

BACKGROUND AND PURPOSE

The Ministry of Defence (MOD) of the United Kingdom (UK) has selected the short-takeoff/vertical landing (STOVL) variant of the U.S. Joint Strike Fighter (JSF) as the replacement for its Harrier aircraft. Current plans call for the UK to procure up to 150 aircraft at a potential cost of up to £10 billion (then-year £). The MOD also wants to develop a capability to maintain, repair, and upgrade its JSFs, which would require investments in facilities, equipment, and labour force. Because many of these capabilities apply to the final assembly and checkout (FACO) of the aircraft, the question arises about what such investments would imply for the cost-effectiveness of performing JSF FACO in the UK.

The UK MOD asked RAND Europe to address this question. Specifically, it asked RAND to accomplish the following:

- Assess synergies between a repair and FACO facility.
- Examine potential UK facilities for JSF FACO.
- Analyse the cost of a UK FACO facility.
- Consider issues regarding the export of technology.

RESULTS OF ANALYSIS

The results of our analyses are as follows.

Synergies Between Repair and FACO

FACO and maintenance, repair, and upgrade (MR&U) tasks overlap. Advantages and disadvantages of doing both activities differ, depending on whether the activities take place at the same location or are divided between two. The advantages of carrying out both activities in the same location include an easier transition from FACO to MR&U, a smaller engineering workforce, and a potential to adjust and level workload more easily. The FACO manufacturing space and tooling could also be used for MR&U, which could reduce total required investments. Additionally, technical support could be consolidated at one site. Disadvantages include the need to manage two processes rather than one and the possibility that the unpredictable nature of MR&U work might interfere with FACO activities.

Dividing FACO and MR&U could enable the MOD to open future repair work to competition, possibly leading to lower costs and higher efficiency. Two sites would broaden the aircraft industrial base and reduce the susceptibility of both processes to influence by such local issues as concerns about aircraft arrivals and departures.

Potential Facilities

The MOD suggested four sites as potential locations for FACO or MR&U. In alphabetical order, these are BAE SYSTEMS, the Defence Aviation Repair Agency (DARA), Marshall Aerospace, and Rolls-Royce. We conclude that three of the four sites could carry out either process, although their different existing facilities and capabilities mean that different levels of investment would be required at each site to enable JSF FACO. We eliminated Rolls-Royce as a candidate largely because the company's strategic focus on propulsion means that it does not have the facilities or past experience in airframe assembly, maintenance, or overhaul to host JSF FACO.

Cost¹

What would it cost to establish a JSF FACO facility in the UK? To protect the business sensitivity of the cost data, we present our

¹The cost figures are reported in FY 2003 £, undiscounted.

results as the incremental cost of assembling the JSF at a UK location compared with the same aircraft assembled at Lockheed Martin's Fort Worth, Texas, plant. In other words, 'How much more will it cost the UK?' (Note that the baseline costs for FACO of the UK aircraft in the United States are approximately £112 million [FY 2003].²) This difference is determined by comparing estimates of the FACO portion of the work done in Fort Worth and the UK, including how moving that work affects certain other costs (described below). We then report the average (arithmetic mean) result over all three UK sites.

There are three possible scenarios for establishing a JSF FACO facility in the UK:

- **FACO Only**—A FACO facility is established in the UK independent of an MR&U facility. This is also the case where there is negligible MR&U work for the JSF.
- **Combined Facility**—Both FACO and MR&U are done for the JSF in a combined facility. Initially, the facility produces the JSF and eventually makes the transition to an MR&U facility. Therefore, FACO investments could be reused for MR&U, reducing the cost of MR&U activities.
- **FACO Added to an Existing JSF MR&U Facility**—FACO activities are added to a planned and fully funded UK JSF MR&U facility. This approach assumes that common facilities, equipment, and tooling would be acquired earlier than needed for MR&U work; thus enabling FACO activities. This scenario is somewhat contrived because it reflects neither the actual sequence of decisions that would have to occur nor the way that the money would be spent. The FACO facility would have to be established *before* the maintenance depot.

The main difference between the last two scenarios is the baseline against which the incremental costs are calculated. The baseline for the second scenario does not include any UK work. The incremental costs for this include the total cost effects from putting a combined

²This value encompasses several assumptions, among which is a constant exchange rate of \$1.61 = £1, which is based on an annual average from the past 16 years, the period for which data were readily available in electronic form.

FACO and MR&U facility in the UK. The baseline for the third scenario incorporates the costs of an MR&U facility. The incremental costs for this include only the cost effects of moving FACO to an existing MR&U facility. The total cost to the UK for FACO and MR&U activities is the same in both cases.

To facilitate cost comparisons, we break them into four components: (1) the FACO costs themselves—the actual incremental cost of moving FACO from the United States;³ (2) the effect on UK MR&U costs for the JSF if FACO work is performed at the same site; (3) the effect on other JSF component costs (i.e., the forward and aft fuselage, the wings, and the tail) caused by moving FACO away from Fort Worth and to a UK site, thereby reducing work at Fort Worth and increasing the overhead rate there; and (4) the effect of adding FACO to other (non-JSF) MOD work being done at a UK site, thereby affecting the overhead rate for the other programmes.⁴ The total effect of the decision to move JSF FACO to the UK needs to incorporate all of these costs and not simply the cost of FACO activities. Table S.1 shows the incremental costs for each scenario.⁵

Table S.1
Incremental Cost of Moving JSF FACO to the UK (FY 2003 million £)

Cost Component	A FACO Only	B Combined Facility	C FACO Added to an Existing JSF MR&U Facility
FACO costs	34.7	35.6	35.6
MR&U	0.0	-10.0	-10.0
JSF components	1.4	1.4	1.4
Other MOD programmes	10.8	5.7	-14.1
Net Total Costs	46.8	32.7	12.9

³This includes the additional required facilities, tooling, and equipment; differences in labour and overhead rates; any royalty costs or licencing fees for technology transfer; costs of other support Lockheed Martin would provide; and a number of other cost components.

⁴These other programmes vary by location.

⁵The assumptions that led to these estimates are discussed in greater detail in the report, along with tests of the sensitivity of the results to changes in the assumptions.

Not surprisingly, Table S.1 shows that establishing a FACO-only facility has the greatest incremental costs. A combined facility reduces the incremental cost by nearly a quarter through savings in MR&U investments and a general reduction in overhead rates. The last scenario shows that the incremental investment to add FACO to an existing JSF MR&U facility is quite modest. (Total costs to the MOD are the same for B and C, but the MR&U investments for C are treated as 'sunk costs', providing the marginal cost for FACO.) Another caution is that the airframe MR&U concept for the JSF has not been fully defined. Therefore, true costs and the exact requirements for MR&U are unknown. The most conservative approach in estimating the possible costs to the MOD for a UK JSF FACO site would be to assume the FACO-only scenario (+£47 million).

Technology Transfer

For a UK site to carry out JSF FACO, certain technologies must be transferred from the United States to the United Kingdom. This process is complex and bureaucratic. When the transfer involves classified technologies, as the JSF does, the process becomes even more complicated and can take a long time. This issue becomes particularly important when the timelines of the JSF are taken into account. A FACO facility needs to be in place by the end of 2009, and we estimate that this will take two years to construct. No organisation would build such a facility without knowing that the transfer of the technology had been approved. Therefore, the transfer process must be completed by the latter part of 2007 at the latest. The process is complex, and the complexity makes the timing unpredictable. Thus, this issue merits immediate attention.

CONCLUSIONS

We conclude that FACO and airframe MR&U activities and investments overlap, so the potential for synergies is significant. Any of three UK facilities evaluated could carry out both processes with different required levels of additional investment and capability development. The mean incremental costs range from about £33 million for a combined, collocated facility to about £47 million if MR&U is not collocated or if no MR&U is required. If the UK MOD decides to create a domestic airframe MR&U facility for the JSF and fully factors

these costs into its plans, the incremental cost to add FACO production is about £13 million. Technology transfer issues are complicated and require resolution before funds are spent to establish either FACO or MR&U facilities. These issues need to be resolved no later than 2007.

We finally note that military aircraft programmes have historically changed during system development and demonstration (SDD). Typically, aircraft design, weight, and procurement plans all change. Any such changes would affect the results of our analysis, which is based on data collected primarily just before SDD began.