

# **Cost Performance on Major Projects and Programmes**

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**WMG is a department of the University of Warwick who work closely with technology-led companies to develop managers and support organisational improvement.**

**WMG was founded by Professor Lord Kumar Bhattacharyya in 1980, and now employs over 400 people and teaches students in 10 international centres around the world.**



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**We now teach an MSc in Project and Programme Management in Singapore.**

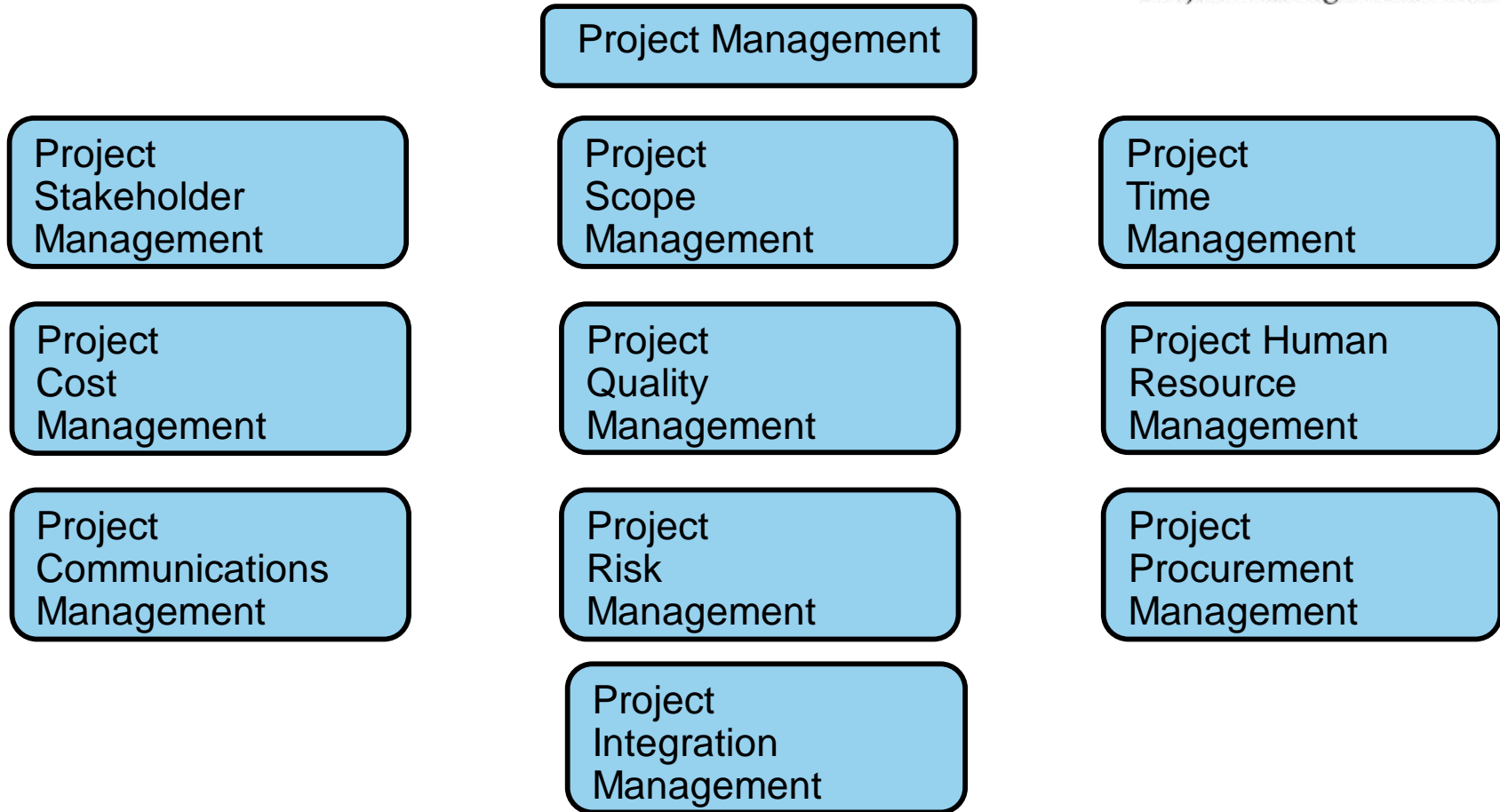
# **Cost Performance on Major Projects and Programmes**

**Major Projects and Programmes continue to overspend.**

**This session draws on evidence from a range of projects and programmes in a range of industries (Aerospace, Transport, Olympics) to address three questions.**

- How bad is the problem?**
- What are the significant issues and cost drivers?**
- What are the appropriate approaches and responses?**

# PMBOK



**Knowledge Areas and Project Management Processes**  
PMI: Project Management Institute [www.pmi.org](http://www.pmi.org)

# Project Cost Performance

**"... the track record of projects is fundamentally poor, particularly for the larger and more difficult ones. Overruns are common ... Many projects appear as failures. "**

**From a review of "... some 3,500 projects drawn from all over the world in several different industries, overruns are the norm, being typically between 40 and 200 percent. "**

Morris and Hough (1987)

# Summary of More Recent Evidence

	Projects	Sample Size	% of Projects Overspending	Average Overspend
1	UK IT Projects	421	60%	18%
2	NASA Projects	27	66%	16%
3	UK Defence Projects	30	77%	14%
4	UK New Build Projects	1877	52%	3%
5	UK Refurbishment Projects	1204	49%	5%
6	Rail Projects (1927 to 1998)	58	87%	45%
7	Bridges and Tunnels (1927 to 1998)	33	70%	34%
8	Road Projects (1927 to 1998)	167	87%	30%

# Project Cost Performance

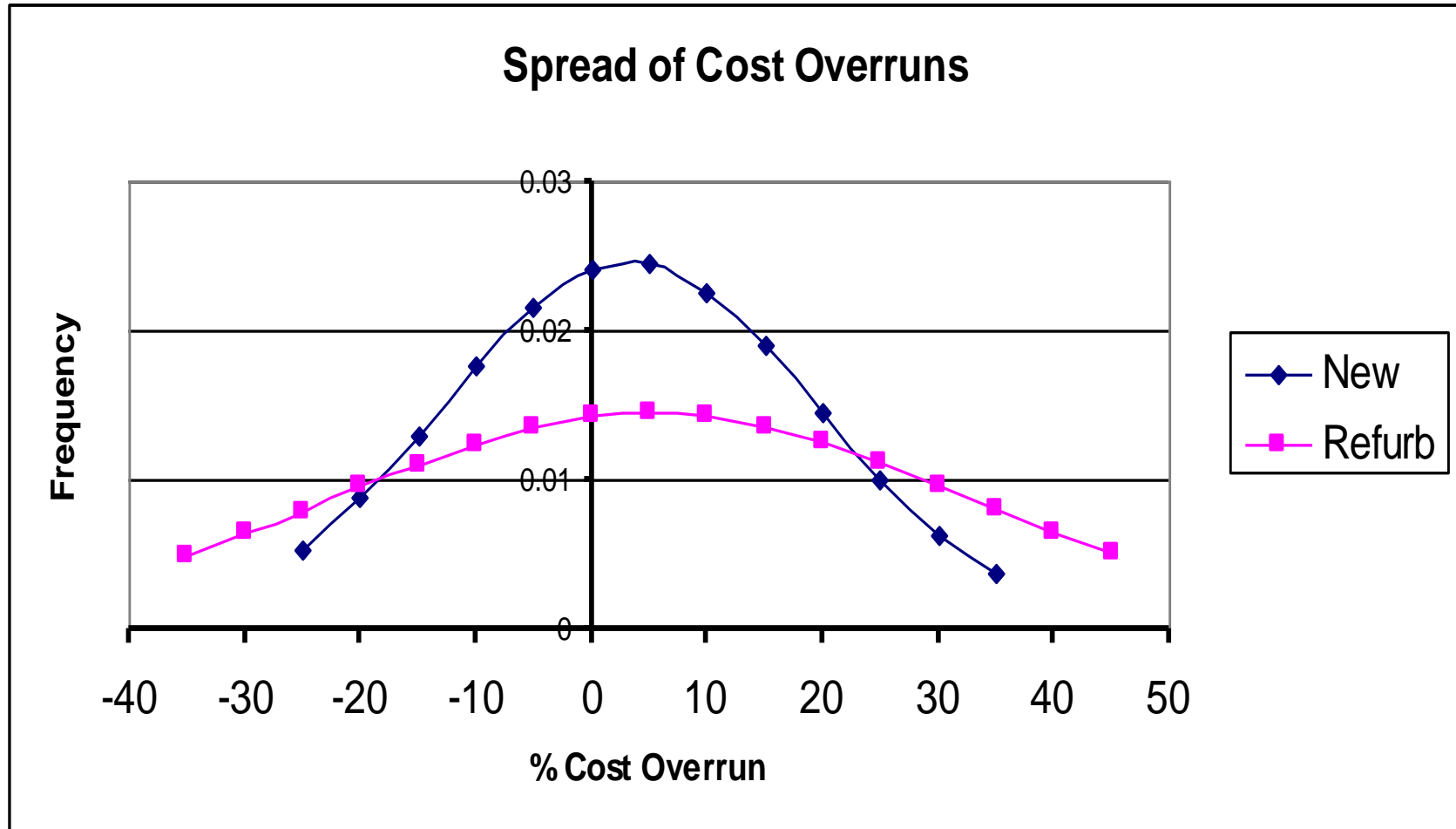
**From a sample of 3817 projects from specific industries:-**

**Overruns range from an average of 3% for UK new build construction projects, to an average of 45% for rail projects.**

**Where there is a portfolio of projects in a given industry or sector; the % of projects overspending ranges from 49% for UK construction refurbishments to 87% for rail projects.**

Newton (2009)

# Spread of Cost Overruns (Data 4 and 5)



# Transportation Infrastructure Projects (Data 6 to 8)

	No. of Projects	Average Cost Overrun	Standard Deviation
<b>Rail</b>	<b>58</b>	<b>44.7</b>	<b>38.4</b>
<b>Bridges &amp; Tunnels</b>	<b>33</b>	<b>33.8</b>	<b>62.4</b>
<b>Road</b>	<b>167</b>	<b>20.4</b>	<b>29.9</b>
<b>All</b>	<b>258</b>	<b>27.6</b>	<b>38.7</b>

Flyvbjerg et al (2003)

# Flyvbjerg's Findings

- **9 out of 10 transport infrastructure projects overrun on cost**
- **Cost escalation is consistent across 20 nations and 5 continents; It is a global phenomenon**
- **Rail project cost escalation is larger in developing countries than in Europe or North America**
- **Cost escalation has not decreased over the last 70 years**

# Flyvbjerg's Findings

**Cost estimates used in decision-making for transport infrastructure development are highly, systematically and significantly misleading.**

**Underestimation of costs at the time of decision to build is the rule rather than the exception for transport infrastructure projects... [This] appears to be intentional and part of the power games played by project promoters aimed at getting projects started.**

# Case Study Expectations

## In a project with excellent cost performance

Expect	Not Expect
Solid Agreed Project Definition (15%)	Lack of Clarity in Definition
Through Life Cost Evaluation	Capital Cost Only
Senior Responsible Owner	Many Owners
Effective Risk Budget	Insufficient Risk Allowance
Robust Project Controls	Poor Supplier Integration
Reference Class Forecasting	Optimism Bias
Period of Stability to Launch	Significant Last Minute Change

# Main causes of cost overrun in UK construction projects

Rank	Main causes of cost overruns
1	Design changes
2	Risk and uncertainty
3	Inaccurate time plan
4	Non-performance of sub-contractors and suppliers
5	Complexity of works
6	Conflict between parties
7	Discrepancies in contracts
8	Interpretation of contracts and specifications
9	Price inflation
10	Financing and payment for completed works
11	Lack of project management training and experience
12	Low skilled manpower
13	Unpredictable weather conditions
14	Dependency on imported materials
15	Lack of appropriate planning
16	Unstable interest rate
17	Fluctuation of currency/ exchange rates
18	Weak regulation and control
19	Fraud and corruption
20	Unstable government policies

Olawale (2010)

# Three Case Studies



**XRL HK High Speed Rail Link**



**Boeing 787 Dreamliner**

**What do they tell us about  
improving Project  
and Programme Cost  
Performance ?**



**Original Estimate**  
**£ 4.04 Billion**

**Final Budget**  
**£ 9.325 Billion**

**Final Spend**  
**£ 9.2 Billion**

# The Olympic Challenge

**A once in a life-time opportunity to leave a lasting impression on the world. The London Olympic Games involved:-**

- 10,560 athletes, 12,000 officials from 204 nations speaking many languages**
- 9 million tickets on sale**
- 34 venues; including 13 totally new**
- 302 events in 26 sports including 39 disciplines**
- 21,000 media personnel broadcasting to a potential audience of 4 billion people**
- 20 million spectator trips to events including 3 million trips on the busiest day**
- A total workforce of around 200,000 people, including more than 6,000 staff, 70,000 volunteers and 100,000 contractors,**

# London Olympics 2012

Criteria	Target	Actual	Difference	Reasons
Time	7 years and 8 months (from Approval)		0 days	
	5 years and 4 months (from Revised Budget)		0 days	
Cost	£ 4.04 Billion (2004)	£ 9.2 Billion	£ 5.16 Billion	Tax and Contingency were added to the original budget
	£ 9.35 Billion (2007)		£ -150 Million	
Performance	34 venues including 13 totally new 21,000 media broadcasting to 4 Billion people 304 events 20 million spectator trips Security			

# Learning

- **Venue security cost an additional £ 500 million from contingency; the sub-contractor failed to deliver and has admitted liability**
- **Legacy Benefits are to be delivered by multiple stakeholders and many organisations. The UK Government Cabinet Office is now responsible for coordination**
- **Overall the Games was deemed to be a success**
  - Opening and Closing Ceremonies received critical acclaim; 11 million tickets sold
  - 70,000 volunteers recruited, trained and delivered
  - UK sportsmen and women exceeded medal expectations
  - No security or transport Incidents
- **Earned Value was used for project control until the last few months**
- **Governance structures changed as project needs changed**
- **Some venues changed from permanent to temporary as the project evolved**

# Case Study Expectations

## In a project with excellent cost performance

Expect	Olympics
Solid Agreed Project Definition (15%)	Yes
Through Life Cost Evaluation	Yes
Senior Responsible Owner	Appropriate changes of governance
Effective Risk Budget	£ 2.7 Billion contingency
Robust Project Controls	Earned Value Management and Snagging Lists
Reference Class Forecasting	Budget changed dramatically in 2007
Period of Stability to Launch	1 year proving of events



**Currency Exchange Rates**



**Political Uncertainty**



**Pollution**



**Doping bans**



**Health Issues**

**Original Estimate  
\$ 3.1 Billion**

**Final Spend  
\$ 4.6 Billion**

# Hong Kong to Guangzhou Express Rail Link



**West Kowloon Terminus**



**26 km of Underground railway**



**Sidings**



**Ventilation and  
Emergency Access**



# The Underground Challenge

- **Underground High Speed Rail Link**
- **Integration with the Mainland**
- **New organisational arrangement (Concession)**
- **Largest excavated underground High Speed Rail station in the world**
- **In a densely populated urban area**
- **Engagement and coordination of multiple contractors**
- **Complex coordination with Government**
- **Previous Hong Kong rail projects had performed really well to aggressive schedules (average delays of 1% or 3% across portfolios of projects)**

# Hong Kong to Guangzhou Express Rail Link

Criteria	Target	Forecast	Difference	Reasons
Time	5.8 years Q3 2015	8.8 years Q3 2018	3 years (+52%)	Unforeseen site conditions Fast-tracked front-end Design changes Flooding Low production rates Labour shortage
Cost	\$64.5 Billion	\$84.42 Billion	\$19.92 Billion (+31%)	Programme delays Change in work scope due to unforeseen events Overheated labour market in HK Material costs
Performance	West Kowloon Terminus 26km long tunnel Underground emergency rescue station Stabling sidings 8 ventilation buildings Rolling stock			

# Learning

## From a Report by Independent Board Committee and External Experts

- **There was not enough schedule contingency for major sub-contracts in the plan**
- **New governance structure needed (Capital Works Committee and Risk Committee)**
- **Visible reporting of major milestones at board level**
- **Use rates of contingency draw down to challenge the project cost estimate**
- **Use Schedule Recovery Index to quantify needed performance**
- **Project team reported effectively and worked hard to recover delays but escalation rules were not precise**
- **Introduce a tiered contingency fund under the concession approach including an allowance for unknown unknowns**

# Case Study Expectations

## In a project with excellent cost performance

Expect	Initial (2010)	After Review (2014)
Solid Agreed Project Definition (15%)	Fast-tracked front-end	
Through Life Cost Evaluation		
Senior Responsible Owner	Yes	
Effective Risk Budget	No	More realistic
Robust Project Controls	Yes; but escalation rules were not precise	Board Level Milestone Plan
Reference Class Forecasting	No	Yes
Period of Stability to Launch	Planned reliability testing	

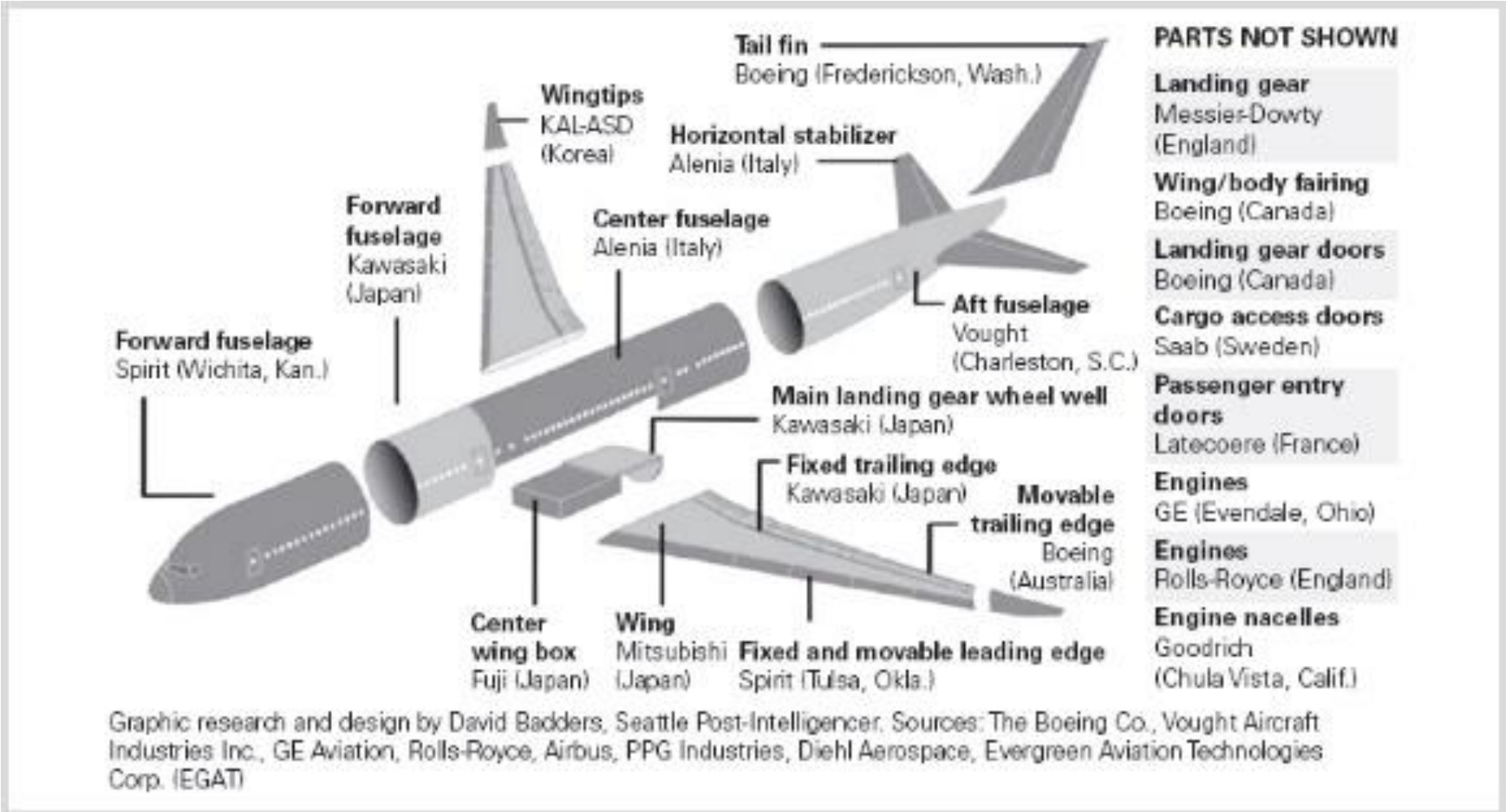
# Boeing 787 Dreamliner Development



# The Supply Chain Challenge

- **Lightweight composite material for fuselage;**
- **Fly by wire control systems and new displays**
- **Faster design and development**
- **Systems supply outsourcing to 700 foreign and local suppliers (70% overseas)**
- **Risk and Revenue Sharing contracts with suppliers owning IPR and funding development cost**

# Dreamliner Assembly Sources



# Boeing 787 Dream Liner

Criteria	Target	Actual	Difference	Reasons
Time	Q1 2008 4 years	Q2 2011 7.33 years	3.33 years (83%)	Composite fuselage failed test Fly by wire extended development Supplier delivery failure Shortage of fasteners Incomplete Software Strikes
Cost	\$ 20 Billion estimate	\$40 Billion estimate	\$20 Billion (100%)	Programme delays \$1 Billion penalties for late delivery \$ 2.5 Billion; Unsellable prototypes \$ 1 Billion bought supplier
Performance	Fuel efficient long-haul transport for 250 passengers (20% lower costs) Lightweight composite materials Fly by wire and large screens Systems development, supply and integration from 700 suppliers (70% overseas) risk and revenue sharing contracts			

# Learning

- **Suppliers were inexperienced and incapable of performing the new systems integration role**
- **Boeing to perform last-stage high-level integration, check-out and test. “Travelled work” (returned incomplete work from suppliers) destroyed flow**
- **Boeing had to introduce a new operations centre to institute control of tier 1, 2 and 3 component supply**
- **Fuselage design changes needed stronger wings and together added 8 tonnes of weight**

# Case Study Expectations

**In a project with excellent cost performance**

<b>Expect</b>	<b>Dreamliner</b>
Solid Agreed Project Definition (15%)	
Through Life Cost Evaluation	Yes
Senior Responsible Owner	Yes
Effective Risk Budget	No
Robust Project Controls	No
Reference Class Forecasting	No
Period of Stability to Launch	Battery Issues 16 months into life?

# Conclusions

# Cost Performance Drivers from the Case Studies

Rank	Main causes of cost overruns	Case 1 Olympics	Case 2 XRL	Case 3 Boeing
1	Design changes		Y	Y
2	Risk and uncertainty	Y	Y	Y
3	Inaccurate time plan		Y	Y
4	Non-performance of sub-contractors and suppliers		Y	Y
5	Complexity of works		Y	Y
6	Conflict between parties			
7	Discrepancies in contracts			
8	Interpretation of contracts and specifications			
9	Price inflation		Y	
10	Financing and payment for completed works		Y	
11	Lack of project management training and experience			
12	Low skilled manpower		Y	
13	Unpredictable weather conditions		Y	
14	Dependency on imported materials			
15	Lack of appropriate planning			
16	Unstable interest rate		Y	
17	Fluctuation of currency/ exchange rates			Y
18	Weak regulation and control			
19	Fraud and corruption			
20	Unstable government policies			

# Cost Performance Issues and Solutions

- **Optimism bias in conventional event based estimating processes**  
**External reference points are really useful.**  
**Use Reference Case Forecasting where possible**
- **Schedule drives cost**  
**Allow “enough” schedule contingency on multiple critical paths**
- **New challenges can break standard processes**  
**How do we know when they are broken ?**  
**Design intelligent redundancy into our top level processes**
- **Radical process change rarely delivers the first time**  
**Pilot it quietly and know the real issues and risks**

# Conclusions



- London 2012 had the political headroom, stakeholder commitment and capability to take action to put an effective budget in place
- Delivery was excellent
- There are project professionals in XRL delivering excellent capability
- XRL reporting and escalation processes were not up to the challenges of a really high risk project
- Boeing took really high risks without formal acknowledgement of those risks
- The capabilities that Boeing developed will be really valuable for the future



# Questions?

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