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SCAF Annual Conference

"Benefits of Cost Engineering and Realistic Cost Forecasting"

Brian Sugden MBE

MoD / DE&S Specialist Fellow for Cost Engineering
and
CAAS (Cost Assurance & Analysis Service) Technical Coach

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"Benefits of Cost Engineering over Time"

4 off Presentation Themes

- **Brief History** of Technical Cost Engineering and Cost Forecasting
- **Benefits** of Cost Engineering to both HM Government and Industry
- **Techniques** of UK Technical Cost Section since its creation in 1915
- **Description** of the inputs to Three Point Estimating for Risk Analysis

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An Early Historical Reference to Technical Cost Forecasting

– **The Bible -*Luke Chapter 14***

Verse 28

For which of you, intending to build a Tower, sitteth not down first to count the *cost*, whether he hath *sufficient* to finish it?

Verse 29

Lest haply, after he hath laid the foundation, but *insufficient* to continue, all that *behold* it shall begin to mock him; saying "This man began to build a Tower, but was *unable* to finish it".

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Brief History of Technical Cost Engineering

The history of Monarchy acquiring Technical Cost Engineering advice from Subject Matter Experts on buying Military Weapons goes back centuries.

However, historically the acquiring of such Specialist Expertise was ‘Ad Hoc’.

But, in the year 1660, Charles II appointed **Samuel Pepys** as Secretary to the Navy Board to control the Technical Costs of Admiralty Ships and Parts.

Hence, in effect **Samuel Pepys** was the first Technical Cost Officer to be employed as a Crown Civil Servant by a HM Government establishment.

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Samuel Pepys

Became the first Technical Cost Officer under Charles II

Samuel Pepys 1633-1703, was Chief Secretary to the Navy Board for 28 years 1660-1688. He negotiated contracts and centralised all Ships & Parts Supply with a Technical Cost Estimating and Recording capability, improving the future acquisition of all Naval Equipment.

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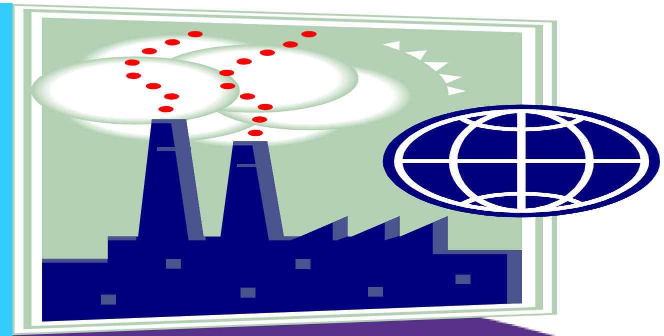

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- However -

However, **Military Equipment** continued to become ever more complex.

By the First World War (WW1) battles were fought with **Machines** and demanded vast quantities of munitions and artillery shells leading to the **"Shell Crisis of 1915"** due to the high rate of fire causing depleted stocks.

So, the Government turned to the **Railway Companies** for extra capacity who were by Dec 1915 producing up to 5,000 off 6" inch Shells per week.

The political **Shell Crisis** and the advent of **Complex Weapons** presented the new Ministry of Munitions with a massive Technical Cost Estimating challenge.

Hence, HM Government needed an internal **Technical Costing** capability.

So, as we commemorate **100 yrs** since the outbreak of WW1, it is timely to recount the contribution by pioneers of the **Technical Cost Section**, who were formally incorporated within HM Government Service in order to secure '**Cost Avoidance**' and achieve **'Value for Money'** from Munitions Suppliers.

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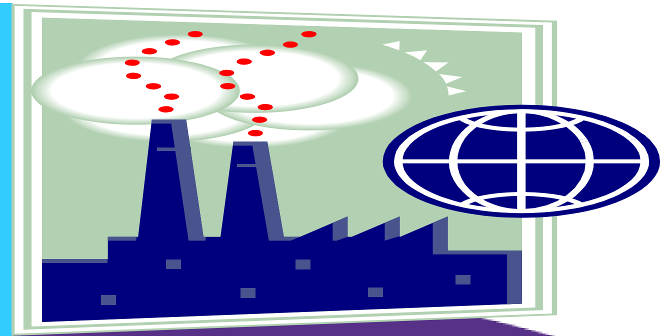

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HM Government > Technical Cost Section

- The **Technical Cost Section** in the new **Ministry of Munitions** was formed in **1915** to obtain Value for Money (VFM) from Industry's urgent vast supply of munitions.
- The **Technical Cost Section** was <u>first</u> headed by **Mr William (*Bill*) Arthur James**.
- **Born 6th May 1887** in Tavistock he Qualified at Plymouth College in Heat Engines.
- He also Served a **5 Year Apprenticeship** with the **Great Western Railway Co**.
- **By age 26 years in 1913** he became Chief Rate-fixer at their Swindon Works.
- **By age 28 years in 1915** he became **Technical Cost Section's** <u>first</u> Director 1*.
- **By age 31 years in 1918** he was Awarded **MBE** in the **1918** New Year Honours List for his services to "*The Compilation of Technical Costs in the Ministry of Munitions*".
- **Parliament stated in 1919** savings of **£300M** in previous 4 yrs; now worth **£8.0 Bn**.
- **Bill James** influence improved the **Quality & VFM of Industry's Cost Claims** for Munitions.

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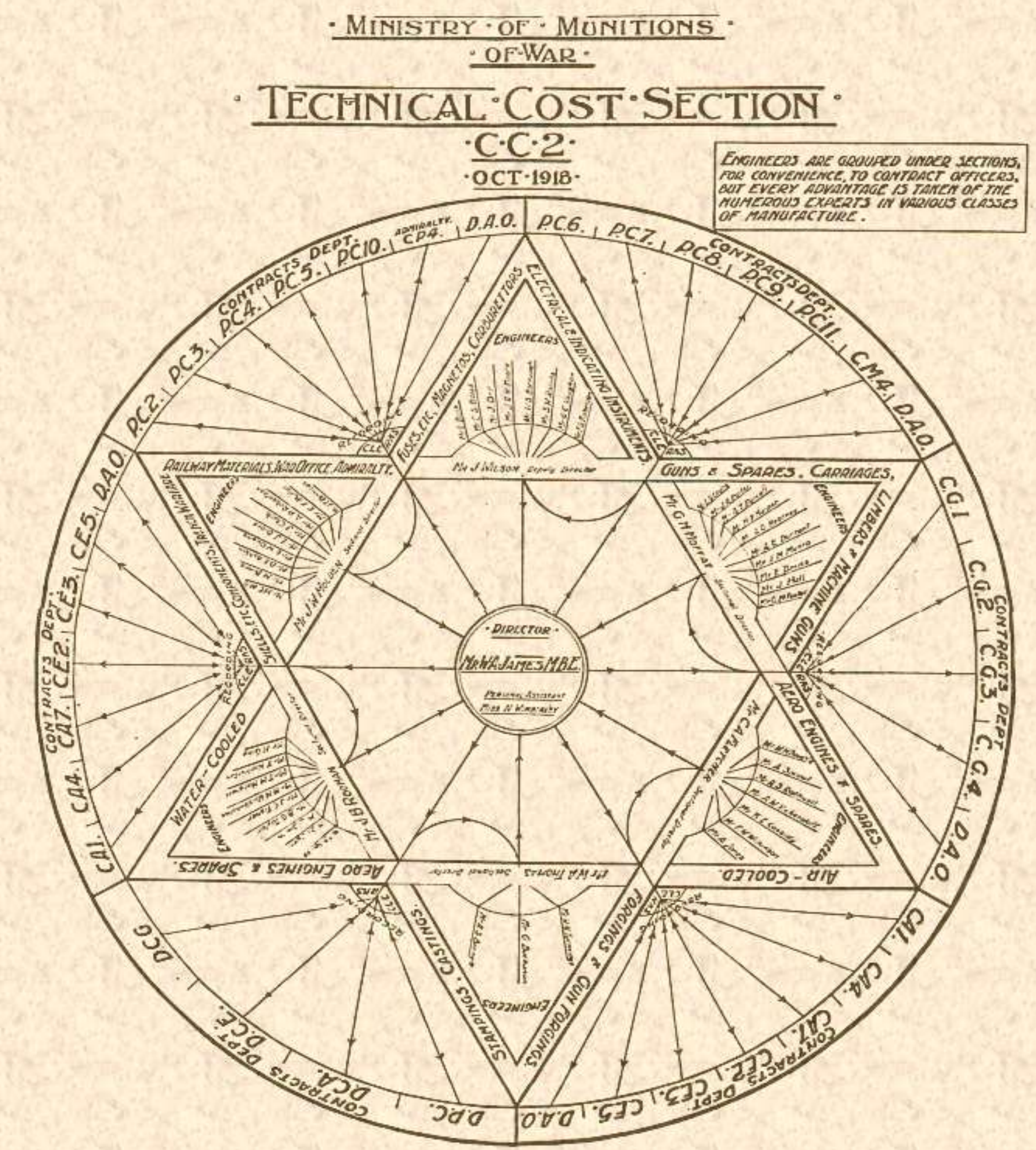

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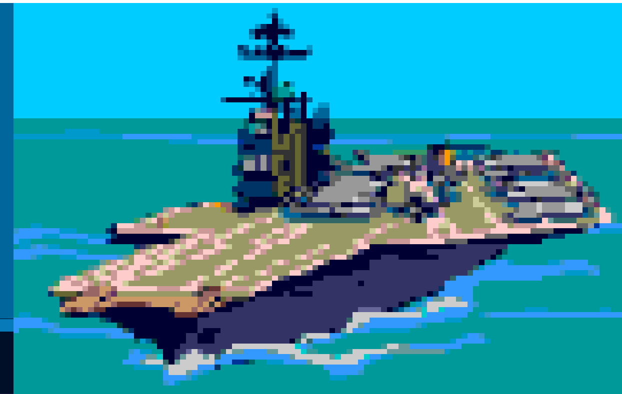
Bill James Wedding Ceremony in 1920



William (*Bill*) Arthur James

- Bill James retained the Director 1* post throughout the inter-war years
- Outbreak of WW 2 in 1939 he was then promoted to Principal Director 2*
- During WW 2 in 1941 he advised the Americans on Aircraft Production

- At age 57 years he was Awarded OBE in the 1944 New Year Honours List for his services to "The WW2 War Effort and Ministry of Aircraft Production"

- At age 60 years in 1947 he retired from HM Government Civil Service
- At age 69 years in 1956 he died peacefully at his home in outer London

- During his career he would have appreciated the concepts behind all of the Cost Engineering Techniques we use today; albeit without the benefit of our advanced computer aided mathematical methods; including the theories of Risk Analysis, Learner and especially the Project Cost Bathtub Curve.

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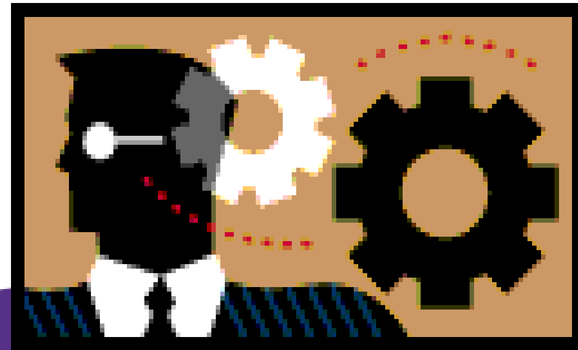
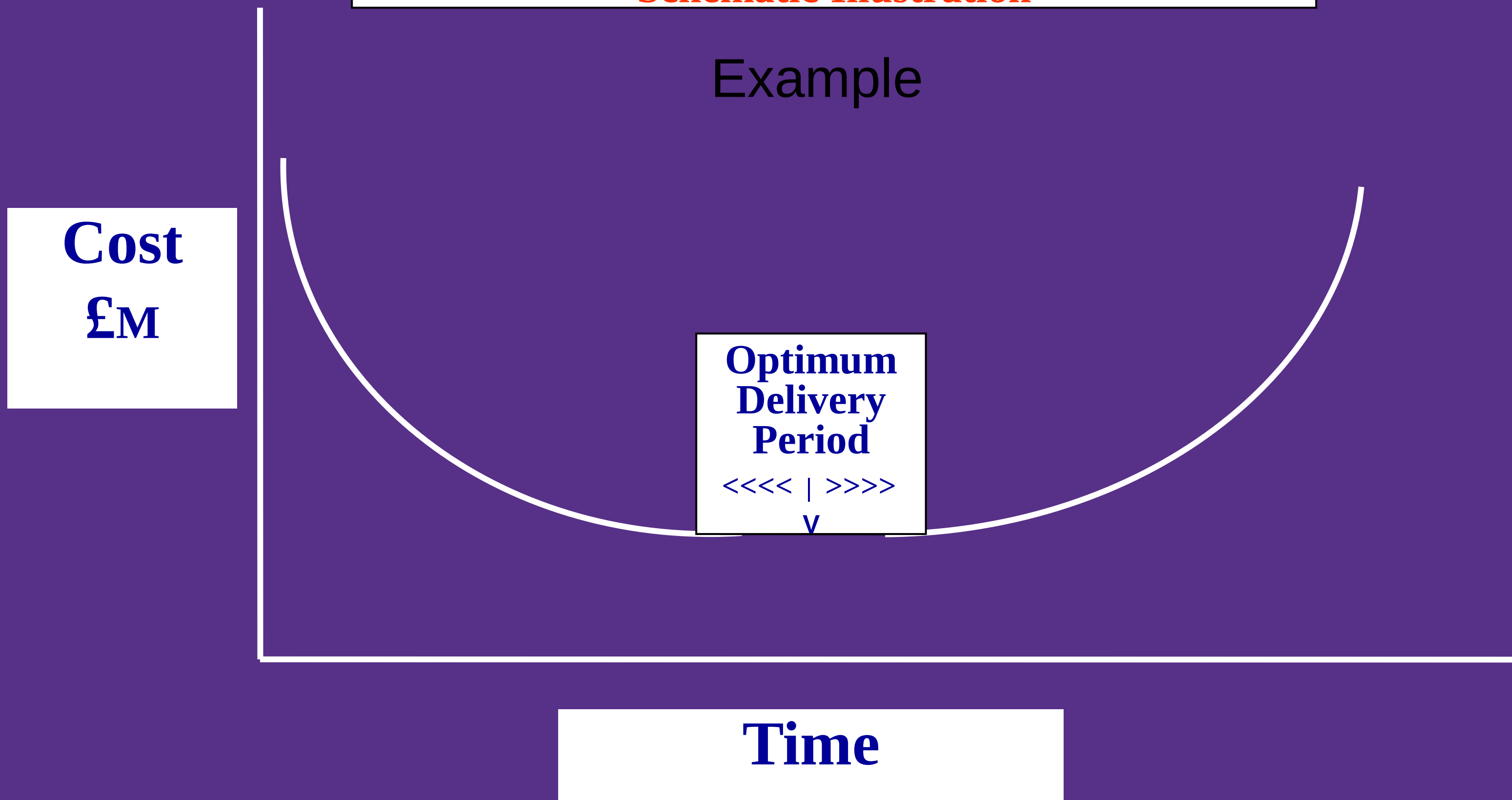


Typical Project Cost -V- Time Bathtub Curve
Schematic Illustration



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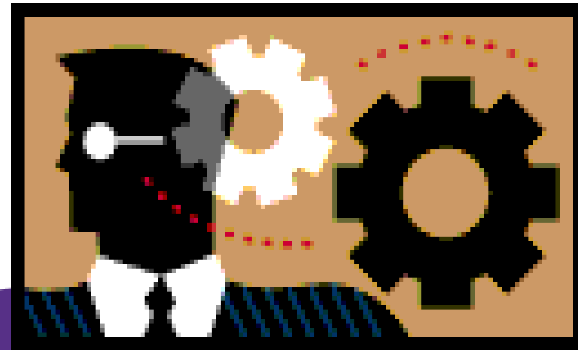

Benefits of the Technical Cost Section over 100 years

- Technical Cost Section operating costs were £75k/yr at 1915 EC's for a Cost Avoidance during WW1 now worth ~ £2.0 Bn/yr over 4 yrs
- Motivating the Defence Industry to submit evidence based Quotations
- Contributing to Equipment acquisition throughout the two World Wars
- Advising USA on converting Motor trade to WW2 Aircraft production
- Legacy of pioneering development of Cost Engineering techniques
- Technical Cost Section will have so far lasted 100 years by 2015
- Technical Cost Section methods were adopted by other Governments E.g. USA (DCMA), Germany (BWB), France (DGA), Australia, etc..

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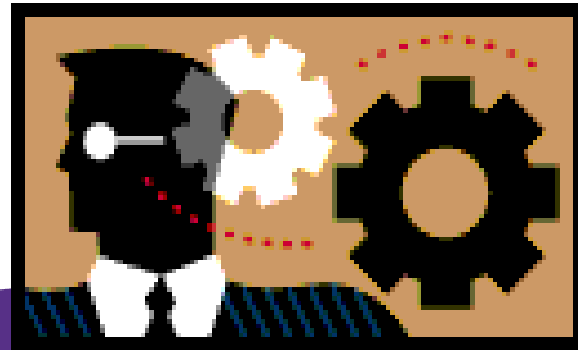
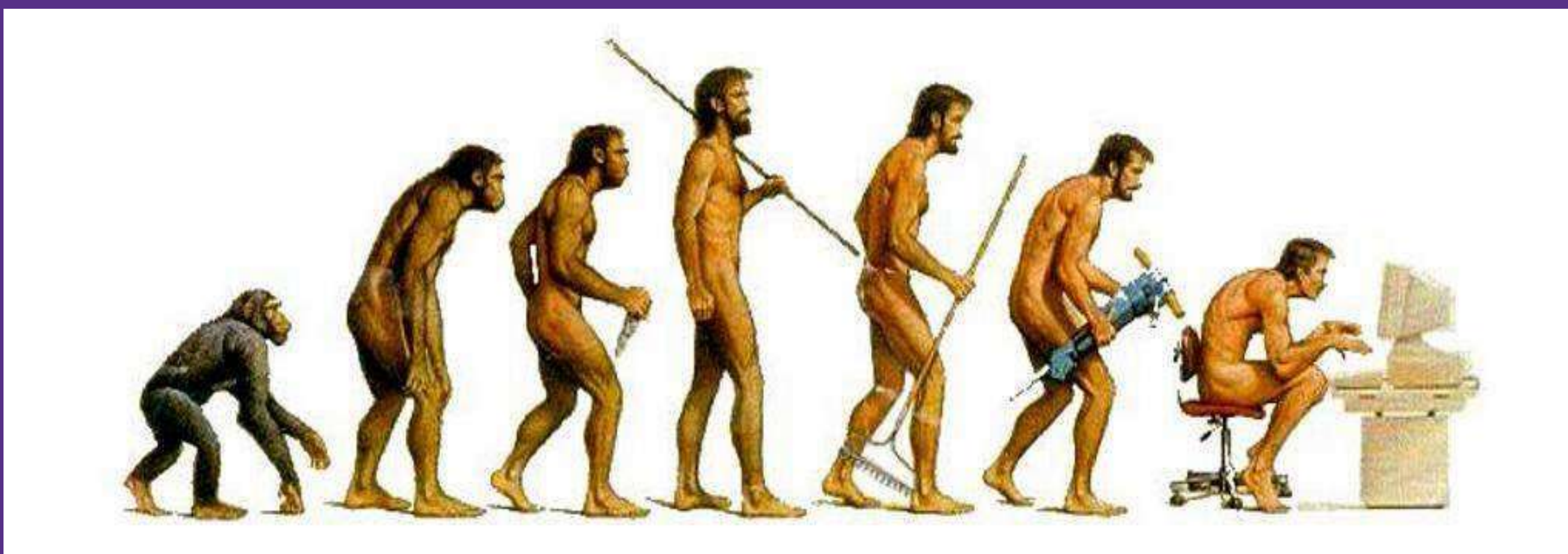


Evolution of the Technical Cost Engineer



Progression from using simple Tools to sophisticated Computer Techniques

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BENEFITS OF COST ENGINEERING

Informs decision-making, cost management, budgeting, trade-offs, efficient product design & development, manufacturing, utilisation, performance monitoring, investment appraisals and in-service support.

Benefits by invoking at Project inception to best inform ‘Option’ decisions.

If a cost estimate is too high it could mean loss of business to competitors or a project enterprise being misguidedly branded as unaffordable

If a cost estimate is too low it could mean loss of profitability or a project enterprise being misjudged as running over budget or even cancelled.

DEFINITION OF COST ENGINEERING

“That area of engineering practice where engineering judgement and experience are utilised in the application of scientific principles and techniques to the challenges of technical cost estimation, cost control, organisational efficiency & profitability”.

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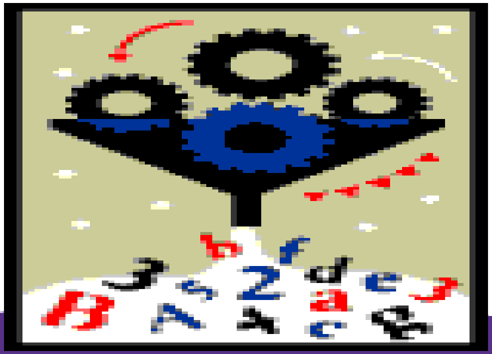
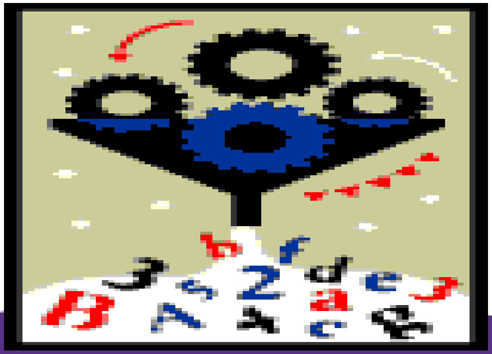


COST FORECASTING – V – ESTIMATING

- "Forecasting" – assesses a prediction of future costs and is conducted 'Top Down'. Forecasting of costs is used in early phases to predict likely budget needs for future funding approvals and compare potential solution options.

- "Estimating" – assesses the probable current costs and implies more accuracy 'Bottom Up' of the probable resource expenditure. Estimating requires greater levels of baseline documentation such as Product design, industrial manufacturing processes, scheduling, make & buy plans, etc.!



THE DEVELOPMENT OF RISK ANALYSIS MODELLING

The advent of **Risk Analysis modelling** based on computer generated Monte Carlo Simulation has been widely adopted since the 1980’s and increasingly utilised for quantifying the levels of assessed risk exposure in commercial pricing between **HM Government and Industry**.

Greater emphasis was placed on this method of Risk Analysis when PM Margaret Thatcher dictated in 1988 all Government contracts must be priced at the outset. By 1991 this translated into the formal policy of “No Acceptable Price No offer of Contract” (NAPNOC).

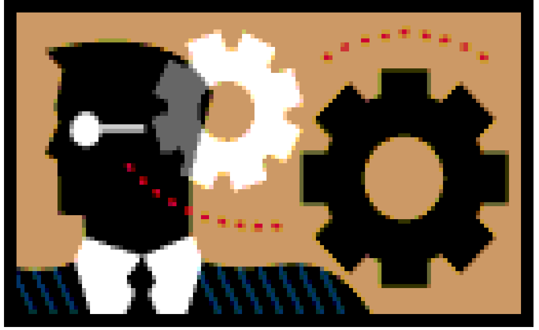
This requires a Three Point Estimating (3PE) approach for devising a **Minimum**, **Most Likely** and **Maximum** cost range of modelling **Inputs.**

Definition of 3PE Input Estimates

Minimum, Most Likely and Maximum cost estimates need “Definition” so that the Cost Engineer knows what to include within each of them.

Risk Analysis Estimate Input Definitions

Comparative Descriptions			**Basic Estimate and Performance Factors**			**Provision for Risk elements** Allowances & Contingencies	
Risk level / Statistical Nomenclature	Cost Description	Estimate as per 3 PE's	Basic (Point) Estimate	Company Expertise Rating Factor	Operator Performance Rating Factor	Allowances included:-	Contingencies included:-
Minimum *Input*	**Target Cost**	**Target Cost** Target for all Minimum resources	**Lowest perceived resources required**	**1.2**	**1.3**	All Allowances at Minimised level & chance of Occurrence	Only beneficial Contingencies (if applicable) Opportunities
Mode *Input*	**Most Likely** Point Estimate Probable Should Cost	**Most Likely** and Highest Frequently Occurring	**Point Estimate (Optimum Predicted)**	**1.0 Expertise Normalised**	**BS3138 rating of 100 = 1 Normalised**	All Allowances at typically probable levels >100% chance	None, Generally Contingencies all Excluded <100% chance
Mean *Output*	Expected Will Cost	Anticipated Out turn	This line will come from the resultant output from the Risk Analysis model.				
Maximum *Input*	**Maximum Cost** Including the concept of a level funding would surely be withdrawn	**Maximum** Including the Company's poorest level of anticipated performance and expertise	**Highest perceived resources required**	**0.9**	**0.8**	All Allowances at Maximised level & chance of Occurrence	All adverse Contingencies Considered, and Judgements of total effects for the Exclusion of any Mitigations.



"Minimum" **The absolute Minimum value of a "Risk analysis" distribution-**

The lowest possible time taken and costs incurred, which enable the Contract to be achieved. This must only include absolutely essential tasks. It is the lowest possible estimated cost value likely to achieve the Project plans. It must contain suitable Allowances, plus both Contractor and Operator performance factors at minimised levels and beneficial effects of all Opportunity Risks.

"Most Likely" **Mode, Most Frequent. Deterministic, Point, Should Cost Estimate**

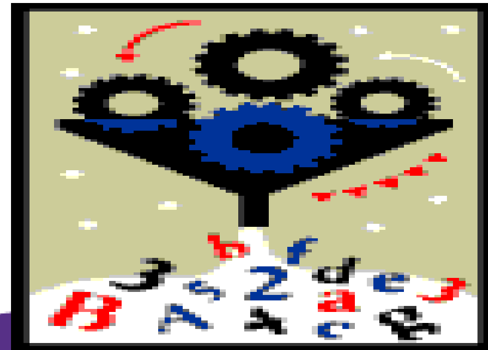
The time for a qualified Operator working at a standard efficient performance (e.g. 100 rating), suitably motivated and trained, with all the required tools, with all allowances at typical levels applicable to the task" Only 100% probability Risk allowances are included in the ML estimate.

It must be considered that Comparative or Parametric estimating based on Recorded Costs will automatically included all embedded risks in the recordings. Appropriate estimated adjustments would be needed to normalise such recorded data before it is used as a ML Input for risk analysis.

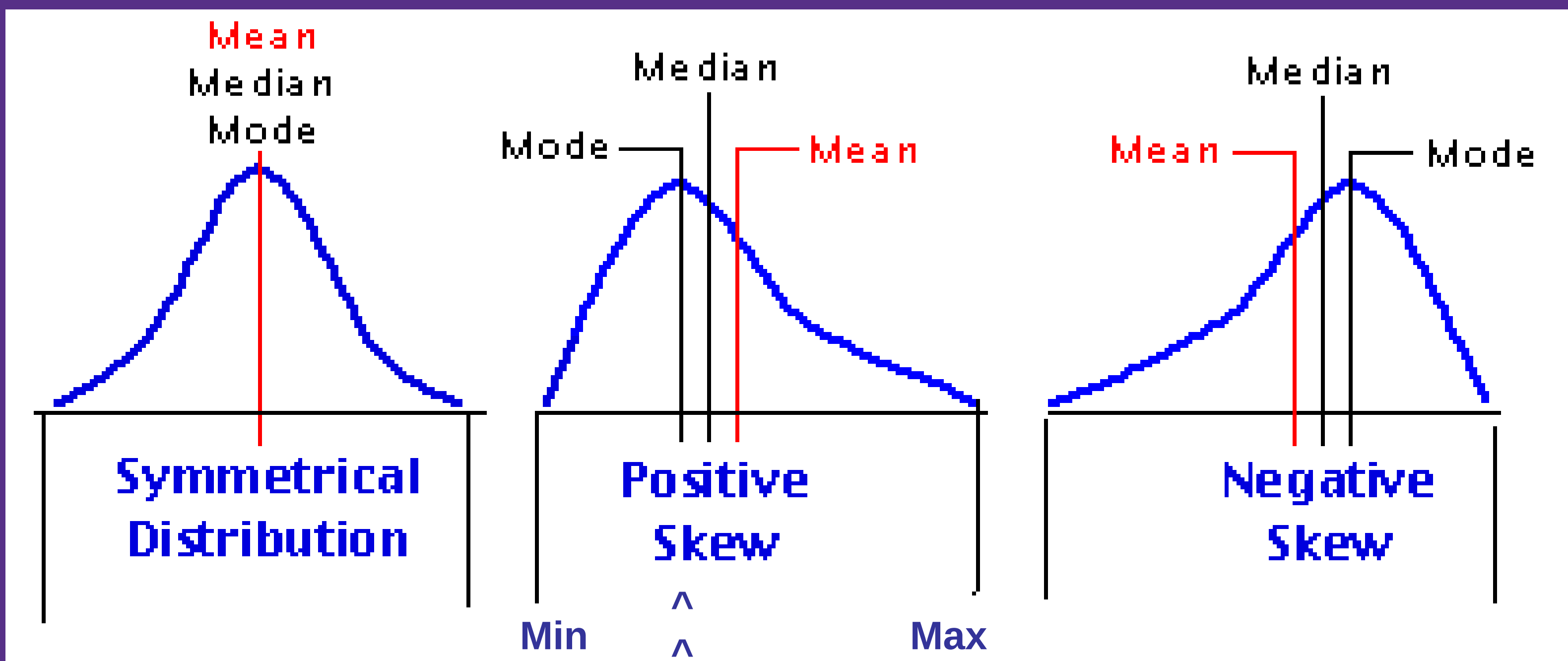
"Maximum" **The absolute Maximum anticipated value of a distribution**

The highest probable time taken and costs incurred to complete a prescribed task when adverse events with probabilities of occurrence less than 100%, cause extra work or costs to be incurred.

NB**:** A limiting constraint being if an impact event causes the project to become un-affordable or at risk of being cancelled, that event may need to be omitted from the Maximum and dealt with separately (e.g. as a Contract separately funded Risk Exclusion until that event arises).



Risk Analysis Three Point Estimates (3PE)



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Mode

Most Likely

Point Estimate

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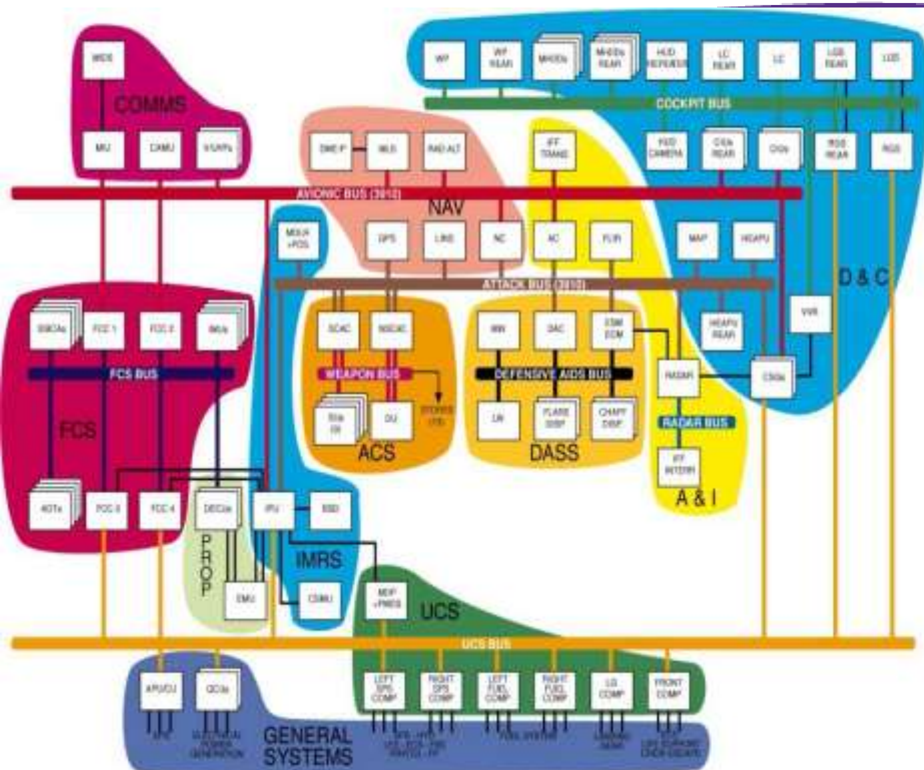
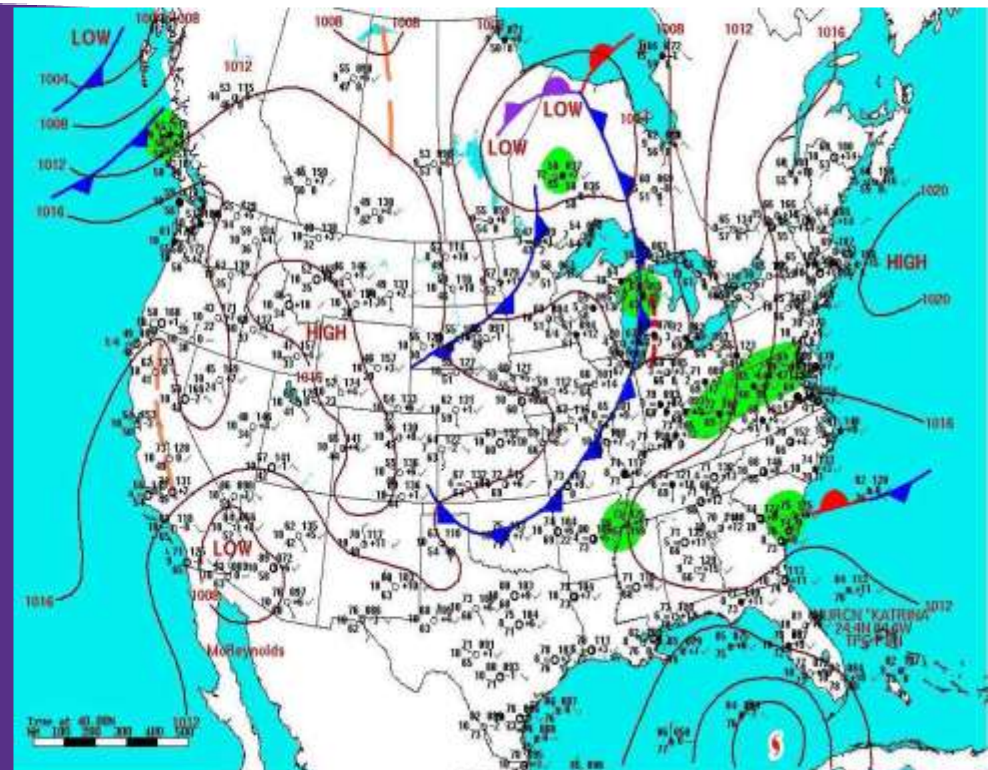
"Forecasting highly complex systems."



Typical Aircraft Avionic System Architecture



Weather map of Hurricane Katrina August 26, 2005

However:-

"High profile publicity when forecasts prove unreliable"

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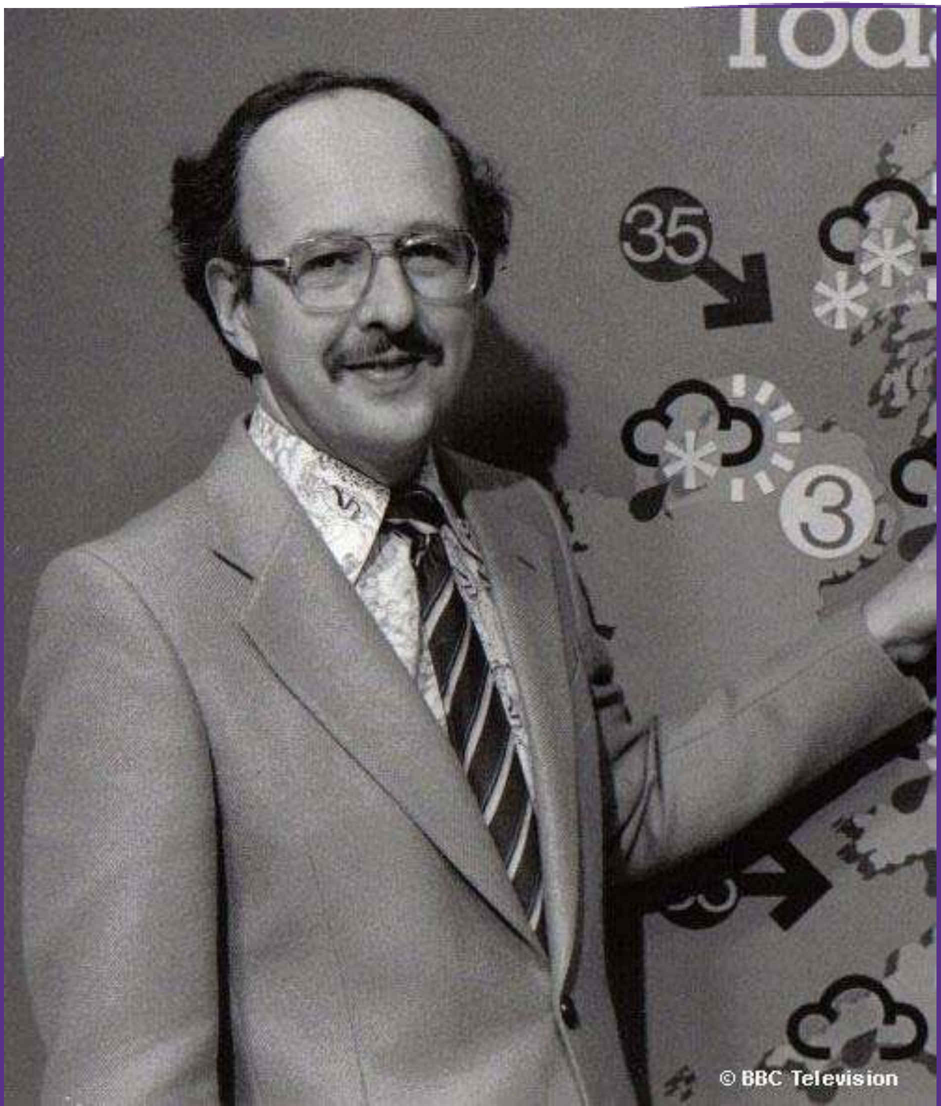
Great Forecaster's famous last words.!



"Earlier on today apparently a lady rang the BBC and said she heard that there was a hurricane on the way".

"Well don't worry, there isn't."

Michael Fish 1987

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Michael Fish – Learning from Experience

Michael Fish later said that one of the Automatic Weather Stations in the English Channel had failed to report storm warnings to him.

Hence, he had made the classic Forecaster's mistake of forming his Professional judgement whilst missing a vital piece of data.

So, the moral is:-

"Capture the best available data as supporting evidence to get the most Benefit of "Cost Engineering and Realistic Forecasting".

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Final Thoughts…!

Benefits gained from **Weather Forecasting**
Can't change future **Weather** conditions.

<<< However >>>

Benefits gained from **Cost Forecasting**
CAN change future **Costing** conditions.

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- End -

QUESTIONS?