ILPI

A limit to safety

Risk, ‘normal accidents’, and nuclear weapons

Background

- Risk is the possibility of some bad event happening, commonly quantified as **the probability of an event multiplied by its consequences**
- Proponents of nuclear deterrence have argued that the risk of nuclear weapon detonations in populated areas is very low
- The absence of nuclear weapon detonations in populated areas since 1945 sometimes put forward as proof of this position
- Is the past necessarily a reliable guide to comparatively rare but catastrophic future events?

How probable is a nuclear weapon detonation in a populated area?

QUANTIFYING THE PROBABILITY OF NUCLEAR WEAPON DETONATIONS IN POPULATED AREAS

The risk of nuclear weapons being detonated in populated areas (for whatever reason, not only nuclear war) is very difficult to quantify because the probability is uncertain. Estimates since the cold war ended have varied widely in their nature, but all depend on sets of assumptions that are subjective and therefore contestable.[4] However, scholars of catastrophic risk have observed that even considering order-of-magnitude estimates of probability can be informative.[5] Most people, for instance, would not board a commercial aircraft if the chances of it crashing were in the range of one chance in 1,000, or even one chance in 10,000—even if the precise probability were not known. Thus, an important question is: what is 'acceptable' probability for use of nuclear weapons, given that the consequences of use could end human civilization? And, if this range is unacceptable, what steps should the international community take (and what costs should it be willing to bear) to reduce that probability significantly?[6]

Organisational & individual bias

- The organisational systems involved in development, production, storage, maintenance, deployment and safety of nuclear weapons are **enormously complex**
- **High reliability theory:** extremely safe operations are possible, even with extremely hazardous technologies, if appropriate organisational design and management techniques are followed
- Problem with high reliability theory – evidence show how organisations are not necessarily rational or effective in delivering safe outcomes
- **Normal accidents theory:** serious accidents with complex high technology systems are inevitable
- **The 'myth tendency'** – organisations/leaders cannot always be counted upon to do what is safest in risk-reduction terms

THE THANKSGIVING TURKEY AND THE PROBLEM OF INDUCTION

Nassim Nicholas Taleb, in his book The Black Swan, related a variant of the philosopher Bertrand Russell's illustration of the problem of induction—'certainly the mother of all problems in life':

'Consider a turkey that is fed every day. Every single feeding will firm up the bird's belief that it is the general rule of life to be fed every day by friendly members of the human race "looking out for its best interests," as a politician would say. On the afternoon of the Wednesday before Thanksgiving [an annual holiday in the United States that almost invariably involves a Turkey roast], something unexpected will happen to the turkey. It will involve a revision of belief.'[26]

A real-world example is the outbreak of the First World War, which was a surprise in the sense that since the Napoleonic conflicts ended a century before, Europe experienced a period of peace that would lead any observer to believe in the disappearance of severely destructive wars. August 1914 brought with it a stark revision of belief.

Taleb observed that the turkey problem is generalizable to any situation in which 'the same hand that feeds you can be the one that wrings your neck.'[27] The problem of induction also applies to the claim that because nuclear deterrence has not resulted in the detonation of nuclear weapons in populated areas since 1945 there is little likelihood of it happening in future. Past experience is not of unconditional benefit here.

COMPETING PERSPECTIVES ON SAFETY WITH HAZARDOUS TECHNOLOGIES

HIGH RELIABILITY THEORY	NORMAL ACCIDENTS THEORY
Accidents can be prevented through good organizational design and management.	Accidents are inevitable in complex and tightly coupled systems.
Safety is the priority organizational objective.	Safety is one of a number of competing objectives.
Redundancy enhances safety: duplication and overlap can make 'a reliable system out of unreliable parts.'	Redundancy often causes accidents: it increases interactive complexity and opaqueness and encourages risk-taking.
Decentralized decision-making is needed to permit prompt and flexible field-level responses to surprises.	Organization contradiction: decentralization is needed for complexity, but centralization is needed for tightly coupled systems.
A 'culture of reliability' will enhance safety by encouraging uniform and appropriate responses by field-level operators.	A military model of intense discipline, socialization, and isolation is incompatible with democratic values.
Continuous operations, training, and simulations can create and maintain high reliability operations.	Organizations cannot train for unimagined, highly dangerous, or politically unpalatable operations.
Trial and error learning from accidents can be effective, and can be supplemented by anticipation and simulations.	Denial of responsibility, faulty reporting, and reconstruction of history cripples learning efforts.

Reproduced from Sagan, *The Limits of Safety*, Princeton University Press, 1993, p. 46.

‘Normal accidents’

- Connection of systems can cause **unexpected failures**, and multiply and interact in unpredicted ways
- Charles Perrow: the failure of individual components or items is a ubiquitous feature of almost all systems
- 3 June 1980: US computer chip fail falsely told operators that the Soviet Union had launched a massive nuclear attack against the US
- Tight coupling: ‘what happens in one directly affects the other’
- Journalist Eric Schlosser documented many accidents involving nuclear weapons during the Cold War
- Both the US and Soviet/Russia have had their share of **close calls** and nerve-wracking experiences

INCIDENTS OF NEAR NUCLEAR USE

DATE	INCIDENT	STATES INVOLVED	CAUSE
October 1962	Operation Anadyr	Soviet Union	Miscommunication
27 October 1962	British nuclear forces during the Cuban missile crisis	United Kingdom	Conflict escalation
27 October 1962	Black Saturday	United States	Conflict escalation and mis-communication
22 November 1962	Penkovsky false warning	Soviet Union	Espionage
October 1973	1973 Arab-Israeli war	Israel	Conflict escalation
9 November 1979	NORAD: Exercise tape mistaken for reality	United States	Exercise scenario tape causes nuclear alert
3 June 1980	NORAD: Faulty computer chip	United States	Faulty computer chip
25 September 1983	Serpukhov-15	Soviet Union	Technical error
7-11 November 1983	Able Archer-83	Soviet Union, United States	Misperception of military training exercise
18-21 August 1991	Failed coup	Soviet Union	Loss of command and con-trol structure
25 January 1995	Black Brant scare	Russia	Mistaken identity of research rocket launch
May-June 1999	Kargil crisis	India, Pakistan	Conflict escalation
December 2001-October 2002	Kashmir standoff	India, Pakistan	Conflict escalation

Reproduced from P. Lewis et al, *Too close for comfort*, Chatham House 2014, p.7.

The Limits of Safety

- *The Limits of Safety* (Sagan, 1993): system accidents should 'raise serious doubts about the central assumption that a nuclear war could not occur unless political leaders decided it was in their states' interest'
- Found that the US' nuclear weapons control complex had all of the characteristics of the 'normal accident' organisation
- Incidents and scandals involving American military personnel with nuclear weapons responsibilities underlines the point that there are **not robust internal learning mechanisms in place**
- There is every reason to believe that nuclear weapons complexes are **far from high-reliability systems**

UNITED STATES NUCLEAR WEAPON ACCIDENTS

Eric Schlosser's book, *Command and Control*, described many accidents involving nuclear weapons during the cold war—a list that in the case of the United States alone ran into the thousands of incidents, although the full scope was not known until information was released later under the Freedom of Information Act. Events included plane crashes, fires, missile explosions, lightning, human error, 'even dropping a weapon from an aircraft parked on a runway were found to be potential causes of a nuclear explosion'.[19] American nuclear weapon designers did not understand some of these sources of risk until at least the 1960s. In one case, a B-52 bomber jettisoned two four-megaton nuclear bombs over Goldsboro, North Carolina in 1961: one of these began the detonation process, which was prevented only by a single low-voltage switch after all other safety systems failed.[20] In September 1980, a technician dropped a tool in the silo of a Titan II intercontinental ballistic missile near Damascus, Arkansas. The tool hit the bottom of the silo, bounced, struck the side of the missile, pierced the skin and caused a fuel leak. The Titan II was carrying the most powerful nuclear warhead ever built by the United States. Despite a heroic effort to save the missile, it exploded, though the warhead did not detonate.

Other nuclear weapon possessor states, including the United Kingdom, have been even more secretive about their safety records, although Ritchie has noted a number of accidents involving British nuclear weapons, some of which have shared American designs.[21] These accidents are not only sources of risk for people on the territories of nuclear weapon states, but also wherever the weapons are deployed.

Shifting the Burden

- *'Those who predict that nuclear weapons can be managed safely indefinitely into the future should have to prove their case and not simply refer back to a perfect safety record that never really existed'*
- Such a shift has yet to occur on nuclear weapons
- Lack of transparency – not enough is currently known or can be verified about recent safety records on nuclear weapons possessors
- **Does not lend credibility** to the deterrence argument: that nuclear deterrence is safe or sustainable with catastrophic failures occurring

Conclusion

- Much of the global policy debate about nuclear weapons after the Cold War has revolved around the **efficiency of nuclear deterrence**
- This may be the wrong question to prioritize, in view of competing bureaucratic agendas and continued lack of transparency
- An achievement of the humanitarian initiative is that it emphasizes **exploring the risks of nuclear weapons** use in hypothetical scenarios
- A logical and increasingly pressing question is what to do about the risks the continued existence and fallible management of those weapons pose