Chapter 4
Analysis Procedure

The primary emphasis in this study was on ways in which competition could be retained throughout the production phase of the JSF and on whether such extended competition might prove advantageous. Our approach to this issue is outlined below, with details and results reported in Chapters Five through Ten. We also recognize that competition is not the only management option available for controlling program costs. In the second part of this chapter, we briefly discuss other options to supplement the analysis of competition.

Analysis of Competition Strategies

In this study, we examined competition in the JSF program from the perspective of a defense policymaker, identifying the information that would be required and the kinds of trade-offs that would be encountered before informed policy decisions could be made.

Our first step in designing an analysis process was to outline the different ways in which competition can be introduced into the JSF acquisition program. In this study, we identified four general categories of competition, organized as shown in Figure 4.1. The most direct form of competition—one within the JSF program itself—is to have two or more suppliers concurrently producing the system or some elements of the system. A second form of competition—one outside the JSF program—is making available other similar systems that could be substituted for the item in question and that could perform at least most of the same military missions. For example, the later variants of the F/A-18 might be considered a competitor to the Navy variant of the JSF.
Actions can be taken to implement these options in the near term (for example, at the start of EMD) or at a later time (for example, following LRIP or when an advanced series is introduced). In this study, we devoted most of our attention to near-term competition for production within the JSF program; we examined the other three options in lesser detail (see Chapter Nine).

### Options for Near-Term Competition in Production

Introducing a second source during production of a weapon system is expected to have a variety of benefits and liabilities. The balance between benefits and liabilities can be judged by several different criteria. How the outcome of the balance is examined and evaluated differs from one criterion to another. Thus, the overall evaluation of where and whether to introduce a second production source entails different analyses and the subjective combination of the individual measures.
In this JSF study, we elected to examine the desirability of introducing near-term competition during production on the basis of two sets of criteria:

- Would competition be likely to reduce total ownership cost?
- Would competition be likely to have other benefits that cannot be easily expressed in terms of dollar cost?

Our approach to each analysis is outlined below.

**Is Competition Likely to Reduce Cost of Ownership?**

We first examined the issue of whether competition during EMD is likely to reduce acquisition cost. The most direct approach would be to estimate the cost for a sole-source producer, then to estimate the cost for a pair of competitive producers, and then to compare the two estimates. The first step is straightforward and draws on well-established historical data on aircraft production costs. Unfortunately, we have no comparable data or cost-estimating relationships that would enable us to estimate production costs in a competitive environment.¹

What we do have is a limited amount of historical data showing the amount by which production cost changed when competition was introduced into an ongoing sole-source production program. To use this information, we modified a strategy suggested by Margolis, Bonesteel, and Wilson (1985):

- Estimate the expected cost of producing the JSF by a sole source, using JSF system characteristics and available cost-estimating procedures.
- Estimate the additional costs of introducing a competitor, including the front-end investment plus the inefficiencies caused by each producer's having a decreased production run.
- Determine the percentage reduction in sole-source cost that would be required to offset the additional costs of introducing competition.

¹ There have been no cases of competitive aircraft production in the United States since World War II. A few parallel production lines have been established, but their goal has been to accelerate production, not to save costs.
• Look to historical evidence on the distribution of production-cost changes when competition was introduced as a basis for estimating the likelihood of achieving competition-induced cost reductions large enough to offset the additional costs incurred by introducing a second producer.

The result is an estimate of the likelihood that the government would break even on the introduction of a competitive second source for producing the JSF. We do not estimate the “dollars saved” or the “dollars lost” as a result of introducing competition; instead, we estimate the likelihood that the overall acquisition cost to the government would be about the same for either strategy. If the likelihood is high, the government might reasonably elect to introduce competition in the expectation of achieving other potential benefits (see Chapter Seven). Likewise, a low expectation of breaking even on production cost would discourage the government from introducing competition, because the net dollar cost of production might increase enough to outweigh other possible benefits. The details of the analysis process, and the results, are presented in Chapter Five.

There is a plausible basis for expecting that, under some circumstances, a competitive production posture might lead to a higher-quality product. This higher quality would, in turn, be reflected in higher reliability and, thus, lower support cost throughout the operating life of the JSF. The available historical data do not permit a quantitative link between competitive production and product reliability. Therefore, we were unable to estimate the magnitude of expected savings in dollar costs. Instead, we assumed various levels of reliability improvement and estimated the likely consequence in reduced operations and support (O & S) costs and then determined whether such reasonably expected savings from competitive production would alter the likelihood of breaking even on introducing a competitive production source. The exact process and results are described in Chapter Six.

Might Other Benefits Be Expected from Competitive Production?

The main emphasis of this study was on estimating the likelihood of breaking even on the cost of production by introducing a competitive
second source. However, we would be remiss if we ignored other possible consequences of competition. We made a cursory examination of five such consequences:

- Would competition tend to mitigate the amount of cost growth that might be expected during development and production?
- Would competition strengthen the industrial base?
- Would competition tend to reduce overall risk levels in the program?
- Would competition enhance the rate of introducing technical innovations and the overall quality level of the product?
- Would competition affect the kind and scope of international participation?

We included the results in our overall evaluation of competition during production. The first consideration lent itself to a quantitative examination. We pursued the others qualitatively, and the results of these secondary examinations are presented in Chapter Seven.

**Tools Other Than Competition to Control JSF Costs**

The focus of this study is on the effects of competition as a means of controlling costs in the JSF program. Other tools are also available to government program managers and other acquisition officials to help control costs, even in a winner-take-all development and production scenario. We summarize those tools here to supplement the analysis of competition discussed throughout this report.

**Institute a Vigorous Cost-Performance Trade-Off Program Among All Stakeholders**

Key to controlling costs on the JSF is to have cost and performance data available to all stakeholders so they have a clear understanding of where marginal improvements or decreases in performance begin to drive nonlinear increases or decreases in cost. This kind of information
is the basis for the DoD policy on Cost As an Independent Variable (CAIV). With better understanding of the costs and performance, the importance and influence of the requirements can be better understood. Those requirements that make little difference in operational performance but that inordinately drive costs can be modified so that only well-analyzed requirements are met by JSF performance. Clearly, cost analysis efforts will have to focus on these areas to ensure that program performance, costs, and risk margins are well understood.

Provide Award Fees as Incentives to Improve Producibility and Reliability During EMD and Production

Award fees are a powerful incentive to ensure that contractors are especially focused on areas that are important to DoD and that drive costs. However, such fees are not always easy to design. While production contracts are normally firm fixed-price instruments, the basis of the negotiated prices is usually the costs incurred to produce previous lots of aircraft, adjusted for cost improvement—learning curves—with a profit percentage added. Contractors may actually lose revenues through producibility initiatives that lower their costs and, therefore, their profits. In addition, costs to produce an aircraft are often locked in early in aircraft design. Producibility improvements may be more difficult to introduce once a design is finalized. Therefore, it is important for DoD to foster innovation during EMD and production by awarding fees that are tied to well-demonstrated initiatives that will reduce JSF production costs. This will require some agreement between DoD and the contractors on a production baseline cost, so that initiatives can be shown to reduce costs from that baseline.

Improvements in reliability are even more difficult to demonstrate, particularly since the effects (and the cost savings) are well downstream of design and production activities. Unless the contractors have some specific incentive to design reliability in and demonstrate these improvements through reliability-growth curves during EMD, they have little financial incentive to save operations and support costs after equipment is introduced into the operational forces. Many suggest that, if the contractor is assured that it will receive the contract for follow-on support, there is enough incentive to try to aggressively improve
reliability during design. With no contracting relationship and a period from design to operational support of 10 years or more, this incentive seems tenuous at best. However, if improvements in reliability can be designed and demonstrated through well-analyzed and tested reliability-improvement projections during EM D, contractors can be motivated more successfully with immediate financial rewards than with assurances of getting operational support business.

**Require an Active Production Price Commitment Curve Following a Major EM D Milestone**

Many targets, objectives, and promises concerning costs are formulated during aircraft development, and many of these tend to either increase inexplicably over time or fall victim to the cost-based negotiations addressed above. Establishing an active, mutually agreed-upon price commitment curve following a key milestone during EM D (for example, following Critical Design Review) would appear to benefit both DoD and the contractor.

The benefit to DoD would be a known price, which the services could use to program and budget for aircraft procurement year to year (or during the multiyear period). A commitment to price would motivate the contractor to focus on producibility continuously but would also allow it to keep the savings from these cost-reduction initiatives on a dollar-for-dollar basis, since the contractor would sell aircraft for the agreed-upon price, regardless of its cost to produce.

Clearly, over time, excess profits could become a concern, so there would have to be periodic renegotiations on the basis of the actual costs, which could be done for each multiyear contract, normally every five years. Thus, instead of losing profit on each dollar saved in production costs, the contractor would achieve a dollar of profit for each dollar saved. A clear designation of the price of the JSF—with the contractor prepared to stand behind its price, much as the commercial aircraft producers must do—has definite advantages for convincing Congress and the American people that the JSF is not going to become another program plagued by cost overruns. Clearly, requirements must be controlled in order to avoid “opening Pandora’s Box” and price renegotiations with each JSF lot.
Emphasize Warranties as Part of EMD and Production Phases

Like the commitment to production prices, the frequent promise of system reliability is often not achieved after aircraft are fielded. As discussed above, award fees can motivate contractors to design in reliability during EMD, and analytically derived reliability-improvement curves can monitor reliability during testing. But design reliability can be fully proven only after a system is fielded. Unfortunately, the contractual arrangements under which DoD must procure its aircraft mean that award fees for achieved reliability can be paid only over the life of the contract, which ends shortly after aircraft delivery. So success in achieving reliability after an aircraft is designed and produced does not result in financial reward to the contractor.

A warranty may be the answer. A warranty of reliability for any number of years can be part of the production contract. This mechanism has been successfully implemented on missiles (which spend most of their operational life in storage). However, unlike the commercial aircraft market, in which warranties are commonplace, DoD has not had an aircraft (particularly a fighter) covered by a warranty. One of the arguments against the use of warranties on combat aircraft is the fact that the actual operational usage is more stressing than the designed usage, so the contractors would object to this sort of “blank check” situation. With the incorporation of the Prognostic Health Monitoring (PHM) system planned for the JSF, this situation can be alleviated. Aircraft usage above the designed limits could be analyzed and warranties either adjusted or voided. Health monitoring on commercial engines is a prime example of how the commercial engine manufacturers can analyze an engine’s usage over its life and warranties can be adjudicated with airlines. Such monitoring could be applied to the JSF.