

# **SYSTEMS THINKING AND DECISION MAKING:**

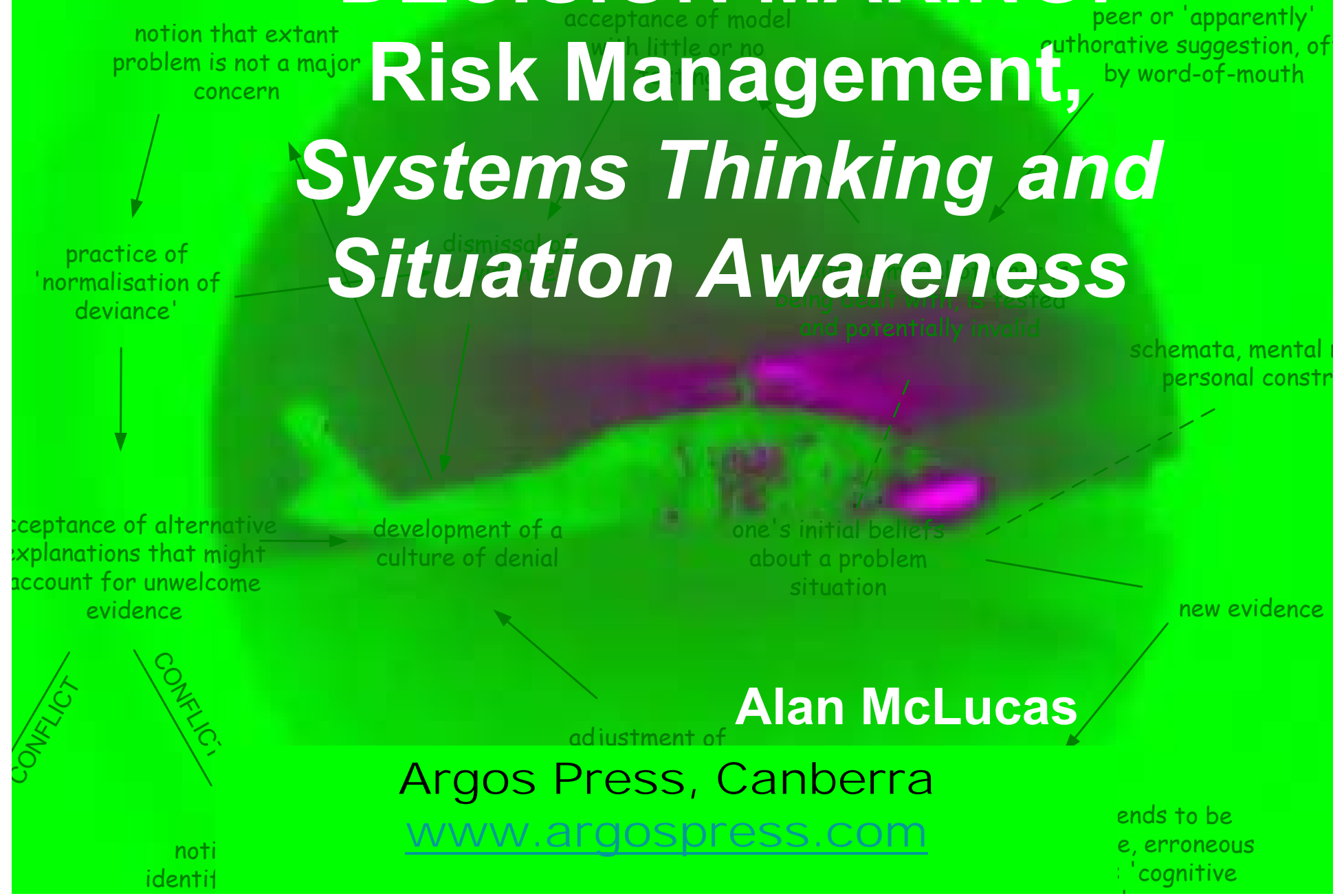
## **RISK MANAGEMENT AND SITUATION AWARENESS**

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# DECISION MAKING: Risk Management, *Systems Thinking and Situation Awareness*



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‘For every complex problem there is always a simple solution. And it is always wrong!’ – *H.L. Mencken*

‘The world we have made as a result of the level of thinking we have done thus far creates problems that we cannot solve at the same level (of consciousness) at which we have created them – we shall require a substantially new manner of thinking if humankind is to survive.’ – *Albert Einstein*

# DEFINITION: *SYSTEM*

*Any combination of real world elements which together have purpose and which form a set of interest to the inquirer.*

# DEFINITION: *EPISTOMOLOGY*

A *theory* concerning means by which we may have and express *knowledge* of the world.

# DEFINITION: *SYSTEMS THINKING*

An *epistemology* which, when applied to *human activities* is based on four basic ideas: *emergence, hierarchy, communication, and control* as characteristics of *systems*.

When applied to *natural or designed systems*, a crucial characteristic is the *emergent properties* of the whole.

# DEFINITION: *EMERGENT PROPERTIES*

Properties exhibited by a complete (hooked-up) system that cannot be exhibited by the parts of the system in isolation They depend on interactions between components (including the environment).

# DEFINITION: *EMERGENT PROPERTIES*

Consider a bicycle composed of a frame, two wheels, pedals, a drive chain, saddle, handlebars, brakes etc. The primary emergent property of dynamic balance is only produced by the combination of the rider and the bicycle.

# DEFINITION: *EMERGENT PROPERTIES*

Only when human power, control and intelligence (and a road surface) are added does the bicycle become a means of transport. Take any one away and the system falls apart. Emergent properties therefore cannot be predicted solely by looking at the components.

# COGNITIVE MAPPING: THE CAUSAL RELATIONSHIP

- Causal relationships are represented by arrows, where each arrow means 'leads to...', such as is expressed in the statement 'smoking *leads to* heart disease. This does not mean all smokers will suffer from heart disease but suggests there is strong evidence to this effect, noting all people who smoke will be affected, at least to some extent.

# COGNITIVE MAPPING: THE CAUSAL RELATIONSHIP

- In our statement, there are two concepts where the first is expressed as a *call for action* in positive terms, in turn, affecting the latter concept in a positive way. These concepts may be more fully expressed as:  
‘partaking in the practice of smoking cigarettes’,  
and  
‘the onset of heart disease later in life’.

# COGNITIVE MAPPING: THE CONNOTATIVE RELATIONSHIP

- Connotative relationships are typically depicted by dashed lines without arrowheads. Here we interpret connotation as causality that may act in either direction, at different times or under varying circumstances. This type of link suggests causality might be ill defined; open to some interpretation, or requiring further observation and investigation.

# COGNITIVE MAPPING: THE CONFLICT RELATIONSHIP

- Conflicting relationships are a special case of the connotative, but where the concepts at the ends of each line cannot co-exist without conflict, or a state of stress being created. The convention used in this book to denote conflict is solid double lines without arrowheads (though in some maps these links may be depicted by dashed lines marked 'CONFLICT'). Where colour is available it is suggested that these conflict link lines be drawn in red to make them stand out.

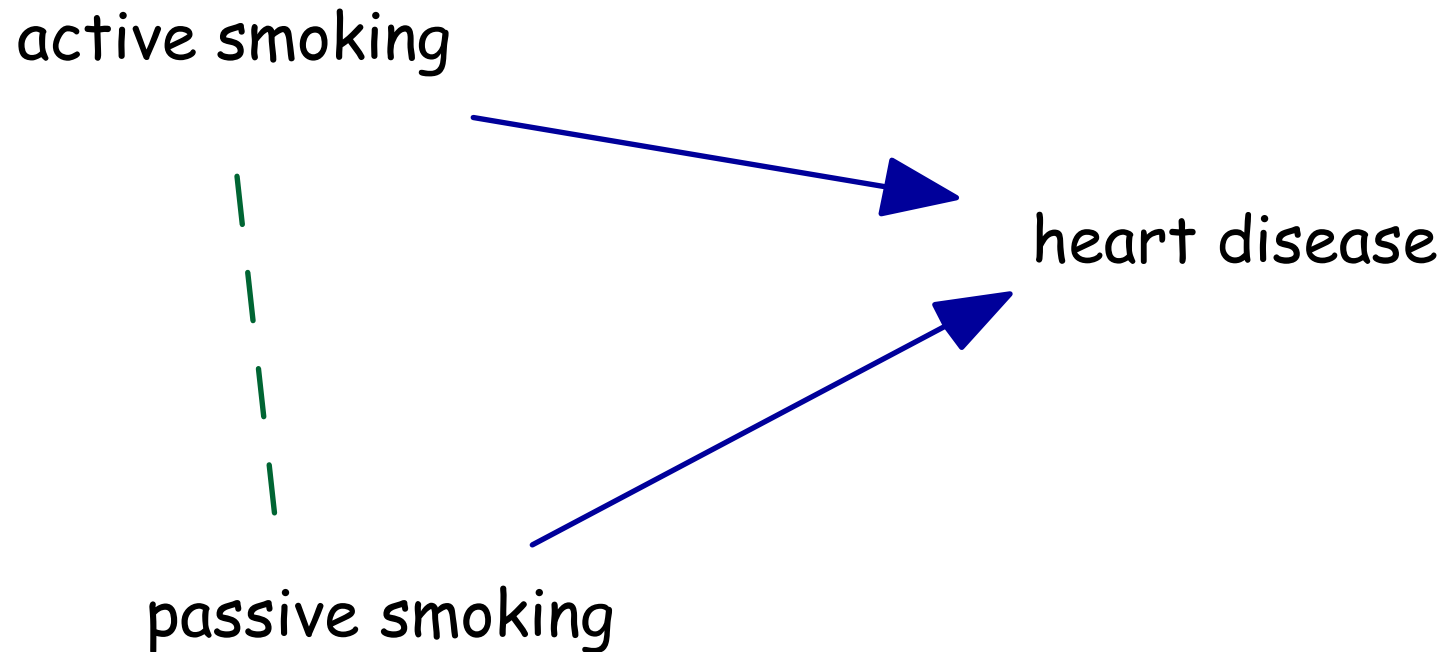
# ACTIVE RATHER THAN PASSIVE SMOKING LEADS TO HEART DISEASE

active smoking ...  
(rather than)  
passive smoking

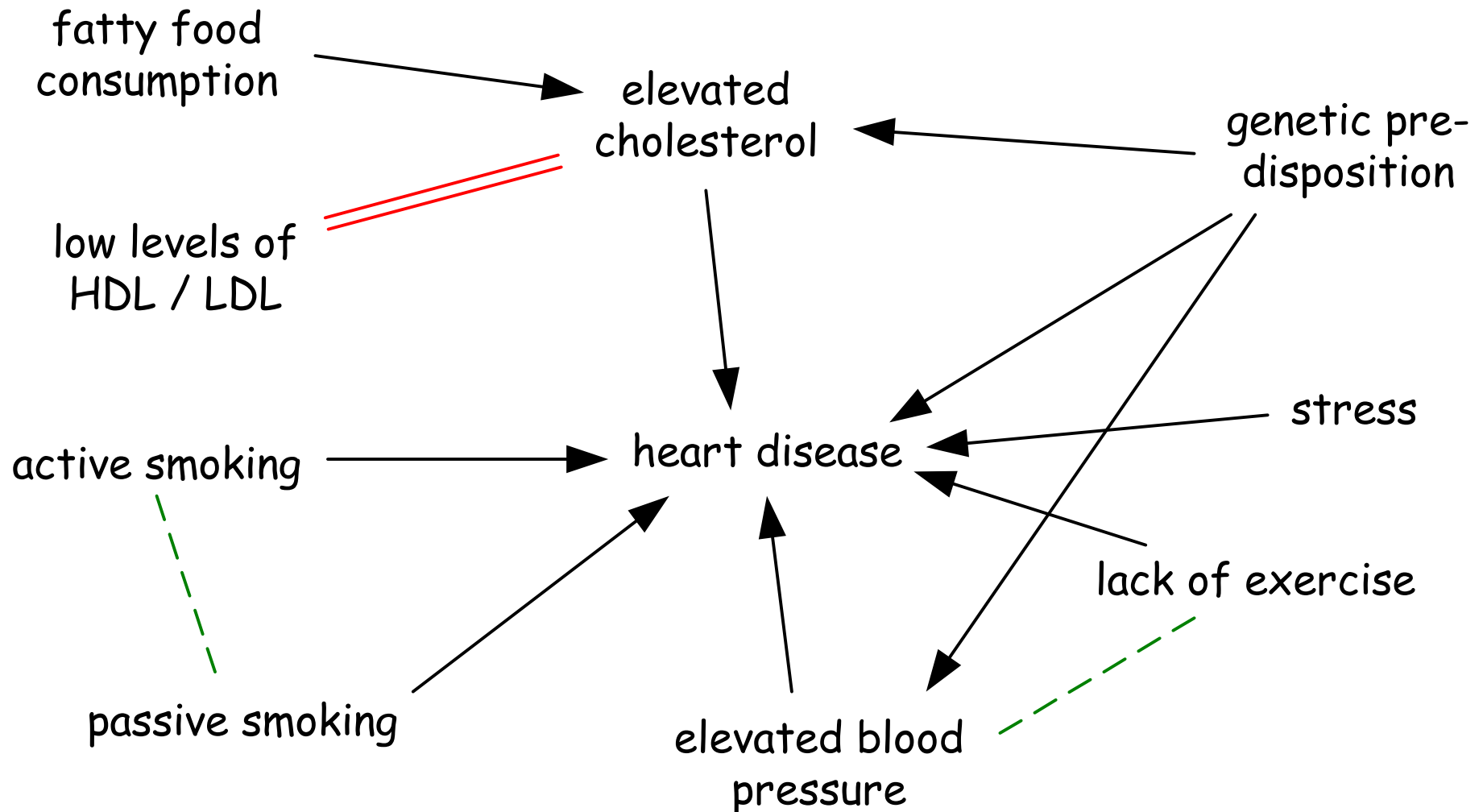


heart disease

# ACTIVE RATHER THAN PASSIVE SMOKING LEADS TO HEART DISEASE – ALTERNATE FORMULATION



# SIMPLIFIED REPRESENTATION - SMOKING AND OTHER CONTRIBUTORS TO HEART DISEASE



# Brief Introduction to Risk

# Risk

- Risk is: *the chance of something happening that will have an impact upon objectives.*
- Risk from exposure to the possibility of such things as financial loss or gain, physical damage, injury or delay, as a consequence of pursuing or not pursuing a particular course of action.

(HB 143:1999)

# Risk Management

- Risk management is: *the culture, processes and structures that are directed towards effective management of potential opportunities and adverse effects.*
  - Allows an organisation to realise opportunities without exposing itself to unnecessary risk
  - Requires systematic rigorous thinking: **MUST** be informed by a *systems thinking* perspective
  - Should be integrated into everyday processes
  - Requires understanding, ongoing learning and thinking about possible future events

# Risk Management Challenge

“Modern managers are not well served by traditional decision-making and risk-management skills, particularly where a litany of systemic problems can arise in domains that are inherently complex and dynamic. In the vast majority of situations, however, a manager does not have to be a domain expert to be effective; he or she needs systems thinking skills, capacity to develop heightened situation awareness and willingness to contemplate what may unfold in future.

The risk management challenge lies in the question:

*‘how can managers, through routine management activities, mitigate the risks that might arise within their domains of action?’*”

McLucas, AC., 2003, ‘Decision Making: Risk Management, Systems Thinking and Situation Awareness’, Argos Press.

# The Nature of Risk

# What is Risk?

- Risk has two elements:
  - *Likelihood* – this is probability or chance of occurrence
  - *Consequence* – the result of occurrence of an uncertain event - normally taken as having adverse impact
- All considerations of risk must make a clear distinction between situations where:
  - The “odds” are known
  - The “odds” are not known, but the main parameters may be known
  - We don’t know what we don’t know
  - We have:
    - (sometimes indeterminate) causal chains, or
    - open networks.

# When The “Odds” Are Known

- Examples of when the “odds” are known:
  - Winning a Division 1 prize in 6-from-45 Lotto, having purchased a single “Systems-8” ticket.
  - A passenger on an international flight in a Boeing 747 dying as a result of a crash brought about by catastrophic failure of the aircraft.
  - Road building activities on the Stuart Highway between Darwin and Katherine being delayed because of rain in January.

# When The “Odds” Are Not Known

- Often the “odds” are not known but the parameters which might suggest an event is possible, are known (cont’d):
  - The Earth being hit by a large meteorite:
    - Astronomers can monitor celestial events which might produce large meteorites, though we do not have “odds” for such an event affecting us.
  - A new virus mutating to a form that enables it to jump species, to threaten human life on a pandemic scale (as Severe Acute Respiratory Syndrome (SARS) has done on a limited scale):
    - We do not know the “odds” but ongoing research might be able to tell us at some stage in the future.
  - The Gold Coast being struck by a tsunami:
    - Almost impossible to determine, but “odds” are small?

# When We Don't Know What We Don't Know

- During World War II, soldiers in off-duty hours in summer, taking a swim in the waters of Far North Queensland:
  - The first (unexplained) deaths from box jellyfish stings occurred when several soldiers stripped off on a hot day and jumped into the water.
  - A couple rapidly exited the water screaming in unbelievable pain - they died shortly after.
  - It was not discovered until years later that the box jellyfish, sea wasp, or stinger existed - these deaths were subsequently linked to the box jellyfish, which is present in in-shore waters during the summer months.

# Causal Chains Involving Feedback

We have causal chains or feedback networks:

- In the playing of a professional-level team ball game such as World Cup rugby, the likelihood that one back line player successfully passes to another, even under moderate pressure expected in a finals game, can be estimated with confidence.

However, during a game the following happens:

- The first player, under pressure from the opposing team, fumbles the ball but just manages to pass to the second.
- The second player, under similar pressure is less likely to make a pass which will be successfully caught by the third, even though he successfully recovered the ball before passing.
- A third payer is even less likely to make a successful pass to a fourth.

# Causal Chain

Whilst the passing and catching of each player can be estimated with a high degree of confidence, the probability of a successful set of passes along the back line:

- should be the product of probabilities associated with the individual player's passing and catching skills, given:
  - probability of:
    - a successful pass is estimated to be 0.95
    - a successful catch is estimated to be 0.90

Success of manoeuvre described on the previous slide, when pressure from the defending side is low, is:

$$0.95 * 0.90 * 0.95 * 0.90 * 0.95 * 0.90 = 0.625 \quad (= 5/8)$$

This means that the team can expect this back line passing manoeuvre to work 5 out of every 8 times they attempt it.

# Causal Chain Involving Feedback

The situation changes when the back line is under pressure:

- Each play will be affected to the extent that each player feels pressured or perceives his team mates' skills are affected by the pressure applied by the presence of the opposing team's attack. Assume a 10% reduction in performance in passing or catching occurs as a result of this pressure, or perception of pressure. Here perception of pressure involves a feedback mechanism, affecting the individual player. The probability of successful back line passing would become:

$$(0.95*0.90)*(0.90*0.90)*(0.95*0.90)*(0.90*0.90)*(0.95*0.90) \\ *(0.90* 0.90) = 0.33$$

- In contrast to the previous example, 1 out of every 3 times that the team attempts this manoeuvre under pressure can they expect it to work.

# Indeterminate Causal Chains

We have indeterminate causal chains:

- In 2000, a Concorde aircraft taking off from Paris:
  - struck debris on the runway
  - pieces of a damaged wheel and tyre punctured a fuel tank, located in the wing of the aircraft
  - leaking fuel trailing behind the wing caught alight
  - the burning aircraft flew out of control and crashed
  - all aboard and several people on the ground were killed
- To hypothesise that these people on the ground might have been killed by a crashing Concorde, brought to the ground because it struck pieces that fell off another aircraft was indeterminate, and would have been seen as fanciful.

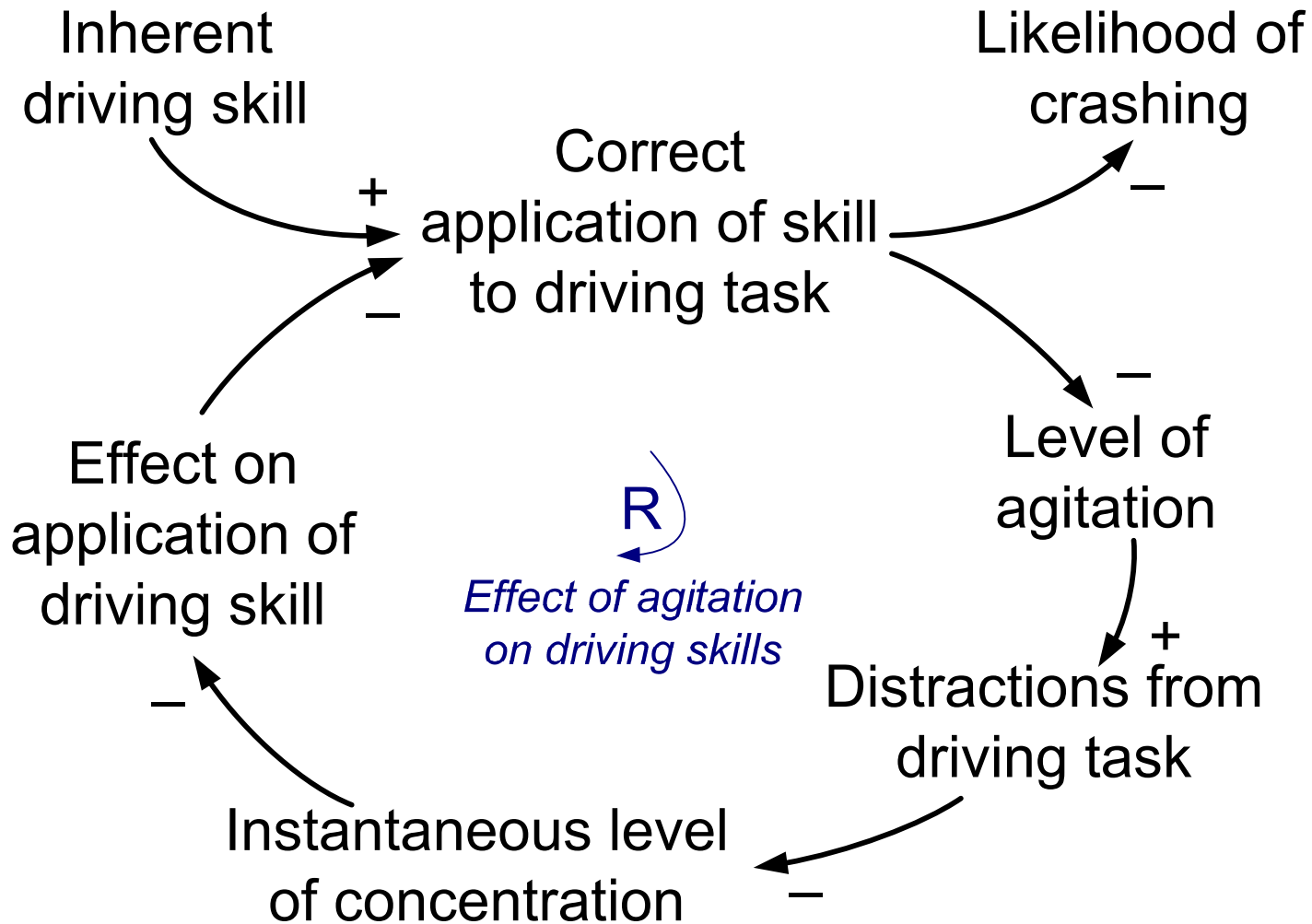
# Another Causal Chain Involving Feedback

A rally driver underestimates his speed coming into a sharp corner on loose gravel;

- The driver successfully corrects the resultant slide, becomes agitated by the near miss, briefly argues with the navigator.
- The driver continues even more determined – now he has to make up for lost time.
- Still somewhat agitated, the driver responds indecisively to the navigator's calls, entering a subsequent corner at excessive speed. This time he does not have sufficient time to correct the sideways skidding of the car.

Here, the driver's attention is reduced by the level of his own agitation as shown in the following causal loop diagram. In this case the causality produces a vicious cycle.

# Causal Feedback Networks



Likelihood of crashing does *not* remain constant

# Open Causal Networks Hospital Implosion

“... it was only at the last minute when they were on their way home from Mass that the Bender family decided to stop by lake Burley Griffin to watch the implosion of the city’s historic hospital. They took up a vantage point 480 metres away from the site, but 12-year-old Katie Bender was hit by debris and killed instantly. Now the city wants to know how a seemingly straightforward demolition job could go so wrong, so wrong that ... ended with bricks and steel raining down on spectators injuring nine and killing one young girl who was watching from an apparently safe distance.”

# ROYAL CANBERRA HOSPITAL IMPLOSION: VIDEO

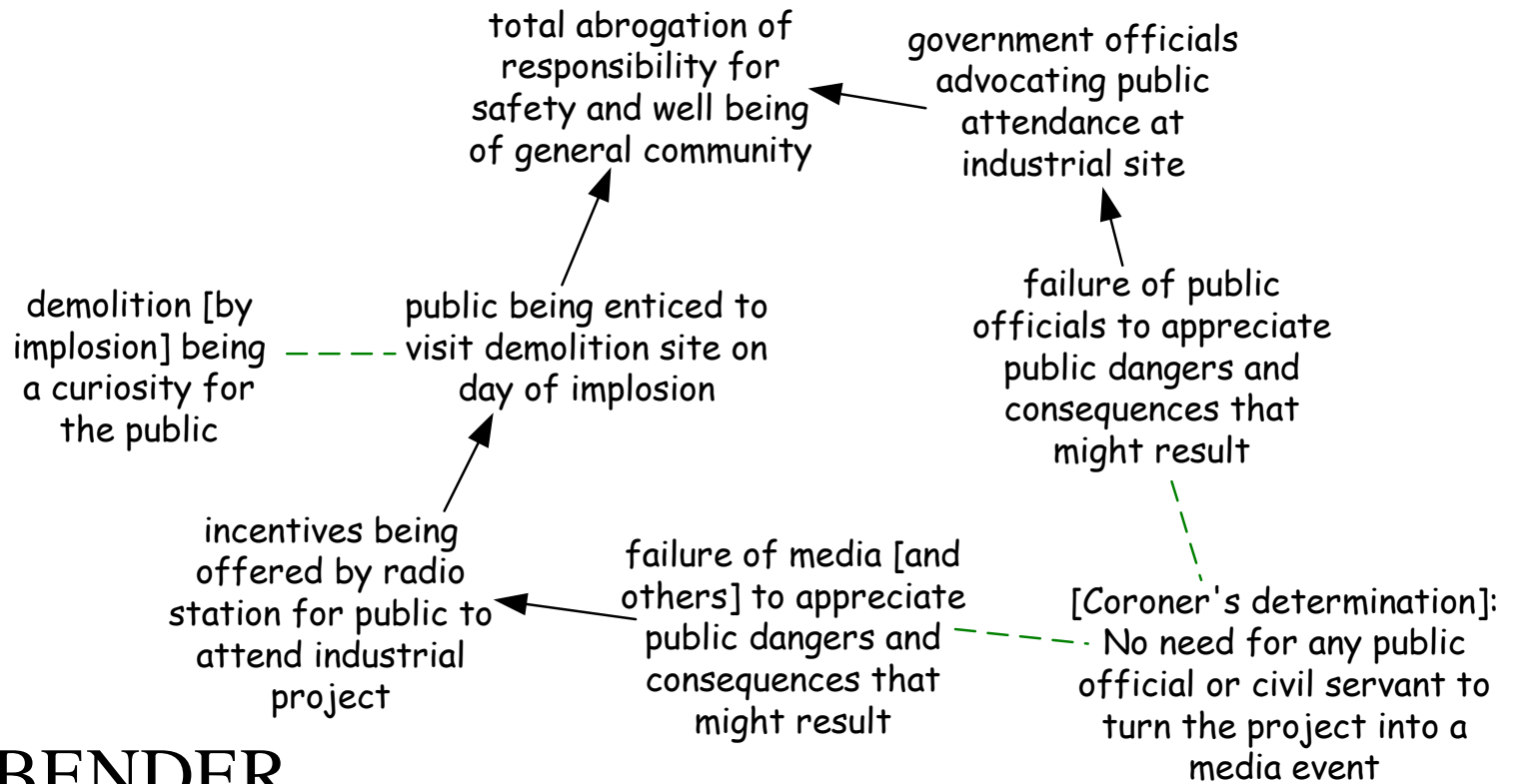
ABC TV: 7: 30 Report

# Open Causal Networks Hospital Implosion

Analysis of the Coroner's report tells a very interesting story about risks involved in the demolition by the chosen method of implosion.

The Coroner concluded, *inter alia*, that as this project developed, as long as one to two years before the day of the implosion, a reasonable person, an intelligent non-expert, having seen what was developing should have been very nervous about this project. Further there were many occasions when the project should have been stopped, on risk and safety grounds, but it was not.

McLucas, AC., 2003, 'Decision Making: Risk Management, Systems Thinking and Situation Awareness', Argos Press, Canberra, pp 69-101.



# KATIE BENDER

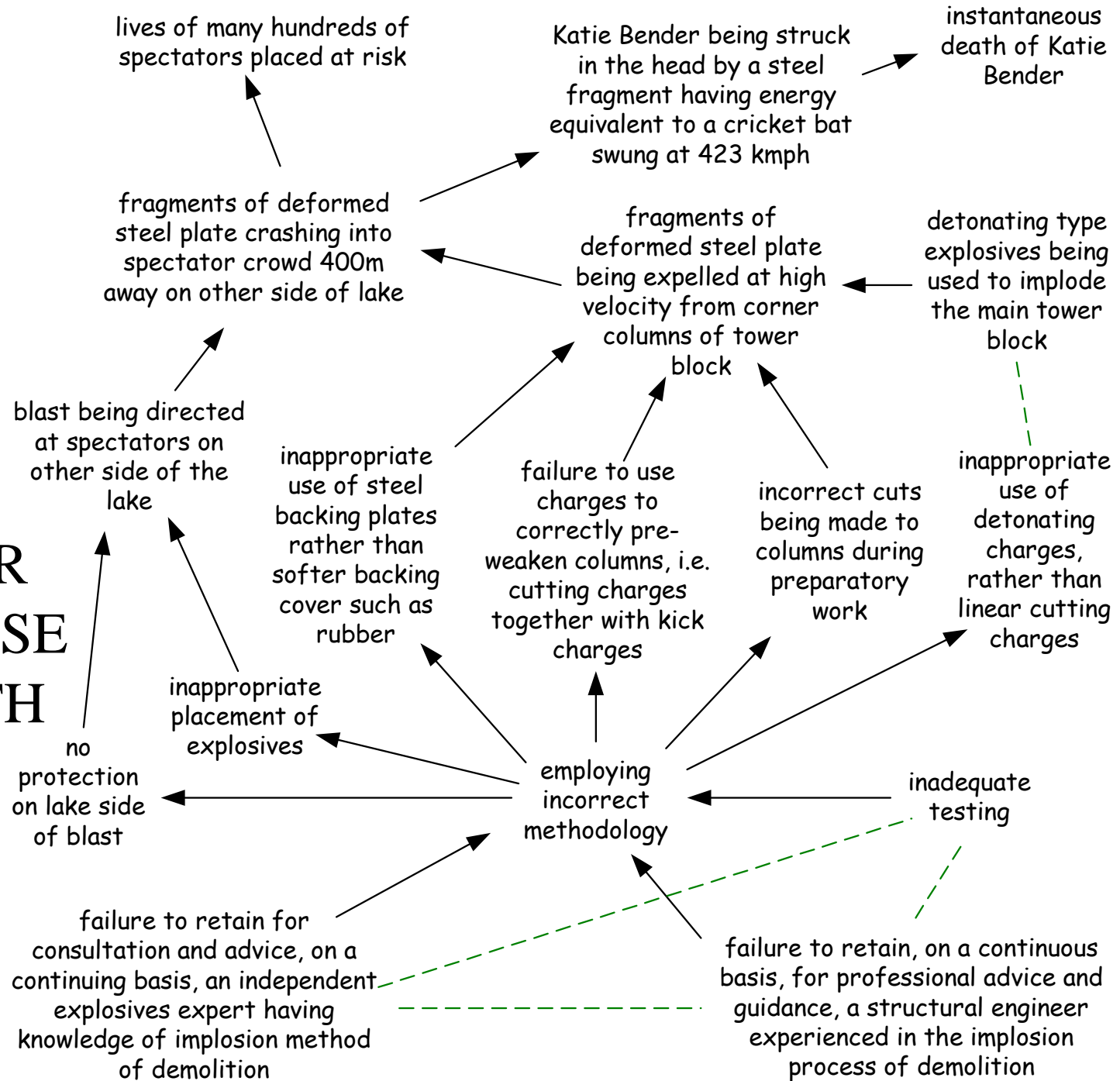
## INQUEST – CORONER'S EXECUTIVE SUMMARY

[Coroner's determination]:  
demolition [and demolition site] are the preserve of those [qualified and] with demolition expertise

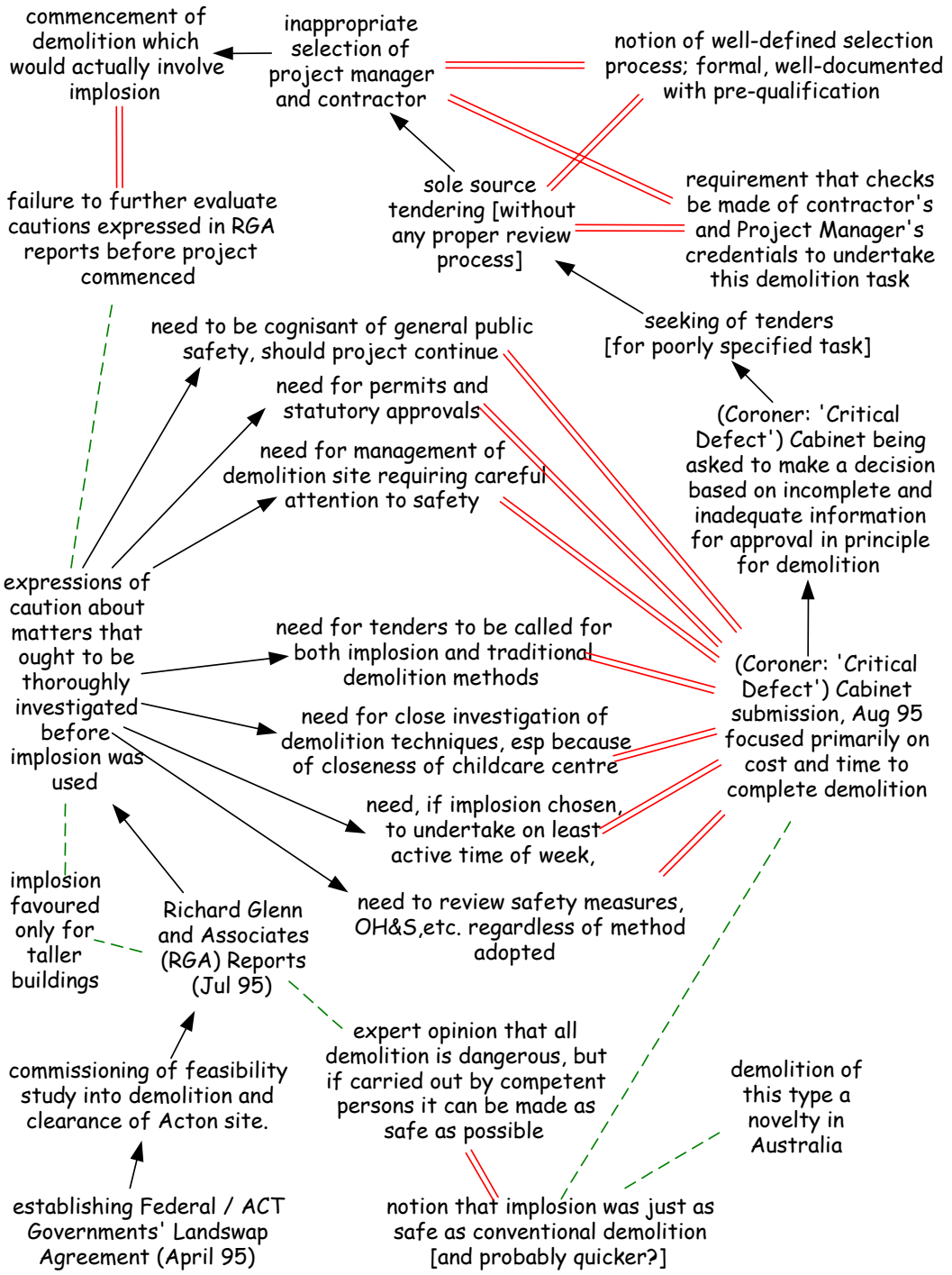
[Coroner's determination]:  
Acton peninsular was a construction and demolition site [by definition]

[Coroner's determination]: No need for any public official to become involved where heavy machinery operated, explosives were used and industrial activities tool place

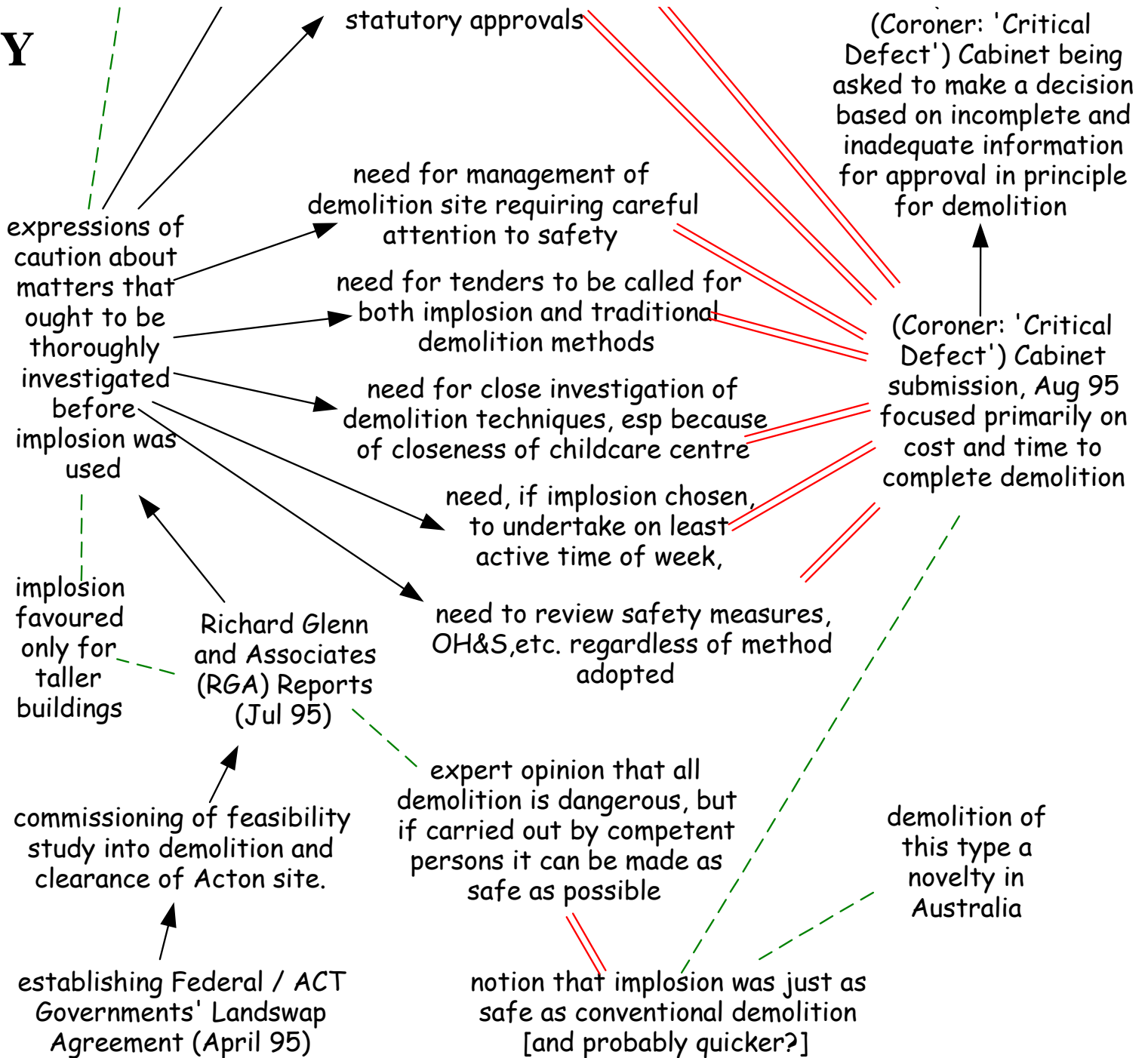
# MANNER AND CAUSE OF DEATH



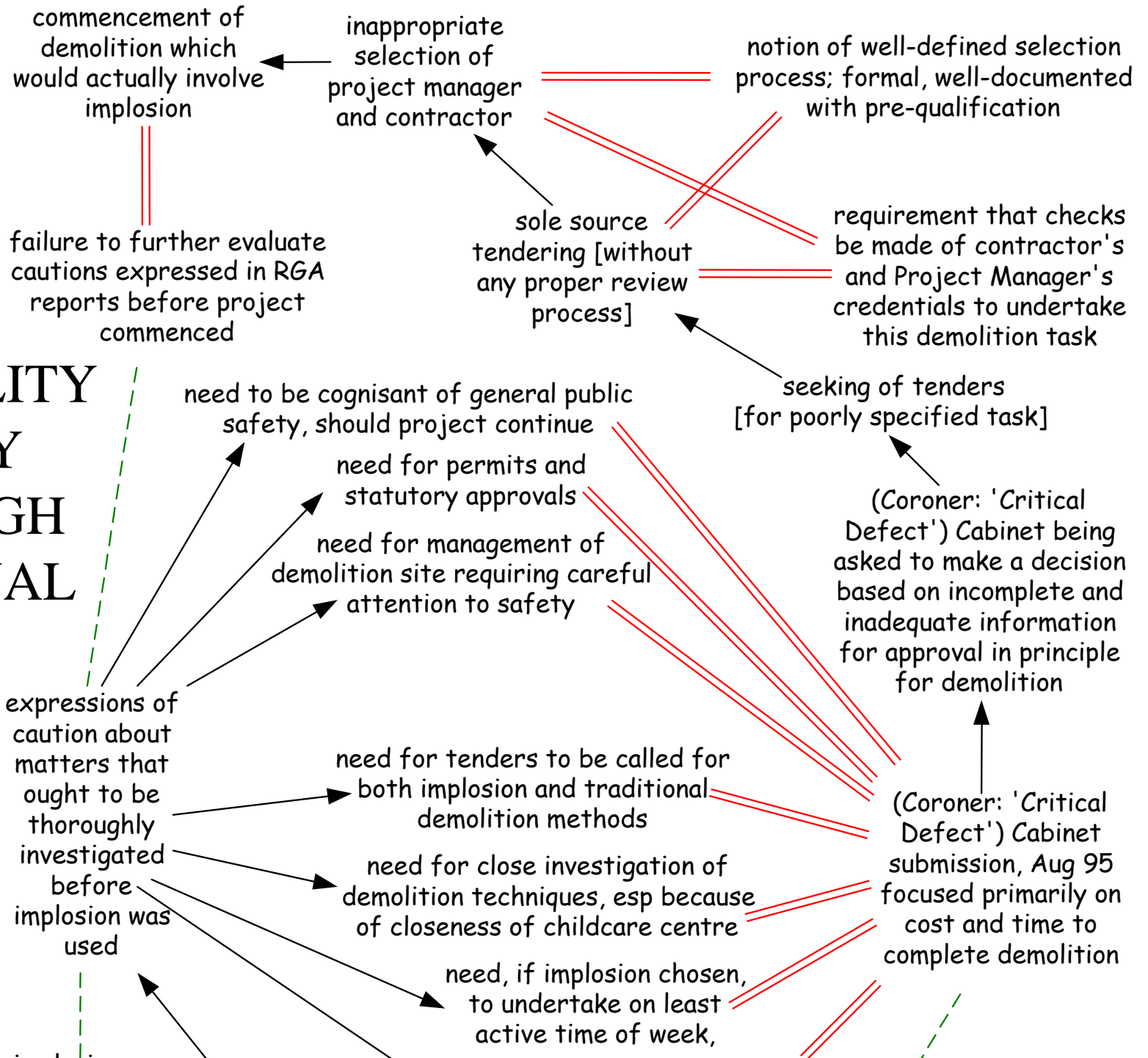
# FEASIBILITY STUDY THROUGH APPROVAL



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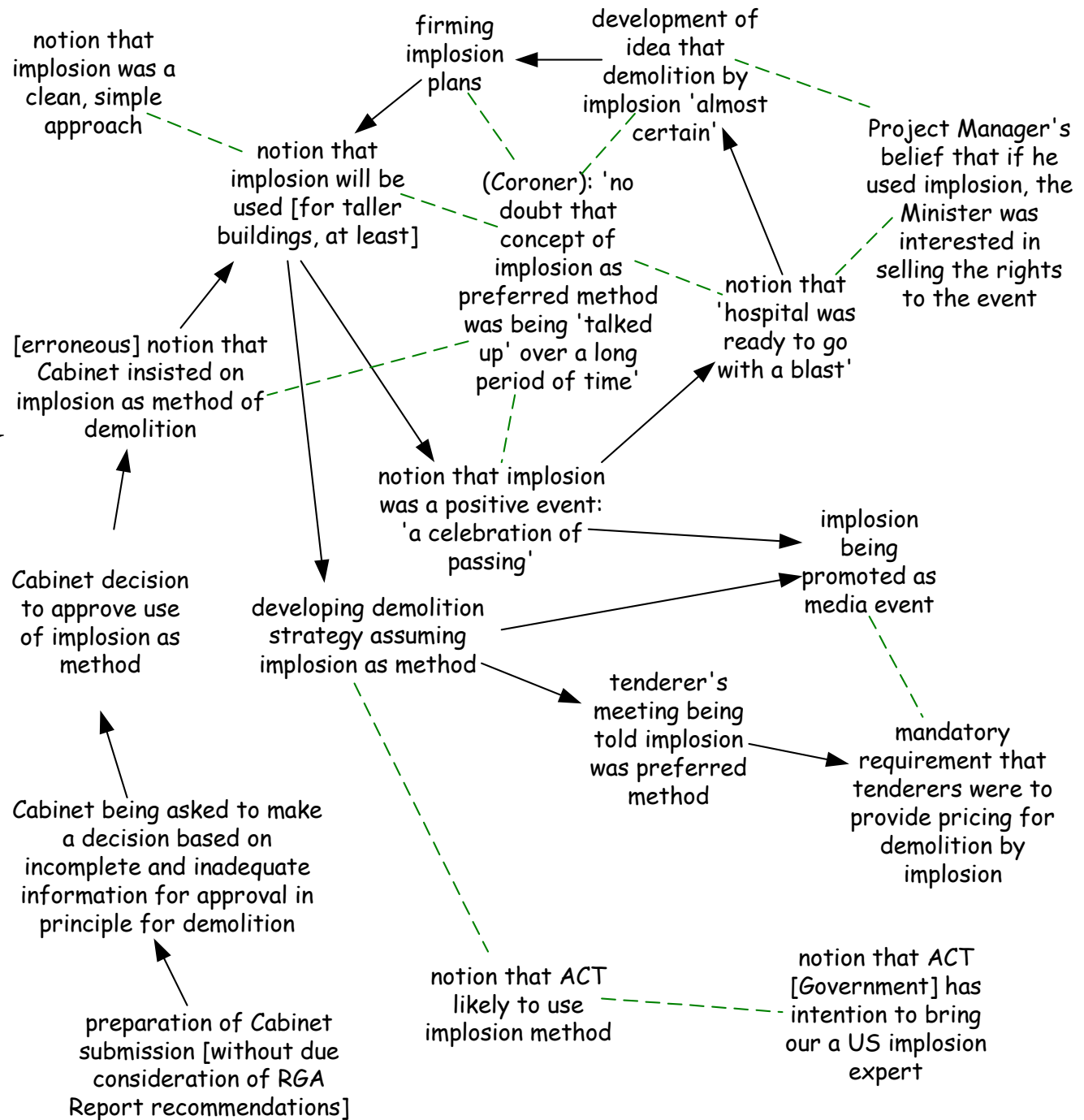


# FEASIBILITY STUDY THROUGH APPROVAL

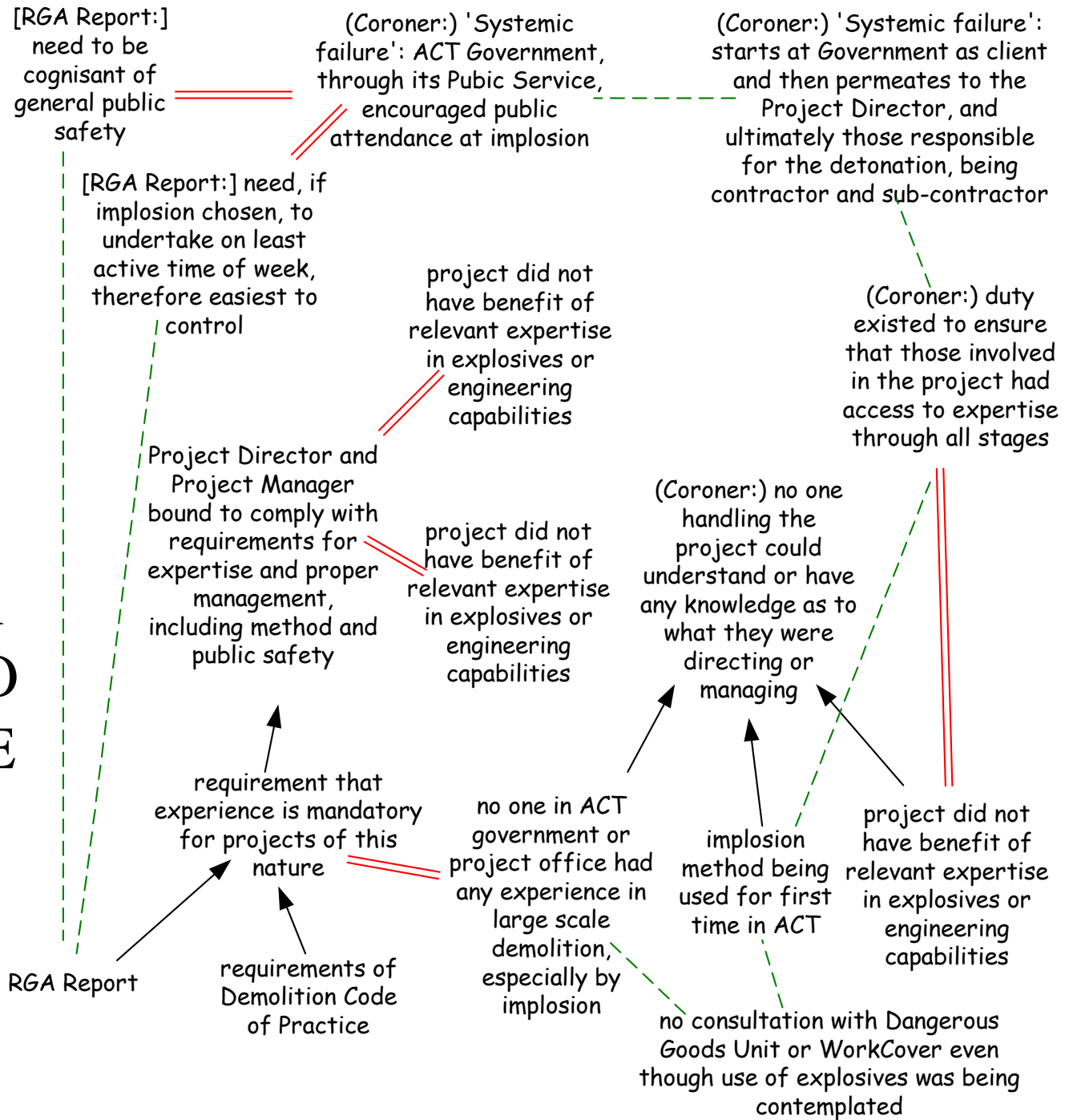




# SETTLING ON IMPLOSION AS METHOD OF DEMOLITION



# NEED FOR ACCESS TO EXPERTISE



(Coroner:) 'Chain of Procedural Deficiencies' - failure on the part of everyone present - if proper efforts had been made to check these people were competent and qualified, they would have never been given the job

actions of contractor and explosives expert contributing to death of Katie Bender

actions of contractor and explosives expert placing hundreds of the public at risk

'rubber stamping' of recommendations made by Project Director re tender selection

contractor and explosives expert undertaking implosion task for which they were entirely unqualified

Project Director's failure overall to manage the project and ensure contractor and sub-contractor met obligations of the contracts

Project Director and Project Manager legally obligated to see potential contractor was, in fact, competent

questionable recommendation of non-compliant bidder of dubious competence

rejection without consideration of all others bids

requirement of RGA Report for Project Director to 'fully canvass implosion method'

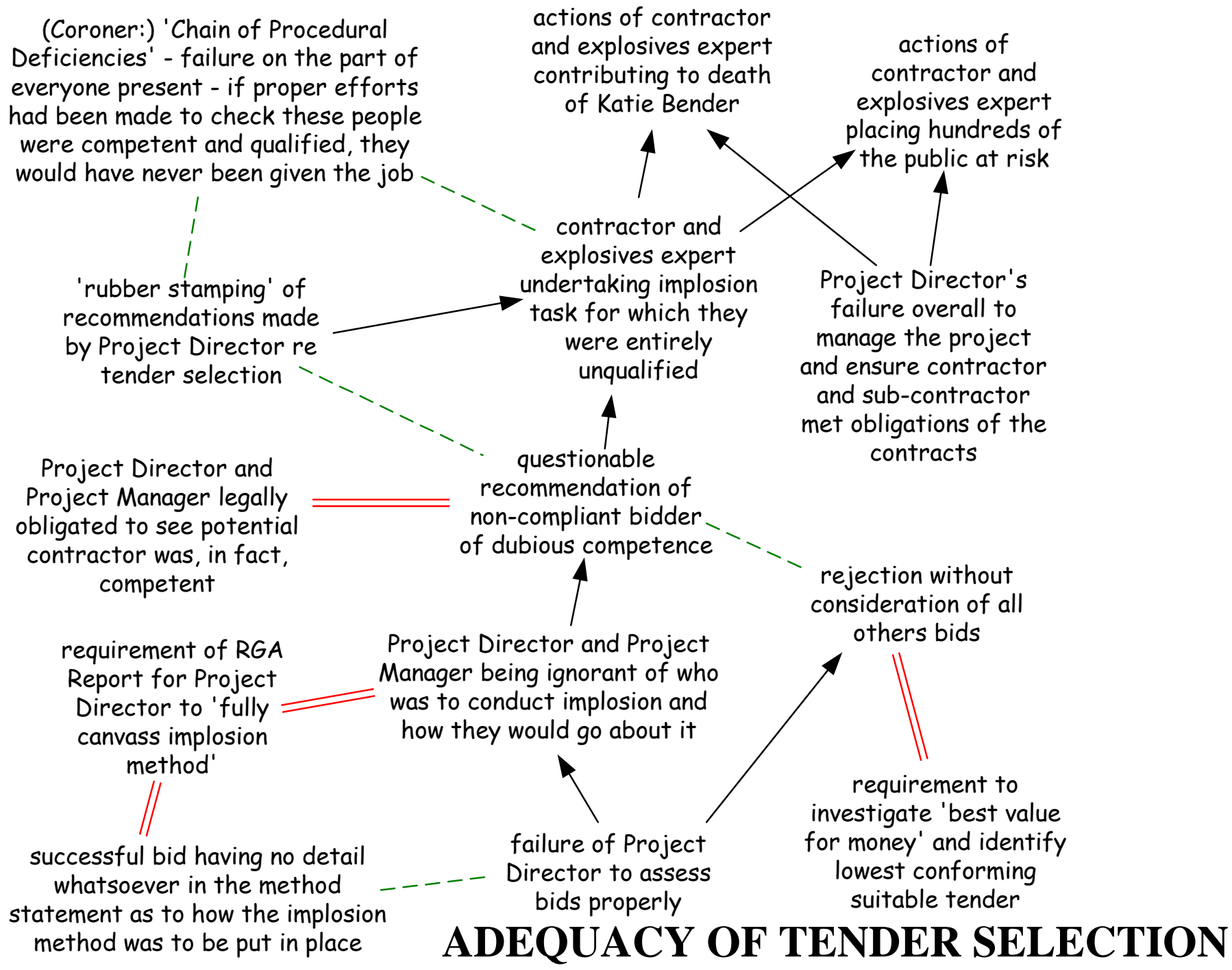
Project Director and Project Manager being ignorant of who was to conduct implosion and how they would go about it

requirement to investigate 'best value for money' and identify lowest conforming suitable tender

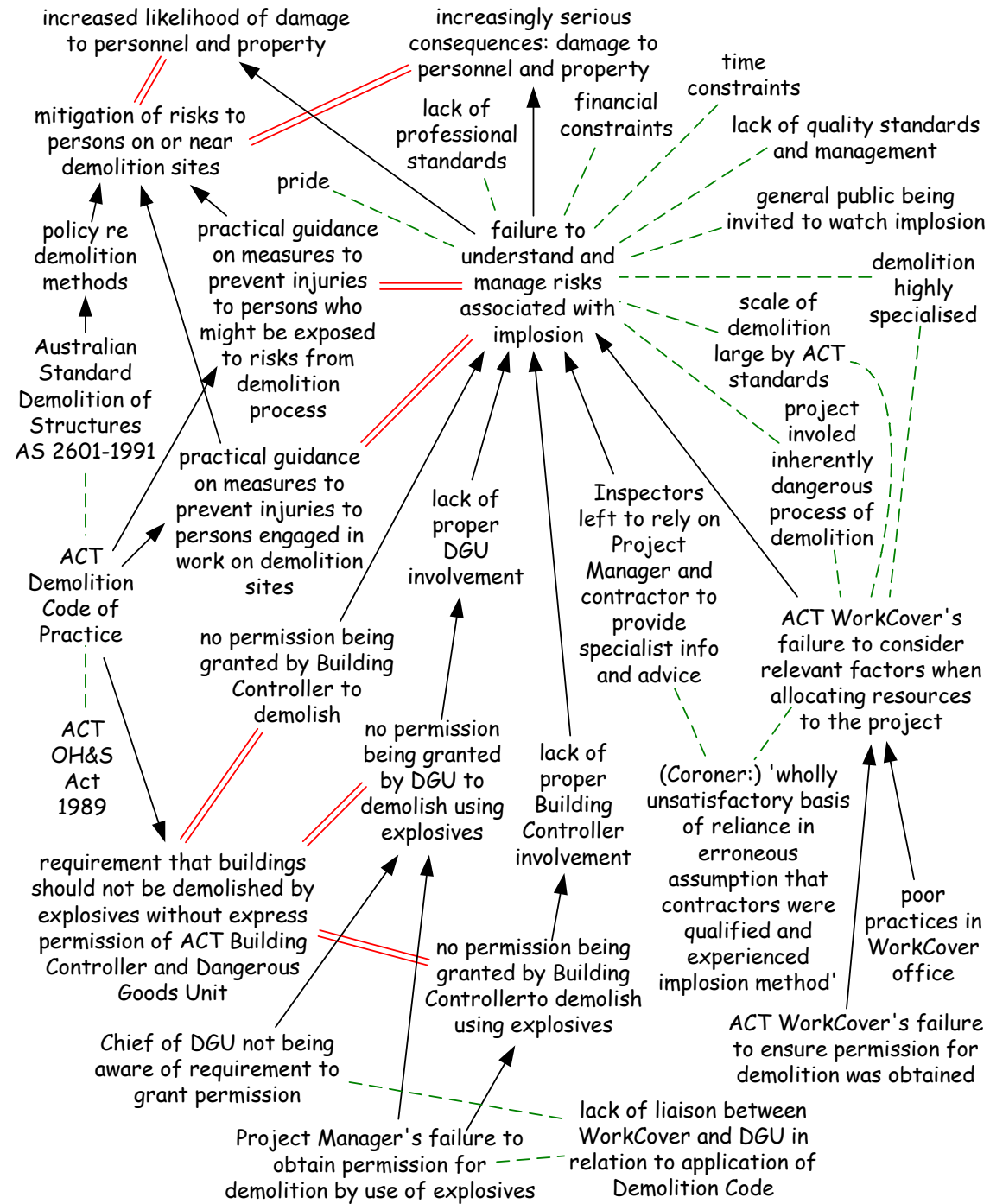
successful bid having no detail whatsoever in the method statement as to how the implosion method was to be put in place

failure of Project Director to assess bids properly

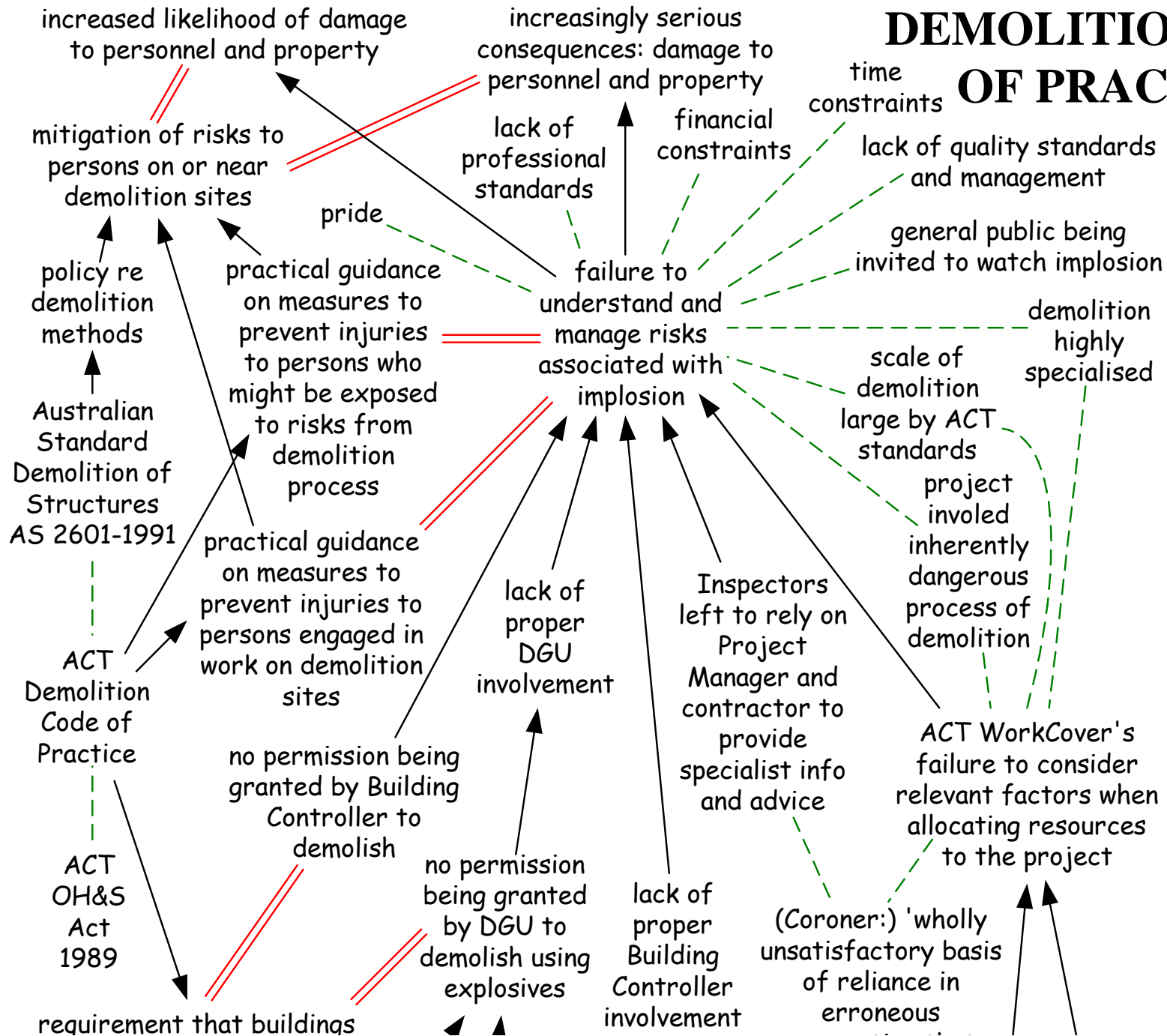
# ADEQUACY OF TENDER SELECTION



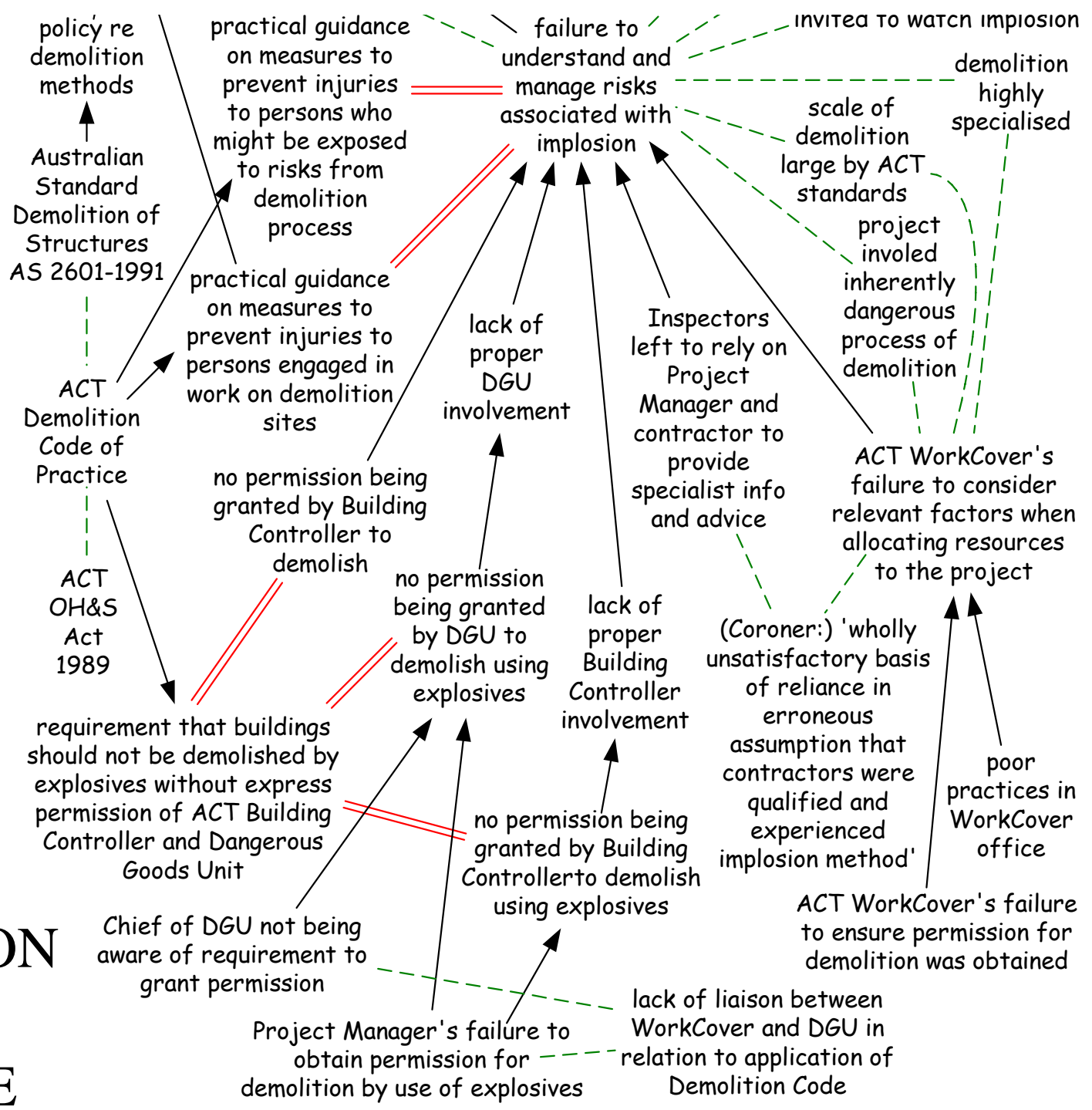
# DEMOLITION CODE OF PRACTICE

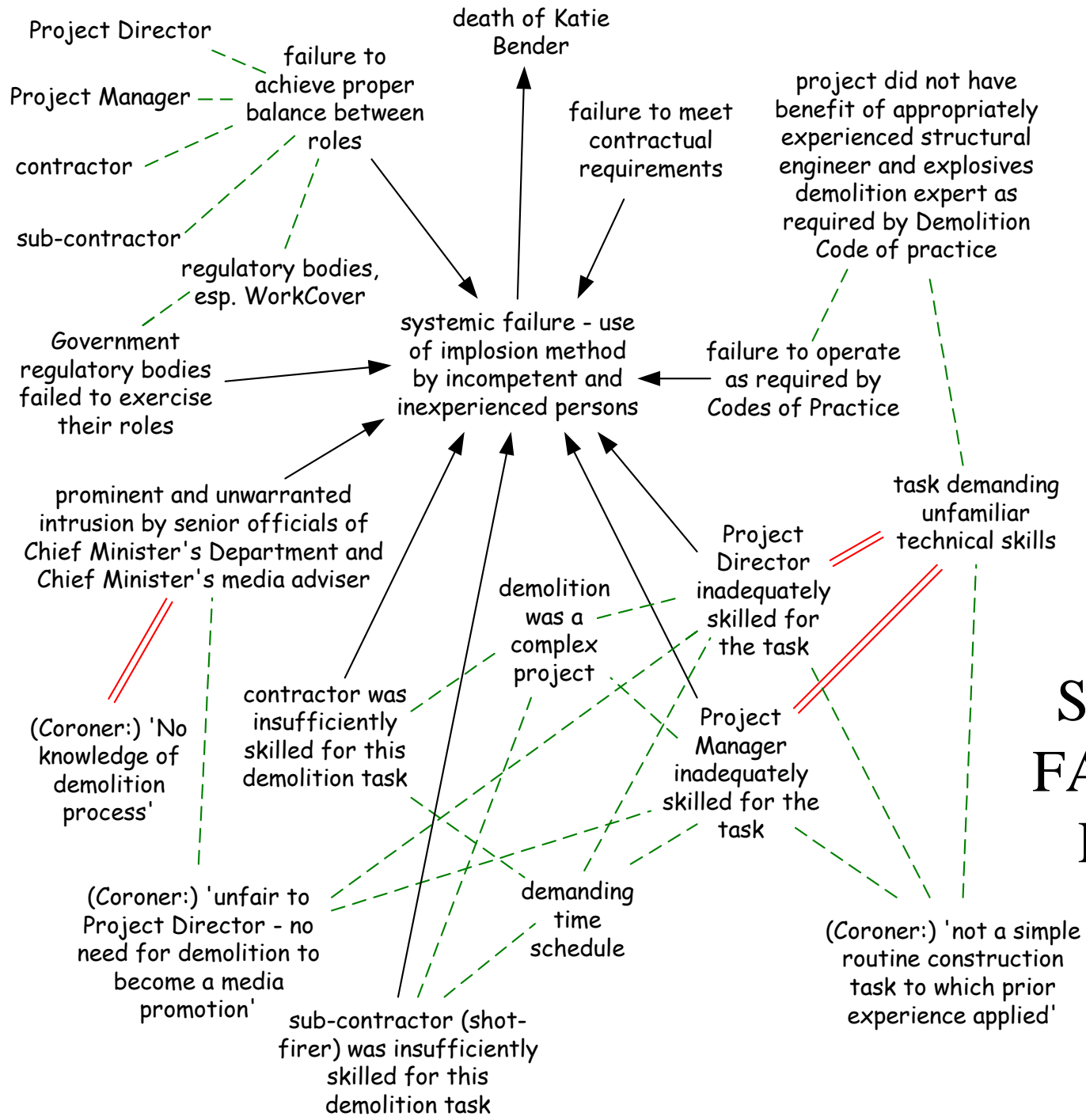


# DEMOLITION CODE OF PRACTICE



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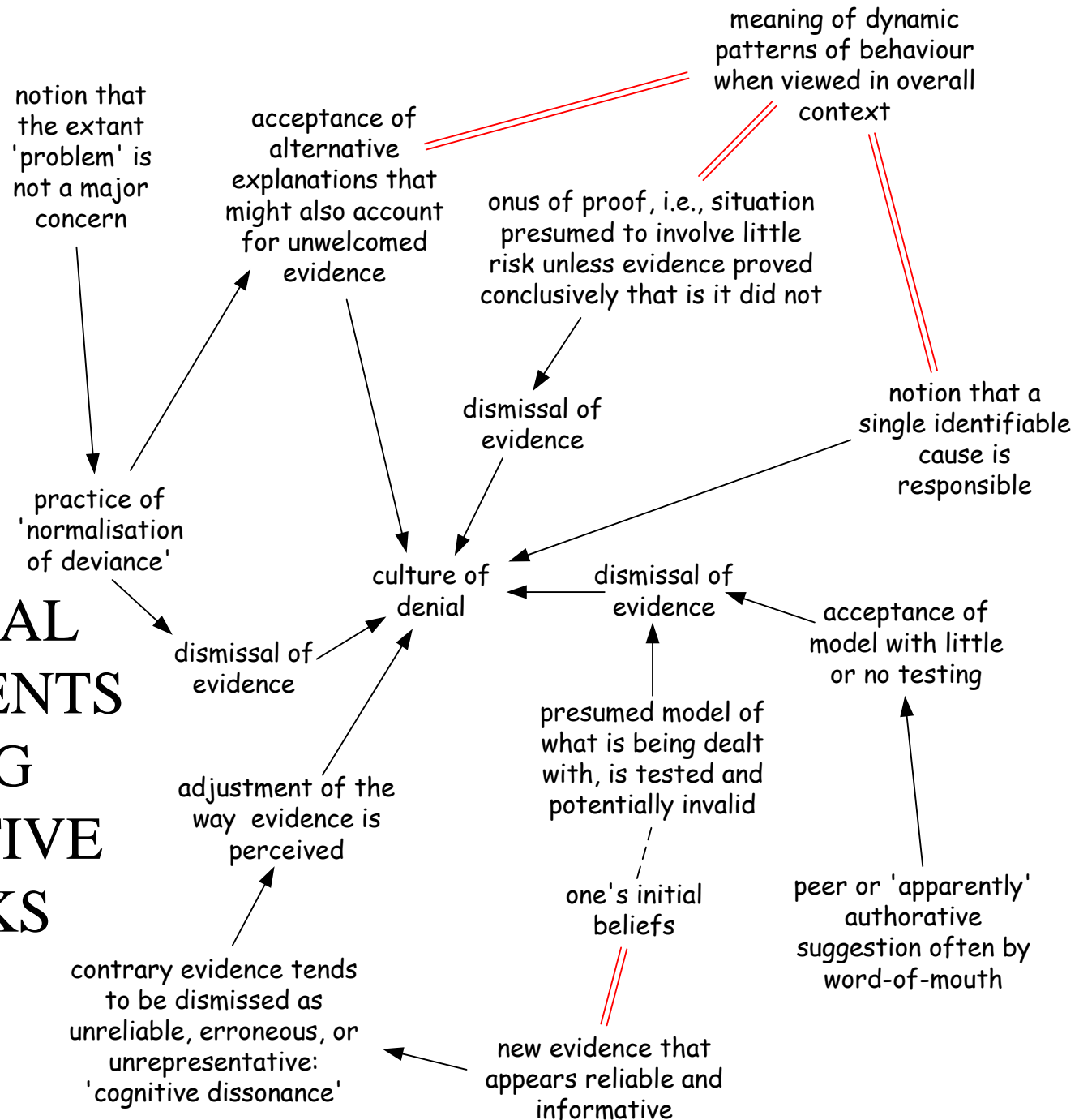




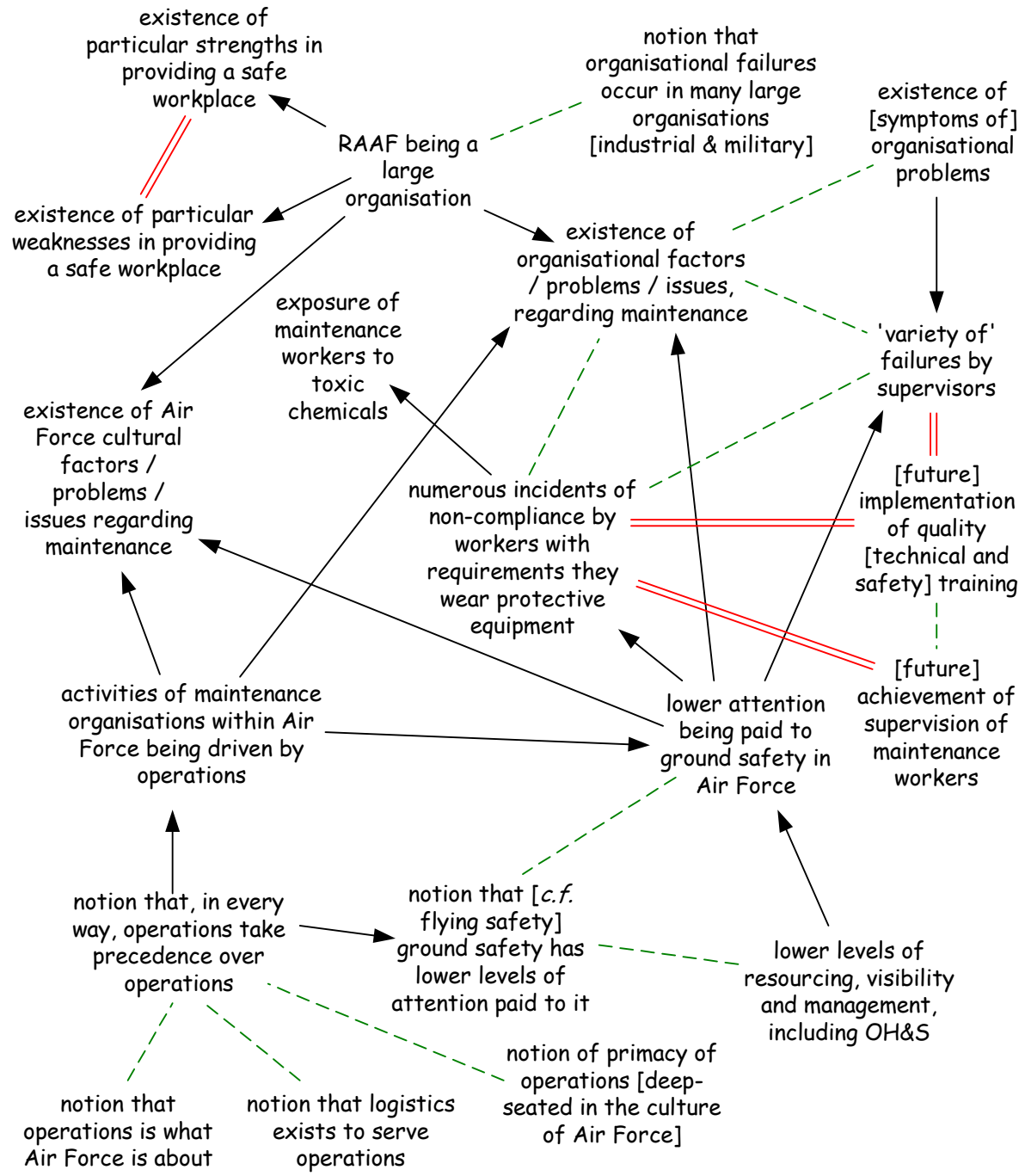
# SYSTEMIC FAILURE OF PROJECT



# CULTURAL IMPEDIMENTS – BEING INSENSITIVE TO RISKS



# ORGANISATIONAL ISSUES F-111 FUEL TANK DESEAL / RESEAL BOARD OF INQUIRY

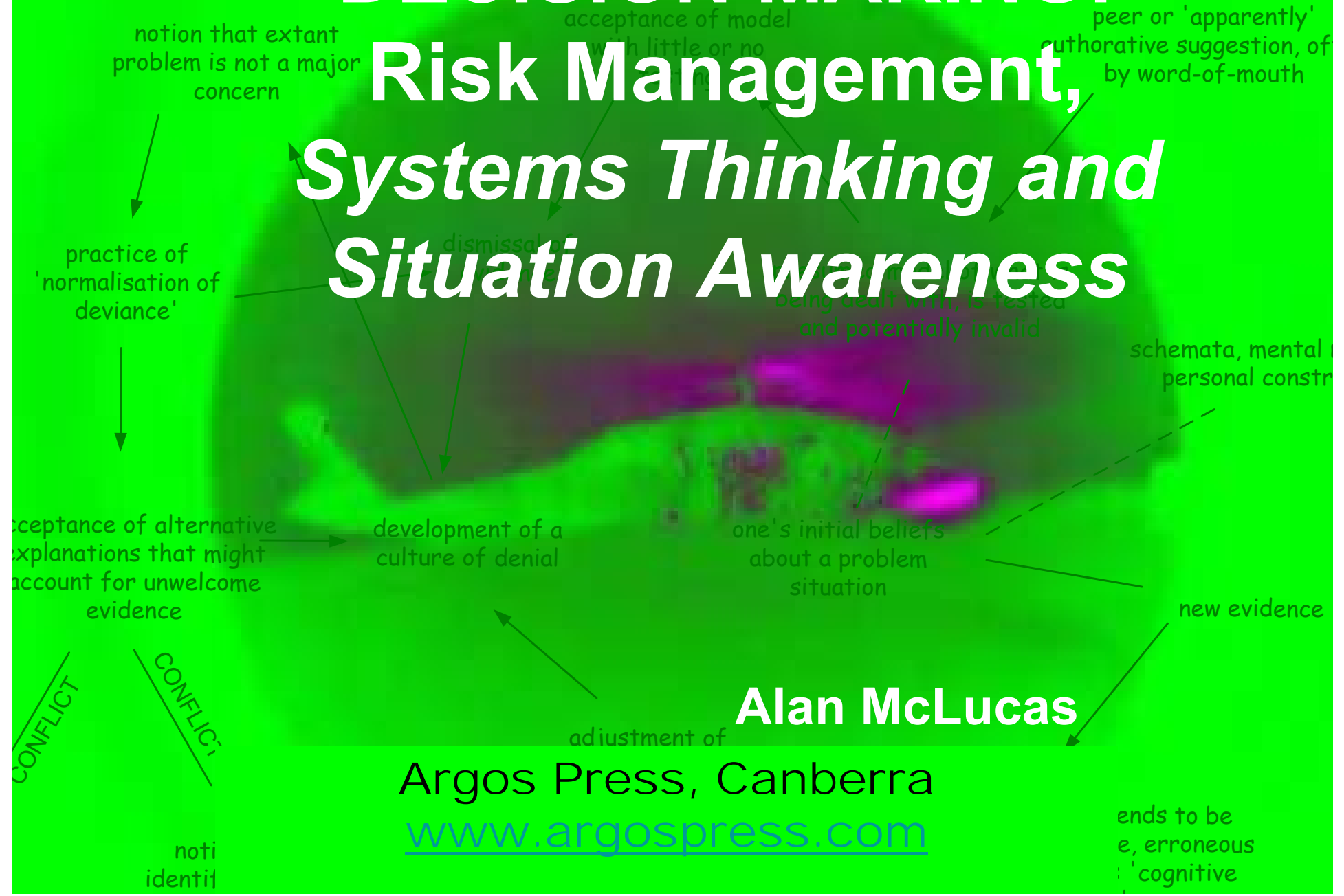


# Risk Management Paradox

The task of managing risks is confounded by a classical paradox:

- If risks are being managed as a matter of routine, there will be very few surprises.
- Nobody becomes aware of just how effective careful risk management actions have proven to be:
  - Nobody slaps you on the back and congratulates you for a job well done
  - In stark contrast, however, if risks are poorly managed, the whole world lines up to tell you so.
- While there is little or no kudos to be gained by being an effective risk manager, poor risk management is certain to result in failure.

# DECISION MAKING: Risk Management, *Systems Thinking and Situation Awareness*



# **SYSTEMS THINKING AND DECISION MAKING:**

## **RISK MANAGEMENT AND SITUATION AWARENESS**

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