1. Brian Efird

Problem Statement

- Energy markets, energy economics, and the choice of/implementation of policy are impacted by politics and stakeholder interactions (what we call more generally *collective decision-making processes (CDMPs).*
- Uncertainty around CDMPs creates fundamental challenges to understand and plan for any phenomena related to economics and policy.
- Decisions resulting from a CDMP can thus vary substantially from *a priori* expectations, as well as from most standard models of energy economics.
  - For example, the election of Donald Trump, and his consequent choices, radically changed expectations regarding the Paris Agreement and all U.S. policies.
  - The impact of a CDMP can be separated into two sources of uncertainty:
    - the inclusion of new actors with distinct preferences or other characteristics
    - the complexity and process opacity that a CDMP generates

Approach

- KAPSARC is a research centre focused on energy economic and policy questions to produce actionable insight for policymakers and decision-makers.
- We utilize multidisciplinary and mixed-method approaches to address uncertainty:
  - expert workshops and interviews, quantitative modelling, qualitative research, fieldwork, alternate sources and measures of data, etc.
- We regularly conduct scenario analysis to evaluate alternate starting assumptions, and sensitivity analysis to evaluate source/analytic/methodological variation.
- For CDMPs, we have developed the KAPSARC Toolkit for Behavioral Analysis (KTAB):
  - to transparently, rigorously, and explicitly model CDMPs in a replicable way
  - to endogenously integrate CDMPs with economic and energy systems models
  - to develop scenarios, for energy market forecasting and other phenomena with the potential for significant political disruption, based on analytic results rather than assumptions

Results and Feedback

KAPSARC
مركز الملك عبدالله للدراسات والبحوث البترولية
King Abdullah Petroleum Studies and Research Center

- Explicitly modelling CDMPs enables KAPSARC research to anticipate/evaluate when (and why) expectations of economic models break down in the real world.
- Nonlinear changes to market processes are often the result of CDMPs.
- Senior decision-makers and policymakers have multiple challenges in absorbing sophisticated uncertainty and risk analyses:
  - limited meeting time and bandwidth
  - inundation of analysis and information from multiple sources (e.g. 17 intelligence agencies in the U.S., with redundant in-house intelligence/analytic capabilities)
  - requirement for rapid decisions
- Research output to key stakeholders is best communicated through:
  - small group meetings to share results based on trusted relationships
  - presentations with clear and easily understandable language to a non-technical audience
  - short, concise, and plain language executive summaries with a more extensive backup report

2. Kris De Meyer

Challenging Current Risk Assessment Approaches for Better Climate Policy

- UCL Policy Commission on the Communication of Climate Science
- Aims
  - Identify and fill “underserved” needs in climate communication and policy
  - Lift communication barriers at boundaries between professional communities
- Problem

Climate science research → Climate Risk Assessment Reports → Mitigation policies

Climate science community
Funding organisations

Barriers? Gaps?

Civil servants
Politicians

Approach

- Workshop (19 Feb.) exploring CCRAR barriers/gaps with
  - Scientists
  - Civil servants
  - Funders & service providers
- Format: facilitated co-production, exploring
  - different perspectives
  - challenges and tensions
  - solutions
  - action planning

Workshop Results and Feedback

- Diverse set of perspectives, tensions/challenges and potential solutions
- "Usual" tensions (e.g., "user" desire for certainty, impacts are far in future,…)
- Sets of solutions identified

Climate science research → Climate Risk Assessment Reports → Mitigation policies

Need for co-production

Climate science community
Funding organisations

Specialised "knowledge brokers"
- Risk assessment specialists
- Co-production "midwifes"

Civil servants
Politicians

Funding changes
- dedicated research for CCRAR

Academic incentive changes
- reward impact to risk question

Manage "risk culture" differences
- False positives vs. negatives avoidance

Range of solutions show that responsibilities are fragmented!

Strategic decision making under uncertainty in defence: Cognition and computation

Our Ref: DSTL/PUB107324

27th Feb 2018, Decision Framing & Uncertainty Network Workshop

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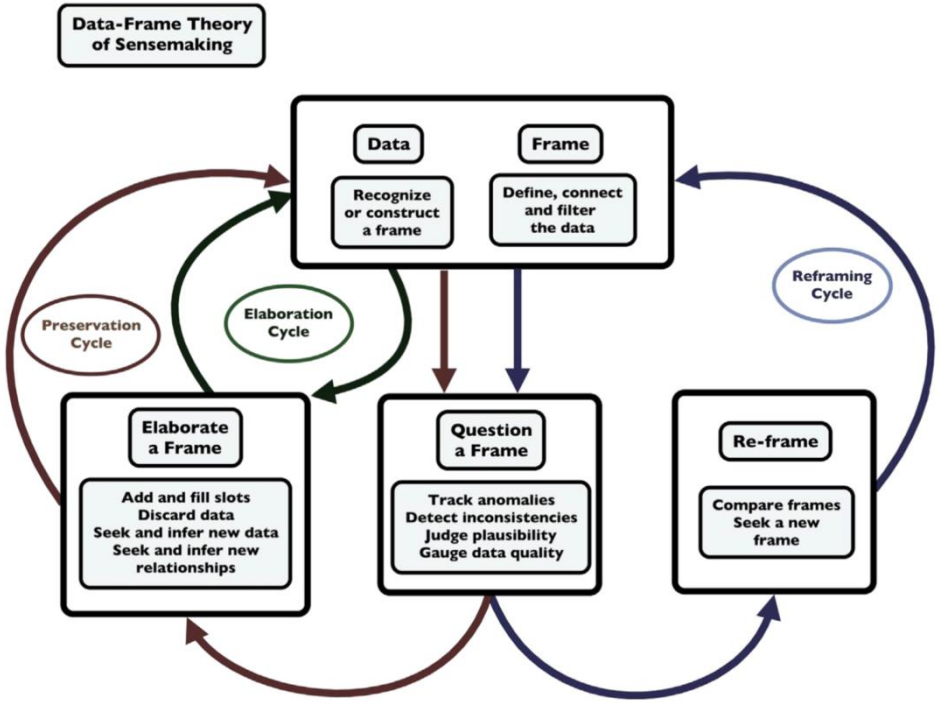
https://www.gov.uk/government/organisations/defence-science-and-technology-laboratory

Problem Statement

Approach

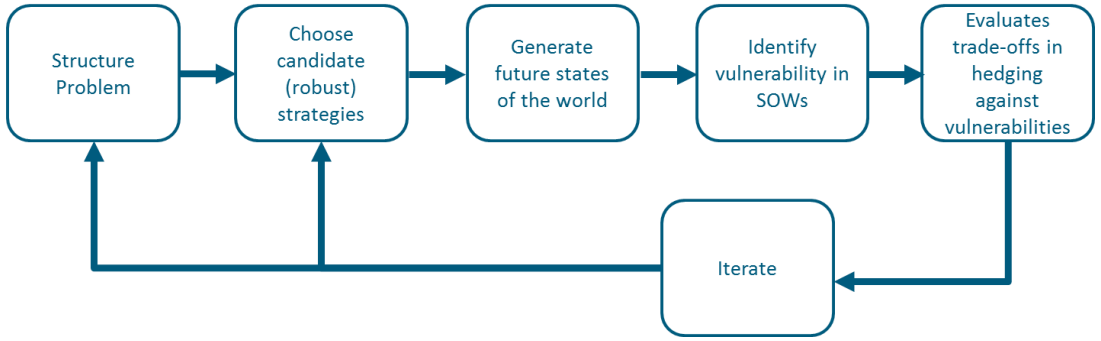
"How can cognitive work be automated?" but "In what ways and to what extent might technology and software amplify and extend the human ability to engage in cognitive work?" [4 p. 76-77]

(Macro)Cognition [4]

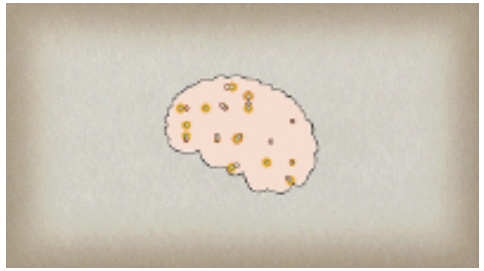


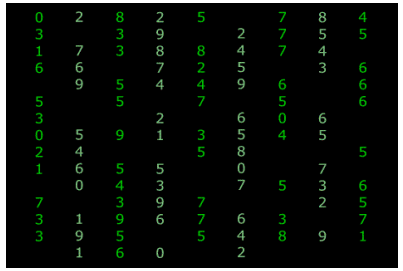
Computation [5]

RDM Process Steps (Lempert et al 2006)



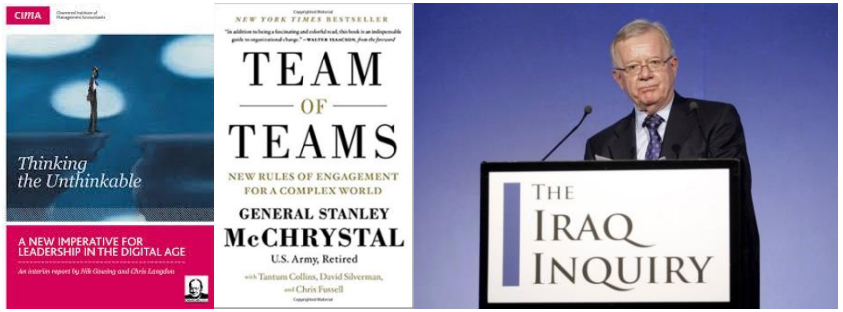
Insights and inferences

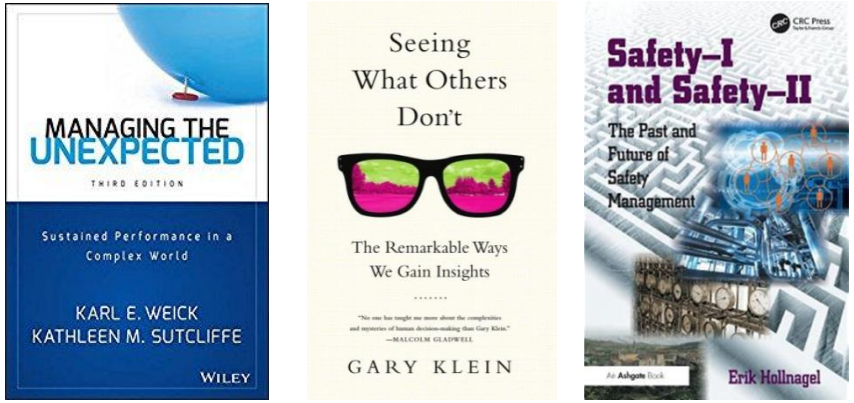




- **Good enough** (decisions and modelling) with **feedback** are required, ***not* perfection** [4,8]
- Seeking robust ***and*** adaptive strategies [4, 7, 8]
- Cognition and computation are **complementary** [2] (Human-agent Collective [9])
- **Iterative exploration** is really important to support sensemaking and robust strategies[2, 4, 5]
- Assumes that the capacity to **adapt can be learnt and developed** [7]
- However, the **culture and processes** of institutions and organisations **inhibit** adoption [10, 11]

Institutional inhibition of abductive reasoning and Macrocognition





Performance improvement = errors & uncertainty + Insights

Contradictions
Connections
Coincidences
Curiosity
Creative desperation

Standards
Controls
Documentation
Reviews
Rigor
Checklists
Procedures

Source: after "Seeing what others don't" Garry Klein (2015)

Questions

References and acknowledgements:

Authors: Jim Maltby FRSA, Dstl UK (jfmaltby@dstl.gov.uk) and Dr Gareth Conway , Dstl UK (geconway@dstl.gov.uk)

Thanks to: Dr Julie Gore, University of Bath (j.gore@bath.ac.uk)

Slide 1

1. Maltby, JFJ. (2017) “Foresight in uncertain times”, Dstl/DSA/708307.

Slide 2

2. Maltby, JFJ., Gore, J., Conway, G., “Does Robust Decision Making mirror *thinking* under uncertainty: Can social science help us to understand the validity of DMDU approaches?” Presentation at Society of Decision Making under Deep Uncertainty annual Workshop Oxford November 2017.

3. Moore, D. T. (2011). Sensemaking: A structure for an Intelligence Revolution. NATIONAL DEFENSE INTELLIGENCE COLL WASHINGTON DC.

4. Lempert, R. J., Popper, S. W., & Bankes, S. C. (2003). Shaping the Next One Hundred Years: New Methods for Quantitative, Long-Term Policy Analysis. MR-1626-RPC. Santa Monica, CA: RAND Corporation.

5. Hoffman, R. (2013). An Integrated Model of Macrocognitive Work and Trust in Automation. In *AAAI Spring Symposium: Trust and Autonomous Systems*.

6. Lempert et al (2006) A general, analytic method for generating robust strategies and narrative scenarios. Management science, 52(4), 514-528.

7. Ward, P, Hutton, R, Hoffman, R, Gore, J, Anderson, T, Leggatt, A. (2016) Final Report - Developing Skilled Adaptive Performance: A Scoping Study, Defence Human Capability Science and Technology Centre, O-DHCSTC_I2_T_T2_077/002.

Slide 3

8. Maltby, JFJ., Brampton, C. (2018) “Applying robustness to long-term defence planning”, Dstl/TR107069.

9. Jennings, N. R., Moreau, L., Nicholson, D., Ramchurn, S., Roberts, S., Rodden, T., & Rogers, A. (2014). Human-agent collectives. *Communications of the ACM*, *57*(12), 80-88.

10. Klein, G. (2013). *Seeing what others don't: The remarkable ways we gain insights*. Public Affairs.

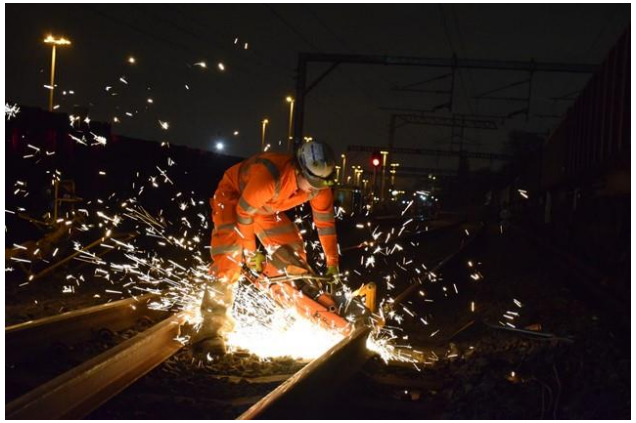
11. Gowing, Nik, and Chris Langdon. (2016) "Thinking the Unthinkable: a new imperative for leadership in the digital age." *Chartered Institute of Management Accountants*. http://heartinbusiness.org/wp-content/uploads/2015/11/Thinking-the-Unthinkable-A-New-Imperative-for-Leadership-in-the-Digital-Age.pdf

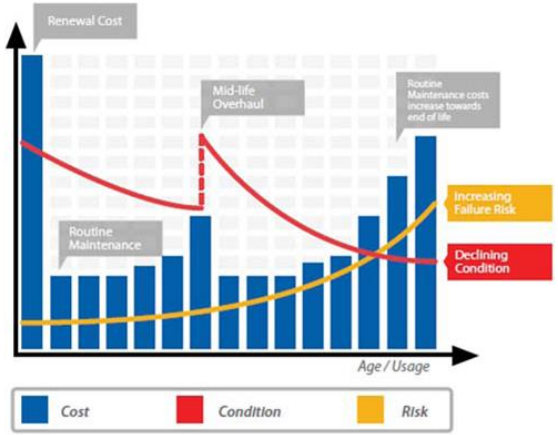
12. Ward, P., Gore, J., Hutton, R., Conway, G.E., & Hoffman, R.R. (in press), Adaptive Skill as the Conditio Sine Qua Non of Expertise. Journal of Applied Research in Memory and Cognition https://doi.org/10.1016/j.jarmac.2018.01.009

13. Ward P, Hoffman RR, Conway GE, Schraagen JM, Peebles D, Hutton RJB and Petushek EJ (2017) Editorial: Macrocognition: The Science and Engineering of Sociotechnical Work Systems. Front. Psychol. 8:515. doi: 10.3389/fpsyg.2017.00515

4. Sunny Modhara

Uncertainties in Decision Making at Network Rail





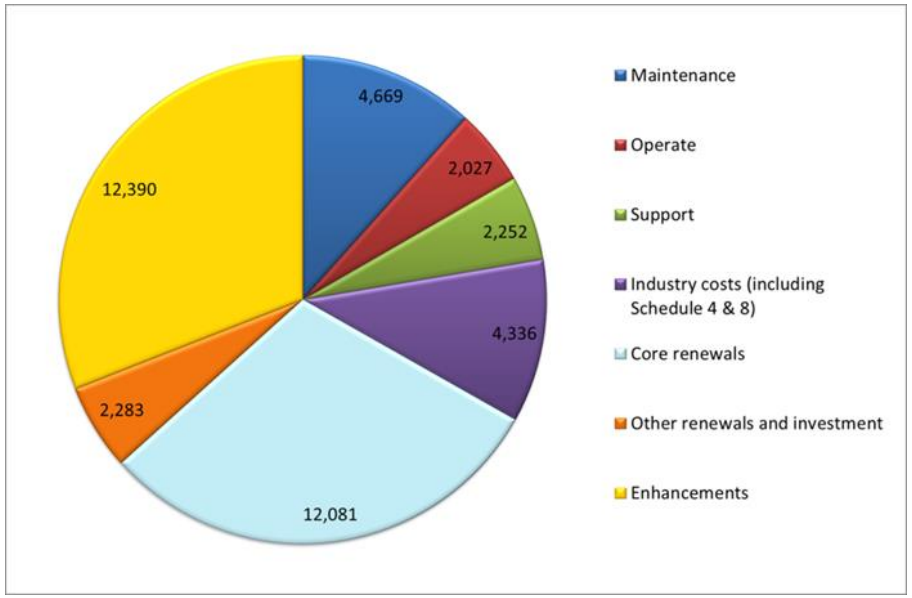
By Sunny Modhara

Network Rail: who are we and what do we do?

Network Rail (NR) is the UK infrastructure operator, managing:

- 20,000 miles of track
- 40,000 bridges
- 2500 stations
- Signalling, power and communications assets and others
- Largest UK purchaser of electricity
- 34,500 employees

Budget value of **£40bn** over 5 years



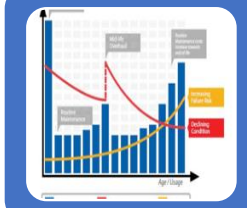
Passenger and freight growth

Pace of digitalisation / automation

Devolution to Operating Routes

Demand for cost efficiencies

Key decisions at Network Rail



Strategic decisions (up to 40 years)

- Long term cost and performance
- Whole network scenario analysis

Network level: What is the sustainable volume of work to deliver the required level of performance?

Uncertainty from situations far into the future e.g. railway usage

Planning decisions (up to 7 years)

- Asset specific work plan to deliver required outputs
- Optimisation of work along line of route

Route level: What specific work is required to meet local stakeholder requirements?

Uncertainty in the impacts of work deferrals under funding constraints

Delivery decisions (up to 3 years)

- Maximising the productivity of possessions
- Minimising disruption to passengers and freight operators

Sub-route level: What is the optimum grouping of work to maximise the availability of time and resources?

Uncertainty about the overrunning of work into operation time

Operational decisions (real time to one month)

- Predicting and preventing failures affecting services
- Detection, diagnostics and prognostics

Asset/component level: How can sensors be best used to predict failures and change from a reactive strategy to a predictive one?

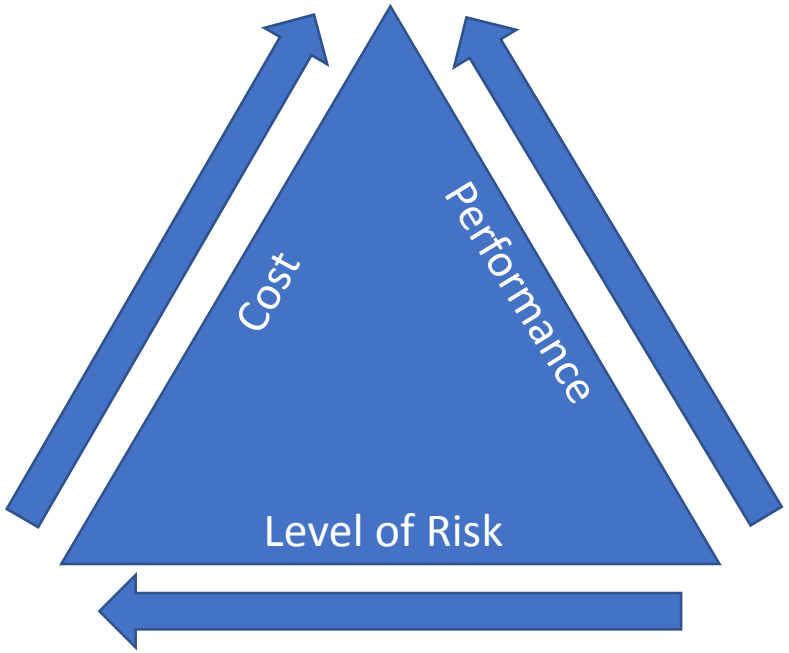
Uncertainties around asset failure likelihood, mobilisation/response time and restoration time

Problem Statement

- **Strategic:** Finding an optimised balance between cost, risk and performance across all assets and intervention types

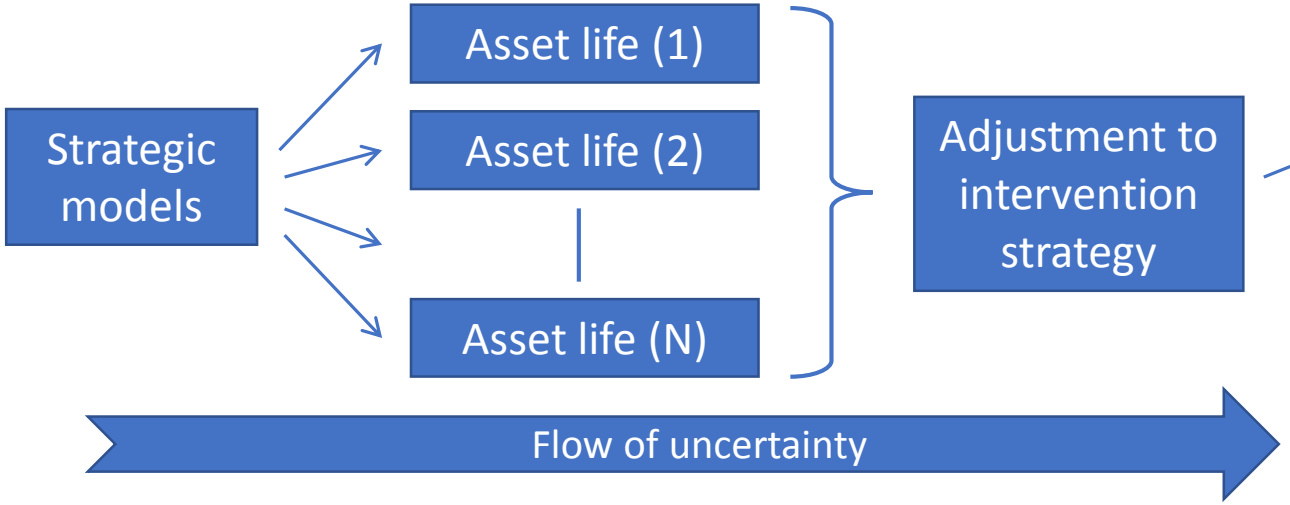
- Several sources of uncertainty exist, complicating the optimisation process e.g.
  - Initial costs and timing of implementation
  - The degradation of assets with age and usage
  - The effectiveness of interventions
  - Non-modelled factors (unknown unknowns)

- To demonstrate a sufficient level of understanding of asset behaviour and associated maintenance costs to the regulator (ORR)

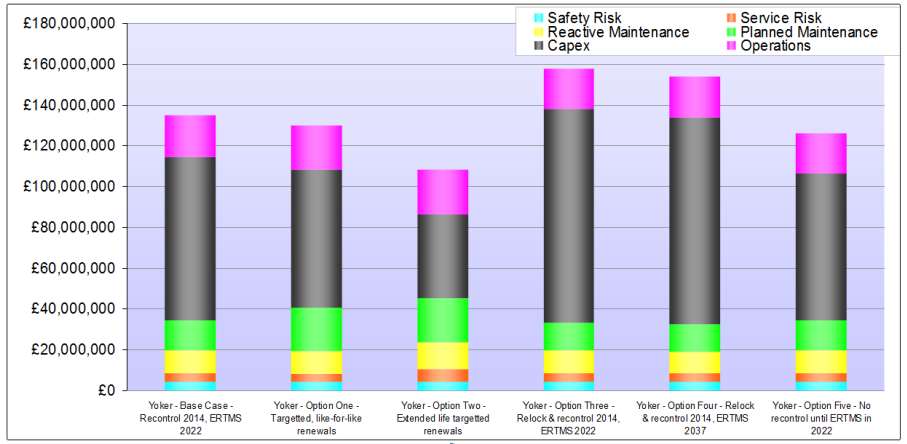


The trade-off between costs, performance and risk

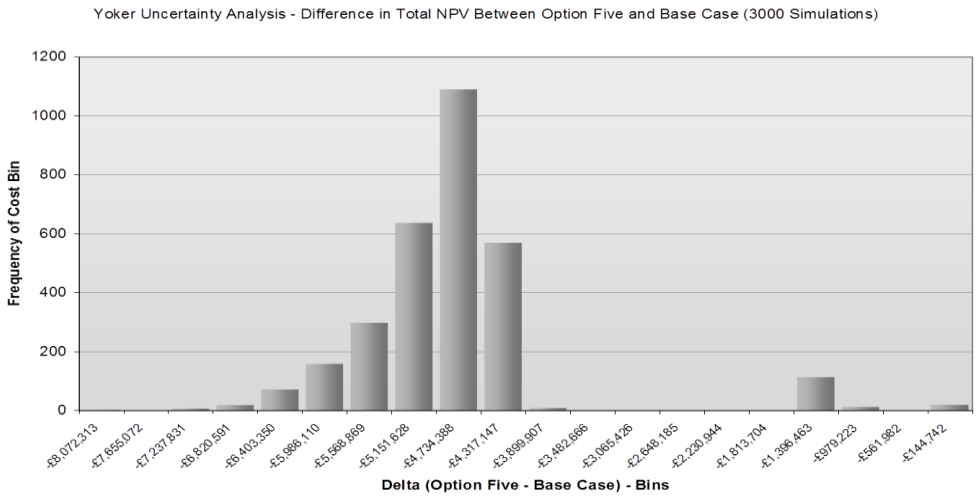
Approach and Results



Costs per option (point estimates)



Distribution of cost difference



- Strategic models used to forecast typical asset lives (costs and volumes) for each asset
- Adjustments to intervention strategy e.g. deferred or premature renewal, based on local knowledge
- Point estimate costs better expressed as distributions
- Currently being tested on a real project: Transpennine Route Upgrade