determined by activity based costing alone.

In summary, the development and use of rating and certification systems has undoubtedly reduced indirect costs associated with poor quality and late deliveries. Nevertheless, defense contractors have not measured the associated costs and costs savings, nor have they developed activity based costing and capacity planning models of their operations. Such models would provide them with important insights about achieving lean operations within their companies and in conjunction with their suppliers, insights that they do not now have.

### **3. Decision Support Systems for Coordinating Supplier and Contractor Activities.**

The discussion above touched upon the need for greater use of decision support systems for coordinating supplier and contractor activities. Consistent on-time delivery by certified suppliers is desirable, but from a total supply chain perspective, it is not clear how the delivery dates are set. Thus, it may be that an arbitrary delivery schedule determined by a contractor forces suppliers to produce their commodities less efficiently, with the added cost passed on to the contractor and the customer. This difficulty can be alleviated by the use of MRP (Materials Requirements Planning) systems to coordinate the contractor's production schedule with the suppliers' production and delivery schedules. In addition, models for optimizing the entire supply chain schedule are needed and would be effective in determining the master schedule used by the contractor's MRP system.

Better management of work-in-process inventories throughout a contractor's supply chain is a related area where recent advances in decision support could greatly benefit defense contractors. Hewlett Packard has been a leader in the development and use of decision support systems for managing these supply chain inventories (see Davis [1993]). Although some processes for improving inventory management of HP's commercial products are not applicable in the defense aircraft industry, the underlying theme of measuring and controlling uncertainty throughout the entire supply chain is highly appropriate to it.

### **4. Strategic Make-or-Buy Decisions and Supplier Portfolio Analysis.**

It is widely recognized by companies in the Defense Aircraft Industry that make-or-buy decisions have strategic implications that transcend immediate economic efficiency. The strategic concern is often related to the "**core competency**" of the company (see Prahalad and Hamel [1990]), a term referring to the company's unique capabilities in designing and/or producing systems for military aircraft that will sustain their competitiveness over the long term. For prime contractors such as Lockheed and McDonnell Douglas Aircraft, the company's core competencies relate to their unique capabilities in managing the design and production of entire aircraft by supplier teams.

From a strategic perspective, make-or-buy decisions should reflect the company's desire to retain and enhance its core competencies. On the one hand, the company is reluctant or unwilling to out source commodities or services that will diminish these



competencies, even when there are suppliers who can provide the commodities or services at lower cost over the short and medium term. On the other hand, the company should be willing to out-source those commodities and services that do not diminish their core competencies, especially if they can make their operations more lean by doing so.

A difficulty developing long term strategies based on the concept of core competencies is the nebulous nature of the concept and the difficulty in clearly identifying and measuring them (a rare example of rigorous measurement of core competencies is found in Henderson and Cockburn [1993]). Moreover, the concept needs to be extended to take into account uncertainties regarding the future, and the risks associated with these uncertainties. A major source of uncertainty is the need for and timing of the company's development of technical and managerial expertise in using specific new technologies that may be critical components in new systems for which the company will seek contracts in the future. Some of this expertise may be developed in-house with complementary expertise residing with outside suppliers working under long-term agreements.

Another important source of strategic uncertainty is the mix and volume of business over the longer term, which for a large defense contractor is roughly the next ten to twenty years. The company must try to adjust its resources to anticipate this profile, a difficult task in today's Defense Aircraft Industry. Clearly, make-or-buy decisions over the longer term should reflect the company's desired level and mix of resources which in turn should reflect its projected product demands. This resource-based view of strategy formation can be found, for example, in Wernerfelt [1984], who also anticipated later developments in core competencies. Strategic planning based on data and analysis, including resource planning and make-or-buy decision-making, can and should utilize the activity based costing and optimization models discussed above.

In conclusion, the complexities and uncertainties faced by a defense contractor in trying to optimize its supplier network calls for a **portfolio optimization** approach. Such an approach would recognize the need to have a mix of suppliers in the network reflecting the range of programs in which the contractor may participate, the range of commodities to be acquired for these programs, and the range of supplier relationships that are appropriate for the various commodities. Whether it is ad hoc or formal, the portfolio optimization approach should serve to identify supplier network strategies and complementary in-house capabilities and resources that effectively hedge against the important uncertainties faced by the contractor.

## 9. References

- T. Davis [1993], "Effective Supply Chain Management," Sloan Management Review, Summer, 1993, pp 35-46.
- D. B. Friedman and R. J. Samuels [1992], "How to Succeed Without Really Flying: The Japanese Aircraft Industry and Japan's Technology Ideology." Report MITJP 92-01, The MIT Japan Program.
- R. Henderson and I. Cockburn [1993], "Measuring Core Capabilities: Evidence from the Pharmaceutical Industry," Sloan working paper.
- M. Magnet [1994], "The New Golden Rule of Business," Fortune, pp 60-64, February 21.

W. P. Rogerson [1992], "Overhead Allocation and Incentives for Cost Minimization in Defense Procurement," The Accounting Review, 87, No. 4, pp 671-690.

J. F. Shapiro [1994], "On the Connections Between Activity Based Costing Models and Optimization Models for Decision Support," WP #3648-94, Sloan School of Management, MIT.

A. L. Velocci, Jr. [1994], "U. S. Shakeout Tests Suppliers' Flexibility", Aviation Week & Space Technology, February 14, pp 48-51.

J. P. Womack and D. T. Jones [1994], "From Lean Production to the Lean Enterprise," Harvard Business Review, pp 93-103, March-April.