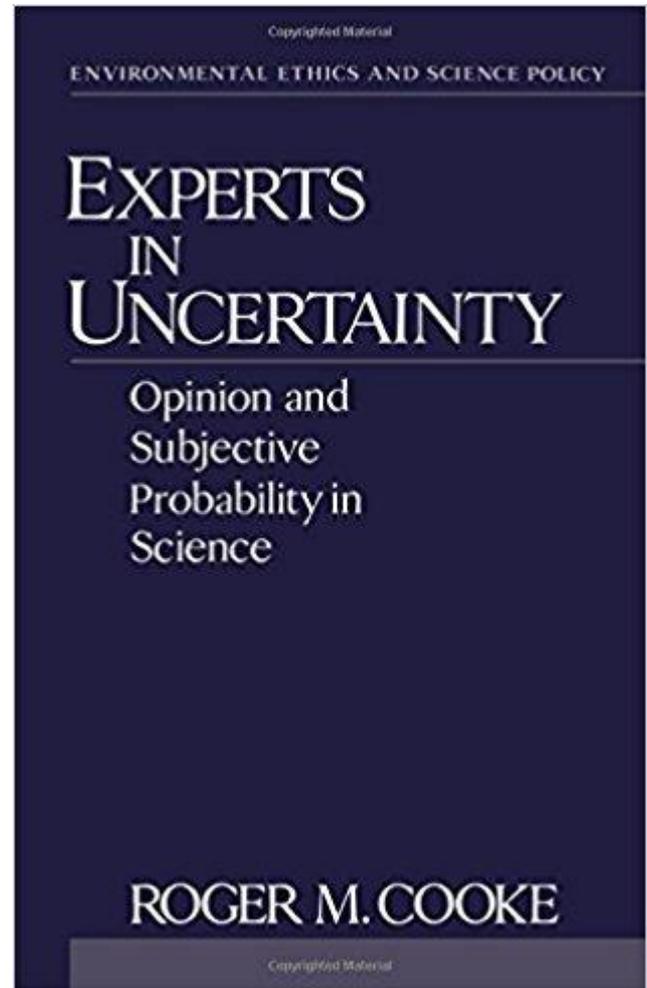# *CLASSICAL MODEL COLLAGE*

✓ *Experts in Uncertainty* was published in a philosophical series

✓ "*After the book things gradually became easier*"

✓ Before the book was published things were bit more complicated …I'm told

ENVIRONMENTAL ETHICS AND SCIENCE POLICY

EXPERTS IN UNCERTAINTY

Opinion and Subjective Probability in Science

ROGER M. COOKE

✓ Results were sent to lots of journals, e.g. Management Science, Operations Research, Journal of Organizational Behavior "*and god knows what else*"

✓ All rejected or un-reviewed

✓ "*The leaders were more interested in owning a problem than in solving it*"
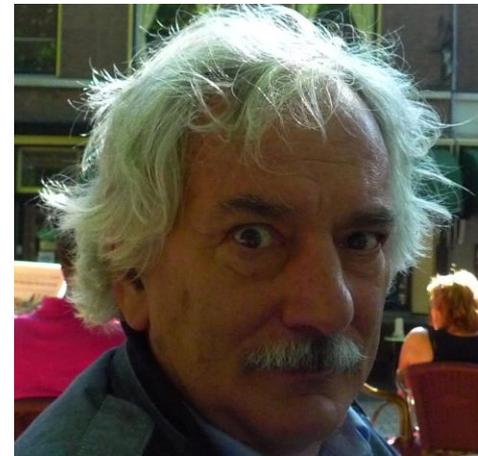
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✓ Cooke, Roger M. French, S. and van Steen, J. "The use of expert judgement in risk analysis - Report to the European Space Agency" (contract no. 8051/88/NL/re(SC)) 220 p. Delft, **1990**.

✓ Cooke, Roger M., Mendel, M., Thijs, W., "Calibration and Information in Expert Resolution". Automatica, 24, 1, 87-94, **1988**

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✓ … because "the engineers don't care about owning problems in EJ."

Max

The Bayesian

✓ Experts vs. Decision Maker

✓ Calibration & Information

✓ Classical Model

The Engineer

- ✓ Supertankers & Royal Dutch Navy

- ✓ I don't care what the experts think

- ✓ Catch flies with honey

Gordon

For the elicitation of expert judgement in the context of radioactive waste disposal, the preferred approach has been to adopt decision conferencing methods such as developed and used by Larry Phillips (LSE).

International Topical Meeting
on Probability, Reliability and Safety Assessment
PSA'89:   Pittsburgh, PA,   2-7 April 1989

Willy

Accademia Nazionale dei Lincei, Rome

LARGE EXPLOSIVE ERUPTIONS

(THE PROBLEMS OF ERUPTION FORECASTING
AND WARNING: LIMITS AND POSSIBILITIES)

International Symposium sponsored by the
Accademia Nazionale dei Lincei and the British Council

(Rome, 24-25 May 1993)

ESTRATTO

WILLY ASPINALL [a] and GORDON WOO [a]

AN IMPARTIAL DECISION-MAKING PROCEDURE USING EXPERT JUDGEMENT TO ASSESS VOLCANIC HAZARDS

ABSTRACT. — Recent eruptions have highlighted the serious difficulties and misunderstandings which can occur when, under great pressure and in the face of uncertainty, groups of working scientists endeavour to provide guidance to politicians or to the media on the possible course of future eruptive activity. Often, straightforward consensus of scientific opinion is not achievable; but contradictory views, publicly expressed, can be confusing to the community at large and present extra difficulties for officials concerned with public safety. Given the present state of volcanological knowledge, the academic Earth scientist might prefer to reserve his opinion until the outcome of the crisis is known, yet the practical and ethical demands of decision-making in a potential life-threatening situation requires that his expert judgement is exercised. High-consequence decision-making in the presence of major uncertainty is a problem in many enterprises, and an elegant new technique for the elicitation of expert judgement has recently been developed in the space industry. It is based on the mathematical construction of a «decision-maker» using the weighted judgements of a group of experts where the weights are assigned from a calibration test of the informativeness and impartiality of individual experts. This optimal decision-maker is superior to traditional methods of pooling expert opinions and, as an impartial aid to critical decision-making, could be very beneficial in volcano hazard assessment: individual scientists would feel encouraged to state their true scientific opinions, which would not be cited directly, but incorporated as factors in the decision analysis. The procedure is suitable for application to many aspects of disaster management.

KEY WORDS - Expert judgement; expert opinion; probabilistic hazard assessment; decision-making; volcanic crisis.

INTRODUCTION

> «In almost all circumstances, and at all times, we find ourselves in a state of uncertainty».
>
> Bruno de Finetti

[a] Aspinall & Assocs. - 3 Cypress Court - Harris Way - SUNBURY-ON-THAMES - Middlesex TW16 7EL (U.K.).
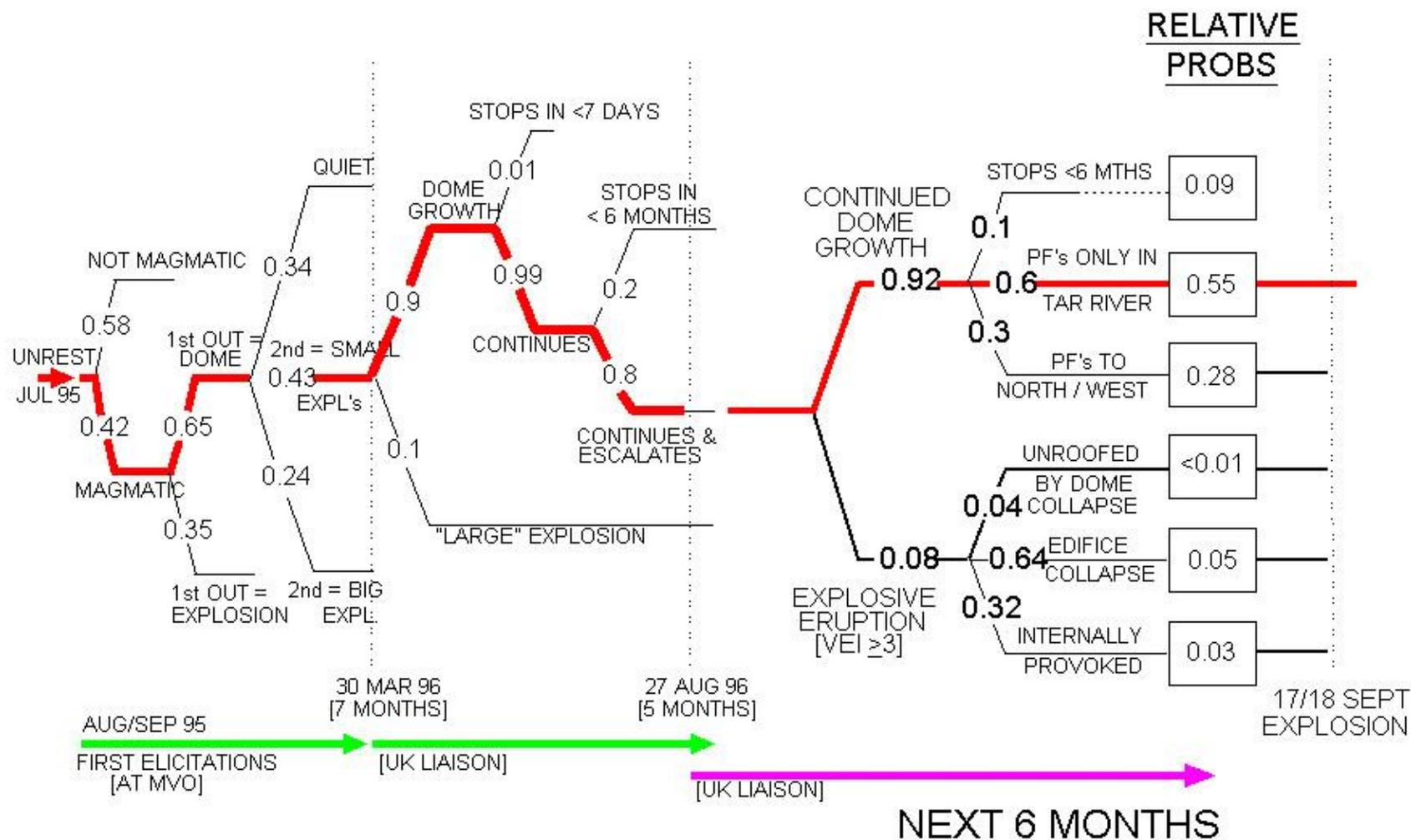
Montserrat volcano, 6 Nov 1997
- photo Paul Cole, MVO

Volcanic unrest starts 18 July 1995 -- what will happen next?

MONTSERRAT VOLCANO CRISIS
EVENT PROBABILITY TREE - UPDATE 27 AUG 96

Simon

Cooke's classical calibration score

Calibration as a hypothesis test

✓ The calibration score in the classical method can be seen a hypothesis test that seed variables are drawn from a multinomial distribution based typically on 5%, 45%, 45% and 5% bins.

✓ Roger showed that the relative information between empirical distribution and the ideal is approximately χ_3^2

✓ But we know that χ^2 distributions are poor approximations on small samples

✓ ~10 seed variables $\Rightarrow$ small samples

Kolmogorov-Smirnov

✓ So Mike Wiper, then a PhD student, Roger and I investigated ways of testing for good calibration. In particular a Kolmogorov-Smirnov test.

✓ Perhaps to our surprise, the χ^2 version turned out to be the more stable.

✓ Generally Mike Wiper in his PhD looked for improvements to the calibration score in the Classical model, but found none.

✓ Cooke's insight behind the Classical Model has proved to be impressive and very hard to improve upon.

Ben

Air traffic Safety

✓ Combine all:

  ✓ Fault-trees, Event-trees and BBN's
  ✓ Uncertainties in the form of value distributions
  ✓ Expert judgement estimates including their uncertainty.

  ✓ Into a giant BBN for evaluation of the probability of an airliner crash and potential risk reducing measures.
  ✓ 1400 nodes and 5000 arcs.

The basic constituents of CATS
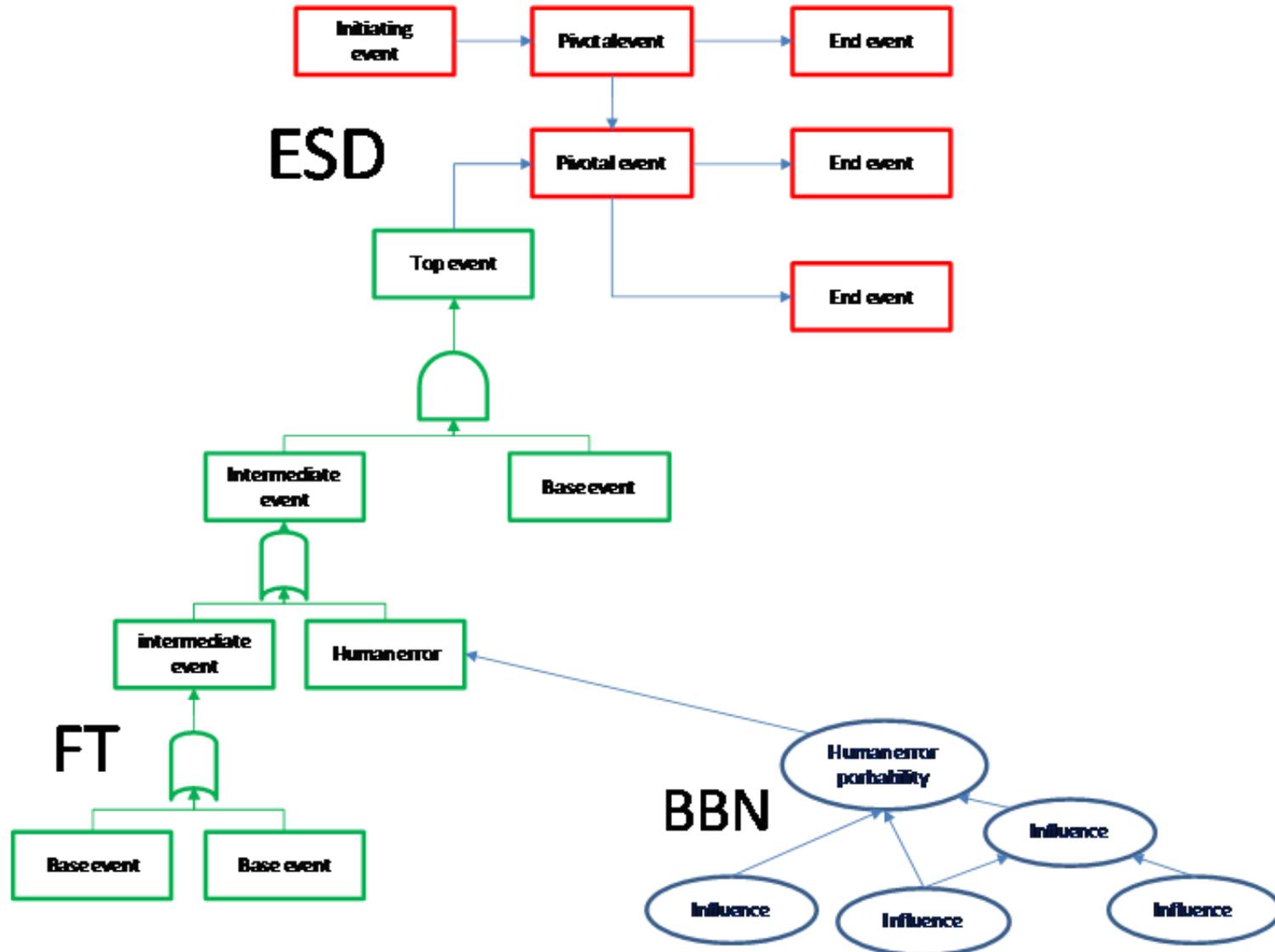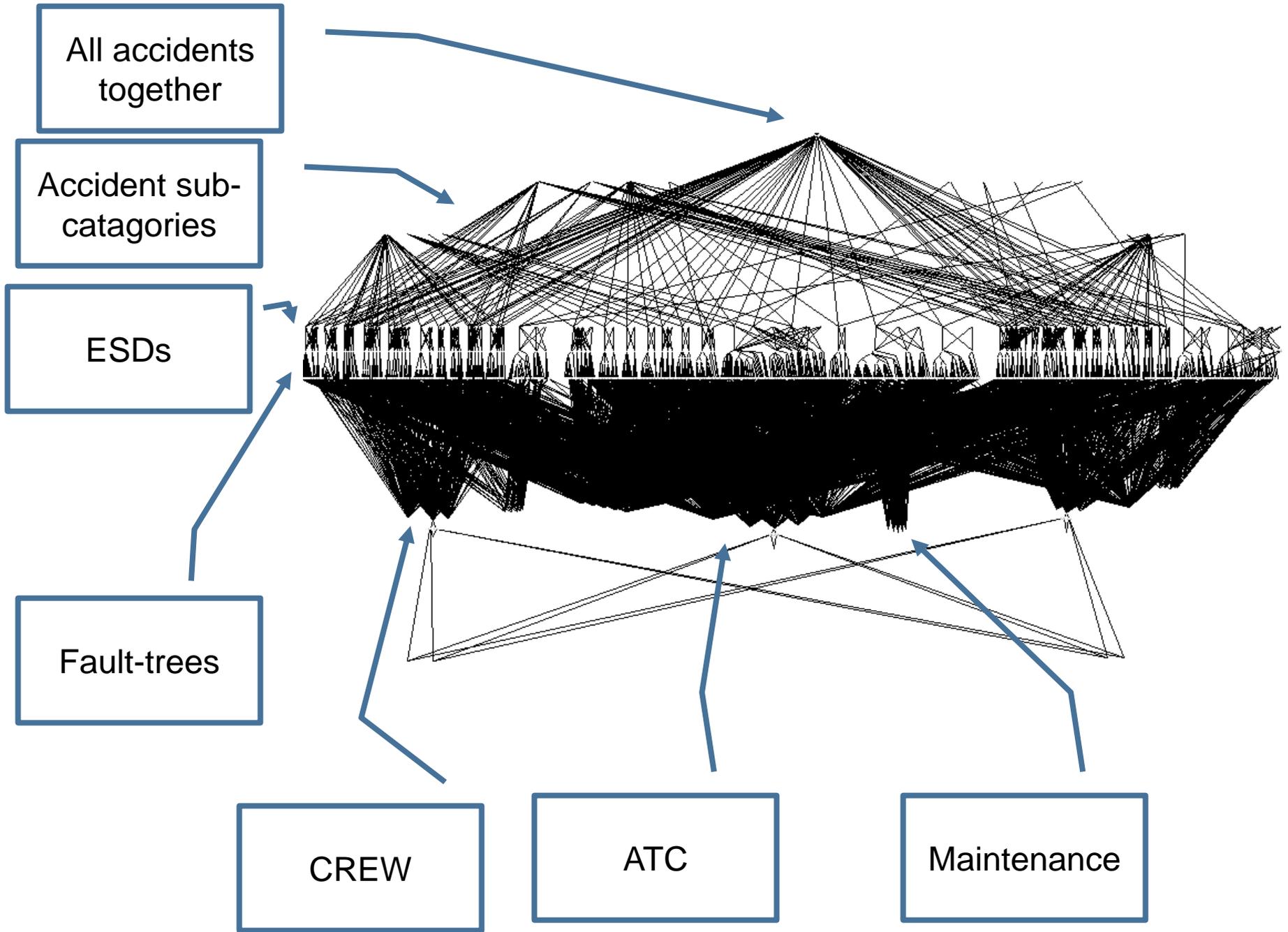
All accidents together

Accident sub-catagories

ESDs

Fault-trees

CREW

ATC

Maintenance