The Developments in a Rational Approach to Risk:

A Practitioner's View over 45 Years

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The Development of a Rational Approach to Risk 1

- This paper seeks to trace the development in the use of Risk Analysis, based on my experience over the past 45 years.

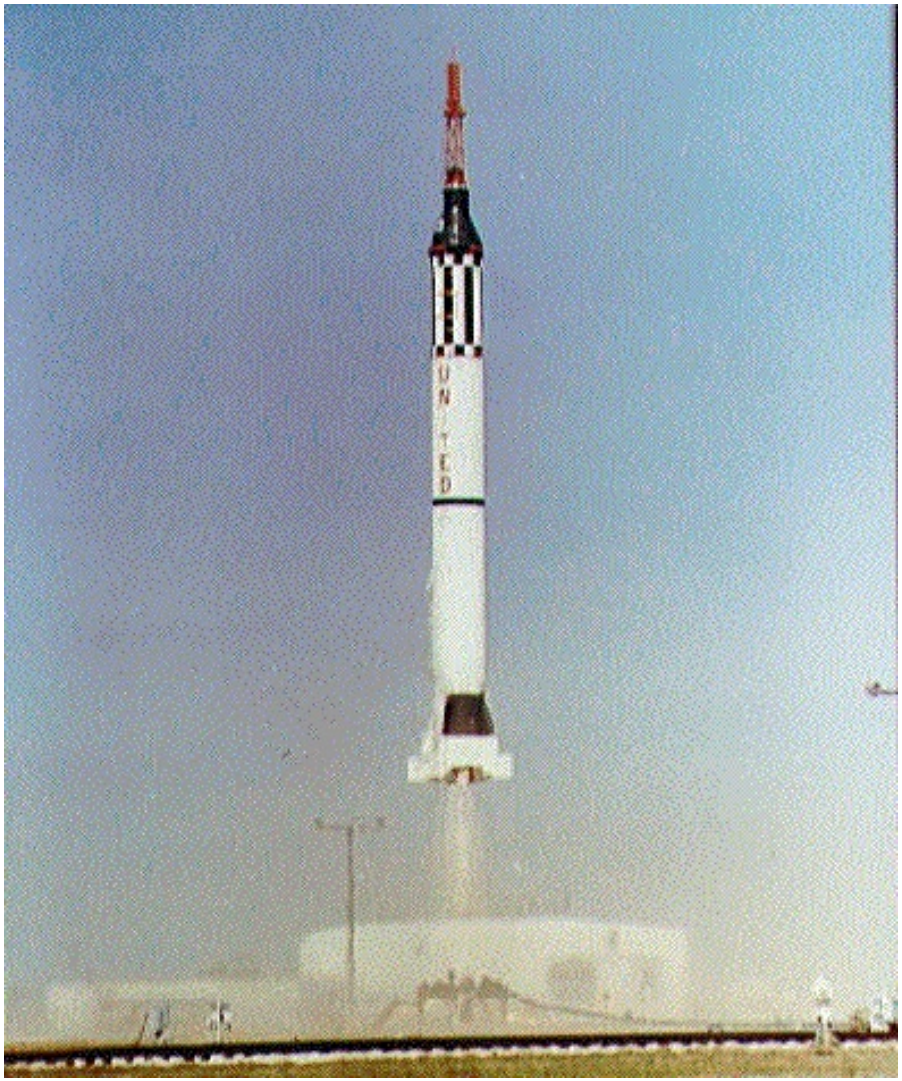
- My paper ranges from risk, perceived and actual, in the aerospace, nuclear and petrochemical field to sectors as wide-ranging as mass transport and environmental risk. These High Hazard Industries have led the use of RA.

The Development of a Rational Approach to Risk 2

- The use of Risk Analysis in a formal sense has developed rapidly over the last 25 years.
- Its use has migrated from the so called “High Hazard Industries” to far wider field.

- The issues this paper addresses include:
- How has the use of QRA changed in the past 40 years?
- Is QRA an aid or hindrance to a rational approach to RISK?

Risk Analysis – the early years 1960's



Source: http://history.nasa.gov/SP-4001/images/fig51.jpg

- Who was using Risk Analysis 45 years ago?
- NASA:
  - Mercury project 1960 1st US manned orbit
  - One of the first aerospace projects to use these techniques

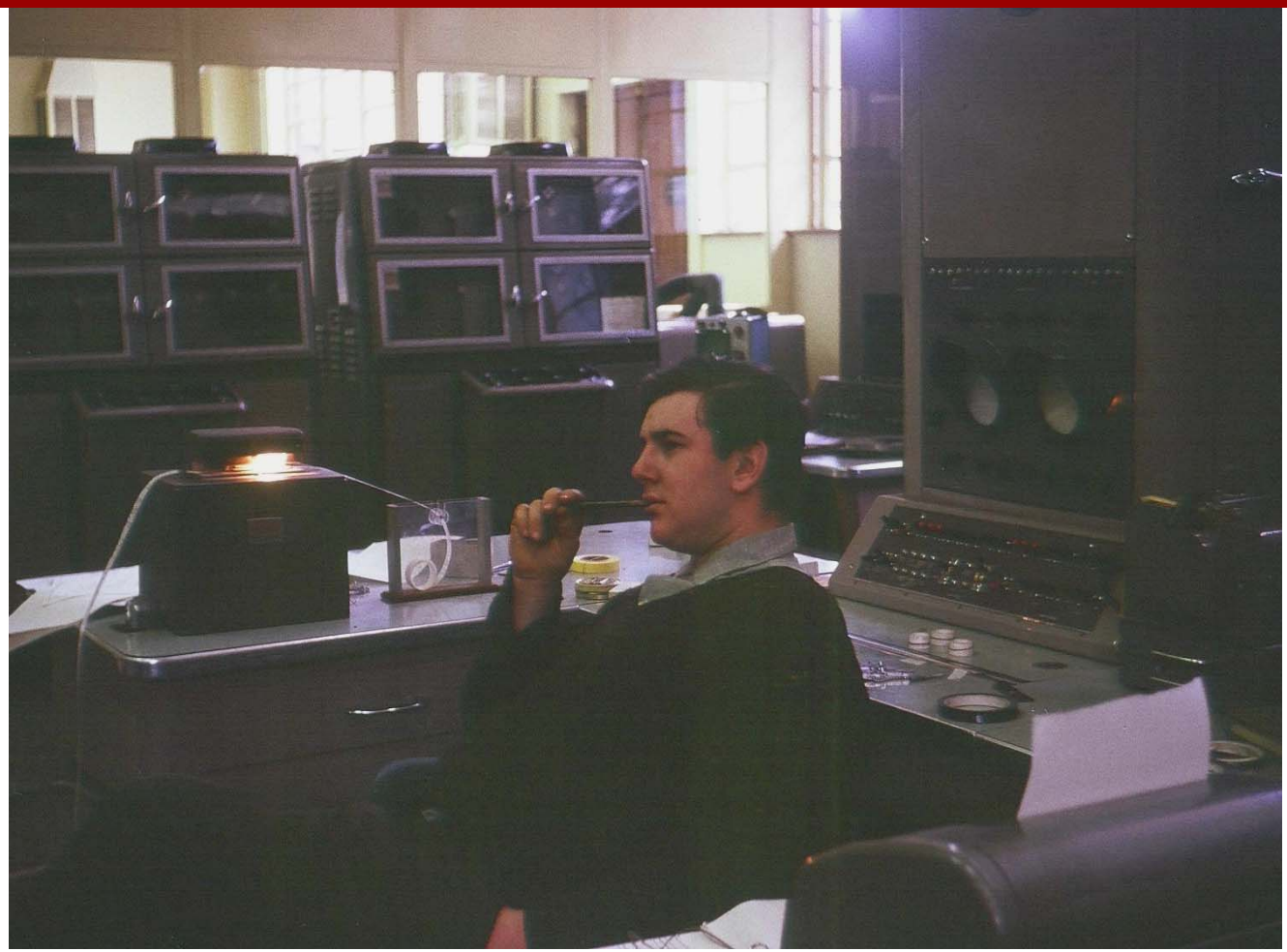
Aviation at the same time?

VC10 first flight 1962

As I saw it back in the sixties, there was little formal assessment of risk in aircraft design

- Safety and quality control was paramount
- Standards were high
- Extensive prototype testing was done
- Computing power was minimal

Computing in the 1960s: Pitiful Power, Huge Space



- How the world has changed in the past 40 years!

A Ferranti Pegasus Computer in BAC 1963

One of four such computers in the UK at that time.

The changing world - Hong Kong circa 1959

The changing world - Hong Kong circa 1985

The changing world - Hong Kong 2003

Definition of a Rational Approach to Risk Analysis

- Risk Analysis has been defined by Jones as:

  'the quantified evaluation of the likelihood of undesired events and the likelihood of harm or damage being caused together with the value judgements made concerning the significance of the results.'

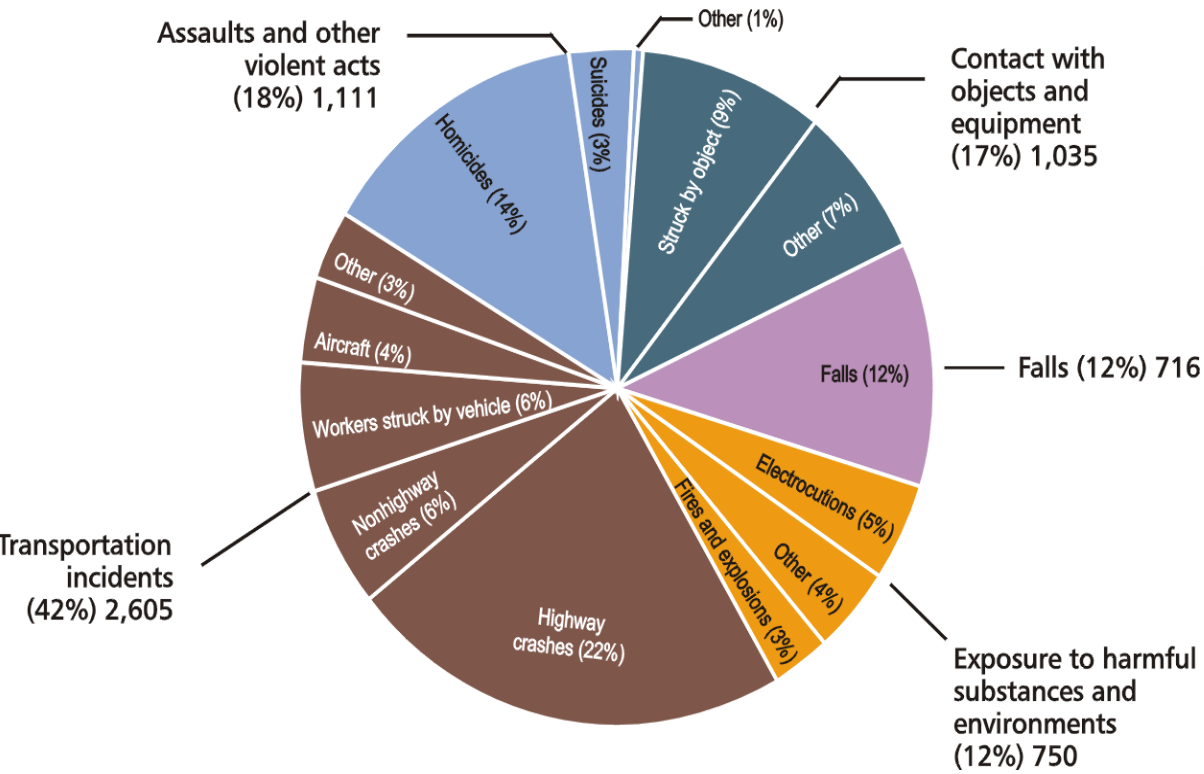
Source: D.A. Jones, D.A. (ed.), *Nomenclature of Hazards and Risk Assessments in the Process Industries*, Institute of Chemical Engineers, 1992

Definition of a Rational Approach to Risk Analysis

- My concept of a **rational** approach to risk analysis relates to the quality of value judgements made by the *significant use of the results* by authorities, government or other regulatory bodies —
- In other words, using a rational basis for making judgements as to how best to use limited resources.

High Risk Industries? Reality and perception:

Perceived: Pilots, Offshore, PetroChem, Military, fishing.



Actual:

In USA: Mining, farming, forestry, fishing & construction. With 60% fatalities from transport accidents & homicides.

In EU: Construction, Farming, Transport, Manufacturing & Utilities

Sources: **U.S. Department of Labor Bureau of Labor Statistics** **HSE Statistical Hilights2003/4**

Power without Authority: drivers to irrationality

- Opinions are formed, and views expressed, by opinion shapers – often without much rational basis.

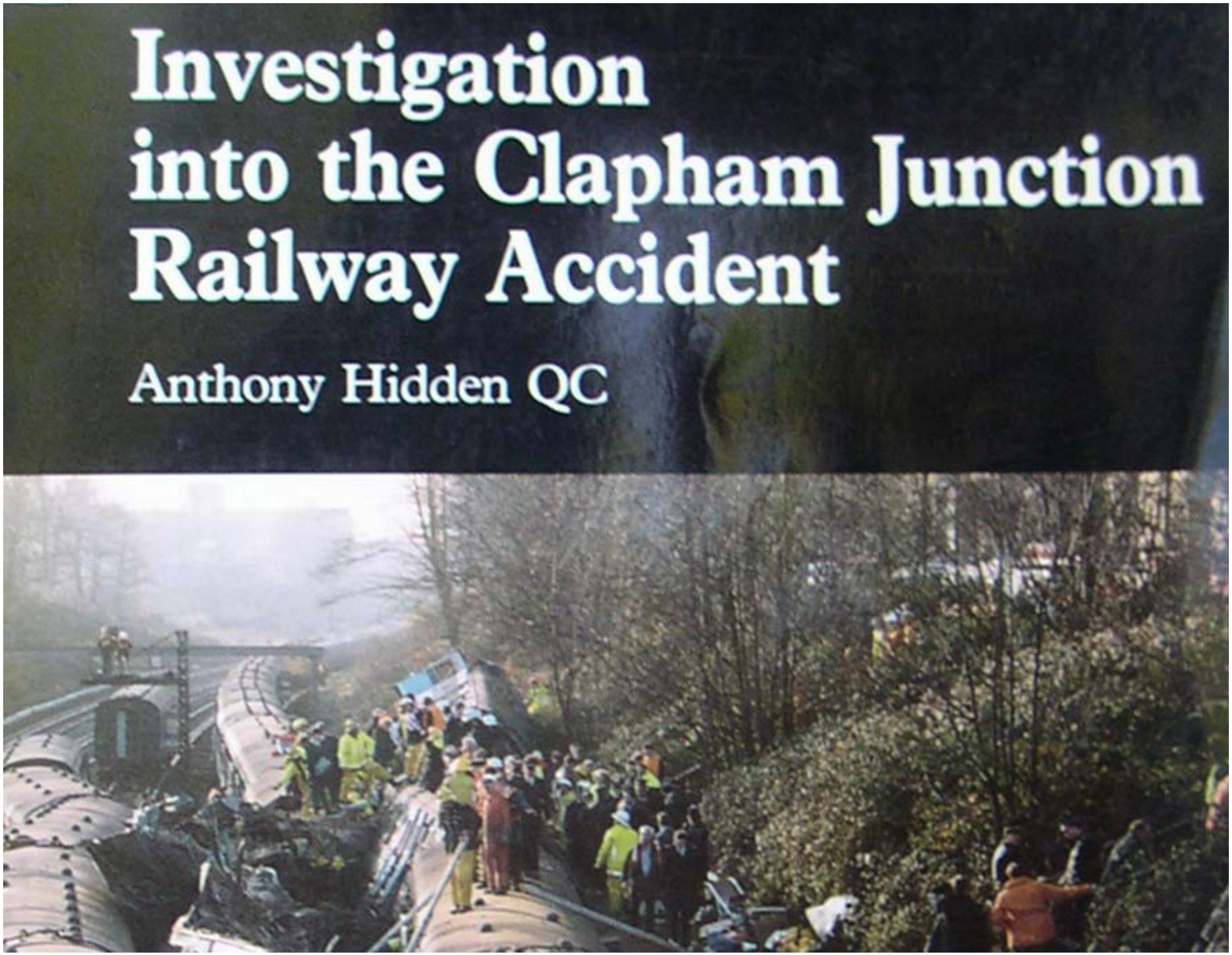
- Reaction to RISK by those in authority: governments, regulators, and power wielded by elements of the media who, as Baldwin put it, have power without authority all form part of the equation.

- We must draw a distinction between formalised "Risk Analysis" and the risk analysis by practiced every one in decision making on a minute-by-minute basis.

CASE STUDY: 1980s Irrational Actions 1

- Clapham Junction London.
- This 1988 railway accident involved three commuter trains and the death of 35 people and the injury of 500.
- The public inquiry held resulted in 93 recommendations, most of which were rational and constructive.
- Potentially the most costly recommendation required the implementation automatic train protection system (ATP) across 30% the UK rail network

CASE STUDY: 1980s Irrational Actions 2



CASE STUDY: 1980s Irrational Actions 3

- There were two reasons to question the validity of this recommendation.

- Firstly, even if all the trains involved in this accident had been fitted with state of the art ATP, the accident would still have occurred due to a human error fault induced into the signalling system during upgrading .

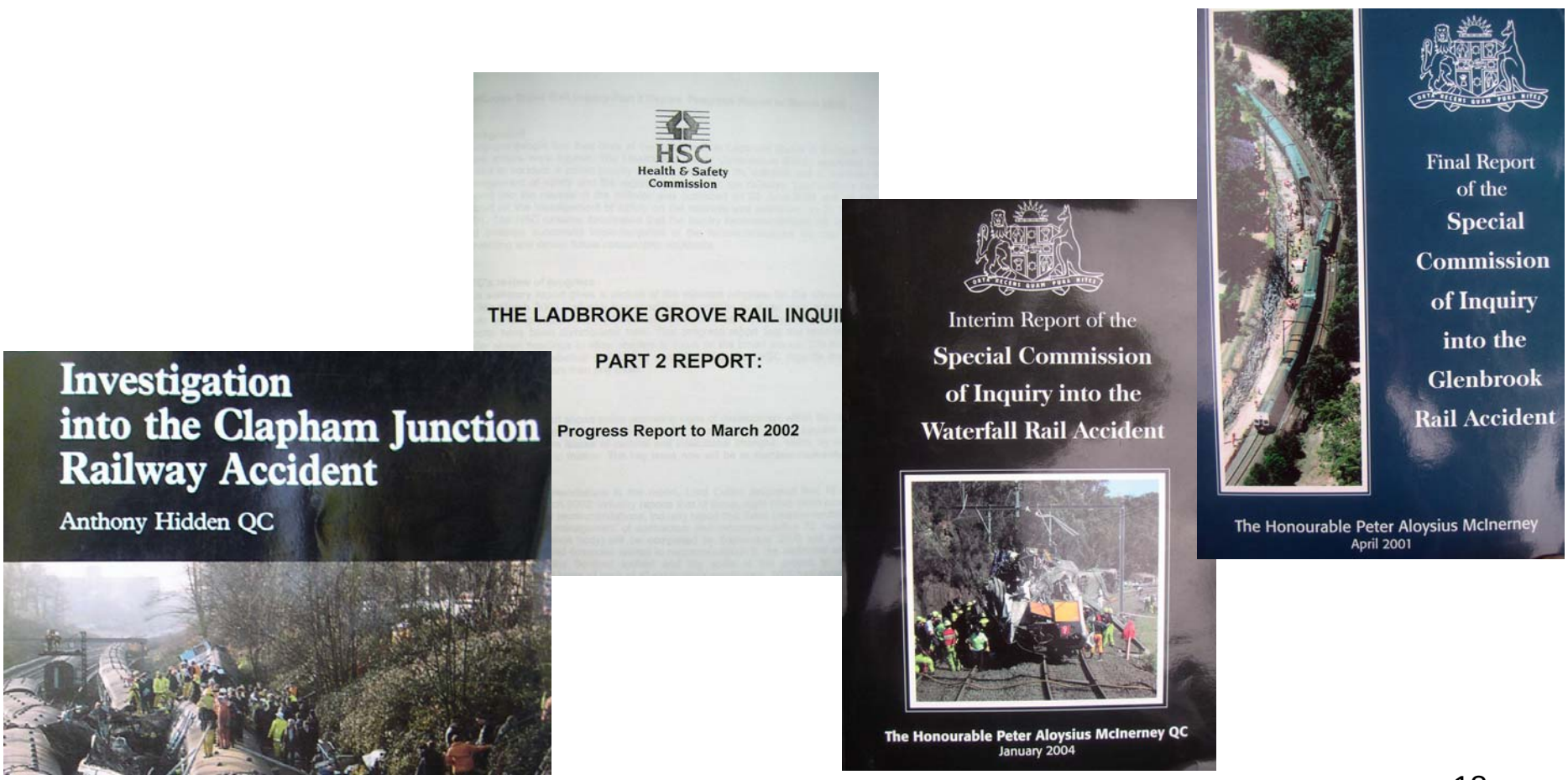
Over-Reaction and Irrational Actions 4

- Secondly, as was shown by subsequent analysis commissioned by British Rail — the state-owned rail authority in Britain at the time — the predicted cost per lives saved at that time exceeded the norms by a large amount.

- ATP was not implemented on a large scale – trial installations were.

Piper Alpha, Hatfield, Waterfall and Ladbroke Grove

There are many man-made disasters, risks which could have been averted by better design or organisation.



Piper Alpha Platform

Photo Source: (1-2) http://www.caolila.org.uk/piper.html; (3) http://www.uib.no/elin/elpub/uibmag/0102/sikkerhet.html

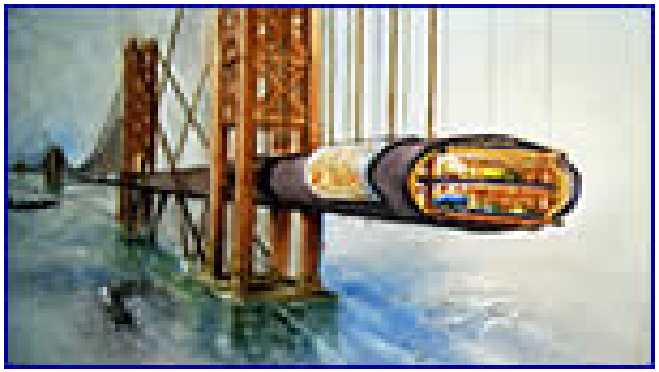
Channel Tunnel – earlier plans 1

In 1986, the British and French governments agreed to a 34-kilometre fixed cross-Channel links between the two countries.

•Consortia conceived a wide range of transport solutions. These proposals ranged from:

- drive-through via a long suspension bridge,
- a bridge-and-tunnel link,
- a combined rail-and-road link,
- a rail link which would shuttle cars and trucks in addition to high-speed passenger trains.

Channel Tunnel – earlier plans 2



Europont

A bridge with 5,000 metre spans suspended by means of Kevlar cables,
was soon eliminated on cost grounds and the fact it was based on untried techniques.

Euroroute
Comprising both a drive-through bridge and tunnel system with artificial islands and a bored undersea rail tunnel.

Channel Expressway
A last minute submission consisting of both road and rail tunnel

Channel Tunnel – earlier plans 3

Eurotunnel

This bid was based on the 1972-1975 project with twin rail tunnels and a third service tunnel.

Channel Tunnel – The Actuality 1

- At concept bid stage, the shuttle bidder had compared their concept's travel risks in relation to those associated with existing air and sea routes.
- QRA was utilised extensively to evaluate the design.
- The travel risks of any drive-through solution were unacceptably large and must have had a major influence on their elimination.
- Nevertheless, millions of francs and pounds were spent on assembling such proposals.

Channel Tunnel – The Actuality 2

- After the Eurotunnel proposal received government approval QRA was utilised extensively throughout the design period.

- This project was an important landmark in the use and application of risk analysis in the transport and construction sector.

RISK ANALYSIS HAS IMPROVED DECISION MAKING

- A formal approach to the analysis of risks has lead to improvements in decision making in the design, engineering and operation of complex plants and processes.
- Such fields range from railways to aerospace and from nuclear power to brewing.
- The process of identifying and categorising the risks and the pattern of the cause consequence chain improves the quality of rational decisions - *even without any attempt at quantification*

HAS QRA IMPROVED THE BASIS OF DECISION MAKING? 1

- However, when one seeks to place values on:
  - the likelihood of occurrence and
  - magnitude of events

  within the cause-consequence chain, that there is contention on the value of such an approach.
- There **are** valid arguments about the quality of data used in carrying out such analysis

HAS QRA IMPROVED THE BASIS OF DECISION MAKING? 2

- O'Connor, and others, have argued against the degree which the quantification may be considered to be credible or useful.

- Few risk analysts believe in the absolute value of predictive likelihoods;

HAS QRA IMPROVED THE BASIS OF DECISION MAKING? 3

- The great strength of quantified risk analysis lies in carrying out comparative analysis of alternative design proposals and outcomes.
- Comparative risk analysis in that subset of risk analysis, whose purpose is well defined by the US non-profit organisation, Environmental Defence:

HAS QRA IMPROVED THE BASIS OF DECISION MAKING? 4

- “Comparative risk analyses are undertaken to achieve numerous goals. The most common goal is to establish priorities for a government agency, political body, or community at large. It is often used to determine how to best allocate limited resources for reducing or preventing environmental risks. Comparative risk analysis generally investigates "residual risks" — the risks remaining after a problem is addressed by current regulatory controls.”

Source: Environmental Defence website

THE GROWTH OF THE RATIONAL USE OF RISK ANALYSIS 1

- During my working life, there has been a significant growth in the application of risk analysis.
- These changes are due, in part, to the growth of personal computing power simplifying analytical tasks.

THE GROWTH OF THE RATIONAL USE OF RISK ANALYSIS 2

- In the European context, media focus on transport accidents, have given the public a false impression of the risks of certain modes of transport compared to others.

Flying versus motoring risk

- Instinctively, and against all evidence to the contrary, people still think that it is more dangerous to fly than to drive a car.

THE GROWTH OF THE RATIONAL USE OF RISK ANALYSIS 2

- When it comes to nuclear power generation, it would appear that all rationality is abandoned.

- Richard Wilson compared analysis of risks in the United States,

Risk Comparison Chart - R Wilson 1979

Risks that increase chance of death by 0.000001

Smoking 1.4 cigarettes	Cancer, heart disease
Drinking ½ litre of wine	Cancer, cirrhosis of the liver
Travelling 300 miles by car	Accident
Travelling 10 miles by bicycle	Accident
Flying 1,000 miles by jet	Accident
Flying 60,000 miles by jet	Cancer caused by cosmic radiation
Living 2 months in average stone or brick building	Cancer caused by natural radioactivity
Living 2 months with a cigarette smoker	Cancer, heart disease
Living 150 years within 20 miles of a nuclear power plant	Cancer caused by radiation
Eating 100 charcoal-broiled steaks	Cancer from benzopyrene
Risk of living 50 years within 5 miles of nuclear reactor	Cancer caused by radiation

Source: Richard Wilson, “Analysing the Daily Risks of Life,” *Technology Review*, February 1979, vol. 81, no. 4, pp. 41—46. Cited in Nicholas J. Bahr, *System Safety Engineering and Risk Assessment: A Practical Approach*, Taylor and Francis, 1997, New York, p. 203.

THE GROWTH OF THE RATIONAL USE OF RISK ANALYSIS 3

- Misunderstanding of the true risks and the media has contributed to the virtual collapse of the United States nuclear industry in and severely retarded such developments in the rest of the world.

Understanding true risks

Chernobyl USSR (now Ukraine)

Understanding of the true risks is however equally vital. Chernobyl

Some progress

- Industry and the service sectors **have** supported the growth of the rational use of risk analysis.
- Little progress has been made in a rational understanding of the balance of true risk with the overall safety of individuals and society

Conclusions “more bangs per buck”

- So have we witnessed ‘The growth of a rational approach to risk’?

- Risk Analysis and QRA **have** improved rationality when deciding which design, operational features or safety systems give “more bangs per buck”
  - i.e. the most value for money in terms of aversion of risk.

Conclusions

- We risk analysis specialists may still have to educate the press or most politicians not to react in an irrational manner when faced with catastrophic and high profile events.

- It may be that work might be done in this field not only to improve the quality and reliability of our analyses, but in the way we present the outcomes to a wider audience

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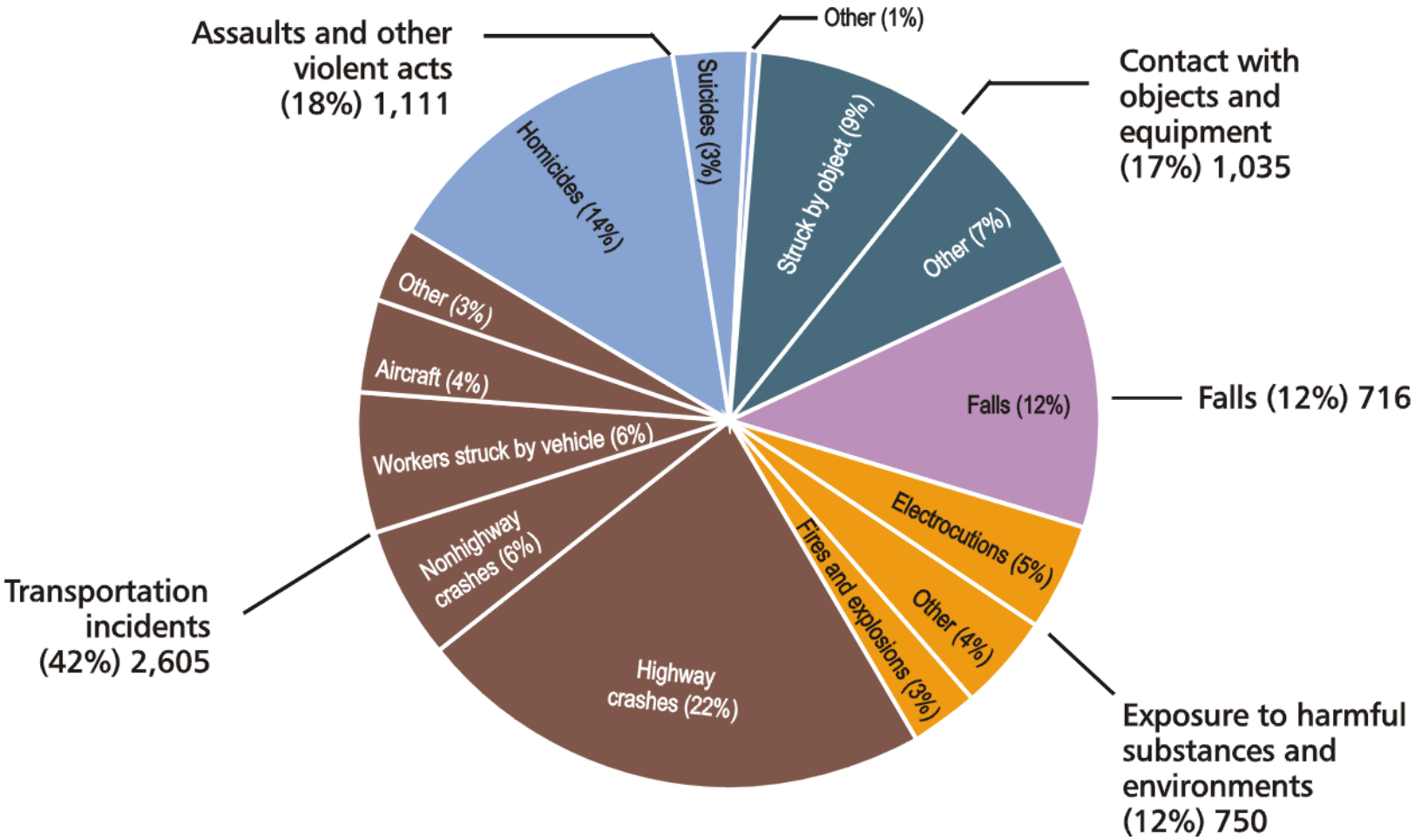
So-Called ‘High Hazard Industries’ 1

US Fatal work stats data



Worker Health Chartbook, 2000

US DHHS (NIOSH)

National Institute for Occupational Safety and Health

Worker Health Chartbook, 2000

September, 2000
DHHS (NIOSH) Publication No. 2000-127

Figure 2–7

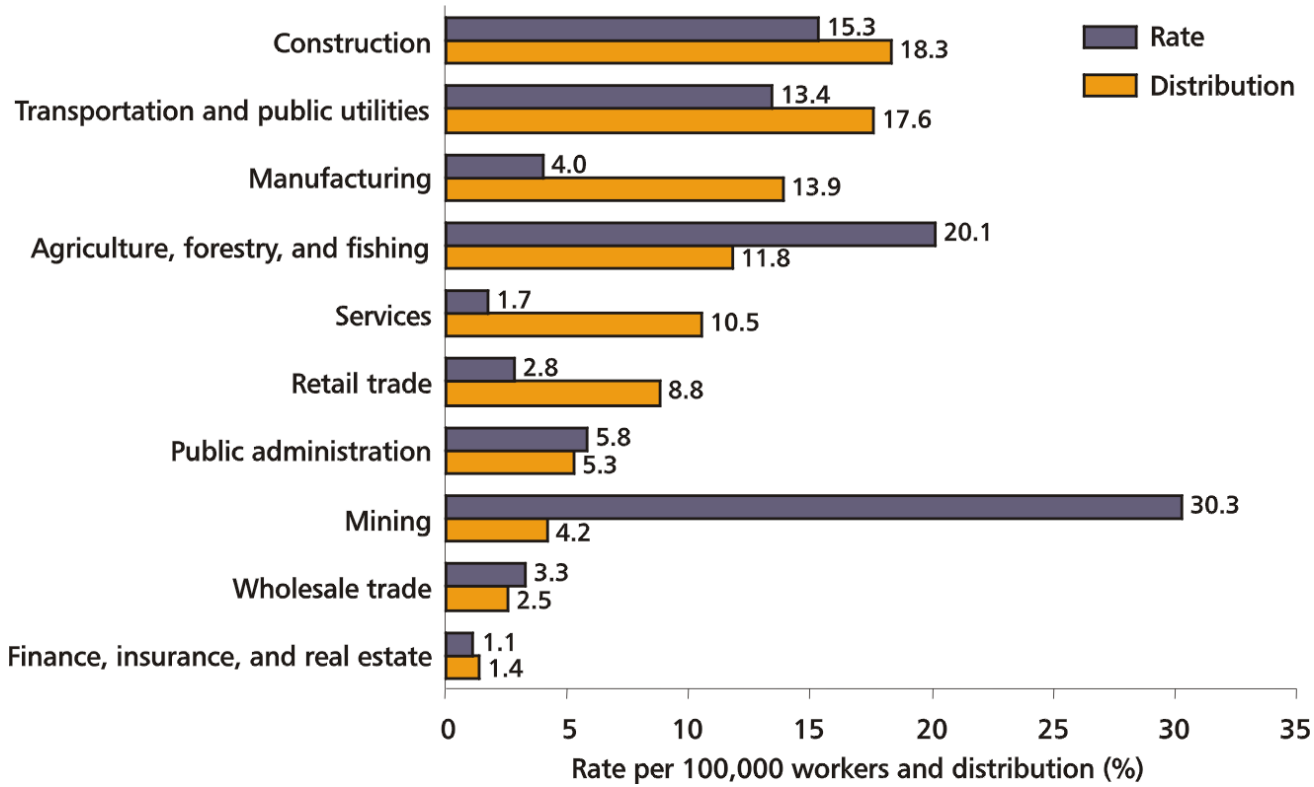
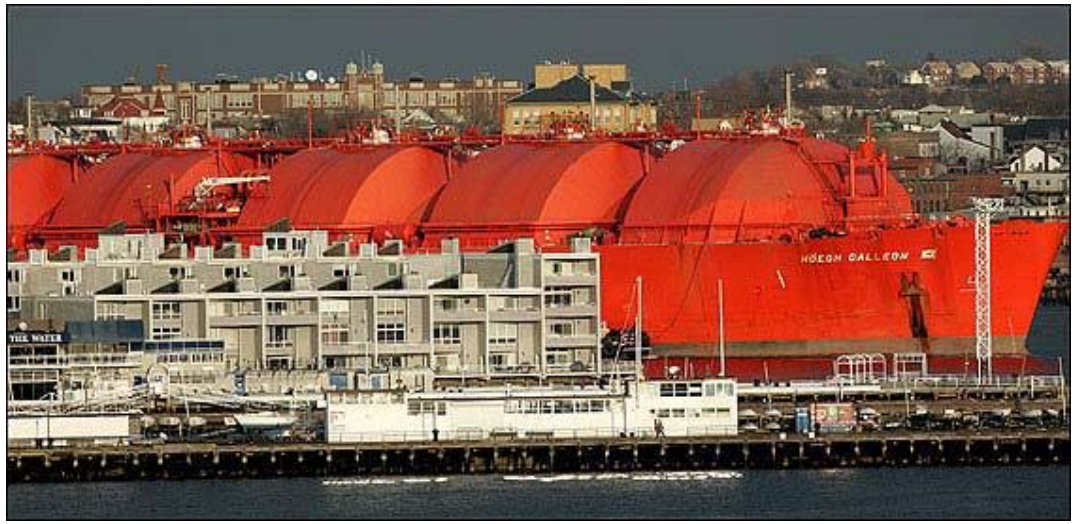


Figure 2–7 Average annual rate and distribution (%) of fatal occupational injuries by industry division, 1980–1995. Total deaths were 93,929; 5.7% were not classified by industry. (Source: NTOF [1999].)

LNG Tankers – the balance of risk



A LNG tanker in Boston Harbor. **Photo courtesy the *Boston Globe*.**

Source: http://fnnc.org/lng.html

Source: http://fnnc.org/lng.html

The stored energy and potential for catastrophes in vessels such as LNG tankers is immense. However at sea accidents are more likely. Far less so in port; the consequence: DISASTER