

# F-35 Joint Strike Fighter

## Ownership At What Price!

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MoD Secretary of State of Defence; Gave a speech on the 22<sup>nd</sup> February 2011 on the subject of Value for Money

- Dealing with the Conspiracy of Optimism
- Real Time Cost Control
- Rebalancing the relationship with industry
  
- *Lack of proper appreciation of risks and costs*
- *Optimism based on poor estimates*
- *Unrealistic timescales*
- *Unrealistic costs*

*The requirement is to provide realistic budgets for **development, procurement and deployment** , to be presented before spending can begin on new programmes*

Meeting such requirements is challenging.

In-service costs of any future platform is difficult to estimate 10 + years in advance. This become increasing challenging when the platform is said to be advanced to the point that nothing currently exists!

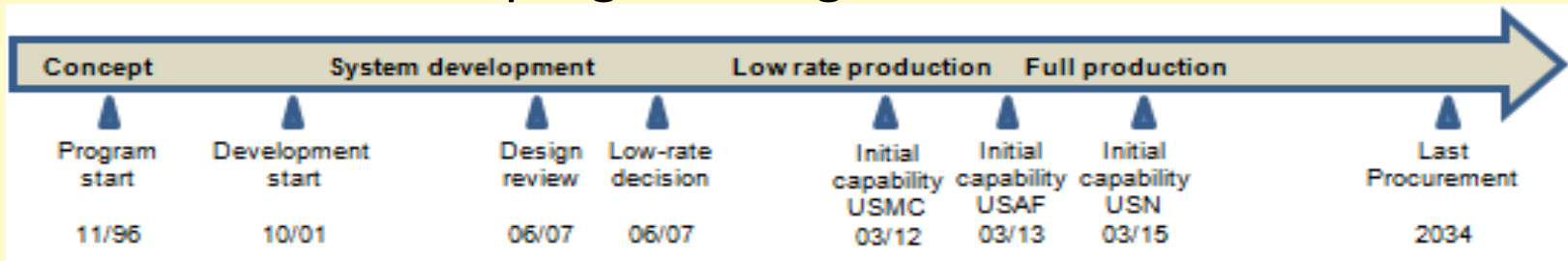
In-service cost' for fast jet aircraft are difficult to accurately estimate as it is driven by so many inter related elements such as number of component parts, LRUs and reliability calculations, usage of the aircraft, flying hours and the level of pilot training, to mention just a few.

Despite all the reliability calculations and the analysis using the prototype aircraft and historical data, the true levels of reliability will only be known once the operational aircraft have been flown for a number of years. It is often during these initial years that issues are identified that might cause reliability to fall below the specified levels, thus requiring additional design engineering activity.

- F-35 Joint Strike Fighter
  - Currently the largest Defence Programme
  - The development and manufacture of 3 Variants
  - Development started 1996
    - F-35a CTOL
    - F-35b STOVL
    - F-35c CV
  - LRIP 3 & 4 are now under contract

- F-35 Programme

- The programme has been through a number of amendments over the years, extending the development timescale and re-distributing the production profile in an attempt to instil a level of realistic programming and cost control



- The latest re-structuring has lead to,
  - Overall development slip of 5 years
  - Near term production quantity reduced by 246 aircraft, this has therefore moved full rate production out to 2018
- The STOVL aircraft moved into a 2 year probation period

- There is currently only one 5<sup>th</sup> Generation aircraft in-service, that being the F-22 Raptor. There are, however, a number of others at different stages of development and some that could be said to be very early in the conception phase
- F-35 Lightning, US led with Partner Nations, is entering low rate production although there remains outstanding development activity.
- T-50 is a joint program with Russia and India. The initial prototype aircraft was flown in 2009/2010 and production aircraft are said to be available in 2015. Indications from a number of unconfirmed sources state that some 60 billion Rubles (1.8 billion Dollars) has been spent/committed for the concept stage up to first prototype flight.
- J-20 Black Eagle is a Chinese 5<sup>th</sup> Generation fighter. Whilst a prototype aircraft has flown actual production is considered to be post 2020.
- Japan has been exploring their technical feasibility to produce an indigenous 5<sup>th</sup> generation fighters however, indications would suggest that they are now considering an acquisition of

- DAS has conducted a number of independent analysis of the potential cost of the F-35 Joint Strike Fighter over a number of years based on data gathered and analysed from public domain sources.
- Financial information available from
  - Selected Acquisition Reports
  - Congressional Government Accounts
- DAS has also generated an independent cost estimate of the Average Unit Production Cost using cost models developed based on historical cost for fighter strike aircraft and whole Life Cost Estimate covering Acquisition and Logistic set up, Operation and Support.
- This research has shown that there are some harsh lessons to be learnt,

Looking at recent fighter/attack procurement programs, an example that demonstrates significant cost growth is that reported for the USAF F-22. A recent report published by the US Centre for Strategic and Budgetary Assessment (CSBA) detailed the cost history of the F-22 program. In 1988, the Advanced Tactical Fighter program office stated that the flyaway average unit cost goal would be \$35 million per plane in FY 1985 dollars, or roughly \$60 million in FY 2009 dollars. The average flyaway unit cost for 175 production F-22s procured by the USAF had grown to \$158.8 million by May 2009.

The increase of nearly \$100 million in the average unit cost of the F-22 could be attributed to the number of changes that have occurred to the program in the past 20 years, but an initial under estimation of the program cost is clearly one reason, coupled with the resulting reduction in the program numbers driving up the unit cost. The F-22 program has many similarities to the F-35 JSF program. Some commentators have expressed concerns about the level of increase in the F-35 JSF program costs at this stage of the program life cycle when compared with the F-22.



# DAS Independent Cost Assessment (1)



- Data extracted from the SAR .
- The GAO report was also viewed to ensure there were no major variations.

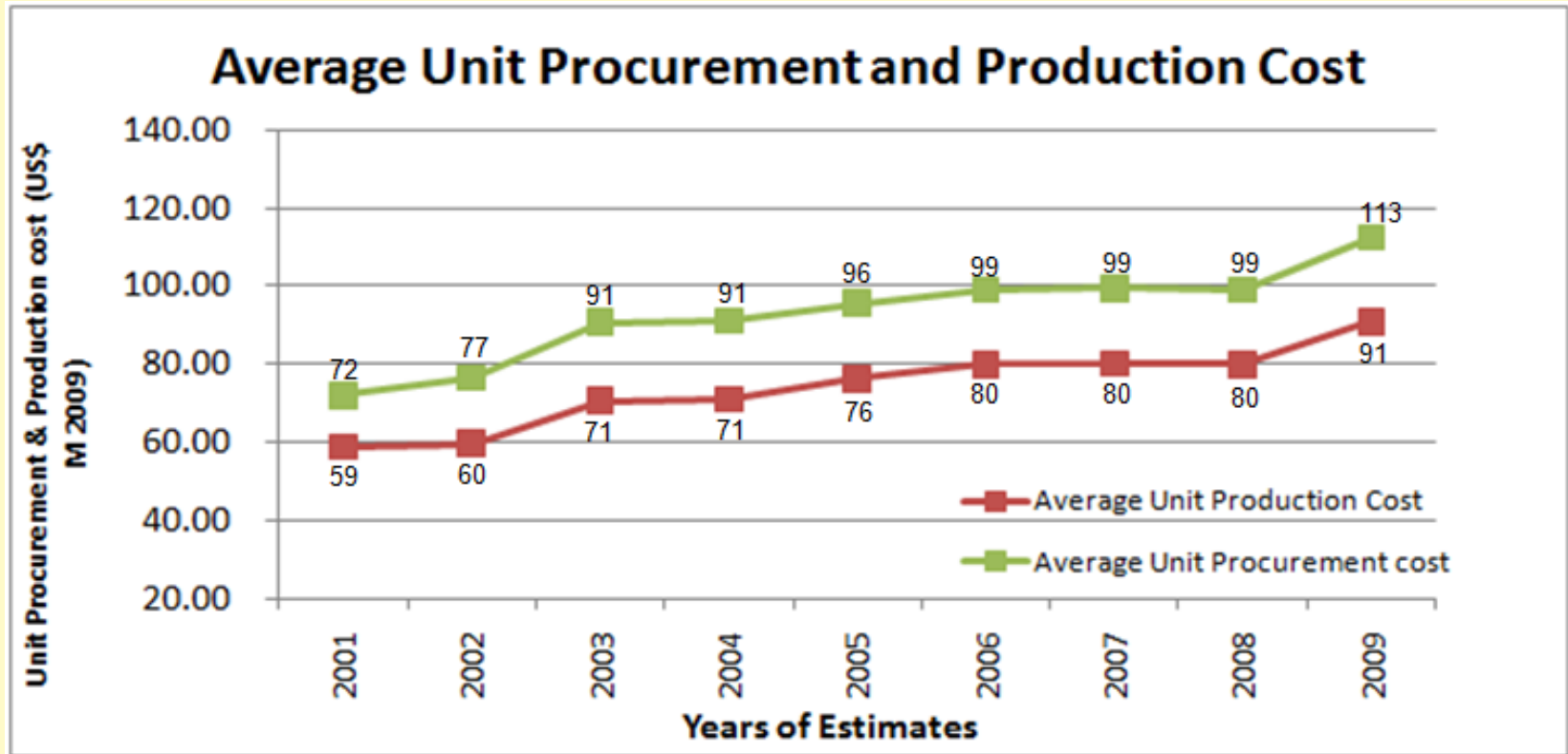
	2000 ec	2000 ec	Total Procurement			AUPC 2002	
	RDT&E	Procurement	cost	Ratio	Qty	ec	2009 ec
	US\$	US\$	US\$				
2001	32,390.90	145,139.70	177,530.60	4.48	2852	62.25	72
2002	35,368.10	125,948.00	161,316.10	3.56	2443	66.03	77
2003	42,032.80	149,403.00	191,435.80	3.55	2443	78.36	91
2004	42,009.30	150,317.00	192,326.30	3.58	2443	78.73	91
2005	40,388.60	161,149.20	201,537.80	3.99	2443	82.50	96
2006	39,987.80	168,980.80	208,968.60	4.23	2443	85.54	99
2007	40,189.40	169,401.20	209,590.60	4.22	2443	85.79	99
2008	39,902.10	170,111.00	210,013.10	4.26	2456	85.51	99
2009	45,333.70	193,264.80	238,598.50	4.26	2457	97.11	112

	RDT&E	Procurement	Total Porcurement	Ratio	Qty	2002 ec	PC 2009 e
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2002		125,948.00	125,948.00		2443	51.55	60
2003		149,403.00	149,403.00		2443	61.16	71
2004		150,317.00	150,317.00		2443	61.53	71
2005		161,149.20	161,149.20		2443	65.96	76
2006		168,980.80	168,980.80		2443	69.17	80
2007		169,401.20	169,401.20		2443	69.34	80
2008		170,111.00	170,111.00		2456	69.26	80
2009		193,264.80	193,264.80		2457	78.66	91

# Selected Acquisition Report (SAR) F-35



The SAR costs have been broken down into two main elements - RDT&E and Procurement Costs. Between 2001 and 2009 they show an overall increase of some 56%. RDT&E cost increased by 40%, and Procurement cost increased by 54%. As the total production cost covers all three variants, it is not possible to establish whether this increase is driven by all or one of the aircraft variants.

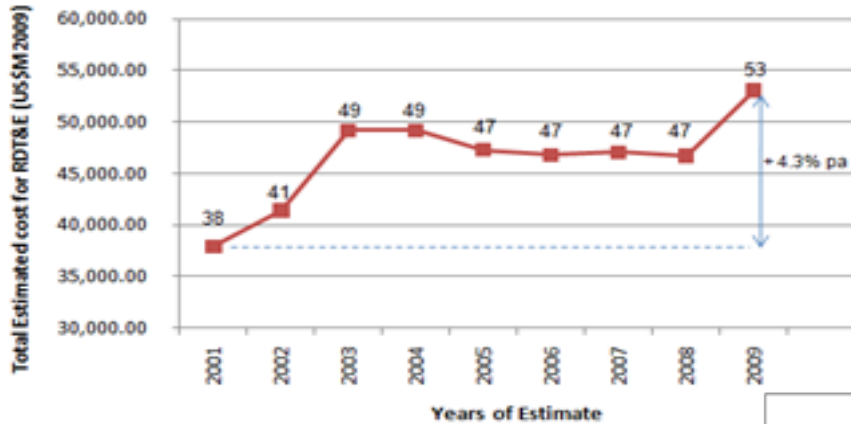


# Selected Acquisition Report (SAR) F-35



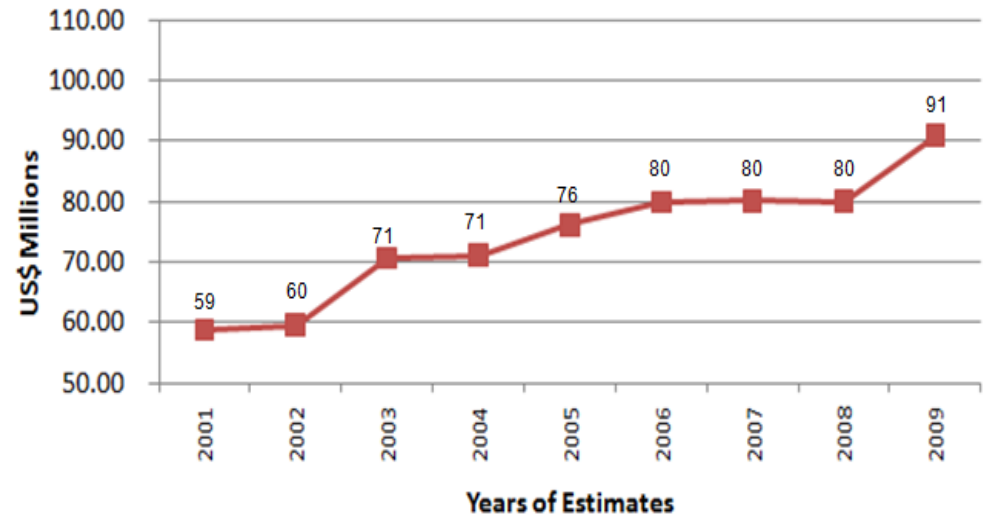
- The SAR cost can be further broken down into RDT&E and Production

Annual RDT&E costs (US\$ 2009)



- The RDT&E cost have increased by nearly 40% between 2001 and 2009.
- Development continues, indication suggest that RDT&E could reach US\$55 billion

Average Unit Production Cost US\$m 2009 ec



- The Average Unit Production Cost has seen a steady increase with jumps in 2003 and 2009. overall increase represents 54%
- With development continuing there will be continuing pressure on the AUPC

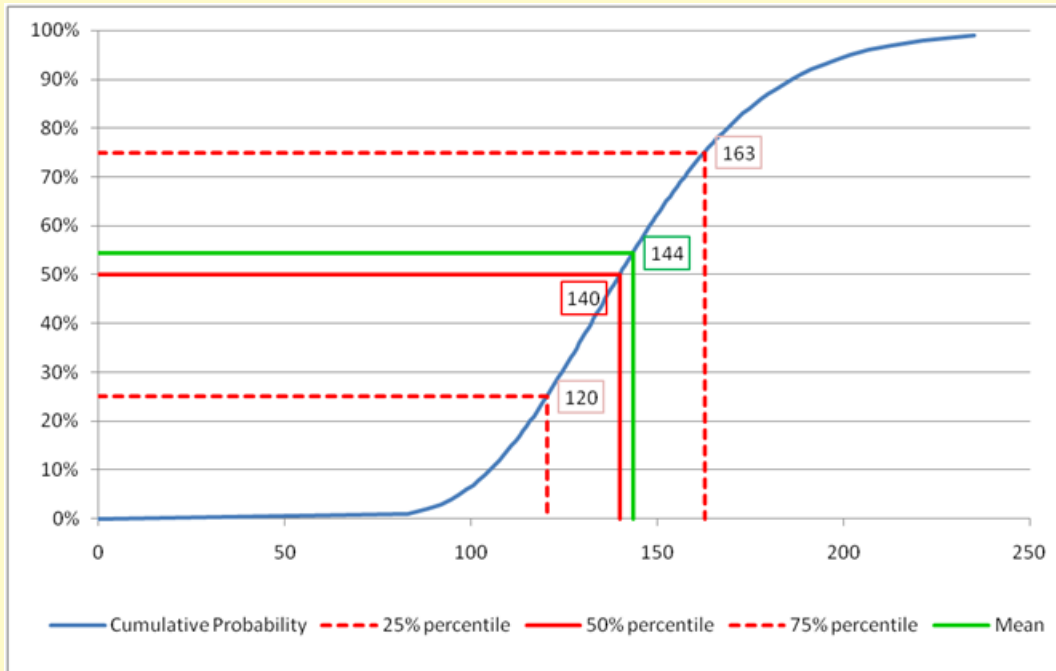
- DAS has produced a range of cost forecasting analysis tools aimed at the generation of acquisition and in-service cost.
- These tools work at the platform top level and take into account such elements as Basic Mass empty, Payload, ISD, Production qty and others.
- The Key input data for F-35
  - Basic Mass Empty = 13,318kg
  - Payload = 9,000 kg
  - ISD =2009 – – – ➤ 2011/12 ?
  - Production qty = 2443

		Current Estimated weight Kg
F-35a	CTOL	13,318
F-35b	STOVL	14,545
F-35c	CV	15,818

# DAS Independent Cost Assessment (2)



- The Mean Average unit production cost generated = \$144 million at 2009 e.c using UK deflators.
- The spread of uncertainty is based on the uncertainty around the inputs and the spread around the base data used in generating the model



- DAS independent estimate for the acquisition of 2443 aircraft is US\$144m (mean) the range is between US\$120m to US\$163m
- The SAR estimate is US\$91m DAS independent estimate would suggest that there is less than 10% probability of achieving this figure.

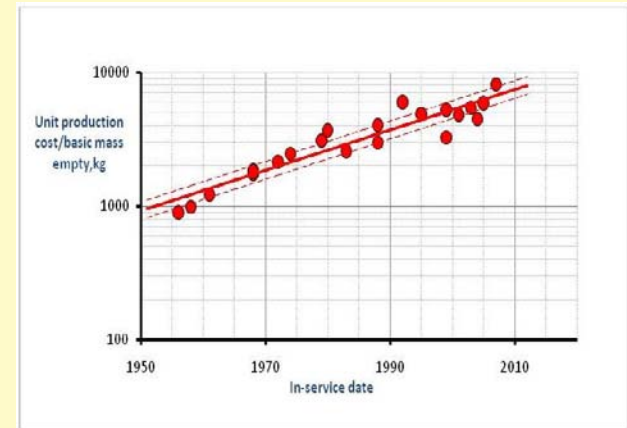
- The in-service cost areas considered
  - Logistics set up
  - Initial pilot training
  - Operation and Support costs
  - Upgrade and overhaul

- Logistics Set Up, is driven by many factors not all have the same financial effects across the various aircraft or nations
- Research from various sources identified the following;
  - F15 = 15% of the aircraft basic Price
  - F-16 C/D = 18% of the aircraft basic Price
  - F-18 E/F = 19% of the aircraft basic Price
  - Mirage 2000= 20% of the aircraft basic Price
  - Gripen = 20% of aircraft basic price
  - Typhoon = 35% this was an initial figure only
- Initial Training figures were also identified;
  - F15 = 4.4% of the aircraft basic Price
  - F-16 C/D = 6.6% of the aircraft basic Price
  - F-18 E/F = ?
  - Mirage 2000= 6.2% of the aircraft basic Price
  - Gripen = ?
  - Typhoon = ?

- An analysis has been continually carried across the Fighter Strike Aircraft to establish a number of CERs relating to the Physical Characteristics of the aircraft and the costs identified for Development and Production and In-service .

This represent most of the aircraft reviewed to date

- A-4B Skyhawk, AV-8A Harrier, F-104 A-D Starfighter, F111 Aedvark, F-14A Tomcat, F-15A Eagle, F-15E Eagle, F-15K Eagle, F16A-D Falcon, F-22 Raptor, F-4 A/B Phantom, F/A-18F Super Hornet, Gripen, Harrier GR1, Mirage 2000-5, Rafel F, Rafel M, T-45A/B Goshawk, Tornado F2, Typhoon.

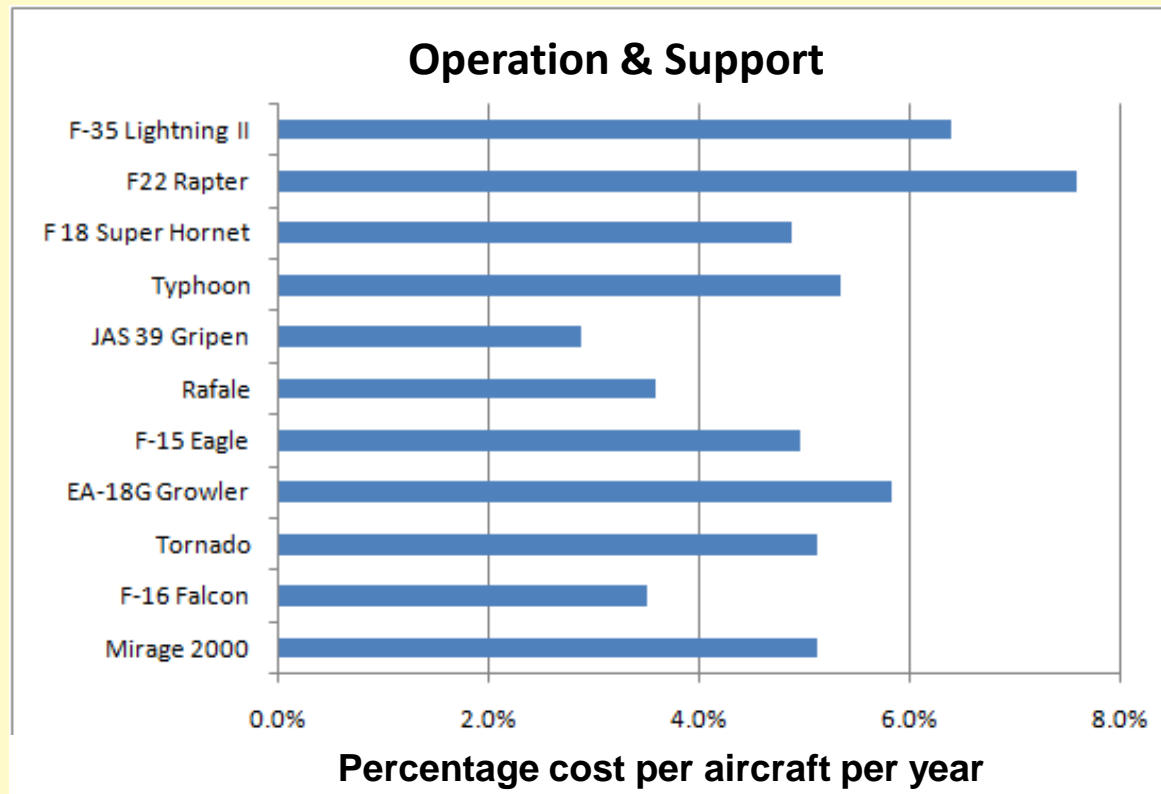


Fighter Aircraft	Aircraft Generation	Basic Mass Empty kg	Max Take off Weight kg	Flying Hours per year
Mirage 2000	4	7,500	17,000	240
F-16 Falcon	4	8,750	19,200	240
Tornado	4	13,890	28,000	240
EA-18G Growler	4	15,011	29,964	240
F-15 Eagle	4	12,700	30,845	240
Rafale	4	9,500	24,500	240
JAS 39 Gripen	4.5	5,700	14,000	240
Typhoon	4.5	11,150	23,500	240
F 18 Super Hornet	4.5	13,900	29,900	240
F22 Rapter	5	19,700	38,000	240
F-35 Lightning II	5	13,318	31,800	240

Aircraft analysed to help identify the cost relationships for Operation & Support



- Using the key aircraft characteristics and assuming a common number of flying hours per year the following percentages of the average unit production cost was generated. This represent the cost per aircraft per year.



- Further analysis was conducted in an attempt to identify the potential cost relating to aircraft Overhaul and Upgrade.
  - Historical costs are very difficult to find
  - They can be unique to the country
  - They are unique to each aircraft
  - There is a considerable level of unknown
    - This is a new generation of aircraft
    - Nothing is known about the upgrade strategy
    - Little is known about how easily the airframe can be disassembled
    - The limits to any major overhaul without effecting such areas as stealth performance
- Tornado upgrade GR1 to GR4 was in the order of £900 million
  - This represented approx 12% to 15% of the initial average unit production cost
- Harrier upgrade GR7/7A to GR9 was in the order of £500 million
  - This represents approx 20% of the initial average unit production cost

# Estimated Cost of ownership

- Using historically analysed and estimated costs we can speculate the cost of owning 100 aircraft over the next 30 years.

Using Independent cost estimates, UK Deflators	Low	Med	High
	\$M	\$M	\$M
Estimated Average Unit Cost	120	144	163
TOTAL Cost 100 off	12,000.00	14,400.00	16,300.00
Logistic Set Up	15%	19%	20%
	1,935.00	2,584.00	2,980.00
Operation & Support	4%	6%	8%
Cost of fleet for 30 years	15,480.0	24,480.0	35,760.0
Overhaul & Upkeep	12%	15%	20%
	1,548.00	2,040.00	2,980.00
TOTAL 30 years	30,963.00	43,504.00	58,020.00

# Latest Procurement Figures



- The GAO published their latest report on the 15<sup>th</sup> March 2011. This included the latest cost for the acquisition of JAS and has included the Nunn McCurdy re-baseline of the JSF.

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2010		325,100.00	325,100.00		2457	132.32	131

Average Unit Production Cost has increase by 44%

# Questions

## WHAT WILL IT COST YOU? HAVE YOU BUDGETED ENOUGH?

**Acquisitions costs**

**Logistic set up**

**Maintenance Training**

**Fuel**

**Flying Hours per Year**

**Pilot Training**

**Test Equipment**

**Overhaul**

**Operational costs**

**Facilities**

**Upgrade**

**Capital Spares**

**Infrastructure**

**Support Costs**

**Tooling**