Can We Quantify Risk? Event Report

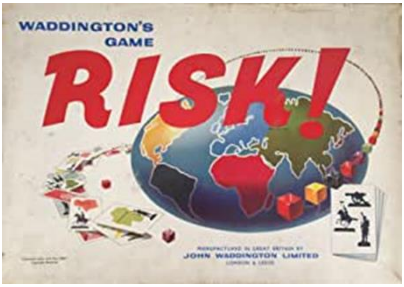


The "Can We Quantify Risk?" seminar was held on 21st October 2021 at the Radisson Blu Edwardian Bloomsbury Street Hotel, London and virtually online. This was the first in-person event held by the SCSC in over 18 months and the first to be a blended event with delegates also attending online. Mike Parsons, chair of the seminar, reports on the event and assesses how well the blended format worked.

The day opened with Mike explaining how pleased he was to see delegates in person at an SCSC event! He said that the Covid-19 pandemic had made us all risk estimators to an extent. He then introduced the event mentioning some aspects of risk and new areas for discussion such as autonomous road vehicles.

This was the first blended club event (held in person and simultaneously online) since the pandemic started, and he noted that much preparation went into the event using no less than five laptops, a video camera, a mixing desk, many cables plus sound and projection systems (many thanks to Alex King and Brian Jepson for solving all the technology problems).

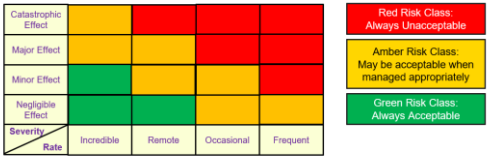
Risks on a Plane



John Spriggs, an independent writer and presenter, started the day with "*Risks on a Plane*"[1]. He gave an introduction to risk, its component parts and how it can be represented within a two-dimensional plane with severity and likelihood.

He had several references to its use in aviation and the software assurance guidelines, DO-178 and DO-278. He gave some definitions of risk from international standards and explained how there were many different definitions which were not consistent. Organisational risk appetites and risk matrices were covered. He noted that risk matrices need to be maintained and reviewed as things changes – he suggested every two years is about right.

Example Risk Matrix with Risk Classes



He explained the concept of Safety Objectives as invariants for that system and organisation. He summed up with "Establish your number system, then use it as the basis of your Risk Classification Scheme, which is developed by eliciting the client's risk appetite. Document it, declaring all assumptions". Addressing the topic of the seminar, he explained that to the question "Can we Quantify Risk?" the answer is "Yes, you can quantify risk but be careful how you use the numbers…".

Risk quantification with a lot of data (but limited knowledge) – Building a road risk tool after Selby



James Catmur of J C & A explained some of the situations he had been in over his career in rail and road. He gave some of the background to the Selby accident in 2001 when a vehicle crashed down an embankment and caused a train to derail and another train to crash into the wreckage. Ten lives were lost and 82 injured, the worst rail disaster of the 21st century in the UK [1].

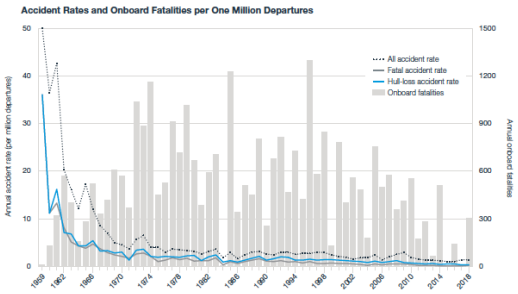
He explained how road crash maps are maintained for UK (crashmap.co.uk) and lots of data on causes is available via the UK government website [2]. He said that human understanding of risk is very biased: people have a tendency to overestimate the frequency/risk of things they have experienced, underestimate the frequency/risk of things they have never experienced, believe they know all about road safety and use 'rationally motivated ignorance', i.e. "what you don't know can't hurt you".

[1] A nice pun given John's aviation background!

He said that risk assessments need to be kept simple and understandable, and the logic (i.e. the working or methodology) behind any numbers produced should always be shown. On the roads we have both Unsafe Acts and Unsafe Conditions so both need to be factored in, but they are different. When managing risks, it is important not to push risk from one group to another, i.e. it would be easier to make some roads lower risk for cars but higher risk for motorcycles. He said we need to seek to reduce our ignorance, i.e. find information to fill in the gaps. There was a lively debate about abuse of hard shoulder lanes on motorways and he explained that you should always wait outside the vehicle and upstream.

Quantitative Risk Analysis: Purpose, Prediction, Problems & Possibilities

John McDermid was on next after the coffee break and explained the difference between Retrodiction and Prediction with the former being the assessing of actual risk, posed by some (class of) system operating in an environment, over some period of time. He used the Boeing accident data plot to illustrate:



Prediction is where we estimate risk which will be posed by some (class of) system operating in an intended environment prior to deployment (or update), perhaps to inform regulatory approval or to inform insurance. He explained that we should be operating on a continuum – updating predictions from operational data, but this rarely happens.

John had some good quotes to illustrate that prediction is difficult: "Prediction is very difficult, especially if it's about the future."[2] and "Remember, John, if a safety case contains numbers, then they are wrong."[3]

He noted that the Watchkeeper accident rate appeared to much higher than initially predicted with several documented accidents. The majority of John's talk was taken up with an assessment framework and maturity model for Quantitative Risk Assessments based on a study and paper "Fixing the cracks in the crystal ball: A maturity model for quantitative risk assessment.



Fixing the cracks in the crystal ball: A maturity model for quantitative risk assessment

Andrew Rae, Rob Alexander *, John McDermid [1]

John listed some of the issues with these models: (i) if the system is safe enough then it may not get any meaningful feedback during the operational life, (ii) models normally assume stationary stochastic processes, but the environment and system change, and (iii) they don't account for "black swan" (very rare and very severe) events.

[2] Attributed to Niels Bohr (various versions). Also attributed to Mark Twain, Yogi Berra …

[3] Former BAe Military Aircraft Chief Safety and Airworthiness Engineer.

He then outlined the maturity model with five levels: **Unrepeatable**, e.g. data sources not stated or analysis pre-dates the final design, **Invalid**, e.g. human/software causes not considered in accident sequences (incomplete, partial), **Valid but inaccurate**, e.g. incorrect assumptions on independence, **Accurate but challengeable**, e.g. use of data from other systems is controversial and **Ideal** – unattainable perfection.

He finished by considering assessment of AI/ML systems illustrated by a discussion of the Uber Tempe accident. His conclusion was that QRA can lead to false confidence in systems but it is possible to utilise the maturity model to get "better" QRA and a basis for reasoning about the figures in a safety case. He said the AAIP's main focus is on autonomy but noted that the performance measures for systems involving machine learning (e.g. for object recognition on the road) are typically in the range of 9X%, not 10^{-X} as we might hope.

Varieties of Risk

Peter Ladkin of Causalis started his talk with a short history of risk estimation and its origins in the insurance industry in London where ships and their cargos could be covered via negotiations conducted in London coffee houses:


LLOYD'S COFFEE HOUSE, LONDON
Coloured aquatint by William Holland, 1798

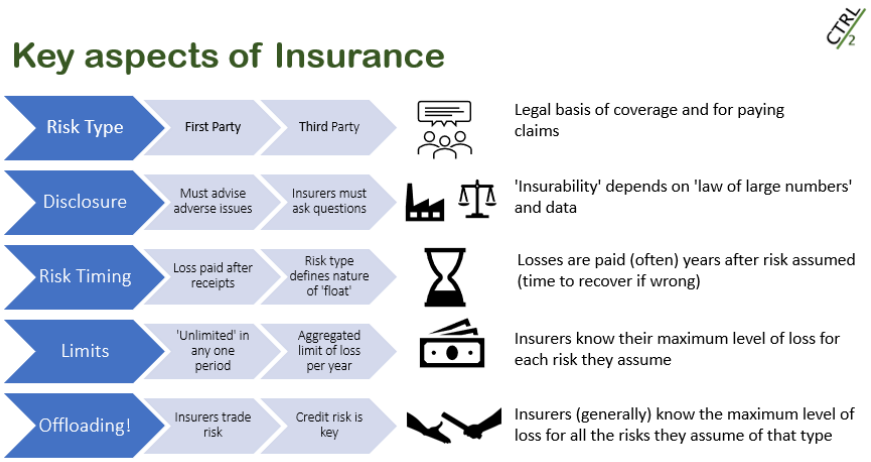
He detailed the many and varied definitions of risk in international standards. He explained that there can be both positive and negative risks. The distinction of uncertainty and risk was historically defined as "Risk is when you know the probabilities; the die is fair. Uncertainty is when you don't know if the die is fair or not."



The Fukushima nuclear accident was discussed and the problems of insuring nuclear risks highlighted. In the UK, Nuclear Peril, i.e. environmental release of radioactive material or breach of the Reactor Pressure Vessel (RPV) is not insured commercially and is something for government. World-wide nuclear accidents were discussed and the possibility that Chernobyl could have been so much worse if a radioactive cloud had landed on Kiev.

Cyber-security risks were thought to be another sort of risk, as they are dynamic as opposed to safety risk which is generally considered static.

How the insurance industry quantifies and prices risk



Clive Thompson of CTRL/2 gave a very interesting perspective of risk from the insurance industry. He explained that risk was viewed as opportunity for the industry, and it was a massive global business. Insurers need to be able to quantify risk to be able to calculate premiums. He explained five key aspects:

- **Risk Type**: first party e.g. buildings and contents vs. 3rd party such as public liability
- **Disclosure**: the underwriter needs information to assess the risk
- **Risk Timing**: including the importance of paying the premium in advance of any claim
- **Limits**: i.e. caps on payouts depending on risk taken on
- **Offloading**: spreading risks by using re-insurers

He explained that now in the digital age, multiple sources of information (e.g. big data analytics and satellite data for weather risks) are available to assist. Insuring some new types of risk e.g. autonomous road vehicles was also discussed.

The day finished with a lively panel discussion with four of the presenters (with three in the room and Peter Ladkin from Germany).

It was felt the day went very well with interesting and useful presentations, good discussions, and the technology for blended seminars had performed better than expected.

References

[1] https://en.wikipedia.org/wiki/Selby_rail_crash, accessed October 2021

[2] https://www.gov.uk/government/statistical-data-sets/reported-road-accidents-vehicles-and-casualties-tables-for-great-britain, accessed October 2021.

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