POLICY ANALYSIS ASPI

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How much will the Joint Strike Fighter cost Australia?

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Executive summary

- Australia's proposed Joint Strike Fighter (JSF) purchase has increased in real cost by at least 30% since the 2002 decision to join the program was made.
- The Australian JSF budget will still allow the acquisition of one hundred aircraft at currently projected prices. The current projection is for a total project cost of A$12.3 billion (December 2007 dollars).
- If the growth in JSF costs is consistent with historical trends, the total cost will increase further, to 50% above the initial estimate. If that occurs, the current budget will still allow for the acquisition of ninety or more aircraft on the current acquisition schedule.
- Cost pressures can always be mitigated by buying some of the aircraft later than currently planned to take advantage of the expected reductions in cost in the first years of JSF production.
- As it stands, the movement in the exchange rate between the Australian and US dollars since 2002 has effectively reduced the total bill for Australia, though what will matter is the exchange rate when orders are placed and contracts signed.

Introduction

The Joint Strike Fighter acquisition mooted for Australia is currently under the microscope of the Rudd Government's air combat review. Some of the factors that the review will have to take into account are the cost and timing of any such purchase. And, of course, the two factors are linked; earlier aircraft are more expensive than later ones.

We are now at a point roughly halfway through the JSF development phase, and have six year's worth of public data with which to examine cost trends. This ASPI *Policy Analysis* analyses the data at hand, makes some predictions about possible final costs and looks at the affordability of the aircraft for Australia.

JSF cost increase

The US procurement system makes procurement financial data available for public scrutiny. Shortly after the US defence budget is submitted,

the Pentagon releases details on major defence acquisition program cost, schedule and performance changes. The 'selected acquisition reports' (SARs) summarise the latest estimates of program costs, schedule and technical status. Historical data back to the 1960s is available on the internet, providing a rich source of data for historical comparisons.[1]

The SARs cost data on the JSF program shows a clear trend. Figure 1 plots the average procurement cost of the JSF as reported since 2001. The data shows a real increase from US$56.5 million to US$77.3 million per aircraft[2] or an increase of almost 37%. (The average procurement cost is the cost to acquire the basic aircraft and the ancillary equipment, support, training and documentation required to operate it, averaged over the twenty year production run of the JSF.)

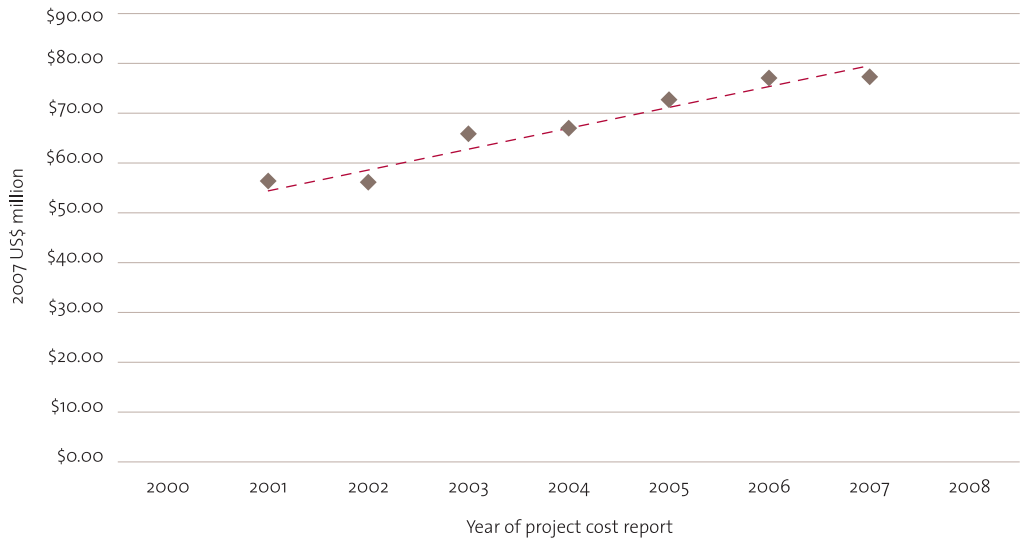

Figure 1. Average JSF procurement cost (in constant 2007 US$)

For our purposes, there are two important points to make about Figure 1. Firstly, it is an average over many years. Most aircraft will be built at a cost a little below the average cost, but the early ones will cost more—and the very early ones can cost considerably more. To illustrate that, Table 1 shows the JSF flyaway cost (the cost of producing the aircraft, but not including the ancillary items required to operate it) from the 2009 US Air Force (USAF) budget papers. For comparison, the 2001 baseline average flyaway cost was (in 2007 dollars) US$51 million. Assuming a 37% increase to parallel the increase in procurement cost, the current average flyaway cost is probably now around US$70 million.

Table 1: JSF numbers and costs for USAF CTOL aircraft

Year of order	Number to be acquired	JSF flyaway cost (2007 US$ million)
2009	8	191.3
2010	12	148.8
2011	24	114.5
2012	42	91.5
2013	48	80.4

Source: 2009 USAF budget papers

The first two years contain some tooling costs as well as the aircraft costs[3] but the subsequent strong downward trend is to be expected because the early aircraft are built in small numbers, reducing the opportunity for achieving economies of scale, and because later aircraft benefit from the lessons learned in assembling the earlier ones—known as the 'learning curve' effect. As experience is gained and numbers ramp up, costs come down.

The second important qualification on the average cost increase is that it is averaged over the three variants of the JSF. Australia is planning to buy the conventional take-off and landing (CTOL) variant, which is less complex and expensive than the other variants.[4] However, there is good reason to think that the CTOL variant is showing a real cost increase not far short of the program average. To see why, the numbers of each variant to be built are shown in Table 2.

Table 2: JSF numbers by variant

Variant	Service	Number
CTOL	USAF	1763
CV	US Navy	340
STOVL	US Marine Corps	340
UK STOVL	Royal Navy	138

Source: GAO reports

Because the CTOL variant comprises two thirds of the production run, it also makes a large contribution to the average cost increase. Even if the carrier variant (CV) and short take-off vertical landing (STOVL) variants had experienced 50% cost escalation, the CTOL variant would still have to be around the 30% mark to produce the overall program average. So, while the heavier and/or more complex CV and STOVL variants are probably showing a greater percentage increase, it seems safe to assume that Australia's proposed CTOL purchase has had a real cost increase of at least 30% since we signed up in 2002.

Historical trends

Of course, we are still some years away from delivery of Australia's aircraft in 2013 or 2014. It is worth trying to estimate what any cost increase might be by then. Historical data provides a way of doing so.

As has been noted in many articles, there is an overall upwards trend in the cost of military equipment over the years. That is not surprising, but the regularity of the trend is often very striking.[5] A good illustration is the growth in cost per kilogram of tactical aircraft manufactured in the United States since 1960. The cost per unit weight is a good measure of complexity, and allows for the obvious fact that large aircraft cost more than smaller ones.[6] To allow for increased efficiencies in manufacturing, the cost figures have all been converted into 2007 US dollars using the procurement deflators published in Pentagon budget papers.

Figure 2 shows the results for fighter, strike and multi-role aircraft ranging from the F-4C Phantom introduced to service in 1960 through to the F-22 Raptor in 2005. The figure shows a strong overall trend, with the cost per kilogram doubling on a twenty year time frame. The capability of each aircraft has, of course, also increased markedly over that period but this data set shows that extra capability continues to cost more in real terms despite advances in electronics, computing and manufacturing technologies. (A similar study of cars and home computers shows that this is not a law of nature. Both have seen significant capability gains while unit costs and costs per kilogram have come down markedly. One possible explanation for the contrary trend is the sheer production volume of these everyday items, but the aircraft on the graph have production runs ranging from hundreds to several thousand. Clearly something else is driving the cost of military aircraft.)

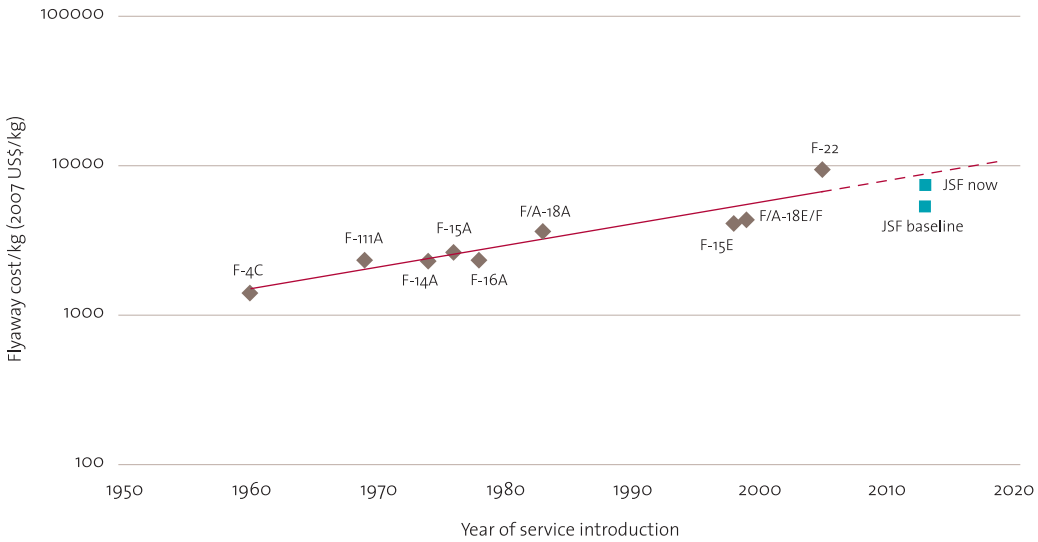

Figure 2. Flyaway costs per kilogram for US tactical aircraft, 1960–2020

It is worth noting that the three most recent data points lie a little off the long-term trend line. The reasons for that are illuminating. The F-22 sits well above the line—no doubt demonstrating the difficulty in developing the first genuine fifth generation aircraft, with its attendant manufacturing challenges and the degree of integration in its sensor systems. (Software costs and complexity demonstrates historical trends that are similar to hardware items, and the F-22 has a complex proprietary software architecture.) Conversely, the F/A-18 E/F Super Hornet and F-15E Strike Eagle both sit below the trend, showing the efficiencies that can result from basing developments on established designs.

Extrapolating the trend line out to the expected in-service date of the JSF allows us to appreciate how ambitious the promised JSF flyaway cost was. The data point labelled ‘JSF baseline’ sits further from the trend than any other aircraft, including the significantly less ambitious Strike Eagle and Super Hornet programs. The point labelled ‘JSF now’ (using the estimated current JSF flyaway cost from the previous section) shows that the JSF program is not going to buck the historical trend. And as discussed earlier, there is still potential for further cost growth. If the final cost settles down to the long-term trend, it will result in a JSF flyaway cost of US$80 million (in 2007 dollars).[7]

Capacity

Before we move on to discuss what the JSF cost trends mean for an Australian purchase, it is worth thinking about the implications of the historical trends identified above. Of course, the upward trend cannot continue forever. Making this point, ex-Lockheed Martin Chairman Norman Augustine once predicted (with tongue firmly in cheek) that the entire US defence budget would be required to procure a single tactical aircraft by the middle of this century.[8] Like most jokes, there is some truth behind it, as can be seen by looking at the numbers of aircraft in service. Most Western air forces (and navies for that matter) are shrinking. Figure 3 shows the number of tactical aircraft in service with the Australian Defence Force (ADF) (RAAF and RAN, until the demise of the fixed-wing component of naval aviation) since 1950.

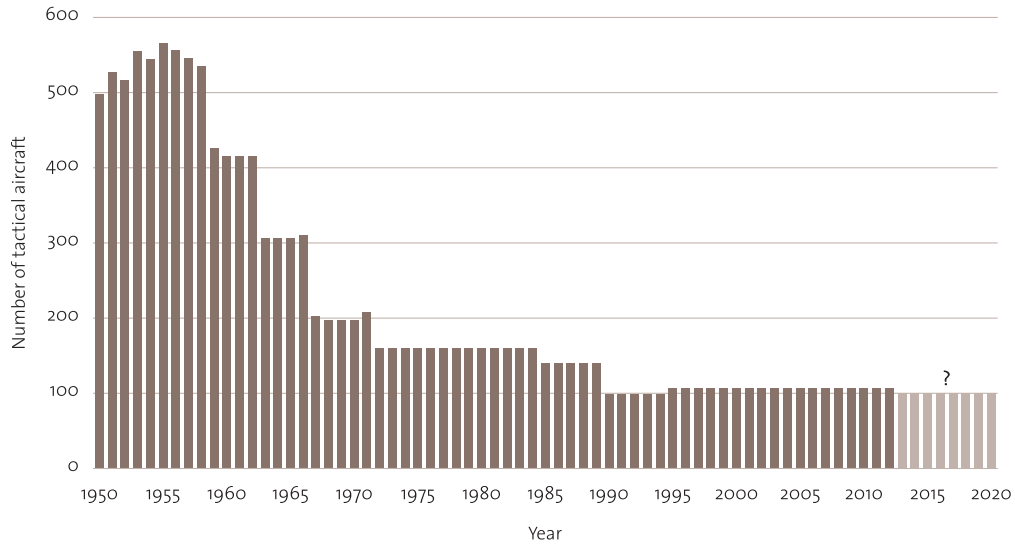

Figure 3 Numbers of ADF tactical aircraft, 1950–2020.
(Source: *A Trillion Dollars and Counting*, ASPI, 2004)

This is not an academic observation. While it is true that modern aircraft are far more capable than their predecessors, as the fleet sizes decreases so does the number of concurrent activities that can be conducted and the rate of effort that can be sustained. The proposed JSF buy of 'up to one hundred aircraft' is consistent with the size of the RAAF tactical fleet over the last couple of decades, but any reduction in numbers has the potential to impact on the ability to raise, train and maintain the air combat capability. Quantity does indeed have a quality all its own.

Australian JSF Budget

The 2006–2016 Defence Capability Plan (DCP) gives a range of A$11.5–15.5 billion for the AIR 6000 project. In order to maintain some commercial bargaining power, the actual project budget is not a public figure, but is probably somewhere near the middle of the quoted range. We will therefore use A$13.5 billion as our indicative budget, but allow that it could be higher, and use A$14.5 billion as the upper figure of our range.

However, we also need to be mindful of the exchange rate. One Australian dollar bought seventy five US cents when the 2006–2016 DCP was drafted. Today the rate is over ninety cents.[9] As per standing arrangements between

government agencies, the current AIR 6000 budget should be scaled downwards with the exchange rate, as fluctuations (in either direction) are meant to be 'without loss or gain' for the agencies budgeting for overseas spending. And of course, there is no guarantee that the current relatively favourable exchange rate regime will apply when payments are actually due. (History shows that major changes occur on timescales of a few years.[10])

The government could choose to let Defence keep planning according to the nominal DCP figure (effectively letting Defence 'keep' the current windfall, representing a policy decision to increase the JSF acquisition budget). But that is not a given, especially in an environment where savings are being sought. ASPI does not have a detailed breakdown of the project cost lines that would be affected by currency fluctuations, but the aircraft and all ancillary items purchased from the United States—the lion's share of the project cost—would certainly fall into that category. We will make the assumption that 85% of project costs are for purchases from the United States. In that case the indicative budget range becomes A$11.6 to A$12.4 billion with today's exchange rate.

Affordability for Australia

We are now in a position to evaluate the affordability of the JSF for Australia. From public statements, we know that the cost of the aircraft constitutes about 65% of the total cost of getting the JSF into service.[11] With a flyaway cost of US$70 million, that would mean a total project cost to Australia of US$107 million per aircraft (about 10% less than the unit cost of Australia's Super Hornet purchase announced last year).[12] At the current exchange rate, that means that acquisition of one hundred JSFs would cost around A$11.9 billion, a figure well within the AIR 6000 budget.

But rather than relying on averages, we can be more precise and use the USAF budget figures to estimate what we will actually pay. An extrapolation of the figures in that table using the industry standard learning curve allows us to predict the flyaway cost for orders placed in the years beyond 2013.[13] Assuming a 'ramped up' buy profile of five aircraft in 2013, ten in 2014 and fifteen per year after that, the one hundredth aircraft would be acquired in 2020. Table 3 shows the costs (in 2007 US dollars) for the Australian buy. (Remember that aircraft delivered in 2013 are ordered approximately two years in advance. We use the 2011–13 USAF budget figure for 2013–15 deliveries and extrapolated numbers thereafter.)

Table 3: Flyaway costs of an Australian JSF purchase 2013–2019

Year of delivery	No. of aircraft	Cost (2007 US$ million)
2013	5	572.4
2014	10	915.3
2015	15	1206.1
2016	15	1101.9
2017	15	1015.5
2018	15	947.7
2019	15	892.7
2020	10	564.6
Total	**100**	**US$7.22 billion**

Source: USAF 2009 budget papers and ASPI analysis

Once the entire project cost is calculated, the total cost estimate becomes A$12.3 billion, a little more than would be obtained from working with the average (because cost reductions from buying the less expensive CTOL variant is offset by buying earlier in the program) but just within the likely project budget. In other words, the current AIR 6000 budget will cover the acquisition of one hundred JSFs, but further real cost increases could mean that the number of aircraft acquired would have to be reduced, or the acquisition schedule would have to be more heavily weighted to later years. Note in this context that the last ten aircraft ordered in 2018 for a 2020 delivery actually cost less than the first five ordered in 2013.

Our historical data and warnings from the US Government Accountability Office show that further cost increases are possible.[14] Ironically, one of the pressures that could see the JSF cost increase further is the weakness of the US dollar. The aft fuselage and tail and some other components are manufactured in the UK and elsewhere in Europe, so the strength of European currencies will tend to push US production costs up.[15]

We saw earlier that the current figures show an average real cost increase of 37%. If the cost increase was to reach the historical trend figure of 50% (still well below the cost escalation of the F-22 program), then the total cost would reach a figure over A$13 billion, somewhat above the project budget we estimated earlier. In this circumstance, the budget would still allow for the acquisition of over ninety aircraft on the schedule in Table 3. The full complement of one hundred would still be affordable, if they were acquired later. Any increases above 50% would result in commensurately higher pressures on the budget and/or acquisition schedule.

Endnotes

[1] The summary tables are at http://www.acq.osd.mil/ara/am/sar/

[2] This report expresses all figures in constant 2007 US dollars. It is the practice of the Department of Defence and the manufacturer, Lockheed Martin, to express the cost in 2002 US dollars, the baseline year for the JSF program.

[3] When tooling costs are included, the cost is referred to as the non-recurring flyaway cost. The term referring only to the cost of producing the aircraft is the recurring flyaway cost. For later aircraft in the production run, there is little difference and we do not make a distinction between the two in deriving our estimates.

[4] The other variants are the carrier variant (CV) for the US Navy which features a strengthened structure and larger wing for operations from large aircraft carriers, and the short take-off vertical landing (STOVL) variant for use from forward airfields and small-deck carriers.

[5] There are some very good examples of historical cost trends in *Augustine's Laws*, American Institute of Aeronautics and Astronautics, Washington (1983).

[6] This method is an industry standard for measuring the real growth in costs for manufactured products. For its application in aviation see http://ocw.mit.edu/NR/rdonlyres/Aeronautics-and-Astronautics/16-885JFall-2004/9DFE0985-C9C2-486B-BD37-42060E082AB2/0/pres_willcox.pdf. An earlier graph of the growth in the cost of military aircraft per unit weight is here: http://www.airpower.maxwell.af.mil/airchronicles/aureview/1973/nov-dec/stark.html

[7] The fact that the JSF actual cost is much closer to the long-term trend line than the initial program estimate is consistent with a US Congressional Budget Office observation that 'parametric cost-growth estimating based on historical data does a much better job of projecting what costs will actually be [than in-program estimates]', cited in 'US DoD receives mixed assessment of its cost-estimating abilities', *Jane's Defence Weekly*, 25 April 2008.

[8] Augustine suggested that the US Air Force and Navy would each have the aircraft three and a half days per week, and the Marine Corps would get to use it every 29 February.
[9] Historical exchange rates are here: http://www.chartflow.com/fx/historybasic.asp
[10] The graphs in the Australian parliamentary library report at http://www.aph.gov.au/library/Pubs/RN/2000-01/01RN09.htm demonstrate the medium-term volatility of the A$-US$ exchange rate.
[11] According to a statement from (then) Defence Minister Brendan Nelson, available at: http://www.minister.defence.gov.au/NelsonMintpl.cfm?CurrentId=6835
[12] The oft-quoted figure of $6 billion for twenty-four aircraft includes ten years worth of support and some facilities work. A more accurate figure is US$3.1 billion for the acquisition of the aircraft and their systems, which equates to US$129 million per aircraft.
[13] Although the calculation here was done using USAF budget figures and some curve fitting, similar estimates can also be obtained from tools such as NASA's learning curve calculator: http://cost.jsc.nasa.gov/learn.html
[14] *Joint Strike Fighter – Recent Decisions by DOD Add to Program Risks*, Government Accountability Office Report to Congressional Committees, March 2008.
[15] 'Sliding US dollar rates hit JSF program', *Jane's Defence Weekly*, 19 March 2008.

About the Author

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