



EUROPE

***Cost Forecasting:  
Where Do We Get It Wrong  
(and Why)?***

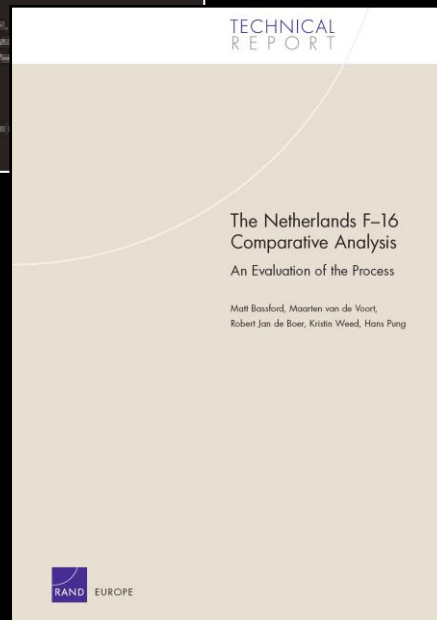
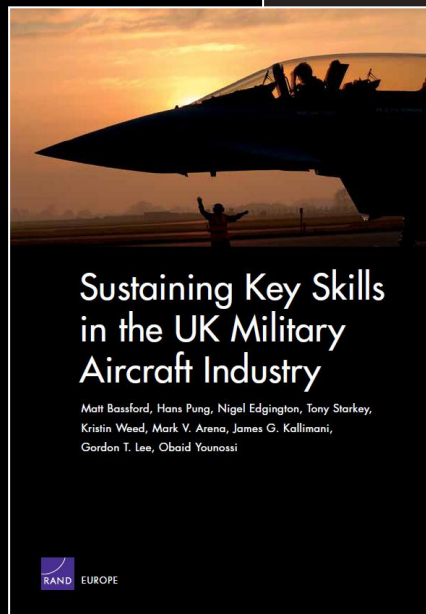
**Matt Bassford**

**Director, Defence & Security Programme**

# ***This presentation draws on RAND's experience of defence analysis in the US, UK, and Europe***

## *From Marginal Adjustments to Meaningful Change*

Rethinking Weapon System Acquisition



- A global not-for-profit research institute with over 2000 staff
- Extensive work on analytical methods and their application to difficult public policy questions
- Over 35 Nobel prize winners

***There are three main areas of focus that the presentation will cover***

- **Meta analysis of cost growth on US and UK defence programmes**
- **Key areas of cost growth on major UK defence acquisition programmes**
- **Insights into sources of error in cost estimates**

## *Or to put it more bluntly...*

- **Where has cost growth occurred?**
- **Which programmes are associated with the largest cost growth?**
- **What are the ways in which cost estimators can act irrationally?**
- **How can we learn from this evidence?**

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## ***Uncertainty in cost estimating is nothing new...***

***“The data is particularly messy. Therefore a good deal of judgement has had to go into these estimates. But even after the most prudent treatment the data leaves much to be desired and a good deal of caution is needed in interpreting the results.”***

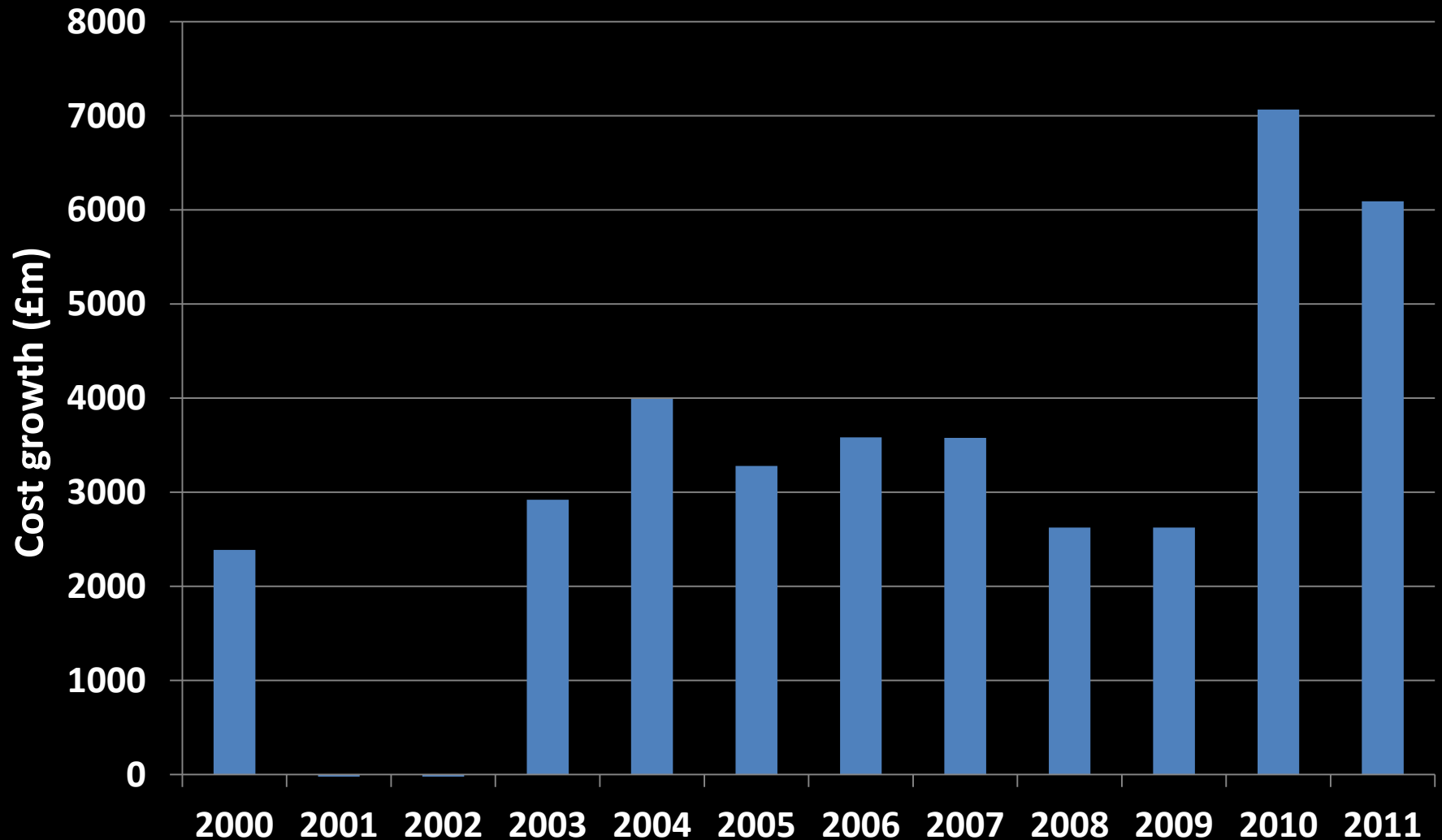
**RAND report of 1959 on cost overruns in defence projects**

***...and in recent years there has been significant cost growth in UK MOD projects***

***“The Ministry of Defence has been hampered by a legacy of poor planning and performance on some past projects, and the resulting cuts and delays are not value for money.”***

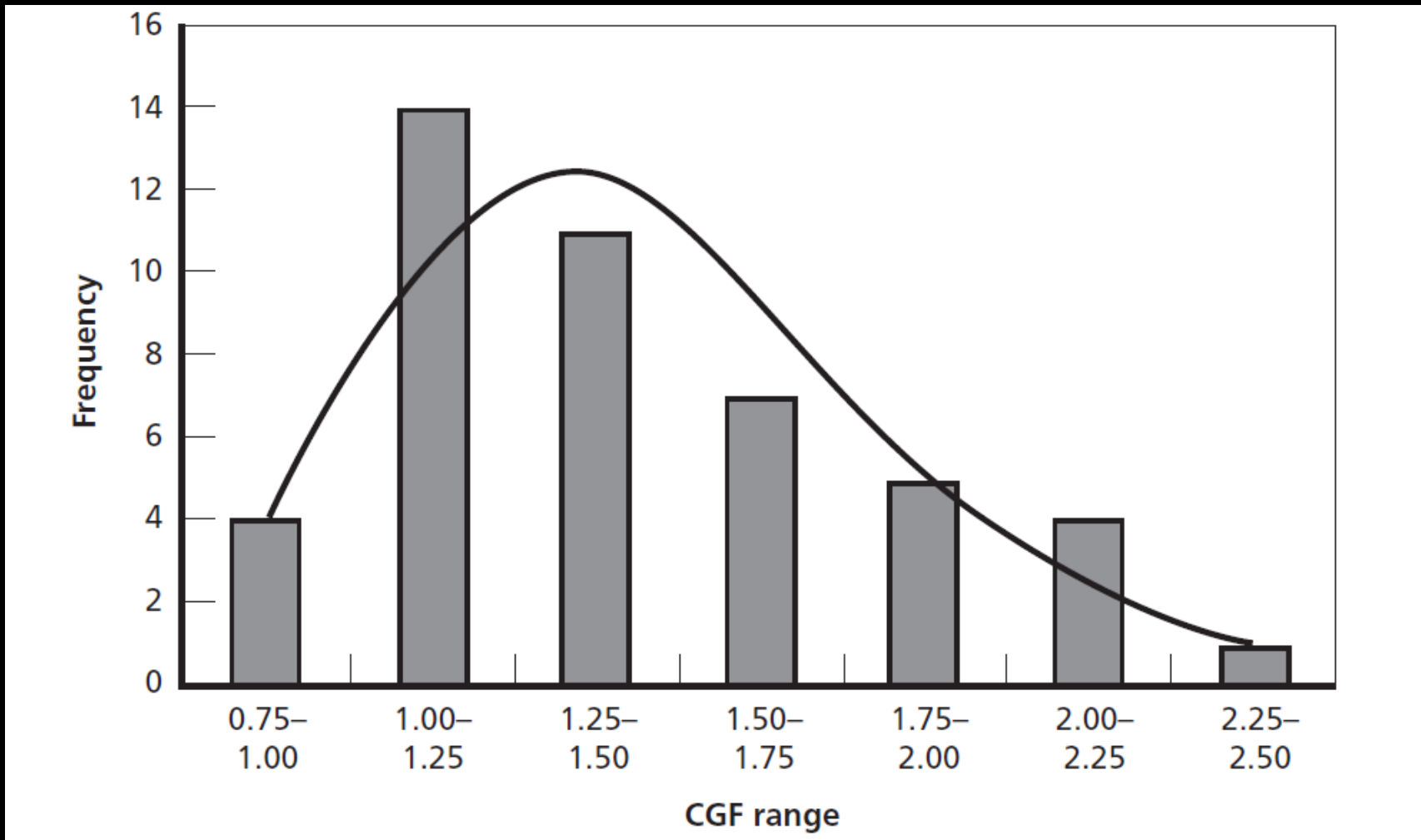
**National Audit Major Projects Report 2011**

# *The aggregate cost growth of the UK's 15 largest acquisition programmes was £6bn in 2011*





***RAND analysis of over 150 US DOD programmes also shows a systematic bias for underestimating***



## *...with mean cost growth of 46 percent*

- **Cost growth factor (CGF) is the ratio of final cost to estimate at Milestone II (broadly equivalent to Main Gate)**
- **CGF less than one indicates an under-run; CGF greater than one indicates an over-run**

<b>Summary Statistics</b>	<b>CGF value</b>
Mean	1.46
Median	1.44
Standard Deviation	0.38
Minimum	0.77
Maximum	2.30

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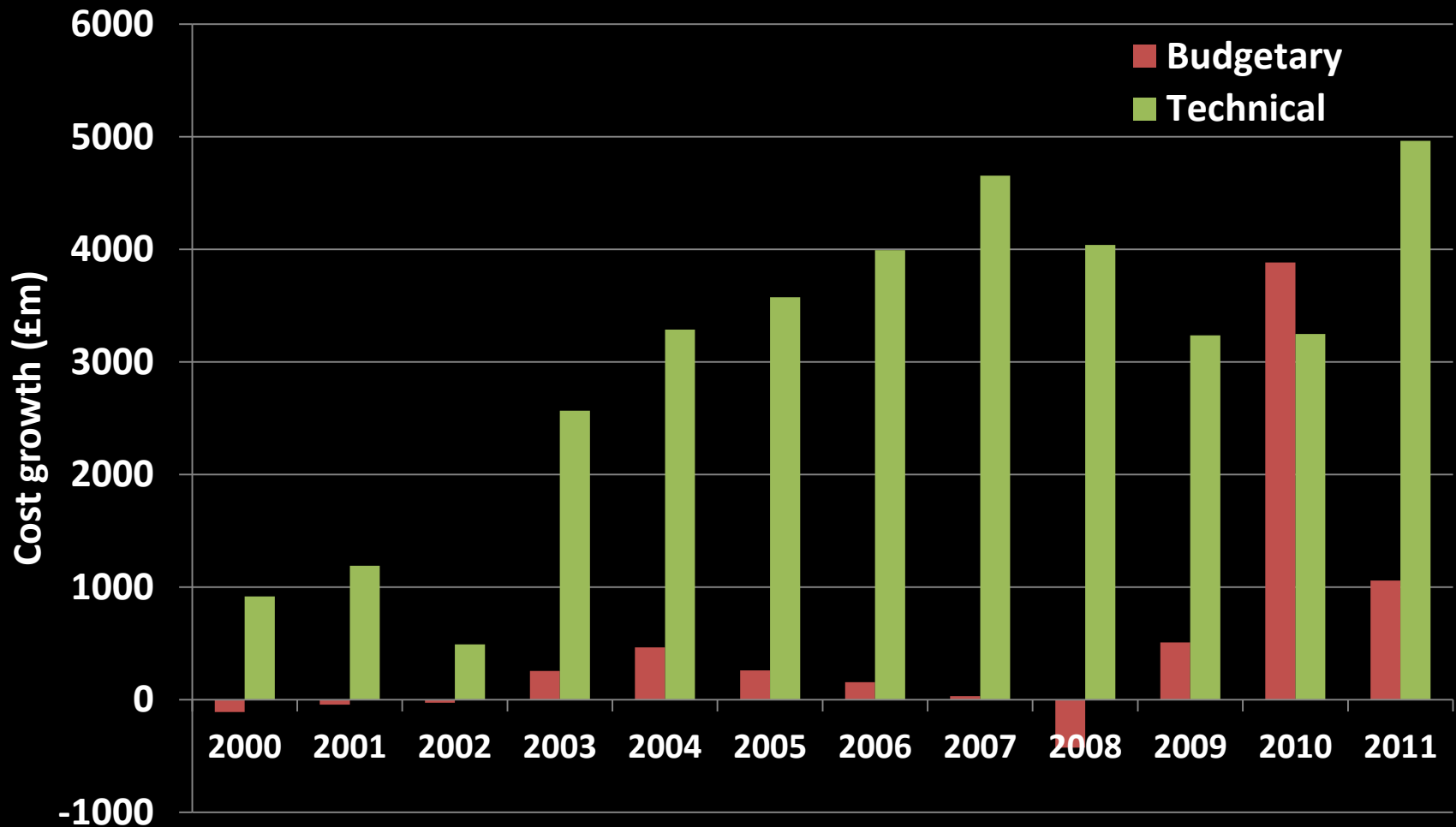
***The NAO major projects report is a useful source of information for analysing cost growth...***

<b>Corporate decisions</b>	<b>Project or technical issues</b>	<b>Macro-economic or accounting adjustments</b>	<b>Other</b>
Changed capability requirement	Technical factors	Inflation	Receipts
Budgetary factors	Procurement strategy/processes	Exchange rate	Change in associated project
	Procurement processes/int. collaboration	Accounting adjustments & redefinitions	HM Treasury Reserve
	Contracting process		

## ***...but the data comes with a number of caveats***

- **Data are reported at high levels of aggregation**
- **Baseline changes, modifications and restructuring are not well documented**
- **Reporting guidelines and requirements change**
- **Allocations of cost growth are inconsistent**
- **Weapon system costs are incomplete**

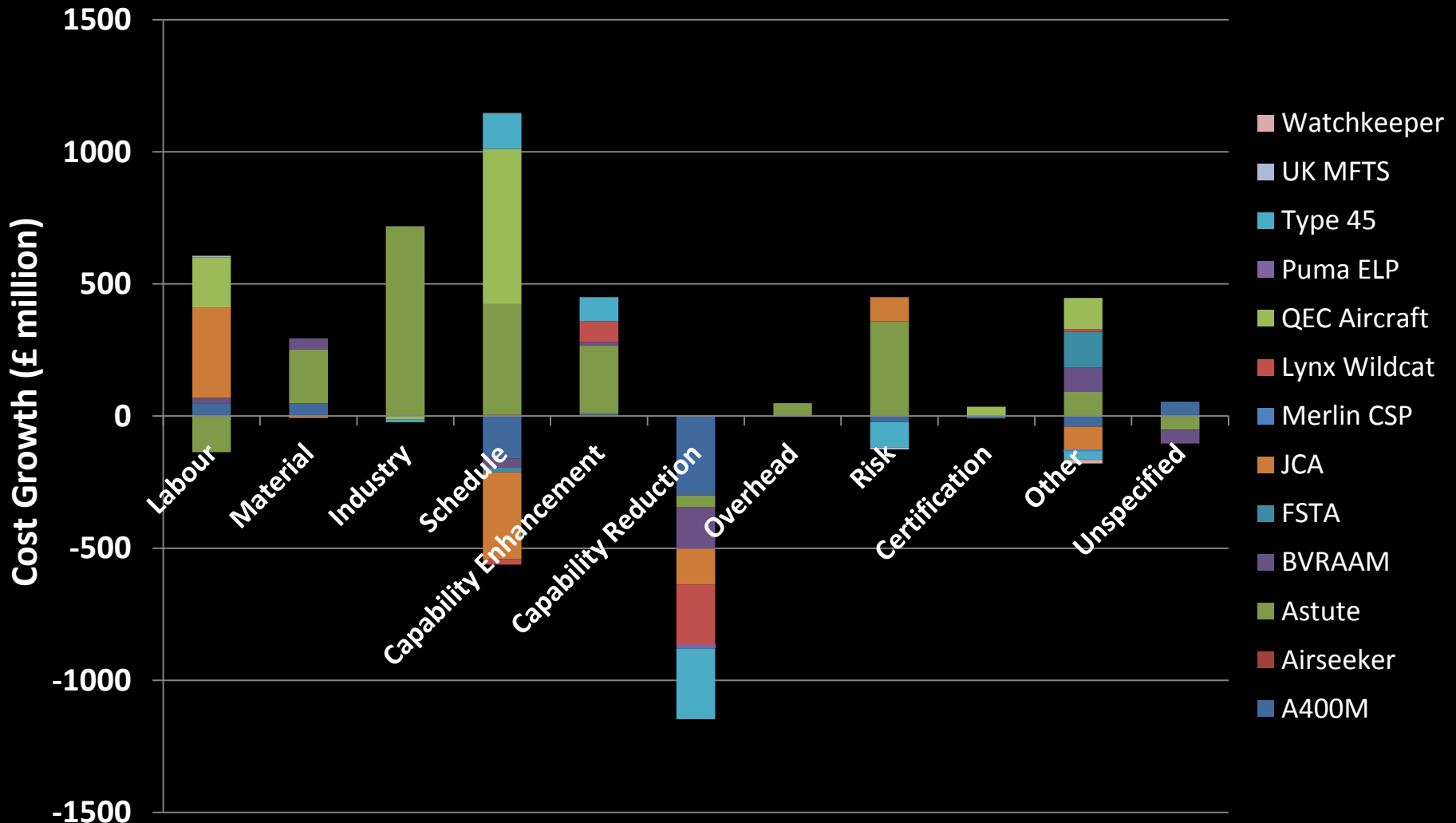
# *Under the NAO typology, the major drivers of cost growth are “Technical” and “Budgetary” factors*



# *We examined cost growth for each project against a more granular typology*

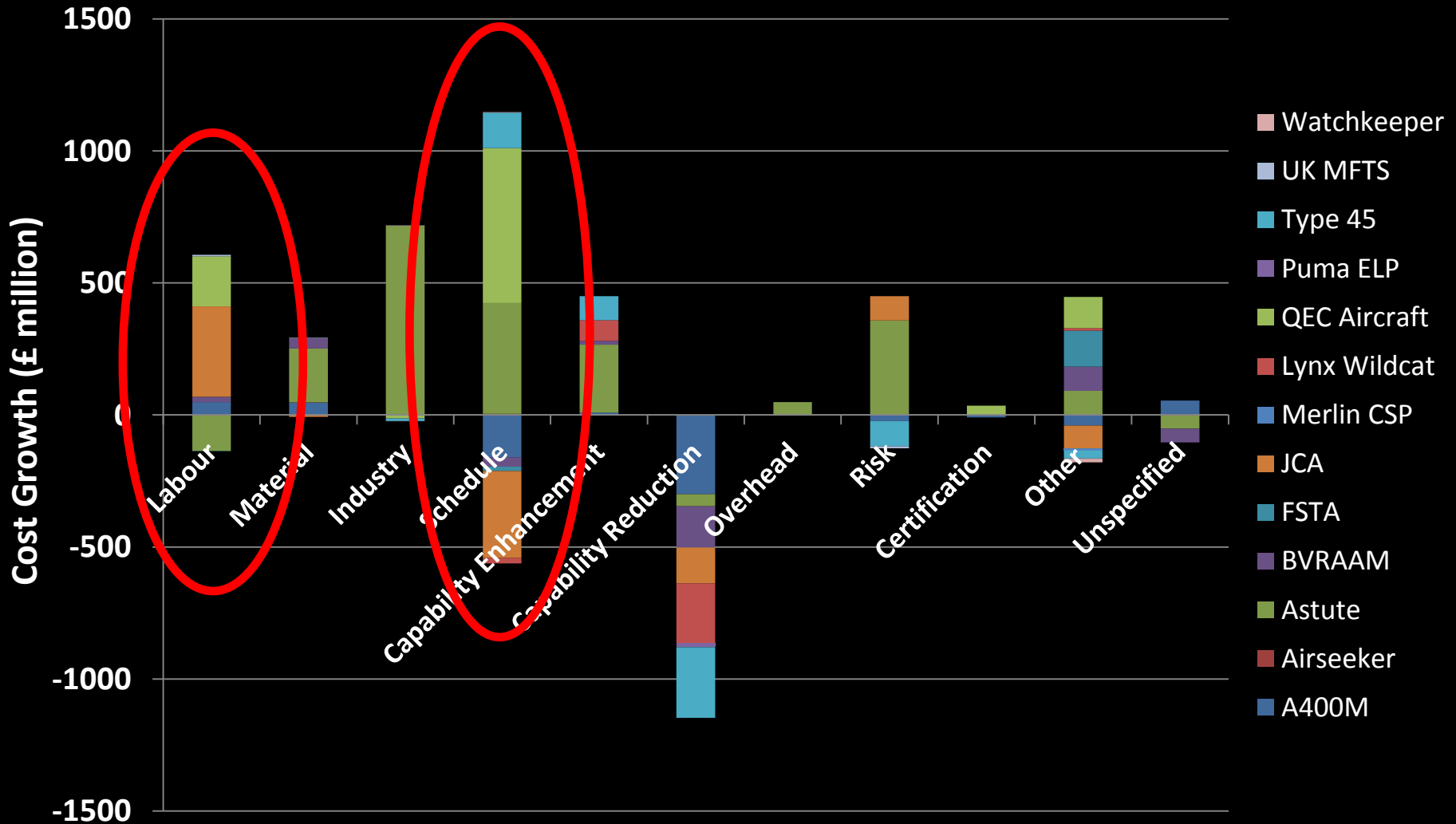
<b>Factor</b>	<b>Description</b>
<b>Labour</b>	Labour costs for system design, development, manufacture and integration
<b>Material</b>	Costs of bought in systems, sub-systems, raw materials and components
<b>Industry</b>	Prime & non-prime contract costs (labour, overheads, materials & VAT)
<b>Schedule</b>	Programme re-profiling, delays and changes in production drumbeat
<b>Capability</b>	Changes in the scope of the programme / number of units etc
<b>Overhead</b>	Re-estimation of overhead rates
<b>Risk</b>	Re-assessment of risk & risk mitigation
<b>Certification</b>	Certification and safety requirements
<b>Other</b>	Sunk costs, UK contribution to international programmes
<b>Unspecified</b>	Unallocated cost growth

# *Our analysis suggests the main sources of cost growth are labour costs and corporate decisions...*

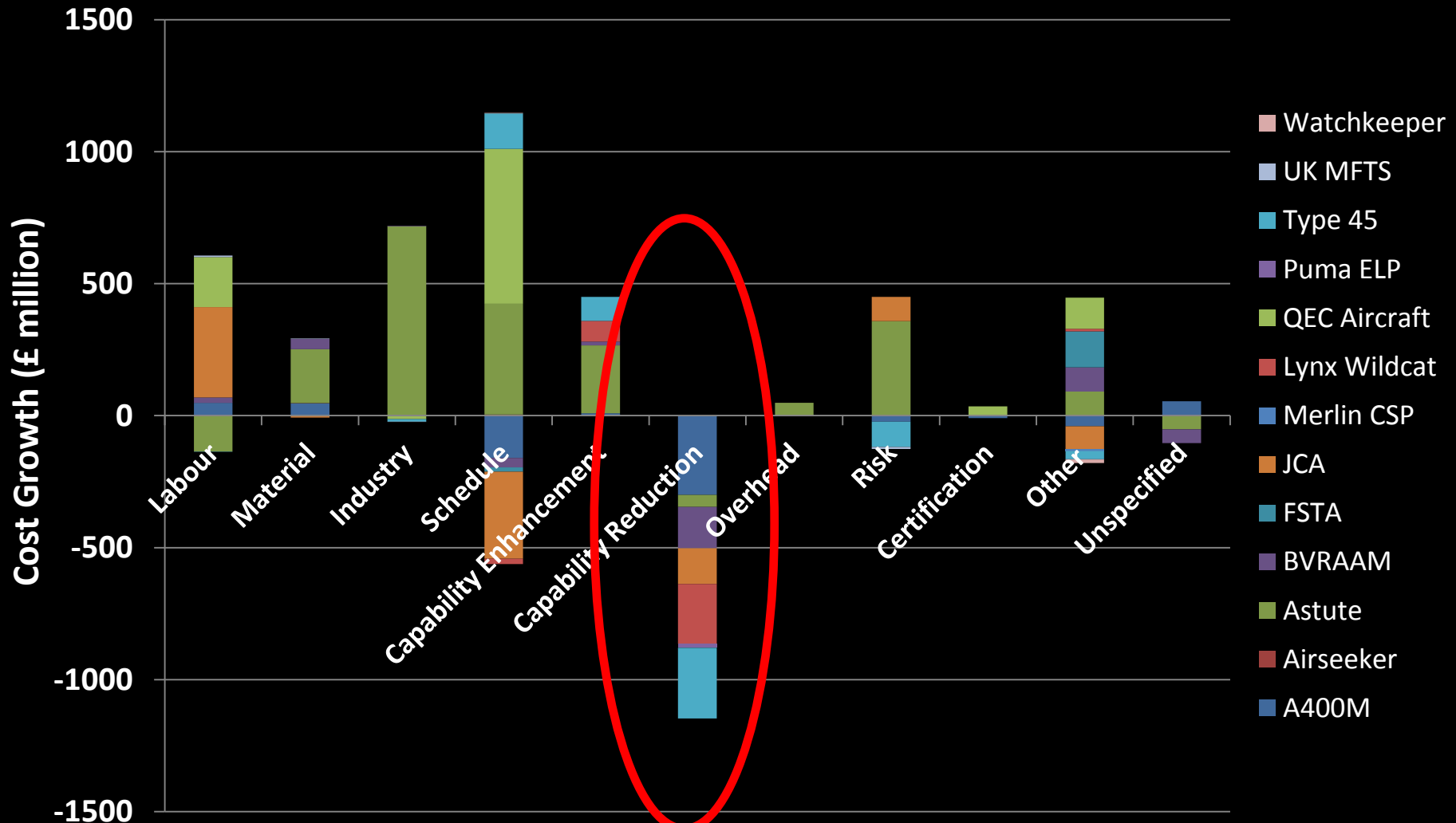




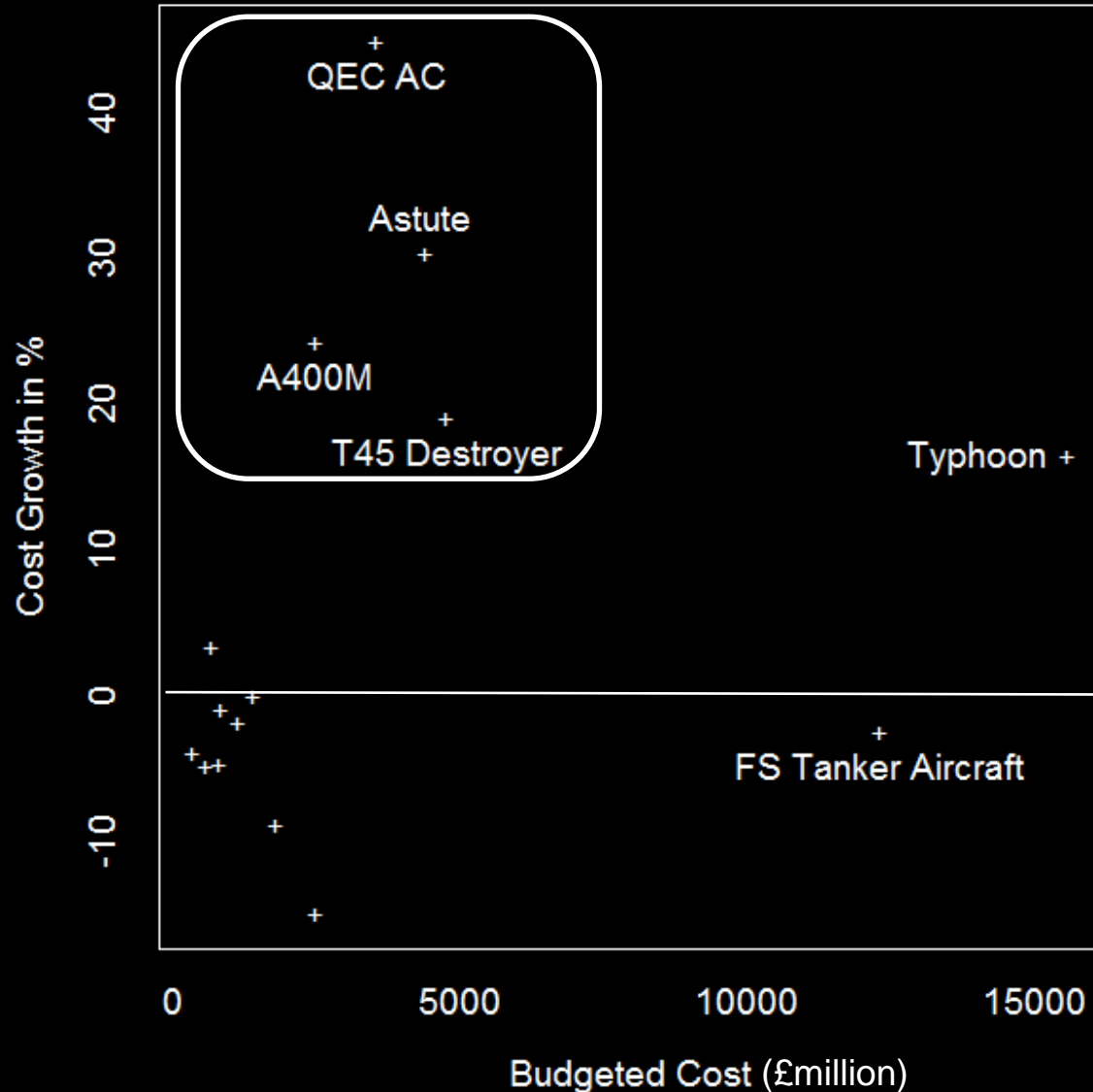
# *Our analysis suggests the main sources of cost growth are labour costs and corporate decisions...*



# *...with capability often sacrificed to balance the books*



***The majority of cost growth is accounted for by a small number of the largest programmes***



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## ***Cost and risk analysis requires judgements based on incomplete and uncertain information***

- **It is easy to identify errors in cost estimates: through *ex post* evaluations**
- **Forecasting future costs and associated uncertainty level requires objective analysis – however people often do not act ‘rationally’**
- **Behavioural economics offers insight into influences on decision process relevant for cost estimating**

***Anchoring and adjustment bias can give undue status to initial assessment***

$$8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 2,250?$$



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*Anchoring and adjustment bias can give undue status to initial assessment*

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$$1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 = 512?$$





## ***Anchoring and adjustment bias can give undue status to initial assessment***

- **Anchoring and adjustment bias reflects a tendency to make estimates by starting with an initial value and making incremental changes**
- **Important to consider what determines potential anchor points: some are more reliable than others: historical value; close analogue; guesswork**
- **Estimates of uncertainty ranges can also be subject to anchoring bias**

## ***The availability or familiarity of data can also introduce a source of bias***

- **Professor Keith Nutt famously compared the risks of horse riding and the risks of illicit drug taking**
- **Empirical data shows that deaths from drug taking are over reported compared with those from horse riding – but popular perception is very different**



## ***The availability or familiarity of data can also introduce a source of bias***

- **Availability bias describes the tendency of humans to judge an event more likely if they have heard about it recently or have particular memory of it**
- **The heuristic of availability makes fault tree analysis potentially vulnerable as analysts rely on what they know and can easily predict**
- **Consequence is that some risks may be overstated and unduly skewed towards previous programme issues**

## *A quick thought experiment*

- There are 90 balls in an urn: coloured red, black and yellow
- You know that there are 30 red balls but no information on number of black or yellow balls
- You win £100 if you can successfully predict the colour of a ball drawn at random from the urn
- What colour do you select?



## ***Ambiguity aversion can lead to underestimating of uncertainty***

- **The famous Ellsberg experiment illustrates ambiguity aversion – the vast majority of people predicted a red ball even though odds are equal**
- **On the whole, people dislike uncertainty and avoid it whenever possible**
- **Cost analysts may be incentivised to report a narrower uncertainty range than a broad one – which may be viewed as a lack of expertise**

## ***The 'conspiracy of optimism' in previous MOD programmes has been well documented***

- **Large incentives exist for project teams to be optimistic on programme costs to increase chance of funding**
- **MOD customers and industry are likewise incentivised to assume things will work out well**
- **Essential to have independent cost analysis and assurance to mitigate this risk**

# *People interpret information in different ways depending on how it is framed*

**Cancer sufferers were given a choice of potential treatment plans**

- **Surgery:**
  - 68% alive at end of first year
  - 34% alive at end of five years
- **Radiation therapy**
  - 77% alive at end of first year
  - 22% alive at end of five years

**18 percent of people would elect radiation therapy**

# *People interpret information in different ways depending on how it is framed*

**Cancer sufferers were given a choice of potential treatment plans**

- **Surgery:**
  - 32% die within first year
  - 66% die within five years
- **Radiation therapy**
  - 23% die within first year
  - 78% die within five years

**44 percent of people would elect radiation therapy**



# ***Framing bias tends to affect decision-makers more than cost analysts***

- **The way information is provided can influence views and interpretation of risk**
- **Cost analysts must exercise care in how they present cost uncertainty to decision-makers**
- **Framing bias could also affect expert opinion of judgement of risks depending how information is presented**

***There are four key messages  
to draw from this presentation***



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to draw from this presentation***

- **More complex and more expensive programmes are more likely to be associated with cost growth**
- **The MOD books have been balanced through delays, fewer units, and reduced capability**
- **The NAO Major Projects Report risks a disservice to MOD cost estimates – corporate decisions are a major source of cost growth**
- **Behavioural economics offers insight into potential influences on cost estimating**



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# The Typhoon Programme is distorted by changes to the status of the Tranche 3 aircraft

