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Uncertainty and complexity in nuclear decision-making

Balancing reason, logic, cognition and intuition at strategic and operational levels

Beyza Unal with Julia Cournoyer, Calum Inverarity and Yasmin Afina

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Summary

- The risks that complexity poses to decision-making in the context of nuclear weapons include possible escalatory actions as a result of miscalculation, misperception or misjudgment. These actions could in turn lead to cascading catastrophic impacts. In times of crisis, such escalatory dynamics can be set in motion by human or machine error and influenced by individual factors such as biases, personal beliefs, culture, religion, and so on. Decision-makers at both the strategic and operational level who are tasked to take critical decisions (e.g. moving nuclear forces into positions of high alert, or deploying nuclear assets into battlefields) may not necessarily always make those decisions on rational grounds.

- This study applies a complexity lens to understanding nuclear weapons policy, including in nuclear decision-making, and assesses the issue of nuclear weapons policymaking as a 'wicked problem'. Complexity can be found in many layers of international relations, including in nuclear weapons policy, nuclear weapon systems design, the security environment and individual decision-making. The interaction of these layers with each other and with other security issues requires – yet has not always received – the utmost attention within nuclear policy communities.

- Complexity studies may help the nuclear policy community to address arms control, nuclear non-proliferation and disarmament from alternative and new perspectives. Such studies can shed light on human processes and judgment, improving and informing future assessments and decision-making.

- By applying the lens of complexity, decision-makers can improve choices made and decisions taken in times of both crisis and peace. Decision-making at times of heightened tensions, however, takes place in a completely different mindset. Decision-makers are required to perform to a high standard under pressure and against a background of increased uncertainty. In crises, the human brain uses shortcuts to find solutions and acts on impulse, leading to decisions that are frequently based on intuition or 'gut feeling'. In order to handle complexity in decision-making, a balance between reason, logic, cognition and intuition is required.

- Historically, data from past instances of near nuclear use have been examined through escalatory dynamics, but not much has been written on how these incidents provide information on complexity.

- Although each nuclear weapon state has a standard operating procedure and/or protocols to prevent unintentional escalation or accidental nuclear weapons use, case studies of the 1983 Soviet nuclear false alarm incident (also known as the Serpukhov-15 or Petrov incident), NATO's Able Archer nuclear-preparedness exercise in the same year (henceforth referred to as 'Able Archer-83') and the 1995 Norwegian rocket launch incident (also known as the Black Brant scare) demonstrate that nuclear decision-making is complex and involves behavioural and psychological factors.

- This study takes a multidisciplinary approach to understanding how information and intuition come into play at the moment when a decision is taken in the nuclear realm. Other disciplines, such as neuroscience, social psychology and systems engineering, can further a better understanding of complexity and human judgment, and can help unpack the various roles played by psychological biases, predispositions and perceptions in influencing decision-making.

01 Introduction

Complexity studies can drive new and innovative approaches in nuclear decision-making by drawing on lessons from other fields and providing policymakers with alternative pathways.

In light of increased challenges to international security, the risks of nuclear confrontation and escalation due to misunderstanding, misperception or miscalculation are changing. This is partly due to the increased complexity surrounding nuclear weapons policies, as a result of the turbulent security environment which has led to increased uncertainties in nuclear deterrence policies and decision-making.

In 2014, Chatham House conducted a study, *Too Close for Comfort: Cases of Near Nuclear Use and Options for Policy*.[1] The authors of that study applied a risk-based approach to cases of near nuclear use, and pointed out that individual decision-making is important in averting nuclear war.[2] By examining cases of near nuclear use, the authors of that study indicated that nuclear incidents (often caused by 'sloppy practices') have frequently been averted by human judgment.[3] Building on Chatham House's earlier work, the authors of this research paper apply the lenses of uncertainty and complexity to nuclear weapons policy, including nuclear decision-making.

There is of course a great deal of debate around what constitutes a near nuclear miss incident, what types of action lead to escalatory dynamics,[4] and whether certain cases in history were close calls or not.[5] From the perspective of complexity and an analysis of alternative pathways in nuclear decision-making, such debate

1 Lewis, P., Pelopidas, B., Williams, H. and Aghlani, S. (2014), *Too Close for Comfort: Cases of Near Nuclear Use and Options for Policy*, Report, London: Royal Institute of International Affairs, https://www.chathamhouse.org/2014/04/too-close-comfort-cases-near-nuclear-use-and-options-policy.
2 Ibid., p. 1.
3 Ibid.
4 See Baum, D. S., de Neufville, R. and Barrett, M. A. (2018), *A Model for the Probability of Nuclear War, Global Catastrophic Risk Institute Working Paper 18–1*, http://dx.doi.org/10.2139/ssrn.3137081.
5 For more information on the existing debate around the Able Archer-83 exercise, please see the analysis of Simon Miles and Nate Jones. Miles, S. (2020), 'The War Scare that Wasn't: Able Archer 83 and the Myths of the Second Cold War', *Journal of Cold War Studies*, 22(3), pp. 86–118, https://doi.org/10.1162/jcws_a_00952; and Jones, N. (ed.) (2016), *Able Archer 83: The Secret History of the NATO Exercise That Almost Triggered Nuclear War*, New York: The New Press.

is not pertinent. What is of importance from the perspective of this analysis is understanding the role of complexity in nuclear decision-making and nuclear weapons policy.

The classic study of nuclear weapons policy thus far has been simplistic. It focuses on understanding the problem and analysing it based on existing information, then finding solutions to the problem. In other words, it follows the classic academic research methodology of understanding, analysing, then solving.[6] The classic methodology is also simplistic because it calls for limiting the research scope to a single level of analysis (e.g. to choose between nuclear weapons policy and nuclear decision-making), and to construct a cause-and-effect relationship between independent and dependent variables. Rather, nuclear weapons policy and nuclear decision-making are mutually reinforcing, and change in one area may result in change in another. In a complex issue, understanding the problem and navigating it is a connected process; in other words, the formulation of the problem is a problem in its own right.

Nuclear weapons policies, including nuclear non-proliferation and arms control, are highly contested, and experts do not agree on the problems, let alone the solutions. This is a fundamental characteristic of a 'wicked problem'.

This study takes both nuclear weapons policies and nuclear decision-making as its principal levels of analysis. This is mainly because of the interconnections between the two, and because they have an impact on and are influenced by the overall security environment. For instance, ever since the 1960s nuclear deterrence has been a dominant theory in the nuclear weapons policy realm. Deterrence as a policy tool has rested on assumptions – such as the assumption that states are rational actors – and perceptions as regards the intent and capabilities of the adversary. This policy tool has a direct impact on how decision-makers, both at the chief and lower levels of decision-making (e.g. presidents, prime ministers, officers or operators), act in times of crisis. Nuclear weapons policies, including nuclear non-proliferation and arms control, are highly contested, and experts do not agree on the problems, let alone the solutions. This is a fundamental characteristic of a 'wicked problem'.[7]

6 Rittel, H. W. J. and Webber, M. M. (1973), 'Dilemmas in a General Theory of Planning', *Policy Sciences*, 4, p. 162, https://doi.org/10.1007/BF01405730.
7 For an earlier in-detail analysis on wicked problems and nuclear weapons, see Lewis, P. (2019), 'Nuclear Weapons as a Wicked Problem in a Complex World', in Steen, B. N. V. and Njølstad, O. (eds) (2019), *Nuclear Disarmament: A Critical Assessment*, Abingdon: Routledge.

The current global health crisis[8] has further accentuated the need for reliable, timely and trustworthy information in times of great threat, and has tested decision-makers' abilities to provide guidance to the public while also managing major uncertainties and a high degree of complexity. Complex systems modelling has been a significant part of the search for solutions and predictions, and has for several years been integrated into not only health policymaking but also discussions related to climate change. However, the nuclear communities[9] still have to fully grasp the value of complexity science.

While the climate change discourse has gained traction, particularly with the utilization of climate modelling approaches to demonstrate the range of potential harms, the discussion around nuclear non-proliferation, disarmament and arms control has stalled. Experts have been pointing to the facts and the need for nuclear risk reduction, disarmament and arms control to prevent future catastrophes. But, just like Cassandra in Greek mythology, who was given the gift of predicting the future, nuclear weapons policy experts are cursed never to be believed.[10]

8 Prior to the COVID-19 pandemic, experts repeatedly warned decision-makers of an upcoming pandemic and asked them to focus efforts on pandemic preparedness. These experts included philanthropic figures such as Bill Gates, who indicated that a pandemic would be 'the most predictable catastrophe in the history of the human race'. See for example Klein, E. (2015), 'The most predictable disaster in the history of the human race', Vox, 27 May 2015, https://www.vox.com/2015/5/27/8660249/bill-gates-spanish-flu-pandemic.
9 The authors of this paper choose to use the plural form to describe the different communities that exist in the nuclear weapons policy field. These communities, although in agreement on the outcome of a world free of nuclear weapons, do not necessarily agree on the process by which this outcome can be achieved. These communities are also referred to in the literature as 'camps' or 'tribes'.
10 The Editors of Encyclopaedia Britannica (2019), 'Cassandra', Encyclopedia Britannica', 14 February 2019, https://www.britannica.com/topic/Cassandra-Greek-mythology (accessed 8 Feb. 2022).

02 Complexity studies and ‘wicked problems’

Complexity science and an understanding of the challenges associated with ‘wicked problems’ can provide insights into different disciplines, including nuclear weapons policy. Complexities can be found in the overall security environment, as well as within individual decision-makers themselves.

Experts define complex systems differently, depending on the disciplines to which they belong. Hence, there is no single definition of complex systems. This paper refers to complex systems as systems that are composed of a moderate-to-large number of mutually interacting sub-units (also referred to in the literature as factors, subsystems or agents), in which the interaction between these sub-units occurs in a non-linear way.[11] This means that the components interact in such a way that the outcome is more than just the sum of the system’s parts.

There is interaction between the system and the environment. This points to the emergent behaviour in complex systems whereby the properties of the system cannot be explained through examining individual components *per se,* and whereby there is a degree of unpredictability within the system.

As the components are connected to each other, the actions of one sub-unit may have implications for those of another sub-unit, and the overall interaction of all sub-units may generate unpredictable behaviour. In some cases, complex systems

11 There are different definitions to measure complexity in different types of systems. See Lloyd, S. (2001), ‘Measures of Complexity: a non-exhaustive list’, *IEEE Control Systems Magazine*, 21(4), pp. 7–8. See also Weaver, W. (1948), ‘Science and Complexity’, *American Scientist*, 36(4), pp. 536–44.

also involve adaptation, whereby the components are either learning or modifying their behaviour through a feedback loop between each other and the environment. Within this characterization, some examples of a complex system would include a human brain, a genome, a colony of ants and social networks, as well as some engineering systems such as space shuttle programmes.[12,13]

Complex systems are often confused with chaotic systems. Although chaos theory led to the emergence of complexity theory, the two have different tenets. While chaos theory examines only 'a few parameters and the dynamics of their values', complex systems are 'concerned with both the structure and the dynamics of systems and their interaction with their environment'.[14] In a chaotic system, there is no cause-and-effect relationship.

It is important to differentiate between complex and complicated systems, in light of the fact that the terms are often (erroneously) used interchangeably. Complicated systems are predictable systems that operate in patterned ways. There are 'known unknowns'[15] in complicated systems, i.e. the types of risks that the user may recognize beforehand but whose impact (in terms of the probabilities of an event) may not fully be understood. Thus, through rigorous analysis it is possible to observe a linear cause-and-effect relationship in a complicated system. A complicated problem could be managed through traditional systems engineering approaches, such as by applying best practices or standard operating procedures. Confusion of the terms 'complex' and 'complicated' often arises when a system has, for instance, both a complex design and a complicated structure. In a complex system, there are 'unknown unknowns',[16] i.e. the types of incidents or errors that the user cannot or may not know beforehand. New forms of systems engineering rely on characteristics such as interdependent components, interacting feedback loops, open-system boundaries, self-organization, adaptation (e.g. learning ability) and emergence. These new characteristics render a system complex. In situations where there are unknown unknowns, decision-makers 'can understand why things happen only in retrospect'.[17]

The concept of 'wicked problems' was introduced in 1973 by Horst Rittel and Melvin Webber[18] as a way of analysing problems involving multiple stakeholders with conflicting interests, whereby the stakeholders cannot agree on the problem. In a complex system, it is hard to judge the consequences of an action ahead of time: minor changes can lead to major impacts (also known as the 'butterfly effect'[19]) and major changes may have smaller impacts. It is likely that a 'proposed

12 Atkinson, J. (2016), 'Complex Systems — More than a Simple Game of Connect the Dots', 20 January 2016, NASA, https://www.nasa.gov/feature/langley/complex-systems-more-than-a-simple-game-of-connect-the-dots.
13 For a comprehensive study around complex systems in multiple disciplines, visit Santa Fe Institute, Research Themes, https://www.santafe.edu/research/themes.
14 New England Complex Systems Institute (2011), 'Concepts: Chaos Vs. Complex Systems', https://necsi.edu/chaos-vs-complex-systems.
15 Snowden, D. J. and Boone, M. E. (2007), 'A Leader's Framework for Decision Making', *Harvard Business Review,* https://hbr.org/2007/11/a-leaders-framework-for-decision-making.
16 Ibid.
17 Ibid.
18 Rittel and Webber (1973), 'Dilemmas in a General Theory of Planning', pp. 155–69.
19 Dizikes, P. (2011), 'When the Butterfly Effect Took Flight', *MIT Technology Review*, 22 February 2011, https://www.technologyreview.com/2011/02/22/196987/when-the-butterfly-effect-took-flight.

solution to one segment of a wicked problem [could often lead] to unforeseen consequences in related segments'.[20]

Wicked problems have a number of distinguishing characteristics, including the following:[21]

- The causes of the problem can be explained in multiple ways, and the stakeholder's choice of explanation determines the choice of resolution.
- There is no 'true-or-false' solution to a wicked problem: assessments of such solutions are instead expressed as 'good' or 'bad', because policy interventions are based on judgment rather than objective truth.
- There is no immediate or ultimate test of a solution.
- Every attempt to solve a wicked problem is important and has consequences for the system – thus, a 'trial and error approach' will not work. The attempt to fix the unintended consequences may also create a new set of wicked problems.
- Every wicked problem can be a symptom of another problem.
- The decision-maker has no right to be wrong, because of the number of potential consequences of their actions.

This study aims to provide insights through the lens of complexity science. The latter is defined as the study of different disciplines, examples from those disciplines, and wicked problems in order to revisit classical approaches to nuclear weapons policies. A focus on the framework of complexity and 'wickedness' that is inherent in nuclear weapons policy problems may offer new ideas for governance and new approaches for forward movement in the nuclear field.

Today's international policymaking and relations rest on a three-dimensional complexity, similar to a game of three-dimensional chess: a) complexity in the issue area (i.e. nuclear weapons policy and new technologies); b) complexity in the overall security environment; and c) complexity in individual decisions of leaders and decision-makers. Added to this is the complexity that comes with internal bureaucratic politics in each country, whereby different organizations (e.g. ministries of foreign affairs, ministries of defence, etc.) working on nuclear weapons policy within the same country may view the problem and/or solution differently. Domestic political concerns are also a factor feeding into complexity, in that each political system – whether democratic or authoritarian – has to accommodate these concerns in some form within its policymaking.

In relation to nuclear weapons policy, nuances of opinion and different perspectives persist on the key questions, which might include the following: Do nuclear weapons act as an ultimate guarantee against large-scale war? What type of aggression do they deter? Are the risks associated with nuclear weapons postures negligible, or so high that they pose the threat of inadvertent catastrophe? In which areas are risks acceptable, in which are they unacceptable, and how

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20 Clemente, D. and Evans, R. (2014), *Wartime Logistics in Afghanistan and Beyond: Handling Wicked Problems and Complex Adaptive Systems*, Research Paper, London: Royal Institute of International Affairs, p. 2, https://www.chathamhouse.org/sites/default/files/home/chatham/public_html/sites/default/files/afghanistan_clemente.pdf.
21 Rittel and Webber (1973), 'Dilemmas in a General Theory of Planning', pp. 161–66.

does the threshold differ from one state to another? How should nuclear weapons possessors outside the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) be addressed? Does the Treaty on the Prohibition of Nuclear Weapons (TPNW) complement or undermine the NPT? How does missile defence affect nuclear relationships? Is it better to have more actors in nuclear decision-making for checks and balances purposes, or fewer for speed and clarity? What type of measure can reduce misperception and misunderstanding in nuclear decision-making?

There are no definitive answers to these questions. Problems related to nuclear weapons policy, just like other policy issues, rely on political judgment, national interests, international commitments, technical capabilities and military strategies. Hence, nuclear weapons policy problems constitute a wicked problem.

Because of the complexity of wicked problems, there will never be agreement among experts as to what the problem is. This is liberating. For too long, experts and officials have all been trying to convince each other of what the problem is and what the solutions are. The answer is that nobody truly knows who is right or who is wrong – but complexity science may offer us new ways of thinking about the issue, provide insights and allow different communities to work together.

03 Complexity in the international security environment

Since the end of the Cold War, a multipolar world order, ambiguous threat perceptions and asymmetrical arms race dynamics have given rise to an increasingly complex and dynamic international security environment.

Apart from the level of complexity in nuclear non-proliferation, disarmament and arms control matters, there is also complexity within the overall security environment. While nuclear weapons policy during the Cold War was full of uncertainty, the security environment was based around a comparatively simple bipolar structure. Today, on the other hand, the security environment is shaped by complex, intertwined and dynamic factors, and nuclear decision-making remains beset by unknowns.

Several factors can serve as a basis for comparing the Cold War security environment with that of today: a) the changing type of world order; b) threat perception; and c) arms race dynamics.

Bipolar vs multipolar world order

During the Cold War, the world order was based on a bipolarity,[22] shaped around the policies of the US and the Soviet Union. In general, understanding the world order required the study of two great powers, and the policies of these powers were often determined by each other's capabilities and intent. Moreover, from the 1960s onwards arms-control treaties increased the degree of transparency and reinforced the bipolarity of the security environment. In such a world order, there was still uncertainty, mainly due to elevated tensions between the US and the Soviet Union. As a result of these tensions, the two powers came to the brink of war in 1962 during the Cuban missile crisis, which consequently led to a level of strategic stability with the establishment of the Washington–Moscow communication hotline, nuclear test ban treaties and the NPT, among others.

Today, the number of states that can access strategic assets has increased. Although military power is still a significant factor in defining world order, other types of power, including economic, cultural, technological and societal factors, have become determining factors. Increased competition is driving not only states but also the private sector to capitalize on investing in science and technology.

Threat perception

Threat perception was static during the Cold War period, having evolved around nuclear weapon states and the quantitative and qualitative dimensions of their capabilities. Both the US and the Soviet Union shaped their nuclear policies around the survivability of their nuclear forces from a first strike: thus, second-strike capability was vital to deter the adversary. From 1985, the 'Gorbachev era' (when Mikhail Gorbachev was general secretary of the Communist Party of the Soviet Union) signalled a shared understanding of the security environment between the US and the Soviet Union despite differences in approaches, and led in November 1985 to an important joint statement with US president Ronald Reagan, with both sides asserting that 'a nuclear war cannot be won and must never be fought'.[23] Thus, the two leaders defined their aspiration under the framework of preventing nuclear war.

The Reagan–Gorbachev statement was reaffirmed on 3 January 2022 in a statement released by the five NPT-recognized nuclear weapon states (China, France, Russia, the UK and the US).[24] Within a matter of weeks, however, this reaffirmation had come under scrutiny. Having launched a full-scale military invasion of Ukraine on 24 February, Russian president Vladimir Putin announced

22 It is important to note that both the Non-Aligned Movement and the proposals around the New International Economic Order have challenged this bipolarity.
23 Ronald Reagan Presidential Library & Museum (1985), 'Joint Soviet–United States Statement on the Summit Meeting in Geneva', 21 November 1985, https://www.reaganlibrary.gov/archives/speech/joint-soviet-united-states-statement-summit-meeting-geneva.
24 The White House (2022), 'Joint Statement of the Leaders of the Five Nuclear-Weapon States on Preventing Nuclear War and Avoiding Arms Races', 3 January 2022, https://www.whitehouse.gov/briefing-room/statements-release/2022/01/03/p5-statement-on-preventing-nuclear-war-and-avoiding-arms-races.

three days later that Russia's nuclear forces were to be placed on high alert.[25] Following this announcement, voters participating in a referendum in Belarus approved a constitutional change that allows for the hosting of nuclear weapons on Belarusian territory.[26] Current Russian nuclear signalling involves mixed messaging, and a blurring of the lines between deterrence and compellence.[27]

Today, nuclear weapon states have different understandings of what constitutes risk and threat. Moreover, the ways in which nuclear weapon states view warfighting differ from state to state – for instance, while some have a 'no first use' policy, signalling that these weapons serve deterrence purposes and are not intended for warfighting, others believe that such a policy might undermine deterrence.[28]

In the 21st century, emerging disruptive technologies have also added to the complexity of threat perception. Cyber, outer space capabilities, artificial intelligence (AI) and machine learning technologies do not operate in isolation from nuclear technology: thus, they play a role in warfighting. The interplay across these technologies, both with each other and with nuclear weapon systems, including nuclear command, control and communication, have thus far resulted in complexity, with limited governance solutions.

Arms race conditions: nuclear vs emerging technologies

During the Cold War, the arms race between global powers extended into both the nuclear and conventional weapons fields. Even then, false perceptions held by each side about the other's capabilities triggered an increase in investment in nuclear weapon programmes on the part of nuclear-armed states.

Today, arms races occur asymmetrically across different technology areas, including in missile technology, quantum computing, communications and sensor technologies, and counter-strike capabilities in outer space. Traditional arms race dynamics (such as the offence–defence dilemma and the reciprocal escalation of weapons and weapons systems), and theoretical arms race assumptions are no longer fit for purpose in today's world order, as technological racing intertwines with defence policies. Technological complexity also has an impact on 'the rationality assumption governing today's nuclear decision-making process'.[29] Given the spread of technological advancements and the interconnected nature

25 *Guardian* (2022), 'Vladimir Putin puts Russian nuclear forces on high alert – video', 27 February 2022, https://www.theguardian.com/world/video/2022/feb/27/vladimir-putin-puts-russian-nuclear-forces-on-high-alert-video.
26 Beaumont, P. (2022), 'Belarus may be about to send its troops into Ukraine, US official says', *Guardian*, 28 February 2022, https://www.theguardian.com/world/2022/feb/28/belarus-troops-ukraine-russia-invasion.
27 Whereas the intention of deterrence is to *dissuade* an adversary from taking an action, that of compellence is to *persuade* an adversary to change their behaviour. See Sperandei, M. (2006), 'Bridging Deterrence and Compellence: An Alternative Approach to the Study of Coercive Diplomacy', *International Studies Review*, 8, p. 253.
28 Woolf, A. F. (2021), *U.S. Nuclear Weapons Policy: Considering "No First Use"*, Congressional Research Service Report No. IN10553, 13 October 2021, https://fas.org/sgp/crs/nuke/IN10553.pdf.
29 Kubiak, K. (2021), *Nuclear weapons decision-making under technological complexity,* Pilot Workshop Report, London: European Leadership Network, https://www.europeanleadershipnetwork.org/wp-content/uploads/2021/03/ELN-Pilot-Workshop-Report-1.pdf.

of most of these technologies with each other and with nuclear weapons command, control and communications, traditional arms race considerations need to evolve to meet the needs of today's security concerns. Moreover, the traditional policy of nuclear deterrence needs to account for developments in technological capability and adapt to the changes dynamically. Such adaptation is possible by embracing the framework of complex adaptive systems.[30]

30 For more on complex adaptive systems, see Sullivan, T. (2011), 'Embracing Complexity', *Harvard Business Review,* September 2011, https://hbr.org/2011/09/embracing-complexity.

04 Complexity factors in nuclear decision-making

Perceptions, beliefs, culture, religion and education are complex factors informing human judgment and thus nuclear decision-making. Crisis decision-making is influenced by behavioural and cognitive factors such as biases, noise, perception and intuition.

Nuclear decision-making is dependent on many interconnected and interdependent layers of structures. These include sociocultural and historical factors, relations between states, regional crisis/conflict, threat assessments (e.g. data readings), intelligence-gathering and analysis, reconnaissance and surveillance capabilities, strategic reliable communications architecture, command and control structures for authorized use, and sensor capabilities to detect a nuclear weapons launch. Nuclear weapons are also composed of complicated structures with complex design, connected to other complex systems. So far, there is no agreement within the expert community on whether such a high degree of complexity within systems design creates a risky situation, or whether it helps states to achieve strategic objectives to deter an adversarial attack through uncertainty. This emphasizes the notion that each nuclear weapon state has different levels of risk appetite and perception and that it is therefore hard to estimate general responses and reactions for all types of situations.

Nuclear decision-making is also complex because it involves multiple actors. The chief decision-makers, such as presidents, prime ministers and ministers of defence, receive the highest attention in this regard. Yet, nuclear decision-making also crucially involves duty officers, operators, defence and intelligence units, and military personnel, among others. Officers and operators read through and analyse data and therefore have the power to escalate a situation to higher echelons of command or to de-escalate it in times of crisis. Individual factors such as religion, education, culture and upbringing all have an impact on the decision-making process.

Historical cases such as the Able Archer-83 NATO exercise and the 1983 Soviet nuclear false alarm incident, analysed in detail in the following sections, illustrate the value of focusing on both high-level decision-makers and duty officers to address complexity in decision-making.

While the events and actors involved in each historical case are unique, there are several common themes within these examples. The decision-making process is informed by evidence and facts but also relies on other complex factors, including perception and human judgment, and their influencing factors (including beliefs, culture, religion, education and upbringing). Moreover, complex individual and behavioural factors, such as cognitive biases, intuition and gut feeling, all have a determining role in decision-making.

Biases

Nuclear weapons are increasing in salience in all nuclear weapon states. As new risks of inadvertent, accidental or deliberate use of nuclear weapons emerge, the role of humans – be it the role of a duty officer or of a high-level decision-maker – is increasingly important. Emerging technology applications (such as automation, cyberthreats, 'deep fakes', AI, and so on) raise concerns over reliable and credible chains of command. An often neglected but important element in decision-making is the possibility for decision-makers to make errors due to bias, faulty memories or a flawed understanding of historical incidents.

Operators' obedience to standard operating procedures and protocol, their trust in early-warning systems, or their judgment of the adversary's willingness to conduct a nuclear first strike are all elements that can be influenced by behavioural and psychological factors, along with evidence and facts.

A common cognitive bias at play in times of crisis is confirmation bias, which is the psychological predisposition to interpret new evidence in ways that align more closely with 'existing beliefs, expectations, or a hypothesis in hand'.[31] In a crisis, even though the initial information or intelligence might not provide a holistic picture, the decision-makers, including officers and intelligence analysts, may 'anchor' their decisions based on 'the first piece of information they receive'.[32] Thus, depending on the type of information received, there exists the risk of misinterpretation and faulty decision-making.

31 Nickerson, R. S. (1998), 'Confirmation Bias: A Ubiquitous Phenomenon in Many Guises', *Review of General Psychology*, 2(2), pp. 175–220, https://doi.org/10.1037/1089-2680.2.2.175.
32 Thomas, T. and Rielly, R. J. (2017), 'What Were You Thinking? Biases and Rational Decision Making', *InterAgency Journal*, 8(3), p. 101, https://thesimonscenter.org/wp-content/uploads/2017/08/IAJ-8-3-2017.pdf.

Another type of bias is conformity bias, which presents itself in hierarchical workplaces where staff are more likely to follow the orders of higher authorities without questioning the validity or morality of the action involved. In the 1960s, the Milgram experiment showed a surprising level of obedience to authority, even when the participants were knowingly harming other people.[33]

Noise

Human error might result not only from judgments that are biased but also from judgments that are 'noisy'.[34] In the latter form, similar groups of experts presented with the same information often come to different conclusions; this is due to preconceived notions or potentially confounding factors that interfere with decision-making (e.g. the time of day a decision is taken). An example might be when two judges deliver very different sentences (ranging from one month to several years) for defendants who have committed the same crime. Similarly, doctors may differ in their diagnosis for patients with the same disease. The system (e.g. the judicial system, medical system, etc.) is noisy, and this explains variability and inconsistency in decisions and judgments. While bias occurs systematically and consistently, noise occurs randomly. Both are types of judgment errors, and a decision can be both noisy and biased. Noise should be considered as an influencing factor in everyday decision-making.

Throughout history, near-miss incidents have often been averted by human judgment, though it is uncertain whether such judgment will suffice to prevent all future catastrophes.

Decision-makers could be 'presented with the same question and asked a very precise question',[35] and the variability in response and judgment would be because of the system noise. In nuclear decision-making, instances where expert judgment may vary fall into this category, for instance: Under what conditions would you alert higher echelons about a problem in the nuclear command centre? or: When is it allowed/appropriate to use or threaten to use nuclear weapons? In order to mitigate noise, social psychologists advise that 'noise audits' be conducted at the organizational level. Incorporating standard operating procedures, checklists and 'decision hygiene' into the decision-making process may contribute to better-informed decisions on a day-to-day basis.[36]

33 The psychologist Stanley Milgram posed this experiment with 40 participants. The participants were separated into two groups: 'teachers' and 'students'. The experiment asked the 'teacher' to deliver electric shocks to the 'student' in 15-volt increments, from 15 volts to 450 volts, without knowing that the 'student' was pretending to be electrocuted. Despite the labels of 'slight shock', 'moderate shock', and 'danger: severe shock' on the switches, Milgram found that 65 per cent of the participants delivered the maximum shocks.
34 For an extensive study on noise, see Kahneman, D., Sibony, O. and Sunstein, C. R. (2021), *Noise: A Flaw in Human Judgment*, New York, Boston and London: Little, Brown Spark.
35 Nesterak, E. (2021), 'A Conversation with Daniel Kahneman about 'Noise'', *Behavioral Scientist*, 24 May 2021, https://behavioralscientist.org/a-conversation-with-daniel-kahneman-about-noise.
36 Ibid.

Social psychology scholars indicate that '[j]udgments are both less noisy and less biased when those who make them are well trained, are more intelligent, and have the right cognitive style. In other words: good judgments depend on what you know, how well you think, and how you think'.[37]

Bias and noise do not necessarily drive more aggressive or escalatory behaviours: in fact, they are coded into human cognition. It is hard to recognize biases and system noise in nuclear decision-making and in nuclear weapons policy. It takes effort and practice for decision-makers to adopt the habit of recognizing biases.

Throughout history, near-miss incidents have often been averted by human judgment, though it is uncertain whether such judgment will suffice to prevent all future catastrophes. The incorporation of emerging technologies and of changing systems engineering practices adds into this complexity.

Perception

Another layer in nuclear decision-making is the role of human judgment, including various risk perceptions and the assumptions of parties involved in decision-making. Perceptions can be based on past experiences, informed by beliefs, culture and religion, as well as facts and evidence. Every individual involved in the nuclear decision-making process and nuclear weapons policy, at whatever level, naturally holds an individual understanding of the adversary that makes risk perception 'at least partially subjective'.[38] As personal judgment and subjectivity is shaped by facts, opinions and feelings and is unique to every individual, it is impossible to eliminate it. Yet, acknowledging one's subjective thoughts, understanding the fallibility of one's beliefs and perceptions and employing critical thinking in a routine manner will be highly beneficial in times of crisis decision-making.

There have been several notable cases where misperception came into play and had an effect on high-level policymaking. In 1976, under the direction of George H. W. Bush, the US Central Intelligence Agency (CIA) undertook a comparative intelligence analysis experiment, composed of two groups (Team A and Team B) with competing views around Soviet strategic intentions.[39] The aim of the experiment was to better analyse Soviet capability and intentions and to assess whether or not the Soviet Union's missile capabilities could overtake the capabilities of the US. While the results of the comparative analysis are controversial due to the clashing views of Team A (led by CIA agents) and Team B (led by an outside panel of experts), the experiment highlighted the influence of perception on various groups, depending on their individual backgrounds and positions in bureaucratic or organizational politics.[40] Overall, bureaucratic politics

37 Kahneman, Sibony and Sunstein (2021), *Noise*, p. 186.
38 Borrie, J. (2020), 'Human Rationality and Nuclear Deterrence' in Unal, B., Afina, Y. and Lewis, P. (eds) (2020), *Perspectives on Nuclear Deterrence in the 21st Century*, Research Paper, London: Royal Institute of International Affairs, https://www.chathamhouse.org/sites/default/files/2020-04-20-nuclear-deterrence-unal-et-al.pdf.
39 For a more detailed account of this experiment, see Pipes, R. (1986), 'Team B: The Reality Behind the Myth', *Commentary,* 82(4), October 1986, declassified and approved for release on 18 May 2012, https://www.cia.gov/readingroom/docs/CIA-RDP93T01132R000100050007-2.pdf.
40 Ibid.

and varying assumptions, preferences and positions of power, along with clashing policy goals between the two teams, had an impact on their competing analyses.

Perception of the adversary also played a role in Soviet decision-making. For instance, in the 1980s there was a growing fear within the Soviet decision-making apparatus that the US and/or the NATO allies could use a large-scale military exercise as a cover for launching a surprise nuclear missile attack.[41] Hence, the Soviet leadership focused in the first instance on 'detecting and pre-empting' such an attack through Operation RYaN, a Soviet intelligence-gathering operation conducted by the KGB (the security agency of the Soviet Union)[42] together with the GRU (the Soviet military intelligence service) to prepare the Soviet Union to detect and pre-empt a first nuclear strike from NATO or its allies. Part of that intelligence-gathering, for example, required KGB operatives to monitor blood banks in the UK, and report back if that country's government was requesting an increase in blood supplies, was paying high prices to purchase blood, or was opening new blood-donor reception centres.[43] The Soviet assumption was that increased blood supply – along with activity around places where nuclear weapons were made or stored, or activity around places government officials would be evacuated – might mean readiness for a surprise attack.[44] This perception is likely to have had a significant impact on the Soviet Union's strategic vision and operational planning, potentially affecting the reading of large-scale military exercises and including the misperception of NATO's Able Archer-83 exercise as a surprise first-strike attack.

It should also be noted that decision-makers and the expert nuclear policy community can have a somewhat distorted perception (at least discursively) that actors operate with all the information necessary to make a fully informed decision. Moreover, there is an assumption that this information exists. In reality, ambiguity and uncertainty play a key role in nuclear strategies and thus contribute to incomplete information. Therefore, even a well-informed decision does not imply infallibility. Being aware of the limits of information and data, and making decisions using this awareness, may help decision-makers and experts to perceive the problems differently.

Intuition and 'gut feeling'

Decision-making is based not only on facts and evidence, but also on intuition, sometimes referred to colloquially in the literature as 'gut feeling'. In nuclear decision-making, it seems that both intuition and information play a role, although the specific contribution of intuition to the process has not been studied in detail in the nuclear literature thus far. In fact, the mainstream nuclear theories rest

41 Jones, N. (2014), 'Stasi Documents Provide Details on Operation RYaN, the Soviet Plan to Predict and Preempt a Western Nuclear Strike; Show Uneasiness Over Degree of "Clear-Headedness About the Entire RYaN Complex"', *Unredacted,* 29 January 2014, https://unredacted.com/2014/01/29/stasi-documents-provide-operational-details-on-operation-ryan-the-soviet-plan-to-predict-and-preempt-a-western-nuclear-strike-show-uneasiness-over-degree-of-clear-headedness-about-the-entire-ryan.
42 Ibid.
43 Andrew, C. and Gordievsky, O. (1991), 'Comrade Kryuchkov's Instructions: Top Secret Files on KGB Foreign Operations, 1975–1985', Stanford: Stanford University Press, pp. 69–81.
44 Ibid.

on the assumption that decision-makers are rational actors, despite examples of policymakers who themselves refer to intuition.[45] Former US president Ronald Reagan, for instance, often referred to his 'gut feeling' in his diary entries from 1981 to 1989.[46]

In both the 1983 nuclear false alarm incident and Able Archer-83, as the following sections will analyse in detail, individuals responsible for decision-making referenced how their gut instinct and intuition played a part in their judgments. The Soviet officer responsible for averting nuclear conflict in the false alarm incident, Lieutenant Colonel Stanislav Petrov, famously referred to a 'funny feeling in his gut' as a crucial part of his decision.[47] Similarly, one of the critical reports produced in the aftermath of Able Archer-83 highlighted how a key actor, Lieutenant General Leonard Perroots, 'acted correctly out of instinct, not informed guidance'.[48]

Intuition emerges from past experiences, behavioural factors, beliefs, biases and so forth. It serves a different perspective to the individual's decision-making process. When they have opted to act on the basis of their intuition or gut feeling, people generally cannot point to why they took one decision over another – it is an intuitive 'judgment call' that requires them to have knowledge without being able to pinpoint exactly what they know. Decisions based on intuition 'could be right or wrong', and thus trusting gut feelings requires special attention.[49] Although 'judgment heuristics are quite useful, they could lead to severe and systematic errors'.[50] In general, experts seem to have better, more accurate intuition than a layperson does, because their judgment is based on experience and recognition of cues and patterns.[51] However, prudence is needed, as 'intuitions do not all arise from true expertise'.[52]

How humans think has been a point of discussion in many fields, notably including psychology and behavioural economics, for several decades. Dual-process theory in social and cognitive psychology explains this question through the lenses of intuition and reasoning. There are, however, several competing models for explaining the relationship between intuitive (automatic)

45 For an earlier analysis centred on behavioural economics insights and nuclear weapons policies, see Knopf, W. J., Harrington, I. A. and Pomper, M. (2016), *Real-World Nuclear Decision Making: Using Behavioral Economics Insights to Adjust Nonproliferation and Deterrence Policies to Predictable Deviations from Rationality*, James Martin Center for Nonproliferation Studies, https://calhoun.nps.edu/handle/10945/47777.
46 Getler, M. (1982), 'Foreign Policy Focus for Reagan', *Washington Post,* 8 October 1982, https://www.washingtonpost.com/archive/politics/1982/10/08/foreign-policy-focus-for-reagan/7bece42a-4cc6-43c6-b06f-94fc1975ff52.
47 Hoffman, D. (1999), 'I Had A Funny Feeling in My Gut', *Washington Post*, 10 February 1999, https://www.washingtonpost.com/wp-srv/inatl/longterm/coldwar/soviet10.htm.
48 President's Foreign Intelligence Advisory Board (1990), *The Soviet "War Scare"*, 15 February 1990, declassified 14 October 2015, p. x, https://www.archives.gov/files/declassification/iscap/pdf/2013-015-doc1.pdf.
49 For a comprehensive analysis on intuition and decision-making processes, see Kahneman, D. (2011), *Thinking, Fast and Slow*, London: Penguin Books.
50 Ibid., p. 10.
51 Herbert A. Simon, for instance, argues that mundane problems which occur every day could be handled through recognition that comes from past experiences. See Simon, H. A. (1987), 'Making Management Decisions: The Role of Intuition and Emotion', *The Academy of Management Executive*, 1(1), p. 59.
52 Kahneman (2011), *Thinking, Fast and Slow*, p. 44.

and deliberate (controlled) thinking.[53] This is mainly because experts look at the issue from different angles: while Daniel Kahneman explains dual-process thinking from a cognitive psychology perspective with a focus on judgment and decision-making, Jonathan Haidt and Joshua Greene expound it from a moral psychology perspective.[54]

Borrowing from Kahneman's explanation, human brains have both a fast-thinking (system 1) and slow-thinking (system 2) mode. While system 1 is quick and impulsive, system 2 is deliberate and relies on logic and analytical thinking.[55] In medical science, similar considerations exist, with the two hemispheres of a human brain providing insights into the link between intuition and reason. While the left hemisphere is responsible for analytical processes and logic, the right hemisphere has the role of recognizing visual patterns, hunches and non-verbal cues.[56] System 1 is responsible for the emotional response and the gut feeling mentioned above, and it 'will interact with the gut as well as, for example, cardiovascular, respiratory, and hormonal systems'.[57]

In day-to-day decision-making, intuition and reason are not distinct processes; they are inherently mutually reinforcing. Information informs intuition, and vice versa. A meta-analysis study on the subject found that both processes are a continuum of each other.[58] Moreover, both processes could be fallible. For instance, while a common source of error in system 1 could be for the outputs to be biased (e.g. biased decisions), errors may occur in system 2 because the decision-maker cannot come up with a solution based on their existing knowledge.[59] The latter case could occur as a consequence of a lack of training or knowledge on the part of the decision-maker.[60]

However, decision-making in times of crisis, and especially nuclear decision-making, is not a usual business, mainly because decision-making when there is time for deliberation is different from decision-making when under pressure.

In nuclear decision-making with high levels of uncertainty, for instance due to clashing intelligence reports, system malfunctions or human error, an analysis purely based on information is hard to find. At times of high uncertainty, duty officers need to quickly assess the situation and decide whether to report it to

53 In order to have a comprehensive understanding on dual-process theory, please also see the work of Jonathan Haidt and Joshua Greene. Haidt argues that 'moral reasoning is rarely the direct cause of moral judgment'. For Haidt, the predominant form of thinking is intuition and moral judgment, and reasoning is often there to justify a decision that has already been taken on the basis of intuition. See Haidt, J. (2001), 'The Emotional Dog and its Rational Tail: A Social Intuitionist Approach to Moral Judgment', *Psychological Review*, 108 (4), pp. 814–34, https://doi.org/10.1037//0033-295X.108.4.814. Joshua Greene argues that humans have two ways of operating (referring to automatic and controlled processing), and that they need both modes in order to be able to trade off between flexibility and efficiency in their thinking when required. See Greene, J. (2013), *Moral Tribes*, New York: Penguin Press.
54 Ibid.; Haidt (2001), 'The Emotional Dog and its Rational Tail'.
55 Kahneman, D. (2011), *Thinking, Fast and Slow*, p. 44.
56 Simon (1987), 'Making Management Decisions', p. 58.
57 Allen, A. P., Dinan, T. G., Clarke, G. and Cryan, J. F. (2017), 'A psychology of the human brain–gut–microbiome axis', *Social and Personality Psychology Compass*, 11(4), e12309, p. 2, https://doi.org/10.1111/spc3.12309.
58 Wang, Y. et al. (2015), 'Meta-analytic Investigations of the Relation Between Intuition and Analysis', *Journal of Behavioral Decision-Making*, 30(1), pp. 15–25, https://doi.org/10.1002/bdm.1903.
59 deLaplante, K. (2017), '019 – Understanding Your Divided Mind: Kahneman, Haidt and Greene', Argument Ninja Podcast, 31 May 2017, available at https://podcasts.apple.com/gb/podcast/019-understanding-your-divided-mind-kahneman-haidt/id1136936889?i=1000386100210.
60 Ibid.

higher echelons. Such decisions at the strategic level may include the possibility of ordering nuclear weapons use to escalate a conventional conflict to a nuclear level.

When making decisions under stress, the human mind is cognitive and emotional, racing to search for ideas and solutions – it is, so to speak, in a different mindset.[61] However, it is not only the brain that responds in this situation, but also the gut. Research on the microbiome reveals the connection between the gut and the brain (referred to in the literature as the gut–brain axis).[62] Although much remains to be discovered, the link between the central nervous system and the enteric nervous system signals 'direct and indirect pathways between cognitive and emotional centres in the brain with peripheral intestinal functions'.[63] Psychological stressors (relating either to chronic or acute stress) may also have an impact on this unconscious process.[64]

The decision-maker should have a critical mindset in order to realize that their preconceptions and prejudices might affect their instincts, or that they may not have the full information at hand to help them decide. In times of crisis decision-making, such awareness would help them to assess the situation with a different mindset. This could, for instance, be achieved through training the mind and assessing potential pathways (as well as alternative situations and scenarios) ahead of a crisis. This type of training could be conducted with individuals and collectively (e.g. in teams, departments, within governments, or on an intergovernmental basis). While individual training could address challenges that are pertinent to personal characteristics, collective training could help address cognitive biases such as groupthink.

In the context of medical surgery, Rahul Jandial, a neurosurgeon, follows a similar training practice:

> Great performers are not immune to pressure, they have simply learned to manage it. Preparation is key. Visualization can be helpful. [...] Mental practice is a particular technique that entails sitting quietly and imagining yourself performing the task from start to finish. Rehearsing in your mind works because you're activating many of the same neurons as you would if you were actually doing it. [...] For me, it's important not only to visualize what I want to do but to create crisis scenarios in my mind to visualize my response when it all goes south.[65]

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61 Discussion with Rahul Jandial, neurosurgeon at the International Neurosurgical Children's Association, on the subject of crisis time decision-making. For detailed analysis on the subject, see, Jandial, R. (2021), *Life on a Knife's Edge: A Brain Surgeon's Reflections on Life, Loss and Survival*, UK: Penguin Life.
62 Carabotti, M., Scirocco, A., Maselli, M. A. and Severi, C. (2015), 'The gut-brain axis: interactions between enteric microbiota, central and enteric nervous systems', *Annals of Gastroenterology*, 28(2), p. 203.
63 Jandial (2021), *Life on a Knife's Edge,* pp. 43–44.
64 Studies on animal models point to the impact of stress on their microbiome which can in turn have an impact on the brain–gut axis. See Allen, Dinan, Clarke and Cryan (2017), 'A psychology of the human brain–gut–microbiome axis'.
65 Jandial (2021), *Life on a Knife's Edge,* pp. 41–42.

05 Nuclear decision-making case studies

Previous cases of near nuclear use provide insights into the human judgment processes in decision-making, highlighting the role of uncertainty and complexity in determining the outcome of critical nuclear decisions.

To illustrate uncertainty and complexity within the nuclear decision-making process, this section focuses on three case studies: the 1983 Soviet nuclear false alarm incident (also known as the Serpukhov-15 or Petrov incident), the Able Archer-83 exercise, and the 1995 Norwegian rocket launch incident (also known as the Black Brant scare).

The authors have chosen these particular cases to analyse in further detail for the following reasons: they provide a comparison of the impact of the security environment in nuclear decision-making; and they enable an understanding of the role of uncertainty and complexity under consistent security conditions.

Both Able Archer-83 and the nuclear false alarm incident took place in 1983, providing an opportunity to compare two incidents where security concerns were similar, in a context of elevated security tensions. On the other hand, the study of the 1995 Norwegian rocket launch incident allowed the researchers to judge whether – and to what extent – the degree of tension in the security environment matters, for instance in causing misperception, escalation or de-escalation.

Whereas Able Archer-83 provides insights into the misperceptions of chief decision-makers, especially in relation to the military exercises and training of forces that take place at times of elevated tensions, the 1983 nuclear false alarm incident captures the role as a decision-maker of a duty officer

(Lieutenant Colonel Stanislav Petrov), who trusted his 'gut feeling' and decided to relay information about incoming intercontinental ballistic missiles (ICBMs) to higher echelons as a false alarm. This action de-escalated a situation that could have led to the issuing of a preliminary command, which would in turn have unlocked the command and control chain to make it ready for a launch order from a decision-maker. Although Petrov trusted his intuition, guided by the experience that Soviet early-warning systems were patchy at the time, it is likely that he made a definitive choice without being consciously aware of it as he interpreted the data which suggested the presence of oncoming missiles. The interpretation that came to Petrov's mind might have dominated the situation, and he may not have been aware of the uncertainty and ambiguity at play at that moment. As Kahneman, a social psychologist, put it:

> System 1 does not keep track of alternatives that it rejects, or even of the fact that there were alternatives. Conscious doubt is not in the repertoire of System 1; it requires maintaining incompatible interpretations in mind at the same time, which demands mental effort. Uncertainty and doubt are the domain of System 2.[66]

Lastly, the 1995 Norwegian rocket launch incident highlights the importance of information sharing and situational awareness in preventing misunderstandings, even in an amicable international security environment. Information sharing diminishes misperception and aids de-escalation.

These cases not only highlight the importance of leadership and human judgment but also provide insights into cognitive biases (i.e. over- and/or underconfidence in nuclear command and control systems) and their impact on decision-making. Trust is also a common tenet within these cases, especially in terms of reliance on humans as gatekeepers to prevent future catastrophes. These incidents showcase the importance of maintaining an amicable security environment to ensure that uncertainty does not reach unacceptable levels. The lessons learned from them can feed into arms control negotiations and discussions at the NPT review process.

Case study 1: the 1983 Soviet nuclear false alarm

Introduction

The events of 26 September 1983 occurred in the context of an atmosphere of extremely high tensions, and the incident is widely regarded as one of several low points in US–Soviet relations during the course of the Cold War. In the early hours of the morning, the Soviet 'Oko' [Eye] missile defence early-warning satellite system, the control centre of which was located at Serpukhov-15, southwest of Moscow, detected a suspected inbound attack from the US. This case study considers the decision-making process that unfolded in response to this warning; the context in which the decisions were made, including the role of uncertainty and complexity; and the lessons that this event provides for nuclear scholars and policymakers.

66 Kahneman (2011), *Thinking, Fast and Slow*, p. 80.

Distrust and uncertainty were at some of their highest ever levels during this period of modern history, as a result both of a ratcheting-up of anti-Soviet rhetoric by the US and deep mistrust of the US on the part of the Soviets, which had been punctuated intermittently by a series of events outlined below. As a consequence the margin for miscommunication, misinterpretation or error was perhaps at its slimmest, and both US and Soviet nuclear arsenals were on near hair-trigger alert,[67] a policy by which nuclear weapons are maintained in a ready-to-launch status to enable rapid deployment.[68] It is for these reasons that this false alarm, in which the Soviet early-warning satellite system mistakenly identified an inbound nuclear attack from the US, could very easily have resulted in retaliation in the form of nuclear war.

Security environment

The early 1980s was a particularly tense and unsettled period within the Cold War. The Reagan presidency, which began in 1981, was characterized by a more robust and confrontational rhetoric on the part of the US towards the Soviet Union than the presidency of Jimmy Carter which preceded it. One of the first indications of this more hawkish approach came rather swiftly in 1981 when Reagan prioritized the modernization of the US nuclear arsenal, in combination with an accelerated general military build-up.[69] It was Reagan's belief that this development of military capabilities was required in order for the US to be able to bargain with the Soviet Union from a position of strength, leading to a 34 per cent increase in US defence spending between 1981 and 1986.[70]

It is hardly surprising that this posturing did not go unnoticed by the Soviets, who had become increasingly concerned about the prospect of the US developing the capability to carry out a decapitating nuclear first strike. In early 1981, the then chairman of the KGB, Yuri Andropov, stated that the prospect of such an attack was sufficiently significant for Operation RYaN to be initiated in order to counter this threat.[71] This operation consisted of extensive intelligence-gathering on possible signs of an impending first-strike attack by the US, reports of which were often inflated and inaccurate, which then increased the appetite for even more intelligence.[72] This contributed towards the perpetuation of a cycle of fear and mistrust that continued apace from 1981 and became more acute as Andropov ascended to become leader of the Soviet Union in 1982.

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67 Roberts, S. (2015), 'NATO War Games Unwittingly Put Soviets and U.S. on 'Hair Trigger' in '83, Analysis Suggests', *New York Times*, 9 November 2015, https://www.nytimes.com/2015/11/10/world/europe/nato-war-games-unwittingly-put-soviets-and-us-on-hair-trigger-in-83-analysis-suggests.html.
68 Union of Concerned Scientists (2014), 'What is Hair-Trigger Alert? Hundreds of US nuclear warheads are kept ready to launch within minutes—making us less safe, not safer', Explainer, 3 October 2014, https://www.ucsusa.org/resources/what-hair-trigger-alert.
69 Council on Foreign Relations (2021), 'U.S.-Russia Nuclear Arms Control 1949–2021', https://www.cfr.org/timeline/us-russia-nuclear-arms-control.
70 Woolf, A. F. (2020), 'Bargaining with Nuclear Modernization: Does it Work?', Arms Control Association, https://www.armscontrol.org/act/2020-10/features/bargaining-nuclear-modernization-does-work.
71 National Security Archive (2018), 'The Soviet Side of the 1983 War Scare', https://nsarchive.gwu.edu/briefing-book/aa83/2018-11-05/soviet-side-1983-war-scare.
72 Jones, N. (2016), 'The Vicious Circle of Intelligence' in Schaefer, B., Jones, N. and Fischer, B. B. (2016), *Forecasting Nuclear War: Stasi/KGB Intelligence Cooperation under Project RYaN*, https://www.wilsoncenter.org/publication/forecasting-nuclear-war.

Further contributing factors to the degradation of the US–Soviet Union relationship in the early 1980s included the failed initial efforts in 1982 towards the bilateral Strategic Arms Reduction Treaty (START),[73] President Reagan's subsequent public designation on 8 March 1983 of the USSR as an 'evil empire',[74] and the announcement on 23 March of the US pursuit of the space-based anti ballistic missile Strategic Defense Initiative[75] (SDI – also known as the 'Star Wars' programme). In combination, these strategic developments contributed incrementally to the worsening of US–Soviet relations to depths that had only previously been witnessed during the Cuban missile crisis.

An additional factor that contributed to heightened tensions between the US and the Soviet Union was the shooting down on 1 September 1983 by Soviet forces of a Korean Air Lines Boeing 747, acting under the presumption that it was a US reconnaissance flight, demonstrating and further exacerbating the strained relations between the superpowers.[76]

The Korean Air Lines Flight 007 incident is a good illustration of decision-making amid uncertainty.[77] The civilian Korean Air Lines flight, which was en route from New York to Seoul via Anchorage in Alaska, entered Soviet airspace due to an error made while flying in autopilot.[78] As a result, the airliner went off course and headed towards the Kamchatka Peninsula in the far east of the Soviet Union.[79] On the same night, the Soviet Union was tracking a US Air Force (USAF) surveillance jet plane (an RC-135[80]), which was waiting to monitor a scheduled Soviet ballistic missile test. Both planes had similar features (e.g. four engines under the wings); confusion occurred when both planes crossed paths in the radar readings, and the system 'somehow lost the RC-135 and picked up the 747, now unexpectedly heading directly for Kamchatka'.[81] The USAF jet returned to its base, as the expected missile test did not take place.[82] The ground controllers tried to determine the type of the plane based on its number of engines, but the weather conditions were poor. A Soviet fighter pilot, Lieutenant Colonel Gennadi Osipovich, tailed the Korean airliner and reported that the plane had 'flickering flashing lights', but this did not raise alarms on the ground. Osipovich received the order to fire. All 269 of the civilians on board the aircraft – including Larry McDonald, a member of the US Congress – died in the incident, which President Reagan called a 'massacre'.[83] This incident was a tragic culmination of the fear, distrust and paranoia that had been engendered through an extended period of escalation.

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73 Kimball, D. G. (2021), 'Looking Back: The Nuclear Arms Control Legacy of Ronald Reagan', Arms Control Association, https://www.armscontrol.org/act/2004_07-08/Reagan.
74 Clines, F. X. (1983), 'Reagan Denounces Ideology of Soviet as 'Focus of Evil'', *New York Times*, 9 March 1983, https://www.nytimes.com/1983/03/09/us/reagan-denounces-ideology-of-soviet-as-focus-of-evil.html.
75 Atomic Heritage Foundation (2018), 'Strategic Defense Initiative (SDI)', 18 July 2018, https://www.atomicheritage.org/history/strategic-defense-initiative-sdi.
76 Mastny, V. (2009), 'How Able Was "Able Archer"?': Nuclear Trigger and Intelligence in Perspective', *Journal of Cold War Studies*, 11(1), p. 117, https://doi.org/10.1162/jcws.2009.11.1.108.
77 For an extensive analysis on the incident, see Hoffman, D. (2010), *The Dead Hand: The Untold Story of the Cold War Arms Race and Its Dangerous Legacy*, London: Anchor, pp. 72–100.
78 The autopilot was falsely set at a magnetic heading.
79 Hoffman (2010), *The Dead Hand*, p. 74.
80 Ibid. The RC-135 was a converted Boeing 707, well known to the Soviet Union.
81 Hoffman (2010), *The Dead Hand*, p. 74.
82 Ibid.
83 Patterson, T. (2013), 'The downing of Flight 007: 30 years later, a Cold War tragedy still seems surreal', CNN, 31 August 2013, https://edition.cnn.com/2013/08/31/us/kal-fight-007-anniversary/index.html.

In the case of the September 1983 false alarm, the impact of mistrust between the US and the Soviet Union meant that the warning of an incoming attack came at a moment when an unprovoked attack had been considered and feared for some time, thus affording a greater degree of credibility to the veracity of the threat than would have perhaps been accorded at other stages during the Cold War, and providing an example of confirmation bias at play. Only months later, these events were also to contribute towards the overarching security environment in the case of Able Archer-83, as will be covered below.

Timeline and decision-making

The 1983 nuclear false alarm incident occurred in relative isolation from the external world, and in a compressed time frame. Other than among the Soviet leadership, no details of the incident were made public until the 1990s (when former colonel general Yuri Votintsev made reference to it in his memoirs).[84] Given that information on the incident was strictly classified, the following account has been woven together from the fullest information available – primarily from published interviews with Lieutenant Colonel Petrov, whose role in the decision-making process cannot be understated.

In the early hours of 26 September 1983, Petrov sat at the control console of the Oko early-warning satellite system at Serpukhov-15, the military hamlet that housed the system's control centre. Suddenly, a launch warning began to flash, indicating at first that a single inbound ICBM travelling from the US had been detected by the satellite sensors. Shortly afterwards, several more ICBMs were registered, giving a total of five registered launches.[85]

As the commander on duty, responsibility fell to Petrov to verify the accuracy of these warnings and relay his assessment to his superiors. What is considered to be the most reliable and comprehensive account of the standard operating procedures in these circumstances was recorded by David Hoffman, who noted that: 'Petrov was situated at a critical point in the chain of command, overseeing a staff that monitored incoming signals from the satellites. He reported to supervisors at warning-system headquarters; they, in turn, reported to the general staff, which would consult with Soviet leader Yuri Andropov on the possibility of launching a retaliatory attack.'[86] Petrov was therefore obliged by protocol to inform his supervisors. However, before doing so, he first attempted to verify the unexpected warning.

As a first port of call, Petrov checked the computer readings from additional satellites within the Oko constellation, which matched those of the initial warning.[87] The accuracy of these warnings was also bolstered by the fact that

84 Chan, S. (2017), 'Stanislav Petrov, Soviet Officer Who Helped Avert Nuclear War, Is Dead at 77', *New York Times*, 18 September 2017, https://www.nytimes.com/2017/09/18/world/europe/stanislav-petrov-nuclear-war-dead.html.
85 Forden, G., Podvig, P. and Postol, T. A. (2000), 'False alarm, nuclear danger', *IEEE Spectrum*, 37(3), pp. 31–39, https://doi.org/10.1109/6.825657.
86 Hoffman, D. (1999), 'I Had A Funny Feeling in My Gut'.
87 Maynes, C. (2017), 'The unsung Soviet officer who averted nuclear war', *The World*, 21 September 2017, https://www.pri.org/stories/2017-09-21/soviet-officer-who-averted-nuclear-war.

the figure '3' had appeared on the command console, which meant that the reliability of this assessment was of the highest order. It was this detail that began to sow doubt in Petrov's mind as to the veracity of the satellite warning. As it was later noted, in such conditions, 'the system technically could not give the highest degree of reliability'.[88] At this juncture, Petrov sought to further scrutinize the satellite data by cross-referencing it with other sources. Unfortunately, poor weather stymied the possibility of visually verifying the satellite information.[89]

As a result, the decision as to whether to confirm the threat as legitimate or to inform his supervisors that this was a false alarm fell to Petrov. The window of opportunity available to him was limited, which undoubtedly contributed to the pressure under which his decision was made. While Petrov admitted later in his life that he believed that the odds of the threat being genuine or false were '50/50',[90] he ultimately made the decision to report the incident as a false alarm. A number of considerations influenced this final decision, ranging from a lack of corroborating radar or telescopic data[91] to assumptions that missiles would not be launched from only one base,[92] nor would they be so few in number in the case of a first strike,[93] as well as an impossible-to-ignore feeling in his gut that the US would not launch a sudden attack on the Soviet Union in this manner.[94] All of these indicate how system 1 thinking (in other words, quick and impulsive thinking), along with system 2 logical considerations, was at play within Petrov's decision-making.

The decision-making process throughout the 1983 nuclear false alarm makes clear that there are moments at which different decisions could have been reached.

Following the relaying of the nuclear false alarm message, it was then a matter of waiting to be proven either correct or incorrect. Fortunately, Petrov's assessment proved correct in this instance, thus arresting the chain of crisis escalation at a relatively early point in the decision-making process by incorporating all the available information at his disposal and reporting his judgment along with the facts, in spite of the standard operating procedures. Later assessments indicated that the incident occurred because of the reflection of sunlight on the satellite's infrared sensors.[95] As a result of Petrov's actions, it is generally

88 Global Security (undated), 'False Alarm – 27 September 1983', https://www.globalsecurity.org/wmd/world/russia/c3i-false-alarm-1983.htm (accessed 14 Feb. 2022).
89 Peppard, M. (2015), 'Accidental Armaggedon', *Commonweal*, 4 February 2015, https://www.commonwealmagazine.org/accidental-armaggedon.
90 Aksenov, P. (2013), 'Stanislav Petrov: The man who may have saved the world', BBC News, 26 September 2013, https://www.bbc.co.uk/news/world-europe-24280831.
91 Jones (2016), *Able Archer 83*, p. 28.
92 Stanislav Petrov, interviewed in Vasilyev, Y. (2004), 'On the Brink', *Moscow News*, 29 May 2004, http://www.brightstarsound.com/world_hero/the_moscow_news.html.
93 Hoffman (1999), 'I Had A Funny Feeling in My Gut'.
94 Jones (2016), *Able Archer 83*, p. 28.
95 Chan (2017), 'Stanislav Petrov, Soviet Officer Who Helped Avert Nuclear War, Is Dead at 77'.

understood that the details of the suspected attack were not discussed with senior Soviet officials at the time of the incident, though some divergences exist on this.[96]

The decision-making process throughout the 1983 nuclear false alarm, outlined above, makes clear that there are moments (or critical nodes) at which different decisions could have been reached, thus affecting the trajectory of the crisis. The possible alternative outcomes and important nodes are outlined below, to provide a better picture of the complexity inherent in nuclear decision-making.

Critical nodes and alternative pathways to decision-making

1. The functioning of the early-warning system

Several elements combine to make the eventual outcome even more fortuitous than it appears at first sight. Firstly, minor conjecture exists as to whether the launch reports from the satellites immediately bypassed Petrov and were automatically escalated to his superiors for their immediate consideration. As Hoffman reported:

> Usually, Petrov said, one report of a lone rocket launch did not immediately go up the chain to the general staff and the electronic command system there, known as Krokus. But in this case, the reports of a missile salvo were coming so quickly that an alert had already gone to general staff headquarters automatically, even before he could judge if they were genuine.[97]

Meanwhile, Eric Schlosser notes that: '[t]he Soviet general staff was alerted, and it was Petrov's job to advise them whether the missile attack was real',[98] while Forden, Podvig and Postol have suggested that it was 'possible that these warnings were automatically sent on to the Soviet General Staff'.[99]

In an interview with TIME magazine in 2015, Petrov remarked that: 'We built the system to rule out the possibility of false alarms',[100] which points to the system engineering concept and the best practice measure of ensuring security by design. Regardless, nuclear command and control architectures are composed of complex systems, interacting with each other in a non-linear manner, and they can still fail to operate as intended, just as had occurred in this incident.

Moreover, the past experiences of both the General Staff and Petrov with the failure of the early-warning systems seem to have had an effect on their judgment. The accuracy of the Oko satellite system and the fact that 'it had been rushed into service'[101] might have provided a baseline understanding of what constitutes trust, or lack thereof, in these systems. By the time of the incident, as historians have

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96 As a log of the incident was not kept, for which Petrov was in fact later reprimanded, there are no records of the conversations between Petrov and his superiors during the incident beyond Petrov's own retrospective recollections. While there is agreement that Petrov consulted with his colleagues at Serpukhov-15 in an attempt to verify the authenticity of the alarm, it is unclear whether the data and circumstances were deliberated between Petrov and his superiors on the telephone, or whether he simply informed them of his assessment that it was a false alarm.
97 Hoffman (1999), 'I Had A Funny Feeling in My Gut'.
98 Schlosser, E. (2013), *Command and Control: Nuclear Weapons, the Damascus Accident, and the Illusion of Safety,* New York: Penguin Books, p. 447.
99 Forden, Podvig and Postol (2000), 'False alarm, nuclear danger', p. 33.
100 Shuster, S. (2017), 'Stanislav Petrov, the Russian Officer Who Averted a Nuclear War, Feared History Repeating Itself', *TIME*, 19 September 2017, https://time.com/4947879/stanislav-petrov-russia-nuclear-war-obituary.
101 Hoffman (1999), 'I Had A Funny Feeling in My Gut'.

indicated, 12 Oko satellites had already failed, having only been put into service the previous year, which provides justification for the presence of doubt over the reliability of the system.[102]

Petrov's retrospective thinking on the subject also shows personal, societal, political, economic and cultural considerations within Soviet decision-making, specifically in that the leadership did not overtly acknowledge the incident at the time. As Petrov noted in a 2004 interview with the Moscow News: 'If I was to be decorated for that incident, someone would have had to take the rap – above all, those who had developed the [ballistic missile early-warning system], including our renowned academicians who had received billions and billions in funding.'[103]

This incident also highlights the role of the human–machine interaction and the need to keep oversight between the two, given the fallibilities inherent in both.

2. The Soviet nuclear posture

US–Soviet relations appeared to be at a low ebb at the time of the false alarm incident. Despite this, it is believed that the Soviet posture was to launch under attack,[104] rather than to launch on warning.[105] This is critical, given the earlier consideration of the uncertainty that surrounds whether the warning reports were indeed escalated to the General Staff automatically when the satellites began to register suspicious activity. Had the Soviets adopted a launch-on-warning posture, in light of the perceived level of threat from the US, this would have narrowed or perhaps even removed entirely the decision-making window from the already limited eight- to 15-minute range[106] that it is estimated there would have been for checks to be carried out.

3. Individual decision-makers' characteristics

The happy chance that Petrov was the officer in command on the night of the incident has been well documented, and it is difficult to understate the centrality of his thought process and character to the avoidance of escalation. The combination of Petrov's education and intuition was instrumental in the handling of the crisis.

Petrov's background as a scientist was extremely important in determining his response to what was placed in front of him that night.[107] It just so happened that Petrov was not originally scheduled to be on shift that evening, but was in fact covering for a sick colleague.[108] It is suggested that Petrov's scientific background

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102 Jones (2016), *Able Archer 83*, p. 28.
103 Stanislav Petrov, interviewed in Vasilyev (2004), 'On the Brink'.
104 Fisher, M. (2015), 'How World War III became possible', Vox, 29 June 2015, https://www.vox.com/2015/6/29/8845913/russia-war.
105 Both launch-on-warning and launch-under-attack postures require that nuclear weapons are primed for rapid deployment within minutes of confirmation. The difference between the two is that the launch-under-attack posture requires more early-warning information. For more, see Barrett, A. M. (2016), 'False Alarms, True Dangers? Current and Future Risks of Inadvertent U.S.-Russian Nuclear War', RAND Corporation, https://www.rand.org/pubs/perspectives/PE191.html.
106 There are differing opinions on the window for response. According to some experts it is an eight- to 10-minute window: see Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*, p. 13. Others indicate the range as between eight and 15 minutes: see Global Security (undated), 'False Alarm – 27 September 1983'.
107 Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*, p. 26.
108 The Times (2017) 'Obituary: Stanislav Petrov', 21 September 2017, https://www.thetimes.co.uk/article/stanislav-petrov-obituary-j78rg8tmx.

led him to critically scrutinize the data from the satellites to a greater extent than one of his colleagues might have done.[109] It is likely that Petrov's assessment of the situation was informed by his engineering background and aptitude with computer malfunctions. Petrov had been 'de-bugging the main computer for several weeks'.[110] Thus his experience and expertise most likely led him to recognize the patterns and question the information with which he was being presented. The US nuclear security expert Bruce Blair, who had the opportunity to interact with Petrov on occasion, believed that Petrov 'had not been trained and conditioned to respond to warnings by checking boxes and accepting computers' assessments as final'.[111]

Particularly when considering the relative isolation in which this incident took place, and the short time frame in which it played out, it is impossible to discount the personal characteristics of those involved – specifically Petrov – in determining the outcome of the incident.

Lessons learned

The 1983 nuclear false alarm incident provides several lessons as a cautionary tale for future decision-makers.

The first of these lessons concerns the oversight of digital systems, such as computers and AI – which is likely to be of greater relevance in the coming years. Neither a computer nor a human is infallible, and both have the capacity to make mistakes or misinterpretations. The incident also highlights the possibility of unforeseen chains of events, such as how the satellites had mistaken the reflected sunlight as the launch of ICBMs.

In future, human oversight and understanding of how these systems work will be imperative as states aim to automate a greater number of the processes involved in nuclear command, control and communication.[112] Just as Petrov, through his background as an engineer, was able to cast a critical eye over the data that had been gathered by the satellites, he was also able to bring wider nuance to this calculation – for example, the strategic understanding that a first strike of only five ICBMs would be highly illogical. While several factors, such as the number of incoming missiles, could be programmed into the algorithms within early-warning systems, a significant challenge lies in recognizing the limitations of programmers in terms of their ability to include all possible outcomes and to account for robustness by ensuring that systems that are trained in one environment can still function in other environments.

Greater automation is inevitable in the coming years: however, the lesson from the false alarm incident is that while human oversight over these processes must be retained, decision-makers must encourage duty officers to think creatively

109 Blair, B. G. (2017), 'My time with Stanislav Petrov: No cog in the machine', *Bulletin of the Atomic Scientists*, 25 September 2017, https://thebulletin.org/2017/09/my-time-with-stanislav-petrov-no-cog-in-the-machine.
110 Ibid.
111 Ibid.
112 For a detailed study on the discussion surrounding AI and nuclear weapon systems, see Boulanin, V. (ed.) (2019), *The Impact of Artificial Intelligence on Strategic Stability and Nuclear Risk, Volume I: Euro-Atlantic Perspectives*, Stockholm: Stockholm International Peace Research Institute, https://www.sipri.org/publications/2019/other-publications/impact-artificial-intelligence-strategic-stability-and-nuclear-risk-volume-i-euro-atlantic.

towards the systems that they interact with, and the way they interpret the information and systems calculations, in order to improve their understanding of the limits of both man and machine. Recognizing that the possibility of failure is inescapable, the human mind (or the human–machine interface, in the future) could prepare for alternative options and solutions ahead of time.

A second, related, lesson that can be drawn from this incident is the value in having a breadth of actors within the decision-making process at different levels and with complementary expertise. As was highlighted, the fact that Petrov was perhaps an outlier within the environment, having not had as substantial a record of combat history as his colleagues and being an individual with a scientific background, may have proved beneficial to the decision-making process. Conversely, the presence of differing perspectives alone may not be enough for the decision-making process to receive adequate scrutiny, and could perhaps be considered as an undesirable impediment to swift decision-making in times of crisis, when windows of opportunity are small. However, it does seem that this case study illustrates how the incorporation of civilian perspectives and/or scientific rigour, as well as individual habits and perspectives more broadly, can play an important consultative role within the decision-making process on the authorization of a nuclear launch or retaliation.

Recognizing that the possibility of failure is inescapable, the human mind (or the human–machine interface, in the future) could prepare for alternative options and solutions ahead of time.

A final lesson from the false alarm case centres around lines of communication during such crises and the need for alternative means by which reliable information can be gathered when relations between countries are at their lowest ebb. As noted in the earlier section on the security environment in advance of the incident, both rhetoric and actions on both sides had been deteriorating at a significant rate in the preceding years. Thus, when the events of that day began to unfold, the possibility – however extreme – that the US had indeed launched a limited first strike was not wholly discountable. Faced with such a major decision to be made, and without the means by which to further verify the accuracy of the satellite reports until it was perhaps too late, the Soviet authorities were faced with the prospect of making this decision with very patchy, incomplete information. Although the Soviet Union and the US had established a communications hotline in the wake of the Cuban missile crisis, it was not used in this incident.[113] Engaging in military-to-military communication or using established hotlines could reduce tensions and clarify miscommunications in times of crisis.

113 Scharre, P. (2016), *Autonomous Weapons and Operational Risk: Ethical Autonomy Project*, Center for a New American Security, pp. 34–37, http://www.jstor.org/stable/resrep06321.9.

Case study 2: The Able Archer-83 exercise

Introduction

The declassification by the US government in the early 2010s of several Cold War-era documents has shed new light on the events surrounding a NATO nuclear-preparedness exercise, codenamed Able Archer-83, which began on 2 November 1983 and which has served to highlight just how close the US and the Soviet Union came to a nuclear confrontation as the exercise progressed. Able Archer-83 was designed to test NATO's operating procedures should a conventional war in Europe escalate to the potential use of nuclear weapons.[114] This incident elevated tensions between the US and the Soviet Union to a point where a nuclear attack from either side could easily have been provoked.[115]

Security environment

As highlighted above in relation to the 1983 nuclear launch incident, by the time the Able Archer-83 exercise took place in November 1983 relations between the Soviet Union and the US were particularly tense. Detente between the two superpowers had largely subsided, and both sides' leadership had begun to adopt distinctly more hostile rhetoric towards one another. Reagan's renowned speech in March 1983 in which he dubbed the Soviet Union an 'evil empire'[116] also marked the beginning of his plans to develop the SDI (see above), a proposed missile defence system capable of intercepting Soviet ICBMs, thus highlighting the defensive nuclear policy posture of the US.[117]

By 1983, suspicions within the Soviet Union in relation to US actions had similarly reached an unusually high point, even in the context of the Cold War. In particular, the Soviets' Operation RYaN had contributed significantly to the atmosphere of mistrust at the time of Able Archer-83. Operation RYaN was an exercise intended to help plan and prepare for a defensive, pre-emptive first strike, based on the premise that intelligence could be gathered on a range of social, economic and political indicators to signal that the West (notably the US) was preparing for nuclear war by means of its own all-out nuclear first strike.[118]

KGB documents dating from 1983 – but not released until some years later – had warned of 'indirect indications of preparation'[119] for nuclear war by NATO nations, a misperception reinforced by the Soviet Union's detection of a spike in classified communications between London and Washington.[120] The nature of this Soviet

114 Atomic Heritage Foundation (2018), 'Nuclear Close Calls: Able Archer 83', 15 June 2018, https://www.atomicheritage.org/history/nuclear-close-calls-able-archer-83.
115 This study and account of Able Archer-83 relies heavily on materials recently declassified by the National Security Archive. These sources are limited to an account of Western intelligence at the time of Able Archer-83, due to the continued classification of Soviet material on this period.
116 Clines (1983), 'Reagan Denounces Ideology of Soviet as 'Focus of Evil''.
117 Atomic Heritage Foundation (2018), 'Nuclear Close Calls: Able Archer 83'.
118 Manchanda, A. (2009), 'When truth is stranger than fiction: the *Able Archer* incident', *Cold War History*, 9(1), p. 118, https://doi.org/10.1080/14682740802490315.
119 Cited in Atomic Heritage Foundation (2018), 'Nuclear Close Calls: Able Archer 83'.
120 This spike in bilateral communications was in fact due to increased communications over the US invasion of Grenada that took place in late October 1983. See Foreign Policy Research Institute (2018), 'Able Archer at 35: Lessons of the 1983 War Scare', https://www.fpri.org/article/2018/12/able-archer-at-35-lessons-of-the-1983-war-scare.

intelligence collection operation, and its founding assumption that a US/NATO first strike was inevitable, highlights the role of perceptions and the state of mind within the Soviet Union – which was mirrored within the US leadership.[121] NATO's war gaming exercise was thus conducted in a security environment fraught with hostility and suspicion that exacerbated the repercussions of the ensuing misinterpretations.

Timeline and decision-making

NATO's Able Archer-83 war gaming exercise took place from 7 to 11 November 1983 and postulated a hypothetical scenario where Warsaw Pact forces outnumbered those of the US and NATO.[122] The exercise itself differed in several ways from previous iterations of the annual exercise: these distinctions are likely to have contributed to the Soviet Union's misperceptions and misunderstandings and to have given rise to its heightened response. One of the most significant differences was NATO's inclusion in Able Archer-83 of rehearsals for the launching of nuclear weapons.[123] This exercise was also more 'provocative' in nature than its predecessors,[124] as it uniquely involved differently coded messaging formats, a higher state of alert than previous iterations, and the incorporation of 'live mobilization exercises from some US military forces in Europe'.[125] Other non-routine elements included long radio silences, a shift of command to an Alternate War Headquarters,[126] and reports of 'nuclear strikes' on open radio frequencies that could have been interpreted as real.[127] In the context of Operation RYaN, with the KGB and GRU paying heightened attention and reacting with a sense of alarm to changes in routine procedures, the specific features of Able Archer-83 led the Soviet Union's authorities to consider that differences had been deliberately introduced to cover for a real first strike against the Soviet Union.[128]

Despite the solely preparatory nature of the Able Archer-83 exercise, an emergency flash telegram was sent on either 8 or 9 November by Soviet intelligence officers to KGB residencies in Western Europe to inform them that NATO forces had been placed on high alert and to ask intelligence officers to seek out further information suggesting US/NATO preparation for a first strike.[129] In response, the Soviet Union moved its ICBMs with nuclear warheads to their launch sites, deployed submarines

121 Manchanda (2009), 'When truth is stranger than fiction'.
122 Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*, p. 14.
123 Jones, N. (2013), 'Countdown to declassification: Finding answers to a 1983 nuclear war scare', *Bulletin of The Atomic Scientists*, 69(6), pp. 47–57, https://doi.org/10.1177/0096340213508630.
124 Manchanda (2009), 'When truth is stranger than fiction', p. 122.
125 Schaefer, Jones and Fischer (2016), *Forecasting Nuclear War*, p. 33.
126 The Able Archer exercise involved a shift of command from NATO's Permanent War Headquarters to an Alternate War Headquarters, located for the purposes of this exercise at the Heinrich Hertz military barracks in Birkenfeld. NATO's Alternate War Headquarters was a predesignated command station for emergency situations that would be used in the circumstance of a major military conflict. See US Air Force (1983), *Exercise Able Archer 83, SAC ADVON, After Action Report*, Seventh Air Division, Ramstein Air Base, Secret NOFORN (No Foreign Nationals), FIOA release, available at https://nsarchive2.gwu.edu/NSAEBB/NSAEBB427/docs/7.%20Exercise%20Able%20Archer%2083%20After%20Action%20Report%201%20December%201983.pdf.
127 Jones (2016), *Able Archer 83*, p. 38.
128 Manchanda (2009), 'When truth is stranger than fiction', p. 118.
129 Manchanda (2009), 'When truth is stranger than fiction'. Although the text of the flash telegram has not been released, it is mentioned in the account of Able Archer-83 by Oleg Gordievsky (a prominent KGB defector), which is cited in Andrew and Gordievsky (1991), 'Comrade Kryuchkov's Instructions'. See also Jones (2016), *Able Archer 83*, p. 32.

carrying nuclear ballistic missiles under the Arctic ice cap, increased the number of reconnaissance flights and heightened the readiness of Soviet air units in Eastern Europe.[130] There is contention over whether the Soviet leadership did in fact consider that an attack was imminent, due to the general absence of mentions of Able Archer-83 in Soviet leaders' memoirs: however, the scale and nature of the Soviet response emphasizes the likelihood that Soviet leaders were involved in the decision to heighten their state of alert.[131]

The heightened response from the Soviet Union to Able Archer-83, while not recorded by the US's early-warning system (it is not known why), was observed by Lieutenant General Leonard Perroots, the assistant chief of staff for intelligence at the USAF in Europe, who reported the atypical Soviet heightened state of alert to General Billy Minter, the commander-in-chief of the USAF in Europe.[132] When Minter asked Perroots whether the USAF should increase its real force generation,[133] Perroots advised that there was insufficient evidence to justify doing so, and that the situation should instead be closely monitored in case of any changes.[134] As a result, neither the US nor NATO decided to increase real force generation and the Soviet Union lowered the state of alert of its missiles and forces.[135] Able Archer-83 concluded on 11 November without a military confrontation between the two superpowers.

Critical nodes and alternative pathways to decision-making

Throughout the trajectory of Able Archer-83, there were several moments when different decisions or circumstances would have led to significantly different pathways and potentially to more escalatory outcomes. These critical nodes highlight how the events of November 1983 could easily have escalated into a nuclear stand-off between the US/NATO and the Soviet Union. This section will explore the various decision-making scenarios that, had different decisions been made or alarms been raised, could have led to a confrontational and nuclear outcome.

1. The Soviet Union's response to Able Archer-83

In response to the perceived threat of the Able Archer-83 exercise, the Soviet Union began preparations for a possible use of nuclear weapons and placed the Soviet 4th Air Army into a heightened state of readiness.[136]

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130 Jones (2013), 'Countdown to declassification', p. 48.
131 For further details on the contention as to which levels of the Soviet leadership were involved in the decision to heighten the Soviet alert posture in response to Able Archer-83, see Manchanda (2009), 'When truth is stranger than fiction' and Mastny (2009), 'How Able Was "Able Archer"?'.
132 Lieutenant General Perroots's testimony comes from his January 1989 'End of Tour Report Addendum'. See National Security Archive (2021), 'U.S. Air Force, Lt. Gen. Leonard H. Perroots, Letter, "End of Tour Report Addendum", January 1989', printed in *Foreign Relations of the United States*, 1981–1988, Volume IV, 'Soviet Union', January 1983–March 1985, https://nsarchive.gwu.edu/document/21035-us-air-force-lt-gen-leonard-h-perroots-letter-end-tour-report-addendum-january-1989.
133 An increase in real force generation refers to increasing the number of personnel and amount of equipment in order to carry out operations and missions, not as part of an exercise.
134 National Security Archive (2021), 'Able Archer War Scare "Potentially Disastrous"', https://nsarchive.gwu.edu/briefing-book/aa83/2021-02-17/able-archer-war-scare-potentially-disastrous.
135 Atomic Heritage Foundation (2018), 'Nuclear Close Calls: Able Archer 83'.
136 National Security Archive (2021), 'Able Archer War Scare "Potentially Disastrous"'.

Several factors contributed to the Soviet interpretation of Able Archer-83 as a cover for a first strike, including: a) the non-routine elements of the exercise; b) the particularly hostile relations between the US and the Soviet Union in November 1983; and c) the possible confirmation bias within the Soviet authorities as their intelligence analysts were seeking evidence to suggest that the West was preparing for a first strike.

If NATO had signalled to the Soviet Union that it was planning to conduct a non-routine exercise, and had warned about the integration of rehearsals for the launch of nuclear weapons as part of the exercise, it is likely that the overall misinterpretations and heightened state of nuclear alert that were engendered by Able Archer-83 would have been avoided. Had NATO avoided conducting an exercise of this scale and nature during a time of heightened tensions, the misinterpretations (and the escalated responses) would have been avoided altogether.

Alternative pathways in this incident could have brought about a Soviet conventional weapons attack or a pre-emptive first nuclear strike in response to the perceived threat of the Able Archer-83 exercise. However, a greater number of steps would have had to be involved for any sort of weapons release to have materialized. Had the evidence suggesting that Able Archer-83 was a veil for a real attack been more convincing and incontrovertible, it is possible that the Soviet Union might have launched a conventional attack against the West. A conventional attack conducted in the tense security climate of 1983, with nuclear weapons on heightened alert, could also have escalated into a nuclear stand-off between the two superpowers. This alternative scenario would have been more likely had senior members of the US leadership – including President Reagan and Vice-President Bush – participated in the Able Archer-83 exercise, as had originally been planned. The decision not to include the president and vice-president had been taken by the US national security advisor, Robert McFarlane:[137] it is likely to have contributed to alleviating the sense of alarm within the Soviet decision-making structure, and it possibly averted a more rapid and escalatory response from the Soviet Union.

2. The role of individual decision-makers

The role played by Lieutenant General Perroots in de-escalating the Able Archer-83 crisis is a thought-provoking departure for an ensuing (and perhaps likely) alternative pathway that could have resulted in a nuclear confrontation between the US/NATO and the Soviet Union. Perroots's individual decision-making characteristics played a significant role in the Western allies' decision to leave the alert posture of their forces unchanged; his decision against escalating US forces in response to the Soviet force escalation, as highlighted in the 1990 report from the President's Foreign Intelligence Advisory Board at the US Department of State,[138] was largely based on 'instinct, not informed guidance' and highlights the influence of gut instinct in determining the trajectory of nuclear decision-making processes.[139] The decision did not follow US standard procedure at the time, which would have required Lieutenant General Perroots and General Minter to alert their

137 Manchanda (2009), 'When truth is stranger than fiction', p. 122.
138 President's Foreign Intelligence Advisory Board (1990), *The Soviet "War Scare"*.
139 National Security Archive (2021), 'Able Archer War Scare "Potentially Disastrous"'.

superiors in order for the US to decide whether to increase its state of alert.[140] Had a different officer been on duty, or had a different commander received Perroots's recommendation to do nothing, the US might have increased its own real alert posture. Indeed, Perroots stated, in his end-of-tour report addendum, 'If I had known then what I later found out I am uncertain what advice I would have given.'[141] Perroots was referring to a full understanding of the scale of the Soviet alert: this statement highlights the fortuity and serendipity of the decision taken.[142] Not only does his decision point to the role of gut instinct in nuclear decision-making, it also signals the role of luck that, according to Benoît Pelopidas, 'seems to have constantly escaped the learning process' in nuclear weapons policy.[143] In the case of Able Archer-83, Perroots's decision to trust his instinct, in preference to carrying out standard operating procedures, may largely be attributed to luck, which can be argued to have played a significant role in averting nuclear crises historically.[144]

The personal nature of this decision also highlights the influence that individual actors had in de-escalating the Able Archer-83 crisis. The role of the commander-in-chief, General Minter, who not only asked Perroots for his recommendation as to which pathway to follow, but also followed this recommendation, has been largely overlooked by scholars. Theoretically, General Minter could have ignored Perroots's recommendation and chosen to increase the US real force posture. This would have further escalated tensions and introduced the potential outcome of a nuclear first strike from either side. What is most significant about this alternative scenario is that had standard procedures been followed, whereby senior US and NATO officials would have been alerted to the Soviet escalation, the decision-making pathway would have been completely different, and the US and the Soviet Union would potentially have found themselves in an escalatory stand-off in Eastern Europe, with both sides' nuclear missiles on a hair-trigger alert.

3. US indications and warning system failure

Throughout the escalatory Soviet response to Able Archer-83, the US indications and warning (I&W) systems 'sounded no alarm bells' despite the rapid escalation of Soviet forces and missile deployment.[145] The I&W systems constitute a 'network of intelligence production facilities with analytical resources' that both produce and disseminate intelligence products within and across commands.[146] While the reasons why the US's I&W systems failed to signal the heightened state of alert on the part of the Soviet Union have not been explored in detail, Lieutenant General Perroots attributed the error to an electronic miscommunication whereby 'electrically reported GAMMA material', or communications intelligence products, was not adequately distributed to those whose need to see the material

140 Jones (2016), *Able Archer 83*, p. 56.
141 National Security Archive (2021), 'U.S. Air Force, Lt. Gen. Leonard H. Perroots, Letter, "End of Tour Report Addendum", January 1989', p. 1427.
142 Ibid.
143 Pelopidas, B. (2017), 'The unbearable lightness of luck: Three sources of overconfidence in the manageability of nuclear crises', *European Journal of International Security*, 2(2), p. 242, https://doi.org/10.1017/eis.2017.6.
144 For a more detailed study of the role of luck in nuclear weapons policy, see Ibid.
145 President's Foreign Intelligence Advisory Board (1990), *The Soviet "War Scare"*, p. 8.
146 Office of the Secretary of Defense (2001), 'Intelligence Warning Terminology', https://archive.org/stream/JMICInteligencelwarnterminology/JMIC_intelligencewarnterminology_djvu.txt.

was the greatest.[147] It is worth noting that Perroots has stated that this error was rectified after Able Archer-83, as it presented a significant failure in the US intelligence cycle.[148]

Despite rigorous testing and planning, technical errors do take place in complex systems, and the cause of such an error may not be human-related. As system engineers argue, 'complexity is leading to important system properties (such as safety) not being related to the failure of individual system components but rather to the interactions among the components that have not failed or […] malfunctioned'.[149] This type of incident symbolizes the 'unknown unknowns' (see Chapter 2).[150] Preparing for the 'unknown unknowns' and embracing uncertainty requires the establishment ahead of time of resiliency measures, such as investing in updating and changing redundant systems, and the training of staff.

As previously stated, the Soviet Union began to escalate its real alert posture after nightfall of the first day of Able Archer-83.[151] However, despite the startling and atypical nature of the Soviet Union's force escalation and missile deployment, the US I&W system did not raise any alarms. The change in Soviet posture did raise strong concerns within the UK government – specifically on the part of the cabinet secretary, Sir Robert Armstrong, who was alarmed by the adoption of such a military posture by the Soviet Union during a major Soviet national holiday (7 November, the commemoration of the October Revolution of 1917). Armstrong warned that the escalation was unlikely to have arisen from routine Soviet procedure, due to its timing, and that it could instead be a reflection of genuine fear within the Soviet Union that the West was preparing for a first strike.[152] Armstrong's analysis can be seen as evidence that his perception of the Soviet leadership's behaviour was based on patterns and past experience, and highlights the role of human cognition in the decision-making process.

Lessons learned

There are several lessons to be learned from the Able Archer-83 case that are valuable in informing future decision-making in the nuclear policy arena.

One of the key lessons learned from the events of Able Archer-83 is the danger of conducting large-scale military exercises in times of heightened tension, often created by hostile rhetoric from leadership. For example, Reagan's 'evil empire' speech of March 1983 and his subsequent labelling in September of the shooting down of Korean Air Lines Flight 007 as 'an act of barbarism' are likely

147 National Security Archive (2021), 'U.S. Air Force, Lt. Gen. Leonard H. Perroots, Letter, "End of Tour Report Addendum", January 1989', p. 1428.
148 Ibid.
149 Leveson, N. (2019), *An Engineering Perspective on Avoiding Inadvertent Nuclear War*, Technology for Global Security Special Report, p. 4, https://securityandtechnology.org/virtual-library/reports/an-engineering-perspective-on-avoiding-inadvertent-nuclear-war.
150 Ibid.
151 Jones, N. and Hoffman, D. (2021), 'Newly released documents shed light on 1983 nuclear war scare with Soviets', *Washington Post*, 17 February 2021, https://www.washingtonpost.com/national-security/soviet-nuclear-war-able-archer/2021/02/17/711fa9e2-7166-11eb-93be-c10813e358a2_story.html.
152 Jones (2016), *Able Archer 83,* p. 30.

to have contributed to the antagonism between the US and Soviet leaderships that provided the hostile context for Able Archer-83 to be misinterpreted.[153] This rhetoric is also likely to have increased the 'risks of miscalculation, escalation and propensity for considering nuclear response'.[154] It was clear from the events described above that leaders and decision-makers needed to be more conscious of the impact of their rhetoric on heightening tensions, a lesson seemingly learned by Reagan, who initiated a remarkable policy shift, demonstrated by his call for the total elimination of nuclear weapons in early 1984.[155] Thus, one of the key lessons from the Able Archer-83 exercise was the necessity to communicate intent to the adversary ahead of time. This has become even more important in an era when the media is far more pervasive and all types of information are liable to 'go viral' on social media platforms. Today, all NATO exercises are declared and strategically communicated to other parties to reduce chances of a misunderstanding.

Effective, open and genuine communication channels and regular NATO messaging could have served as a means of mitigating the Soviet misinterpretation of this exercise as a veil for a first-strike attack against the Soviet Union.

Furthermore, Able Archer-83, and specifically the role played by Operation RYaN, highlights how confirmation bias can play a role in influencing intelligence operations and thus the ensuing military or policy responses. Operation RYaN postured the Soviet Union in a defensive manner that assumed an inevitable pre-emptive strike on the part of the US; any non-routine elements, whether misinterpreted or not, contributed to the hypothesis that a first strike was likely, as well as altering perceptions. This change in perceptions played a role in increasing the propensity for misinterpretation and miscalculation in the context of a large-scale military operation.

Effective and timely communication, as well as clear messaging on nuclear command and control exercises, is essential for avoiding crises. According to the Soviet defence minister, Dmitry Ustinov, NATO's military exercises were 'becoming increasingly difficult to distinguish from a real deployment of armed forces for aggression'.[156] Effective, open and genuine communication channels and regular NATO messaging could have served as a means of mitigating the Soviet misinterpretation of this exercise as a veil for a first-strike attack against the Soviet Union. In 2013 it was revealed that in early 1984, in response to the concerns surrounding the inadequate messaging and informing of NATO exercises, the UK Foreign and Commonwealth Office and Ministry of Defence

153 *New York Times* (1983), 'Transcript of President Reagan's Address on Downing of Korean Airliner', 6 September 1983, https://www.nytimes.com/1983/09/06/world/transcript-of-president-reagan-s-address-on-downing-of-korean-airliner.html.
154 Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*, p. 29.
155 DiCicco, J. (2011), 'Fear, Loathing, and Cracks in Reagan's Mirror Images: Able Archer 83 and an American First Step toward Rapprochement in the Cold War', *Foreign Policy Analysis*, 7(3), pp. 253–74, https://doi.org/10.1111/j.1743-8594.2011.00137.x.
156 Foreign Policy Research Institute (2018), 'Able Archer at 35'.

had drafted a joint paper for discussion with the US that proposed that 'NATO should inform the Soviet Union on a routine basis of proposed NATO exercise activity involving nuclear play'.[157] Reagan also began to take action to improve communication with the Soviet Union in the aftermath of Able Archer-83, delivering a speech calling for increased dialogue on 16 January 1984.[158]

The documentation now available on Able Archer-83 provides a unique opportunity for scholars to analyse how leaders and decision-makers 'might not have learned as much from the Cuban missile crisis […] as they should have'.[159] During the course of the Able Archer-83 exercise, and despite the increasingly escalatory posture adopted by the Soviet Union in response, there was again no use of the crisis communication mechanisms that had been established as a result of the Cuban missile crisis, including the hotline between the US and the Soviet Union. Neither the US nor NATO communicated that the exercise was taking place, despite the non-routine elements that risked misinterpretation; nor was the West warned by the Soviet Union of the escalating tensions and the heightened alert status of the latter's own forces.

Despite the measurable gains in the nuclear decision-making process that have been achieved by using I&W systems, as well as increasingly automated technologies and communication systems in the field of military intelligence, there remains scope for error. The necessity for human supervision is demonstrated by the failure of the US I&W system to accurately provide a timely signal of the heightened state of alert of Soviet forces and missiles. With the increased automation of early-warning systems and of the means by which these warnings are distributed, this lesson is even more critical today.

Finally, the Able Archer-83 exercise also provides lessons on the value of declassified archival material in building an understanding of nuclear decision-making and the likelihood of inadvertent nuclear war. It provides a clear example of the dangers of allowing information about nuclear near-miss incidents to remain secret, as it can provide valuable further lessons for nuclear policy.[160] Indeed, much of the material related to Able Archer-83 and the decision-making process on both the US/NATO and Soviet Union sides remains classified, significantly hindering decision-makers' ability to learn from the miscommunications and misinterpretations that took place. Several critical documents, including Lieutenant General Perroots's end-of-tour addendum and the 1990 report by the President's Foreign Intelligence Advisory Board,[161] were declassified in 2015, since which date they have shed valuable light on this nuclear near-miss incident.

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157 Doward, J. (2013), 'How a Nato war game took the world to brink of nuclear disaster', *Guardian*, 2 November 2013, https://www.theguardian.com/uk-news/2013/nov/02/nato-war-game-nuclear-disaster.
158 Manchanda (2009), 'When truth is stranger than fiction', p. 127.
159 Birch, D. (2013), 'The U.S.S.R. and U.S. Came Closer to Nuclear War Than We Thought', *The Atlantic*, 28 May 2013, https://www.theatlantic.com/international/archive/2013/05/the-ussr-and-us-came-closer-to-nuclear-war-than-we-thought/276290.
160 Scott, L. (2011), 'Intelligence and the Risk of Nuclear War: Able Archer-83 Revisited', *Intelligence and National Security*, 26(6), pp. 759–77, https://doi.org/10.1080/02684527.2011.619796.
161 President's Foreign Intelligence Advisory Board (1990), *The Soviet "War Scare"*.

Case study 3: the 1995 Norwegian rocket launch

Introduction

The Norwegian rocket launch incident took place on 25 January 1995.[162] Norwegian and US scientists launched a Black Brant XII four-stage sounding rocket from the Norwegian island of Andøya. The rocket was designed to assist with the scientific study of the aurora borealis (Northern Lights) by collecting data on atmospheric conditions at various altitudes. As the launch was a scientific endeavour, it was not covered under the 1988 Ballistic Missile Launch Notification Agreement[163] between the Soviet Union and the US. Thus, the details of the rocket launch were communicated in advance to Norway's neighbouring states, including Russia, by the Norwegian foreign ministry by means of a letter of notification – however, it is not known whether this information ever reached the relevant Russian authorities.

Upon the launch of the rocket from the Andøya Rocket Range, its radar signature resembled that of a Trident II submarine-launched ballistic missile (SLBM), and it had a higher boost range[164] than previous Norwegian rockets. Thus, the Soviet early-warning radar misidentified the rocket as a nuclear-tipped ballistic missile.[165] Several scholars argue that Russian president Boris Yeltsin was notified of the launch 'within minutes' and was presented with the *Cheget*, a connected transmission system in the form of a portable 'nuclear briefcase'.[166] In fact, it is not at all clear at what stage (i.e. immediately, on the same day, or after the fact) Yeltsin became involved in this incident (see below). This incident attests to the importance of hotline communications – both internal and external – at all levels of decision-making to prevent an inadvertent escalation.

Security environment

This incident occurred in a post-Cold War security environment, a relatively stable period during which US–Russia relations were relatively amicable. The previous decade in particular had seen both superpowers' nuclear arsenals reach their peaks, and, as reflected in the two preceding case studies from 1983, tensions had run at unprecedented heights between the US and the Soviet Union. In contrast, the Norwegian rocket launch incident took place in 1995, a few years after the dissolution of the Soviet Union in late December 1991 and the handover of power, and control over the Soviet Union's nuclear arsenal, to the president of

162 For more on nuclear close calls, see Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*.
163 U.S. Department of State (1988), 'Agreement between The United States of America and The Union of Soviet Socialist Republics on Notifications of Launches of Intercontinental Ballistic Missiles and Submarine-Launched Ballistic Missiles (Ballistic Missile Launch Notification Agreement), Bureau of Arms Control, Verification and Compliance, https://2009-2017.state.gov/t/avc/trty/187150.htm.
164 Sokov, N. (1997), *Could Norway Trigger a Nuclear War? Notes on the Russian Command and Control System*, PONARS Policy Memo 24, Centre for Nonproliferation Studies, Monterey Institute, p. 1; and ibid., as cited in Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*.
165 Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort,* p. 17.
166 Ibid.

Russia. The decade 1985–95 is even reported to have marked 'the biggest reduction in the global nuclear stockpile', partly in concert with the end of the Cold War.[167]

In addition, in the year leading up to the incident, Russia concluded three major bilateral arms-control frameworks. First, in January 1994, Yeltsin and US president Bill Clinton concluded negotiations for a bilateral agreement on mutual de-targeting, which was implemented on 30 May 1994.[168] Then, in February, Russia and the UK announced the conclusion of an agreement whereby the UK would also de-target its nuclear weapons.[169] Finally, in September 1994, China and Russia issued a declaration pledging that they 'would not be the first to use nuclear weapons against each other and would not target their strategic nuclear weapons at each other'.[170]

Timeline and decision-making

The Norwegian rocket launch incident was reportedly the first time in history when a Russian or Soviet leader had activated the *Cheget*, the transmission system that would enable the launch of a nuclear attack in response to an alert.[171] President Yeltsin was reportedly 'notified within minutes of the launch and presented with one of three briefcases used to relay the authorization of a nuclear launch'.[172] Even more than 25 years later, uncertainties persist as to how the Russian authorities responded to the incident in such a short time frame, owing to a scarcity of official documentation. Several experts have indicated, however, that there exist different versions of this incident, one of which suggests that the activation of the *Cheget* was staged on the day following the launch, specifically for President Yeltsin to display the readiness of his armed forces.[173]

Upon its launch, the rocket's radar signature resembled that of a US Navy Trident II SLBM. As a result, 'Russia's missile warning system [abbreviated in Russian as SRPN], quickly identified the rocket as a nuclear-tipped ballistic missile'.[174] This

167 Futter, A. (2021), *The Politics of Nuclear Weapons*, Cham: Palgrave Macmillan, p. 69, https://doi.org/10.1007/978-3-030-48737-9_4.
168 Federation of American Scientists (undated), 'Clinton, Yeltsin Reaffirm Importance of Joint Cooperation: Text of Moscow Declaration by President Clinton and Russian President Yeltsin, Moscow, Russia, January 14, 1994', https://fas.org/nuke/control/detarget/docs/940114-321186.htm. It must be noted that the credibility of the 1994 US–Russian mutual de-targeting agreement has been heavily questioned, notably due to the absence of a concrete verification procedure to ensure the implementation of the agreement by both parties. In fact, it was reported in 1997 that the General Staff of the Russian armed forces, 'from their wartime command posts in Moscow, Chekhov, Penza and elsewhere, can use a computer network called Signal-A to override the Clinton-Yeltsin de-targeting agreement and re-aim all their silo-based missiles at the United States in 10 seconds'. See Blair, B. G. (1997), 'Russian Nuclear Policy and the Status of De-targeting', Testimony before the Subcommittee on Military Research and Development, House Committee on National Security, 13 March 1997, available at https://www.globalzero.org/wp-content/uploads/2019/03/BB_Russian-Nuclear-Policy-and-the-Status-of-Detargetting_03.17.1997.pdf.
169 Davis, I. (2015), *The British Bomb and NATO: Six decades of contributing to NATO's strategic nuclear deterrent*, Stockholm: Stockholm International Peace Research Institute, https://www.sipri.org/sites/default/files/files/misc/NATO-Trident-Report-15_11.pdf.
170 Permanent Mission of the People's Republic of China to the United Nations Office at Geneva and Other International Organizations in Switzerland (2005), '"China's Endeavors for Arms Control, Disarmament and Non-Proliferation" White Paper', https://www.fmprc.gov.cn/ce/cegv/eng/zywjyjh/t210708.htm.
171 See Matthews, D. (2019), '24 years ago today, the world came disturbingly close to ending', Vox, 25 January 2019, https://www.vox.com/future-perfect/2019/1/25/18196416/nuclear-war-boris-yeltsin-1995-norway-rocket; Hoffman, D. (1998), 'Cold-War Doctrines Refuse to Die', Washington Post Foreign Service, 15 March 1998, https://www.washingtonpost.com/wp-srv/inatl/longterm/coldwar/shatter031598a.htm.
172 Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*, p. 17.
173 The authors of this paper conducted confidential interviews with experts in the field that point to these claims.
174 Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*, p. 17.

information was relayed by radar operators at the Olenegorsk early-warning station in the Russian Arctic. According to information which was subsequently leaked, the rocket was of a 'much larger design than previous versions used by Norway, and it also used the initial stage of a retired US tactical missile […], giving it a much higher boost range'.[175]

The uncertainty surrounding the incident led Russia to also consider the possibility of a surprise attack, for instance in the form of an electromagnetic pulse attack, designed to blind and disable Russian radars.[176] Such an attack on the Russian early-warning system could have indicated the subsequent launch of a surprise nuclear attack.

An attack on the Kola Peninsula, which hosts Russian nuclear submarines, was also considered as a possibility.[177] In 1993, a US Navy nuclear-powered attack submarine had collided with a Russian Delta-class submarine, 'which is normally equipped with 16 ocean-spanning nuclear-tipped missiles' in the Arctic Ocean.[178] This could have been a reason why the Olenegorsk radar operators were minded to identify the 1995 rocket launch as a threat and to relay the information to the relevant officers beyond the radar station.

Nevertheless, on this occasion the Russian authorities ultimately decided not to launch a nuclear attack against the US. Primary open-source information relating to the Russian decision-making process at the time of the incident is unfortunately very limited. Using such information as is available, the next section captures the critical nodes and alternative pathways.

Critical nodes and alternative pathways to decision-making

1. The letter of notification from the Norwegian government

Prior to the incident, on 21 December 1994 the Norwegian Ministry of Foreign Affairs had sent letters of notification to neighbouring countries, including Russia, outlining Norway's intention to launch the scientific research rocket in the period between 15 January and 10 February 1995.[179] The letter provided the location of the rocket's launch site and the coordinates for its predicted impact areas.[180,181] Whether or not the letter was received by the relevant Russian authorities is highly contested. On the one hand, there are claims that 'due to an error at the Russian Foreign Ministry, the alert was never given to the Russian General Staff, or any part of the Russian military'.[182] On the other hand, it was also claimed – notably

175 Sokov (1997), *Could Norway Trigger a Nuclear War?* p. 1; and ibid., as cited in Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*.
176 Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*. See also Barrett (2017), *False Alarms, True Dangers?*.
177 Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*.
178 Gordon, M. R. (1993), 'U.S. and Russian Subs in Collision In Arctic Ocean Near Murmansk', *The New York Times*, 23 March 1993, https://www.nytimes.com/1993/03/23/world/us-and-russian-subs-in-collision-in-arctic-ocean-near-murmansk.html.
179 Lewis, Williams, Pelopidas and Aghlani (2014), *Too Close for Comfort*.
180 Ibid.
181 Russian Strategic Nuclear Forces blog (2005), 'Norway Black Brant letter', 8 August 2005, https://russianforces.org/blog/2005/08/norway_black_brant_letter.shtml.
182 Budalen, A. and Klausen, D. H. (2012), '– Verden har aldri vaert naermere atomkrig' [The world has never been closer to nuclear war], *NRK*, 26 Feb. 2012, https://www.nrk.no/nordland/_-aldri-vaert-naermere-atomkrig-1.8005229.

by the US senator Pat Roberts – that the letter 'got lost in the mail' – so that neither the radar operators at the Olenegorsk early-warning station nor President Yeltsin were in possession of the information it contained.[183]

2. The Olenegorsk early-warning station

In the 1990s, Russia's early-warning systems involved a series of radars and a constellation of satellites, providing uninterrupted coverage of US continental missile fields. At the time of the launch of the Norwegian Black Brant XII rocket, two early-warning satellites – Cosmos-2217 and Cosmos-2261) – provided coverage on highly elliptical orbits.[184] During this incident, the early-warning satellites functioned correctly, yet the initial assessment of the information by human operators was fallacious, since the operators of the early-warning system were not in possession of the information supplied by Norway on the rocket's launch and intended trajectory.[185]

Early-warning systems are a critical node for many incidents, as they are the first line of defence. In this instance, however, the early-warning system seemed to function as intended, in that it alerted the station staff of the rocket launch. Not all incidents are linked to technical errors: some can be attributed to human/operator error (for example the obtaining of false readings, or a poor assessment of the available data).

3. High-level decision-making by *Cheget* holders

The final critical node pertains to the deliberations made by the three *Cheget* briefcase holders: the Russian president, the minister of defence and the chief of the General Staff.[186]

There is disagreement among scholars as to whether all three briefcases were needed to issue a nuclear launch order or whether a single briefcase would have been sufficient.[187] To date, moreover, it remains unknown whether launch authority rests solely with the Russian president or not. Information on Russian command, control and communication systems dates back to the knowledge around Soviet command and control systems.[188]

One analysis argues that for the Russian president to issue a strategic retaliatory launch, the Russian early-warning systems first need to transmit a 'missile attack signal'. Such a signal needs to be verified by early-warning radars.[189] Once the

183 Congress (1998), *Congressional Record*, 144(29), 17 March 1998, p. S2099, https://www.govinfo.gov/app/details/CREC-1998-03-17/context.
184 Podvig, P. (2002), 'History and the Current Status of the Russian Early-Warning System', *Science and Global Security*, 10, pp. 21–60, https://cisac.fsi.stanford.edu/publications/history_and_the_current_status_of_the_russian_earlywarning_system.
185 There have been discussions on the reliability of Russia's early-warning system, given the economic depression Russia experienced following the collapse of the Soviet Union, and the reportedly outdated systems in the Russian early-warning network at that time. See Hoffman (1998), 'Cold-War Doctrines Refuse to Die'.
186 Tsypkin, M. (2004), 'Adventures of the "Nuclear Briefcase": A Russian Document Analysis', *Strategic Insights*, 3(9), https://www.hsdl.org/?view&did=792465.
187 MacDonald, E. (2017), *Whose Finger is on the Button?: Nuclear Launch Authority in the United States and Other Nations*, Union of Concerned Scientists, Issue Brief, https://www.ucsusa.org/sites/default/files/attach/2017/11/Launch-Authority.pdf.
188 Podvig, P. (@russianforces) via Twitter (2022), 'Can Russia's president launch nuclear weapons alone? The honest answer is "we don't know." A short answer is "probably." A longer answer is "it's complicated." A longish thread that may (or may not) help clarify things 1/', 5 March 2022, https://twitter.com/russianforces/status/1500252764810719235?s=20&t=28W80XvKANYBEidxAcxpog.
189 Podvig, P. (ed.) (2001), *Russian Strategic Nuclear Forces*, Cambridge, MA: MIT Press, p. 62.

signal is verified, the same analysis indicates that the president – with the advice of the ministry of defence and the chief of the General Staff – would decide on the course of action to be followed.[190] Thus, there seems to be a fail-safe mechanism embedded into the Russian command and control for cases of retaliatory launch. In the case of delivering a first strike, it is argued that 'the supreme commander and the minister of defence would order this signal to be generated. This arrangement enables the military leadership to prevent a situation in which the decision to deliver a first strike is made by the supreme commander alone.'[191]

Yet, the Russian constitution and the current federal Law on Defence confer the ultimate authority on all nuclear-related matters to the Supreme Commander-in-Chief (i.e. the president).[192] Thus, it is unclear whether in today's Russia the launch order has changed or not.[193] Even if the president has the power to override the system in one way or another, there is a chance – however small in today's security environment – that the Russian military may not abide by such an order. Retired colonel Valery Yarynich, who had served in the Soviet Strategic Rocket Forces, pointed out in 2003 that: 'The widely held opinion that the *Cheget* is the same "nuclear button" with which the president can launch strategic missiles is erroneous. The launch of a missile is impossible without the military, starting with the crews at the command posts of the General Staff. The authorization of the president is no more than the permission and order to launch.'[194]

Lessons learned

The 1995 Norwegian rocket launch incident provides key observations and lessons, even though it may not in itself be considered to be a 'threshold raiser'.

The first lesson is that communications, both externally and internally, are key to reducing uncertainty and to better navigating complexity, even when the security environment is amicable. In 1987, the US and the Soviet Union agreed to each set up a Nuclear Risk Reduction Center in their respective capital cities (the US centre was later renamed the National and Nuclear Risk Reduction Center – NNRRC) in order to ensure a 'secure, rapid, and reliable means of communication'.[195] These centres have aimed to exchange notifications with other countries on arms-control-related matters, including ballistic missile launches and international cyber incidents.[196] However, no such system was set up between the Soviet Union and Norway, and no such system exists today between Russia and Norway.

190 Ibid., p. 63.
191 Ibid., p. 63.
192 Korda, M. (2020), 'What do Putin's constitutional changes mean for Russian nuclear launch authority?', Federation of American Scientists, 27 January 2020, https://fas.org/blogs/security/2020/01/what-do-putins-constitutional-changes-mean-for-russian-nuclear-launch-authority.
193 Podvig, P. (@russianforces) via Twitter (2022), 'Can Russia's president launch nuclear weapons alone?'.
194 Yarynich, V. E. (2003), *C3: Nuclear Command, Control Cooperation*, Washington, DC: Center for Defense Information, p. 150.
195 U.S. Department of State (2021), 'Renaming of the National and Nuclear Risk Reduction Center', 8 February 2021, https://www.state.gov/renaming-of-the-national-and-nuclear-risk-reduction-center.
196 See U.S. Department of State (2022), 'National and Nuclear Risk Reduction Center', https://www.state.gov/bureaus-offices/under-secretary-for-arms-control-and-international-security-affairs/bureau-of-arms-control-verification-and-compliance/nuclear-risk-reduction-center.

06 Conclusion and recommendations

The nuclear policy community can look to various other fields, including social psychology, systems engineering and data science, to help navigate complexity and mitigate uncertainty.

Chief decision-makers often look to history to inform their decisions, but the uniqueness of each crisis and the increasing complexity of nuclear weapons policies make it challenging to identify what kind of approach politicians should take in a crisis, especially when it is fast-moving. New approaches, such as complexity studies, will allow nuclear policy communities to better understand the issues in a different way.

For far too long, decision-makers developed their policies and strategies on the basis of rational parameters. This led to the formation of nuclear policies (such as mutual assured destruction and nuclear deterrence more broadly) based primarily on the assumption that decisions will be rational. Although the literature on perception, biases, systemic noise and intuition (gut feeling) has been largely ignored, it brings important considerations that should be incorporated into the strategic analysis.

As was pointed out in an earlier Chatham House study:

> New understandings about rationality and the way people really tend to behave in stressful or crisis situations [indicate] that (a) people often do not have fixed or even stable preferences; (b) they are subject to cognitive biases or constraints that shade their thinking, without them necessarily being aware of this, especially in complex or crisis situations; and (c) humans have a poor intuitive grasp of probability.[197]

197 Borrie, J. (2020), 'Human Rationality and Nuclear Deterrence' in Unal, Afina and Lewis (2020), *Perspectives on Nuclear Deterrence in the 21st Century*, p. 11.

Decision-makers in all spheres may plan in detail, either mentally or in writing, as to how they would respond in a crisis, but they may still be required to radically adapt their plans and make critical decisions under stress or in unanticipated circumstances. In the medical sciences, for instance, surgeons are required to plan and map all alternative scenarios in detail, and must perform under stress. How doctors manage pressure in a complex surgery may provide some insights for nuclear decision-making: preparing for a crisis through training and mental visualization exercises may provide a better understanding when working under pressure. At the individual level, the 'mental practice' of different pathways and imagining all possible scenarios can prepare the practitioner for the unexpected. As indicated by a neurosurgeon undertaking complex cancer operations, '[r]ehearsing in your mind works because you're activating many of the same neurons as you would if you were actually doing it'.[198] In the nuclear weapons policy field, forecasting and tabletop exercises can not only help to predict possible scenarios but also assist in preparing decision-makers to make decisions under pressure.

The historical incidents examined in this paper have highlighted that both technical and human error may lead to miscommunication and misperception. When building complex systems – such as early-warning systems – the managers and designers should ensure that these systems are trustworthy. There will always be some limits to the system design and a degree of inevitability of accidents in complex systems. This does not mean that decision-makers should accept unacceptable levels of risk when such risks could be mitigated. The nuclear weapons policy community should address the level and types of risks that are acceptable, manageable, and unacceptable by nuclear weapon states and non-nuclear weapon states. Such a discussion has yet to take place. Straightforward and rigorous designs, along with extensive testing and documentation, may help achieve maturity in system engineering techniques.

To reduce human error and empower human judgment, it is important to find a balance between the cognitive brain, where reason resides, and the emotional brain, where intuition resides. Through the provision of adequate mental training, decision-makers may better observe their thoughts in times of crisis and may be able to control the urge to use impulsive, vs reflective, thought processes.[199]

While addressing risk-mitigation measures, the focus should be equally grounded across chief decision-makers and duty officers. For instance, while presidential-level hotline communication measures could help minimize miscommunication, creating risk reduction centres between nuclear weapon states, as well as between nuclear weapon states and non-nuclear weapon states, would help reduce misunderstanding at the lower levels of decision-making.

A study on different types of biases in nuclear decision-making and nuclear weapons policy may also open new venues of research in the field. This paper has highlighted common cognitive biases – including confirmation and conformity biases – but there are many other psychological predispositions that warrant further analysis in the study of nuclear decision-making. For instance, there

198 Jandial (2021), *Life on a Knife's Edge*, p. 41.
199 On reflective and impulsive thought processes, see Kahneman, Sibony and Sunstein (2021), *Noise*, p. 191.

seems to be a status-quo bias[200] in the nuclear field, whereby the individuals/decision-makers choose the current situation (status quo) over change.

Perceiving nuclear weapons as a 'wicked problem' and realizing that complexity exists not only in human decisions but also in organizational processes, nuclear weapons systems and the overall security environment, decision-makers need to conceptualize improvements to tackle uncertainty and complexity in the decision-making process. Below are some recommendations that may help in this endeavour:

Recommendations for policy- and decision-makers

- Policymakers and decision-makers should embrace and apply 'system of systems' thinking approaches that will help them to engage with, and respond to, complexity in the nuclear weapons policy arena. A 'system of systems' methodology examines two aspects of a problem: the nature of the systems and the nature of the participants (decision-makers) 'in which the problem is located'.[201] It examines problems in term of a simple vs complex dichotomy.[202] In a complex system where decision-makers are in a 'unitary relationship', they share similar values, beliefs and interests.[203] When decision-makers are in a 'pluralistic relationship', however, 'although their basic interests are compatible, they do not share the same values and beliefs'.[204] The nuclear weapons policy field confronts the latter problem. Although states share basic interests – for instance, in preventing the use of nuclear weapons – they differ in their assumptions, knowledge and beliefs. While tackling this type of problem, as the systems scientist Michael Jackson points out:

  > Space needs to be made available within which debate, disagreement, even conflict, can take place. If this is done, and all feel they have been involved in decision-making, then accommodations and compromises can be found. Participants will come to agree, at least temporarily, on productive ways forward and will act accordingly.[205]

- To find solutions in nuclear arms control, nuclear non-proliferation and disarmament, it is necessary to study the interactions between these disciplines and other fields, and with the security environment. Small changes in one area may lead to extensive changes in another.

200 For more information on status-quo bias, see Samuelson, W. and Zeckhauser, R. (1988), 'Status Quo Bias in Decision-Making', *Journal of Risk and Uncertainty,* 1, pp. 7–59.
201 Jackson, M. C. and Keys, P. (1984), 'Towards a System of Systems Methodologies', *Journal of the Operational Research Society,* 35(6), p. 474.
202 Ibid., p. 475. A system can be both simple and complex, depending on the question (problem) at hand. For instance, a problem related to oil consumption might be a simple one involving supply and demand equilibrium, whereas a problem linked to oil prices could be complex.
203 Ibid.
204 Ibid.
205 Jackson, M. C. (2019), *Critical Systems Thinking and the Management of Complexity*, Chichester: John Wiley & Sons Ltd, pp. 157–59.

- Decision-makers should train duty officers for them to better understand heuristics and biases in their decisions; and there should be a closer scrutiny of impulsive decision-making. Training of duty officers should not only involve going through the standard operating procedures and checklists that a duty officer should follow in normal times, but should also cover critical thinking in times of crisis. Empowering officers and operators through mental skills training that involves behavioural and psychological insights offers them the opportunity to realize and acknowledge differences between insights, instincts, facts and evidence. This may help deliver a better-informed information assessment.
- Providing alternative options and information for reporting to multiple chains of command, to avoid critical information being discarded, may help with reducing bias in group thinking. Moving away from bureaucratic organizational structures based on hierarchical rules to a circular system of information and intelligence collection with feedback loops may allow officers to raise their voices and make counter-arguments in peacetime, which would then help reduce the circulation of misinformation in times of crisis.
- Setting up risk reduction centres between nuclear weapon states and non-nuclear weapon states could help ease tensions and address issues of misperception at lower levels of decision-making, especially in times of crisis. All type of notifications (e.g. of missile tests) could also be handled by these centres.
- Policymakers and decision-makers should practise – and ask for – greater transparency about past cases of near nuclear use and should learn from archived material in order to better manage complexity and uncertainty in nuclear weapons decision-making.
- In the current security environment, several nuclear weapon states deliberately maintain a level of ambiguity in their nuclear postures, indicating that this would help deter an adversary and that ambiguity would leave room for reconsideration of actions in times of crisis. Others call for transparent nuclear postures, including the implementation of a 'no-first-use' policy. One potential pathway for helping to reduce risks might begin with a collective analysis of nuclear postures with considerations of cognitive biases and systemic noise.

Recommendations for the nuclear policy community

- By bringing mathematical modellers and scientists of complexity systems together with nuclear weapons policy experts, the nuclear community can develop a multidisciplinary approach that could help generate innovative strategies for tackling nuclear weapons policy problems and help reduce tribalism in the nuclear field. Modelling approaches from different fields of study can provide alternative pathways for policymakers.

- Future research could include examining nuclear risk reduction through the lens of complexity sciences.[206] In parallel to the system of systems analysis, a study focusing on a set of problems, how they interact with each other and with the overall security environment, and alternative pathways and solutions to these problems would be a worthwhile research area.

- Similarly, an assessment of the impact of complexity in nuclear deterrence policies, and of whether increased complexity helps or impedes nuclear deterrence postures, presents another opportunity for further research. This would also help to answer questions around the added complexity from emerging and disruptive technologies.

206 For remarks on this subject by Christopher A. Ford, see Ford, C. A. (2021), 'Arms Control and Disarmament Through the Prism of Complexity: Advent of a New Research Agenda?', New Paradigms Forum, https://www.newparadigmsforum.com/arms-control-and-disarmament-through-the-prism-of-complexity-advent-of-a-new-research-agenda.

Acronyms and abbreviations

AI	Artificial intelligence
CIA	Central Intelligence Agency
GRU	The Soviet Union's foreign military intelligence agency
ICBM	Intercontinental ballistic missile
I&W	Indications and warning
KGB	The Soviet Union's security agency
NATO	North Atlantic Treaty Organization
NNRRC	National and Nuclear Risk Reduction Center
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
SDI	Strategic Defense Initiative
SLBM	Submarine-launched ballistic missile
SRPN	Russian missile-attack warning system
START	Strategic Arms Reduction Treaty
TPNW	Treaty on the Prohibition of Nuclear Weapons
UNIDIR	United Nations Institute for Disarmament Research
USAF	US Air Force
USSR	Union of Soviet Socialist Republics

About the authors

Beyza Unal
Dr Beyza Unal is deputy director of the International Security Programme at Chatham House. She covers the science, technology, security and defence portfolio, specializing in the interaction between emerging technology applications and security. Her research includes nuclear weapons policy, cyber, space, and critical national infrastructure security, and quantum technologies. Beyza also leads on NATO's security and defence policy at Chatham House.

Julia Cournoyer
Julia Cournoyer is a research assistant in the International Security Programme at Chatham House. Her area of focus includes nuclear weapons policy and outer space security. Julia formerly interned for NATO's Joint Intelligence and Security Division in the Strategy and Policy Unit. She also worked as an international strategy consultant for ONHYS, a French technology company developing COVID-19 virus simulation software.

Calum Inverarity
Calum Inverarity is a senior researcher at the Open Data Institute and a former research associate in the International Security Programme at Chatham House, where his work focused primarily on conflict prevention and resolution, including the role of governance in facilitating these processes. He formerly worked with Bruegel, a Brussels-based economic think-tank, the Democratic Progress Institute and UN House, Scotland.

Yasmin Afina
Yasmin Afina is a research analyst with the International Security Programme at Chatham House. Yasmin is also a PhD candidate in law at the University of Essex, researching the role of reliability in assessing the legality of artificial intelligence use for military targeting. She formerly worked for the United Nations Institute for Disarmament Research (UNIDIR) and the United Nations Office for Disarmament Affairs (UNODA).

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Cover image: A target selector is seen at the commander's console inside a Titan II silo's control centre at the Titan Missile Museum, Green Valley, Arizona, 12 May 2015.
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CHATHAM HOUSE

The Royal Institute of International Affairs
Chatham House
10 St James's Square, London SW1Y 4LE
T +44 (0)20 7957 5700
contact@chathamhouse.org | chathamhouse.org

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