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The Project on Nuclear Gaming

NSSC – Nuclear Science & Security Consortium

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Investigating deterrence impacts of tailored nuclear weapons through modern serious gaming

Specifically, what impact will nuclear weapons with alternative effects regimes (AER) have on deterrence and strategic stability?

Tailor radiation outputs
- Electromagnetic pulse
- High-precision, low-yield systems

How can serious games be constructed and executed to place players in situations to model escalation challenges, including threats of AER use?

About the Project on Nuclear Gaming (PoNG)
Investigating deterrence impacts of *tailored* nuclear weapons through *modern serious gaming*

- What impact will nuclear weapons with *alternative effects regimes* (AER) have on deterrence and strategic stability?
  - Enhanced radiation outputs
  - Electromagnetic pulse
  - High-precision, low-yield systems

- How can *serious games* be constructed and executed to place players in situations to *model escalation challenges*, including threats of AER use?
Approach

• **Three Types of Gaming Techniques**
  - Scenario Analysis
    - Allows for expert-level, open-ended play
    - 3-player (Nuclear dyad in a multi-polar world)
  - Board Game
    - Allows for “structured” play
  - Online Games
    - Allow for large-\(n\) playthroughs and analysis
    - Allows for multi-\(n\) games

• **Units of Analysis:**
  - The Game
  - Player Behavior (Dyad)
Outcomes

• Improved understanding of nuclear thresholds
  – Modeling crisis decision-making
  – Modeling escalatory behavior
  – Examining the nuclear thresholds, escalation dynamics, and “next turn” dynamics

• Model use of gaming techniques to address social science research questions
  – Expansion into non-state actor modeling
  – Expansion into “proliferation games”
Effects of a Nuclear Detonation

A nuclear detonation creates:
- Blast
- Thermal pulse
- Neutrons
- Radiation
- Electromagnetic Pulse (EMP)

Strategic nuclear forces underpin nuclear deterrence and mutually assured destruction

Tactical nuclear forces, however, are still deployed around by a number of states (Kristenson and Norris 2018)
“Tailored” Effects

• Nuclear weapons can be designed to provide specific enhanced outputs, e.g.,
  – EMP weapons optimized for higher gamma ray output and height of burst
  – Enhanced radiation weapons with higher neutron output (neutron bomb)
  – Precision-delivered low-yield weapons to provide lethality to targets that otherwise would require higher yields

• The 2018 Nuclear Posture Review suggests that the U.S. stockpile be augmented with modified weapons to provide lower yield capability to address adversary threats of limited nuclear use in war
Theorized Costs and Benefits of AERs

**Potential Benefits:**
- AER weapons less likely to lead to civilian deaths (Carpenter 2016)
- Increased probability of damage/kill for a given yield (Gen. Schwartz 2014)
- Providing a more credible nuclear deterrent for certain regional scenarios (Lieber and Press 2009)
- Raising the threshold for nuclear use (Williams and Lowther 2017)

**Potential Costs:**
- Breaking the nuclear taboo/Lowering threshold of nuclear use (Tannenwald 1999, Rovere and Robertson 2013, Doyle 2017)
- Lack of utility (Nelson 2010)
- Crisis instability
  - Blurring the distinction between conventional and nuclear weapons
  - Risk of inadvertent escalation if the adversary cannot discriminate between low- and high-yield attack (Sagan 1992, Posen 2013)
  - Inability to control escalation (Work 2015)
- Proliferation risk: Encouraging other countries to develop their own low-yield nuclear deterrent (Coyle and McKeon 2017, Gerstein 2018)
The Research Question

• Do nuclear weapons with alternate effects alter the threshold of nuclear use?

• IV (Player Capability) → DV (Nuclear Use)

• Methodological Challenge:
  – The dearth of empirical data related to the effects of nuclear capabilities upon state behavior

• The Solution:
  – Rigorous, multi-dimensional war-gaming that provides an experimental setting for analyzing behavior (Wack 1985; Kupers and Mangalagiu 2013; Barma et al. 2015; Lytwyn 2017)
• This simple example presents a dyadic game between two players with varying nuclear capabilities

• The project, in its simplest terms, examines the employment patterns of nuclear weapons (of AER and traditional varieties) given player capabilities—or nuclear outcomes in each quadrant

• Hypothesis: If players have AER capabilities, then they are more likely to use nuclear weapons
Mapping Escalation Dynamics

Figure. Spectrum of Conflict with Nuclear Adversary (Adm. Haney)

- **Integrated Tools**
  - Diplomacy
  - Information
  - Military
    - Conventional
    - Cyber/Space
    - Nuclear
  - Economic

- **Decision Calculus**
  - Costs of Action
  - Benefits of Action
  - Benefits of Restraint
  - Costs of Restraint

- **Timeline**
  - Rhetoric, R&D, Misinformation
  - Adversary action
  - US/Allied action
  - Decision/Escalation Control Point
  - Escalation Milestone

- **Intensity**
  - Limited Nuclear
  - Conventional Conflict
  - Nuclear Capability Demo
  - Off-ramp

- **Other Dimensions of Crisis/Conflict**
  - Hybrid Warfare
  - Asymmetric Warfare
Examples from the Game
Game Structure

The structure of a three player game...
We code conflict classes based on data collected during the game.

- Classes are defined by collective set of player actions, and not on outcomes
  - Escalation is unilateral
  - De-escalation is unanimous
- Deterrence is a function of the choices made by the players, so outcomes are less important
- Classes are treated as a collective status, or as an aggregated assessment
  - Not currently looking at sub-player groupings, such as dyads
  - Raw data can be “re-classed” using other rules later to facilitate other questions

Player 1: Trade
Player 2: Threaten Military Action
Player 3: Do Nothing

Non-Nuclear Threat
Mapping Player Actions to Conflict States

- Peace
- Traditional Nuclear Threat
- AER Nuclear Threat
- Non-Nuclear Threat
- MFSA Armed Conflict (Single Actions)
- MFMA Armed Conflict (Multiple Actions)
- SFSA Armed Conflict (Single Front)
- SFMA Armed Conflict (Multiple Fronts)
- Traditional Nuclear Use

Traditional Conflict Ladder

Figure. Spectrum of Conflict with Nuclear Adversary (Adm. Haney)

Integrated Tools
- Diplomacy
- Information
- Military
  - Conventional
  - Cyber/Space
  - Nuclear
  - Economic

Decision Calculus (specific to a decision)
- Costs of Action
- Benefits of Action
- Benefits of Restraint
- Costs of Restraint

Adversary action
- US/Allied action
- Decision/Escalation Control Point
- Escalation Milestone

Timeline

Peace
Non-Nuclear Threat
Traditional Nuclear Threat
Traditional Armed Conflict
SF Armed Conflict
Limited Nuclear
Limited Nuclear Use
Large Scale Nuclear
Large Scale Nuclear Use
Off-ramp

Other Dimensions of Crisis/Conflict
Hybrid Warfare
Asymmetric Warfare

Rhetoric, R&D, Measures of Action
Conventional Conflict Begin
Nuclear Capability Demo
Example:

- Fraction of games including nuclear use vs. mean number of "turns" before conflict begins
- Can plot by "game type"
- Games without AER at origin

More Games Go "Nuclear"

- AER may deter conflict initiation, but provide wider pathways to nuclear use

AER may be destabilizing

Games Escalate "Slower"

AER may be stabilizing

Fewer Games Go "Nuclear"

Games Escalate "Faster"

AER may strengthen the stability-instability effect
Risks and Challenges

• **Variation in results across game outcomes**
  – What inferences can be drawn from differing conclusions across game types?

• **Findings are only as good as the simulation environment**
  – Appropriateness of win conditions
  – The games are set up to test “crisis stability”
  – Iteration unlike in the real world, these games “end”
  – “Gaming behavior”
Future Work

• Delivering game at various electronic gaming conferences:
  – Connections Wargaming Conference National Defense University in Washington, DC (July 2018)
  – Connections UK Wargaming conference in London (September 2018)

• Workshop at University of California, Berkeley
  – In cooperation with Lawrence Livermore National Laboratory and Sandia National Laboratories (early 2019)

• Delivery of online game in early FY2019

• Future applications
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