Project Controls Expo
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What is Cost Engineering and Cost Estimating

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Speaker Profile - Carl Dalton

- Carl is a Fellow of the Association of Cost Engineering and has over 30 years of experience in providing management and technical consultancy to governments and industry. Carl has worked for a variety of government organisations and leading contractors in Europe, North America, the Far East and Australia.
- He specialises in Cost Analysis and Project Risk Management; generally on large complex programmes. These include large aircraft and ship programmes, military and commercial vehicles, complex weapons, other transportation systems, software intensive programmes, personnel and commodities.
- He is experienced in utilising commercial available cost and risk management products and tools as well as developing bespoke solutions.

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- Why Estimate
- What to include
- Types of Estimating
- Data Collection
- Cost Engineering
- Verification

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What is an Estimate?

*"An assessment of the likely **quantitative** result. Usually applied to project costs and durations."*

PMI-Guide to the PMBOK 4th Edition

*"An **approximation** of project time and cost targets that is refined throughout the project life cycle."*

APM Body of Knowledge 5th Edition

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Why Estimate Project Cost?

To establish a cost conscious attitude at the offset of a programme, to improve decision making and increase confidence in budgetting and the allocation of resources.

Need to:

- " How much will it cost?"
- To obtain budgets/ allocate resources
- Set targets
- Know if your project budget is achievable
- Value for Money (Value Management)
- To support investment appraisals
- To calculate payments and/or price.

Helps to evaluate:

- Alternative designs
- Alternative procurement options
- Cost effective decisions
- Investment decisions
- Against customer constraints
- Different operational needs
- Support concepts
- Early in the life cycle

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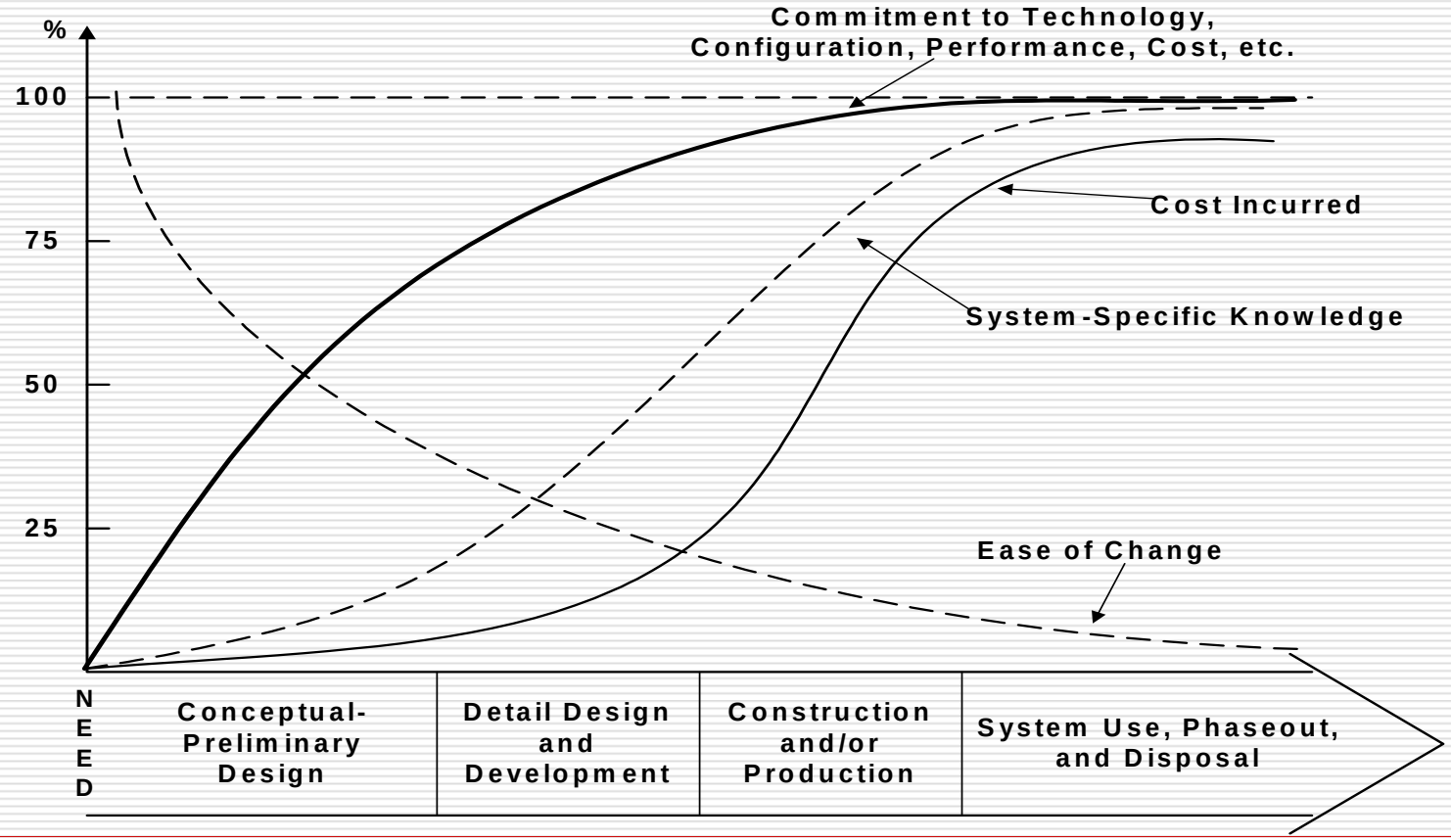
Cost Commitment on Projects



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Blanchard, B., Fabrycky, W., *Systems Engineering & Analysis*, Prentice Hall, 1998.

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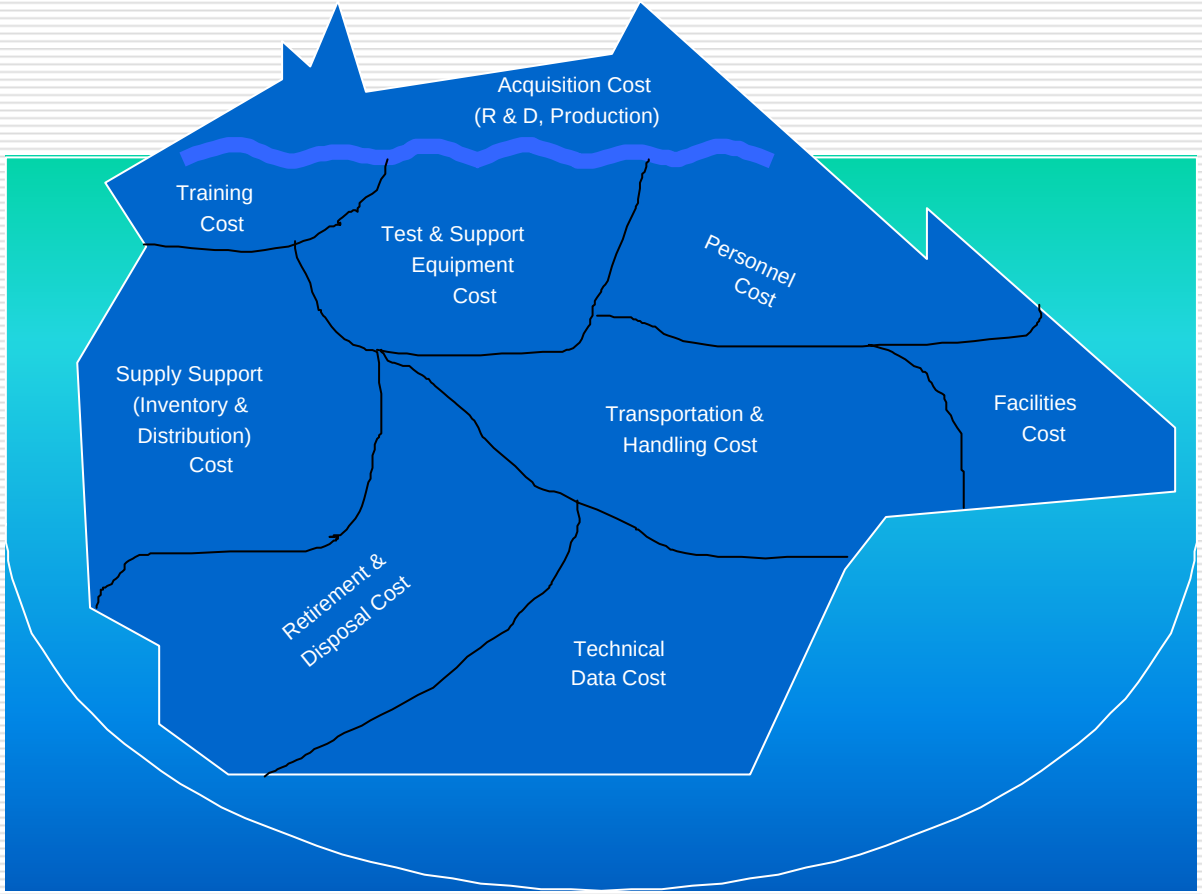
The Tip of the Iceberg



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Define Cost Elements and Boundary

Cost Elements

- Development
- Production
- Bringing into Operation
- Operating
- Supporting
- Disposal

Estimate Boundary

- Physical – Equipment Breakdown e.g. Space System
  - Ground station
  - Launcher
  - Satelitte
- Programme
  - Quantity
  - Phases
  - Life
  - Whole Life? Or Partial Life
- Economic
  - Economic conditions
  - Currency

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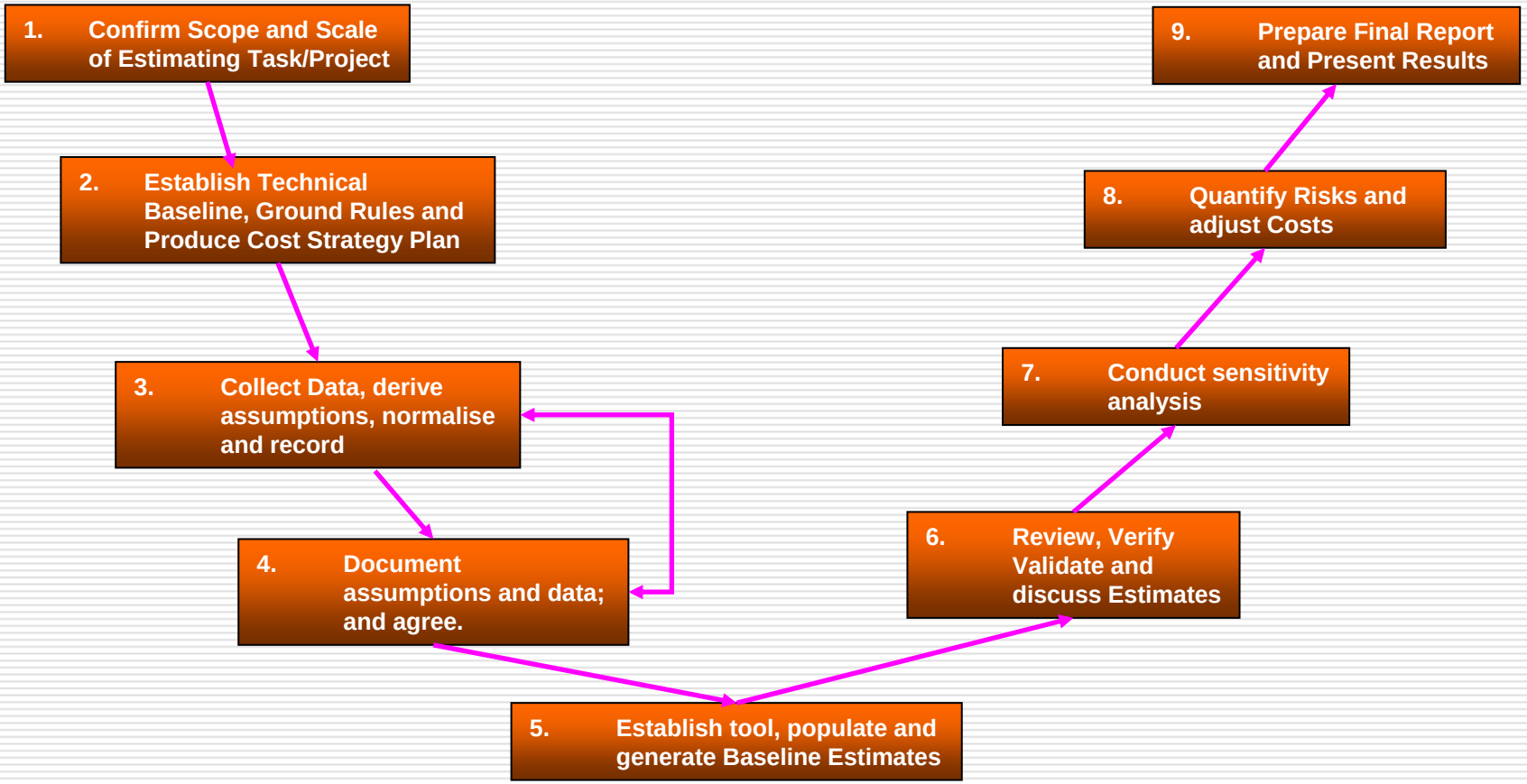
Through Life Cost Assessment Consistent Processes = Reliable Estimates



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Types of Estimating Techniques

- Cost estimating requires arithmetric operations; many of which must be performed in a specified sequence
- Parametric
- Analogy
- Scaling
- Detailed
- There is usually no single predictive technique/tool/model that covers
  - the whole of the life cycle and
  - all of the cost elements required

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Parametric

- Estimates costs based upon various characteristics or measurable attributes of the candidate system e.g. number of bedrooms, equipment weight, speed
- Uses algorithms/models to convert a few key project drivers into a definitive estimate
- It depends upon a cost estimating relationships (CERs) between system cost and these parameters
- Such CERs are typically established from historical data using statistical (regression analysis) techniques
- The CER will capture the relationship in mathematical terms relating cost as a dependent variable to one or more independent variables
- Relies on a ‘large’, accurate database of previous/historical project information
- Do not depend entirely on statistical methods – use common sense and experience as well.

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Analogy

- Also called Comparative Estimating or Scaling
- Interpolates or extrapolates accurate, historical data from similar projects
- Assumes a new programme evolves from an existing system or represents a new combinations of existing sub-systems
- Candidate system should be of a similar size, complexity and scope
- Estimator makes a subjective evaluation of the differences between the new candidate system and historical systems

> *There is no word which is used more loosely or in a greater variety of senses, than 'Analogy'.*
>
> -J.S. Mill

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When to employ different techniques

	Analogy	Parametric	Engineering Build-Up	Actuals
Concept	Assessment	Demonstration	Production	Support

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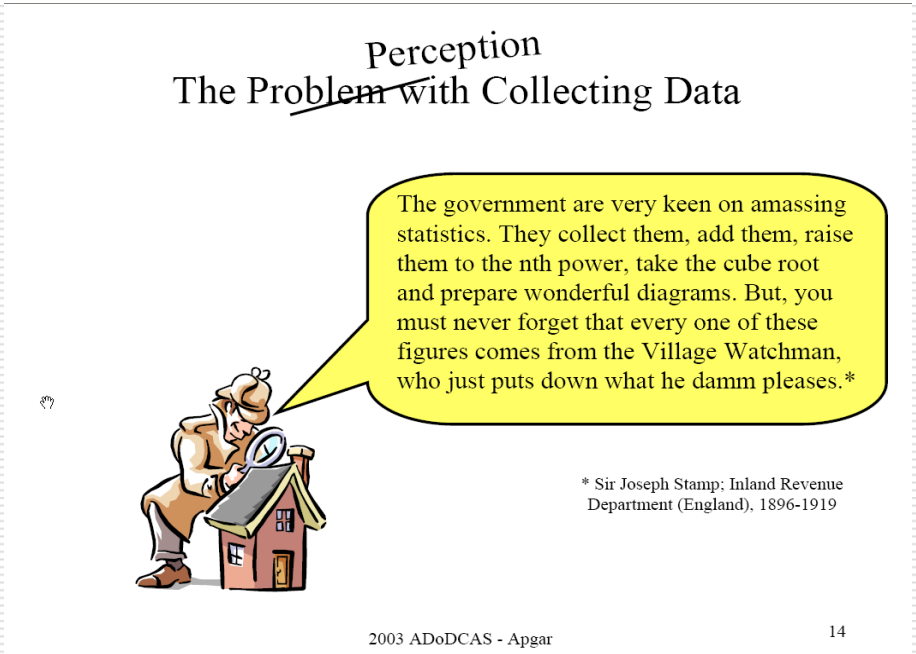
Data Collection

- Data Requirements
- Data Sources
- Gathering and Normalisation
- Recording Data and Assumptions



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Data Requirements

- Historical/Actuals
  - Essential to assist in the future prediction of cost and schedule estimates
  - Analogy
  - Model development
  - Model calibration
- Candidate Solution
  - Technical
  - Physical
  - Programme
  - Economical
- Alternative Options
- Cost
- Effort
- Schedule
- Phase
- Labour rates
- Base Rates
- Supporting technical/physical data
  - Option description
  - Physical characteristics; weight, size, material
  - Use Case
  - Reliability/Defects

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Data Sources

- Contractors
  - Across all disciplines; Engineering, Production Support….
- Conceptual Designs/Engineering Drawings
- Bills of Materials
- Process/Routing Sheets
- Master production Schedules
- Accounting/Finance/Historical Records/Standard Time data
- Supplier/Cateloque information
- Labour rates
- Use cases
- Repair and Maintenance Schedules
- Enterprise Resource Planning Systems
- Actual hardware
- Company experts; interviews/questionnaires/input sheets
- Lessons learned reports
- …and don't forget your colleagues!

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Gathering and Normalisation

- Major phase of any cost study; Most time/effort consuming phase of the assessment…iterative…more data becomes available becomes available
- Establish a structured approach
- Need for quality data
- Need for relevant data
- Historical cost data needs to be normalised to a common base
  - Common economic conditions
  - Common currency
  - Common allowances e.g. Profit, Tax etc
- Data needs to be sanity checked
- Where data is suspect; or not available assumptions need to be made
- These need to be clear, unambiguous and agreed where-ever possible
- Provides background ‘EVIDENCE’

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Document Data and Assumptions

- General
- Option Specific
- Exclusions
- Known Data
- Cost Data Assumptions List

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Cost Engineering

- Outturn; inflated to then year costs
- Constant; baseline economic condition
- Discounted; allows comparison
- Normalised Outputs
  - Equivalent Annualised Costs
  - Rate of Return
- Cost Indices
- Cost benefit analysis
- Cost Effectiveness
- Design to cost
- Value Analysis
- Budgets
- Benchmarking
- Cost Control
  - Objectives
  - Approaches
  - Cost Variances
  - Earned value

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Discounting/Discounting Cash Flow

- Discounting is a technique used to compare costs and benefits that occur in different time periods. Not the same as inflation
- Based on the principal that we prefer to receive goods/services now rather than in the future. Time preference.
- Time value of money: e.g. a £ today is worth some amount less in the future.
- For comparison purposes, future expenditure occurring at different points in time must be adjusted to a common point in time. Discounting or present value analysis)
- Recommended discount rates are normally set in-country by the Treasury Department. The UKs rate is currently 3.5%.
- Calculating the present value using discount rates is called the Net Present Value (NPV)
- Candidate options can be compared using NPV.
- Equivalent annualised costs is a way of comparing options which have different lives.

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Factors affecting Accuracy

- Estimating is not an exact science. Some of the factors that affect the quality of estimates are:
  - the scope, approach and the estimating technique employed
  - accurate historical data
  - understanding the problem/requirement
  - the availability of reliable design/technical information for the candidate system/project
  - the type and size of the project
  - the extent to which feedback is used
  - the teams/estimators optimism and desire to protect own position
  - the estimators skill and knowledge; or lack of it; and ability to use appropriate judgement.

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Uncertainty/Variability in Cost Modelling

- In source data
- In assumptions
- In modeling approach
- …

- Important to produce a cost estimate based on a single currency..but;
  - Often costs/prices are provided from suppliers etc. in different currencies
  - Use exchange rates at a common base point
  - Document values used in an Cost Data Assumptions List
  - Conduct sensitivity analysis to test how much the exchange rates need to move to significantly change the costs.

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The Effects of Risks on Estimates

- A Point Estimate is never correct!
- There is always potential variability in inputs.
- Costs of managing the Risks that we decide to manage:
  - Budget for Managed Risks
- Costs of the impacts of Risks that we decide to accept (Known-Unknowns):
  - Contingency Reserve
- Costs of the impacts of Risks that we were unaware of (Unknown-Unknowns):
  - Management Reserve

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Risk Quantification

- **Aim**: Quantify the effects of risk
- **Input**: Qualitative risk assessment
- **Techniques**:
  - Monte-Carlo simulations
  - Path convergence
  - Decision trees
- **Results**:
  - Defines range of outcomes + most likely
  - May create false impression of precision and reliability

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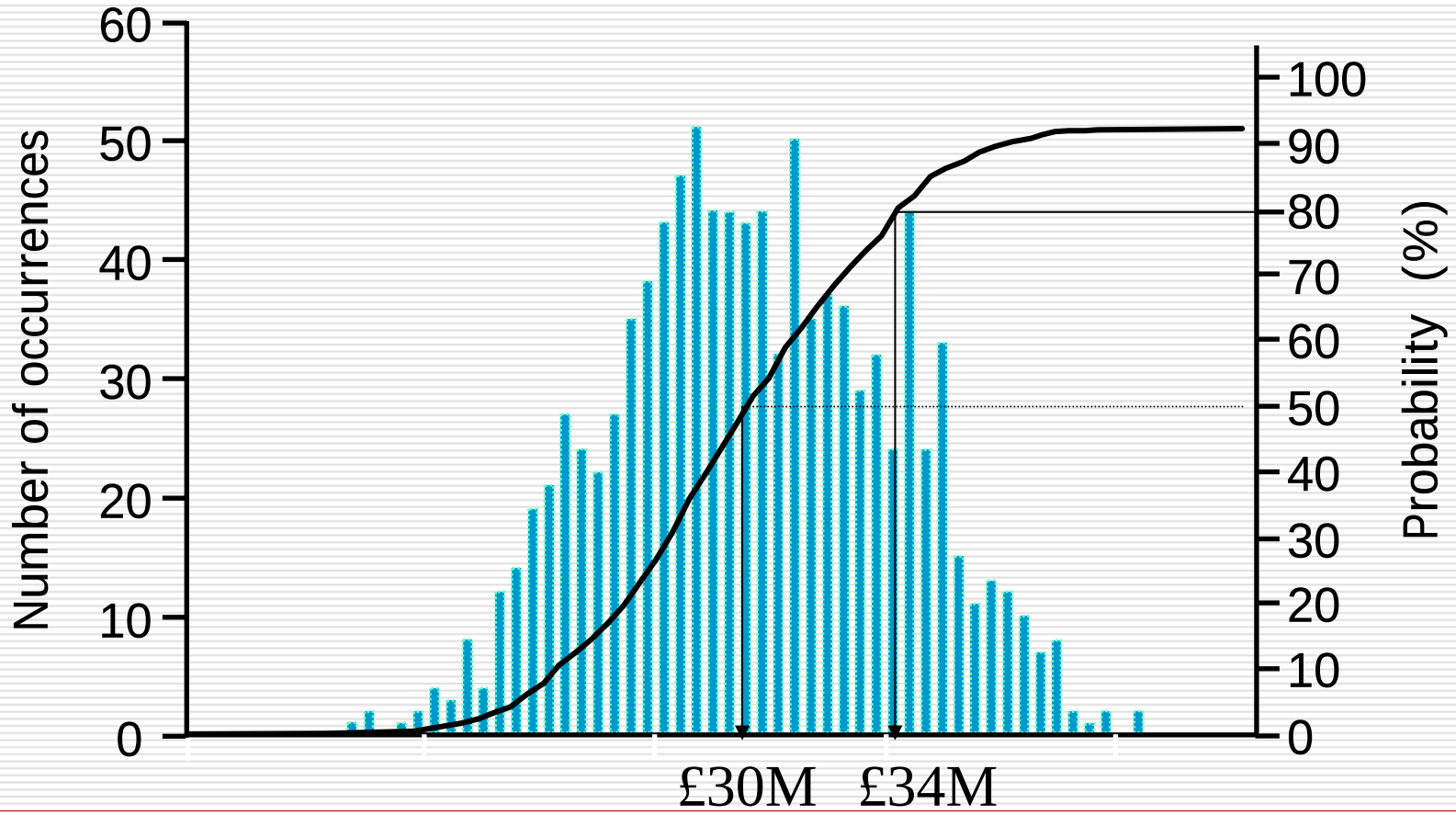
Risk Assessment - Quantitative



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Independent Verification and Validation

- Model should be fit-for-purpose and working correctly..this needs to be validated
- Cost model needs to be verified to confirm it meets its specification
- Model and data must be documented to allow evidence for an audit trail
- In-built relationships e.g. CER should be checked
- VBA is frowned upon unless to help functionality i.e. adding lines
- Data entry and manipulation of data needs to be confirmed
- Check for double counting…missed items
- Can the Business Case costs be traced back to the cost model..have costs changed since the previous iteration
- Need to ensure the model can conduct:
  - Sensitivity analysis
  - Risk Analysis

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Seven Tests of a Quality Cost Estimate

- Objectivity
  - Is the estimate based on objective data; grounded in facts and related historical data. Firm foundation
- Honesty
  - Genuinely building on above data; representative of the true position of the bid.
- Relevance
  - Are the data and analysis relevant and pertinent to what is being estimated
- Logic
  - Does the estimate make sense. Are the maths correct. Are there any gaps or overlaps?
- Accuracy
  - Are you estimating processes producing accurate estimates. Have you tested past estimates/outturns and made adjustments where necessary. Does an independent estimate verify the main estimate?
- Holism
  - Is it complete? Integrated?
- Communicability
  - Is the estimate clear and easy to understand. How well is the cost estimate being communicated internally, to peers and reviewers, and externally. Is it well documented with assumptions etc. How is the estimate being perceived.

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Questions

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