RISK ASSESSMENT

WHAT DO WE MEAN BY RISK?

- Chambers – “hazard, danger, chance of loss or injury”
- OED - “Exposure to the possibility of loss, injury, or other adverse or unwelcome circumstance”
- Common usage – the probability of suffering an undesired event
- The Risk Analyst’s definition would be the combination of the probability of suffering a loss together with the magnitude of that loss

A GAME OF CHANCE – TOSS A COIN

- Game 1 - Heads I give you £1, Tails you give me £1 Will you play?
- Game 2 - Heads I give you £100, Tails you give me £100
- Game 3 - Heads I give you £100,000 Tails you give me £100,000

WHAT'S THE POINT OF RA?

- Not so much to provide a value to the risk of a given activity

Rather

- To provide a comparison between various alternatives

QUALITATIVE RA

- Levels of loss Probability
  - High
  - Moderate
  - Low
  - Improbable
- Levels of loss Magnitude
  - Severe
  - Large
  - Moderate
  - Trvial

THE RISK MATRIX

Probabiity > Magnitude v	High	Moderate	Low	Improbable
Severe				
Large				
Moderate				
Trivial				

ACTION SCALE

	Avoid at all costs
	Avoid if at all possible
	Consider but look for ways to improve risk
	Accept risk but do not over commit
	Go for it

FINANCIAL RISK
Comparing Investments

- Case A – High probability of failure but small losses
  Probability of failure = 0.4
  Loss if investment fails = £100
  Risk 0.4 x 100 = £40/investment
- Case B – Low probability of failure but high losses
  Probability of failure = 0.05
  Loss if investment fails = £1000
  Risk 0.05 x 1000 = £50/investment
- So Case A gets our vote

FINANCIAL RISK
Incorporating gains and losses

- Case A – High probability of failure but small losses or modest gains
  Probability of failure = 0.4, Probability of success = 0.6
  Loss if investment fails = £100, Gain if investment succeeds £100
  Risk 0.6 x 100 - 0.4 x 100 = £20/investment
- Case B – Low probability of failure but high losses or modest gains
  Probability of failure = 0.05, Probability of success = 0.95
  Loss if investment fails = £1000 , Gain if investment succeeds £100
  Risk 0.95 x 100 - 0.05 x 1000 = £45/investment
- So now Case B gets our vote!

RISK OF DEATH OR INJURY

- Average person visits a pub once a month
- Probability of contracting COVID 0.1% (0.001) per visit
- Probability of dying if you contract COVID 4%

Thus risk of COVID infection from pub visits is :

12 x 0.001 x 0.04 = 0.00048 fatalities/person/year (4.8×10^{-4})

COMPARISON WITH OTHER RISKS

- Working in agriculture/forestry - 7.73×10^{-5} fatalities/person/year
- Working in admin/support - 0.23×10^{-5} fatalities/person/year

SO IT'S SIMPLE THEN!
Unfortunately there are complications

- Working out the probability of loss events
- Working out the magnitude of loss
- Working out overall risk from multiple loss events each with their own probability and loss magnitude

DETERMINING FAILURE/LOSS PROBABILITIES

- Analytically from 1st principles e.g. toss of a coin or throw of a dice
- Historical Data
- Decomposition into sub-events

HISTORICAL DATA
BEWARE LOW BEAM!

- The King Head has a low beam in the public bar – how do we determine the probability of a customer banging their head
- Employ student to sit in the bar and record the number of head bangs over a given period
- Thus period of record – 6 weeks (42 days) for 8 hours per day
- Number of head bangs recorded 31
- Number of customers in 6 weeks - 240
- Thus frequency of head bangs = 31/240/42/8 = 0.000384 bangs/customer/hour (3.84×10^{-4})

HISTORICAL DATA INFREQUENT EVENTS

- What if the event is very rare e.g. number of fatalities at pedestrian crossing at Halesworth Station
- Could use data from a much larger sample size e.g. national records
- But data may not be representative of Halesworth specific circumstances
- Data needs adjustment but can be v. complex

EVENT DECOMPOSITION

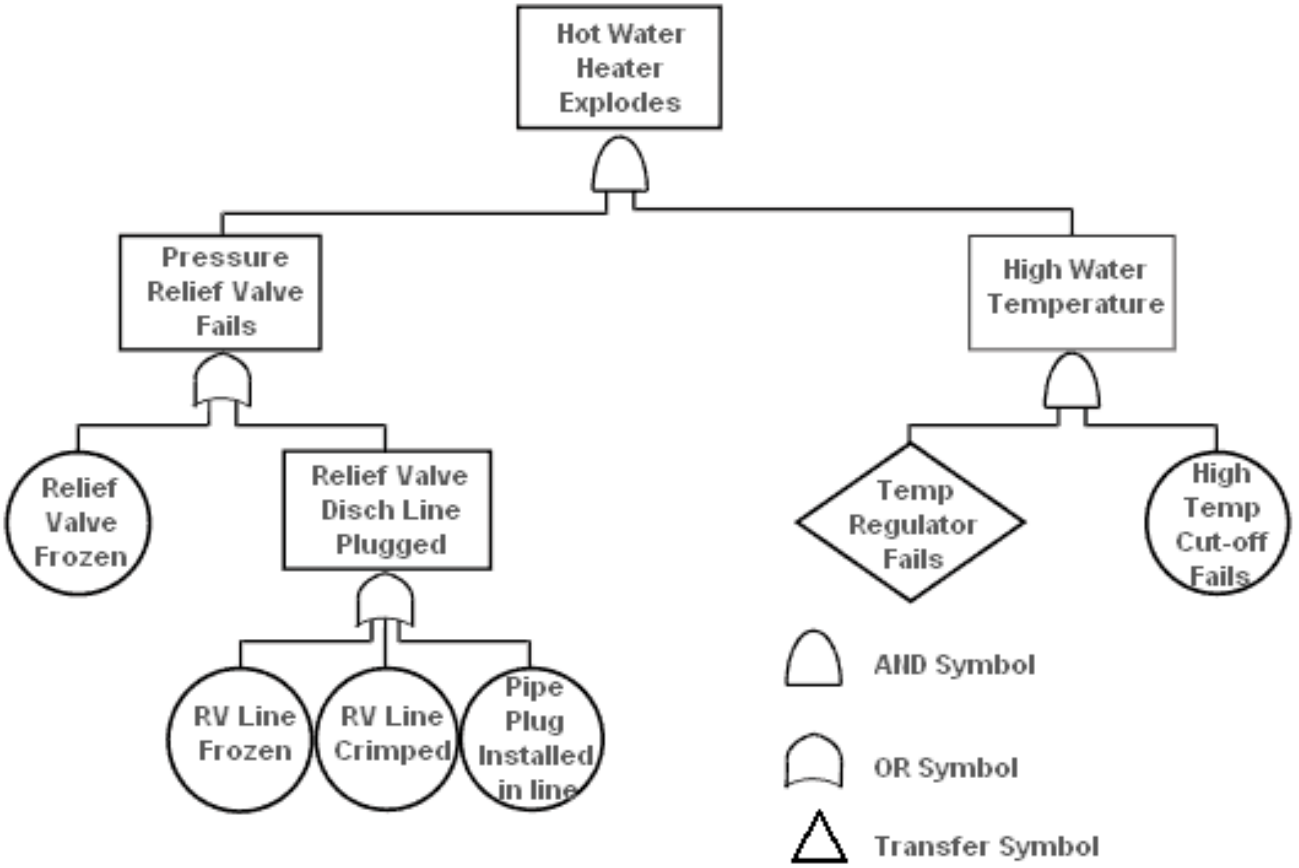
Break down failure event into a set of simple sub-events for which data exists

Combine this data using Boolean logic to build up a composite failure probability for the whole system

FAILURE OF A 7 CYLINDER PETROL ENGINE!

- Engine comprises sub-systems : cylinders (including valves & spark plugs), crankshaft, block, fuel injection, ignition etc.
- Take data for each subsystem from a typical 6 cylinder engine
- Combine data for each sub-system plus the failure rate for an additional cylinder

DECOMPOSITION OF COMPLEX SYSTEMS
FAULT TREE ANALYSIS



DETERMINING LOSS MAGNITUDE

- Financial Loss
- Loss of life
- Loss of good health or injury
- Loss of reputation
- Loss of peace of mind

EVENTS WITH SINGLE OUTCOMES
THE BEIRUT FERTILISER EXPLOSION

- Known quantity of Ammonium Nitrate (2750 tonnes)
- Know from previous NH_4NO_3 explosions (Oppau, Texas Bay, Tiajin) fraction of material that will explosively decompose (30-50%) hence can calculate energy release
- Calculate and plot explosion overpressure contours
- Know population density within affected areas
- Fatality fraction in relation to overpressure exposure
- Calculate number of fatalities

EVENTS WITH MULTIPLE OUTCOMES THE CORONA VIRUS PANDEMIC

- Different people have different probabilities of contracting COVID19
- Magnitude of hazard differs for an individual
  - No observable symptoms
  - Headache, Mild fever and short lived cough – no medical intervention required
  - A more severe cough requiring them remain at home for a few days to recover
  - Severe symptoms requiring hospitalisation
  - Very severe symptoms requiring ventilation
  - Death

EVENT TREES

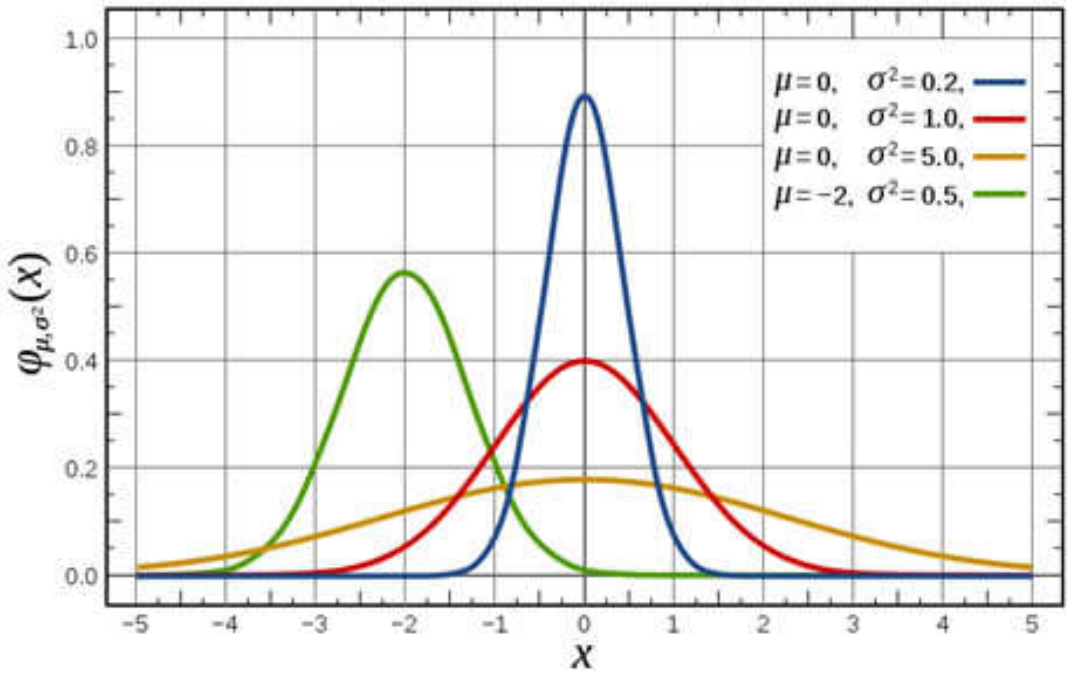
- Go to Excel file

PROBLEMS AND PITFALLS

- Availability of event frequency/probability data
- Data accuracy and spread
- Impact assessment
- Loss acceptability
- Loss equivalency

FAILURE DATA AVAILABILITY

DATA ACCURACY & SPREAD



IMPACT ASSESSMENT COMPLEXITIES

RISK ACCEPTABILITY
CROSSING THE ROAD

RISK PERCEPTION

- Are lots of little accidents better than one big one?
  - 1700 deaths/year from road accidents
  - 0 deaths/year from UK nuclear power station accidents (in 60 years of operation)
- Do we have an unfounded belief that we are in control and therefore safe?
  - 77% of RTAs caused by driver of vehicle involved

LOSS ACCEPTABILITY

- What value do we put on life
  - How much are we prepared to spend to reduce the probability of dying
  - How much should other organisations or our government be prepared to spend to save an individual's life.