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The views expressed are those of the authors and are not the official policy or position of the U.S. Army War College, Department of the Army, Department of Defense, U.S. Government, or any other agency or organization.

Preface

This report summarizes the 2019 Connections USA wargaming conference hosted by the U.S. Army War College’s Center for Strategic Leadership (CSL) at the Army Heritage and Education Center (AHEC), Carlisle, Pennsylvania 13-16 Aug 2019. The report consists of a conference overview, working group summaries, facilitated discussion (game lab) summaries, and post-conference survey analysis. The appendices include full-length reports prepared by conference working groups.

Acknowledgements


Thank you to the many presenters, facilitators, support staff, and participants who contributed to Connections USA 2019.
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EXECUTIVE SUMMARY

This report summarizes the events and products of the Connections USA 2019 wargaming conference. Connections USA is an annual unclassified conference for the purpose of advancing art, science, and applications of wargaming by bringing together all elements of the field (military, commercial, and academic) and is the only national event dedicated specifically to professional wargaming.

The U.S. Army War College (USAWC) hosted Connections USA 2019 at the Army Heritage and Education Center (AHEC), Carlisle, PA with the Center for Strategic Leadership (CSL), Department of Strategic Wargaming (DSW) as lead.

The conference theme was “Futures of Wargaming” and consisted of twelve seminars, three panels, thirty-six game labs, three working groups, and two wargame testing and demonstration sessions (game nights). The conference had 177 participants (not including support staff) representing 89 organizations and nine countries (in addition to the USA).

Conference working groups produced two full-length reports (included as appendices) with papers from an international group of researchers and practitioners: Wargaming the Future (chaired by Dr. Stephen Downes-Martin) and Future of Wargaming (chaired by Dr. ED McGrady and Mr. Mike Ottenberg).

Key insights on the future of wargaming (organized into three categories) are:

Institutional
1. Our national security institutions are short term focused.
2. A peacetime military becomes inflexible in the face of massive surprise.
3. Concern with the near term reduces motive to be rigorous when gaming the far future.

Process
1. Wargaming in the far future is reactive.
2. Command and control of advanced technology enabled forces is unclear.
3. Technology often dominates thinking of the future and could possibly replace the whole game, both players and controllers.
4. Immersion may be an important component of future games and introduces many questions and possibilities.
5. Need to build games and simulations that address key issues without adding costly requirements that do not increase effectiveness.

Uncertainty
1. Indeterminism and uncertainty grow as one looks out into the far future.
2. There is a combinatorial explosion of possible interactions and futures.
3. Credibility, plausibility and probability of far future scenarios are hard to determine.
4. Discontinuous and black swan advances in technology will occur.
5. Complexity of interacting causal factors grows as we look into the future.
REPORT OVERVIEW
This report consists of four sections. The conference overview provides background on Connections and summarizes the 2019 event. Working group summaries include overviews and key insights from the three working groups. Game lab summaries provide notes from six facilitated discussions on specific gaming-related topics. Post-event survey results include detailed analysis of participant demographics and survey data to inform future events, including segmented by major participant groups. Additional appendices include the conference and agenda and schedules and complete working group reports.

CONFERENCE OVERVIEW
Connections USA is an annual unclassified conference with purpose of advancing art, science, and applications of wargaming by bringing together all elements of the field (military, commercial, and academic) and the only national event dedicated specifically to wargaming. The U.S. Air Force Air Command and Staff College started Connections in 1993. The National Defense University, Washington, DC, hosted Connections 2018.

The U.S. Army War College (USAWC) hosted Connections USA 13-16 August 2019 at the Army Heritage and Education Center (AHEC), Carlisle, PA with the Center for Strategic Leadership (CSL), Department of Strategic Wargaming (DSW) as lead.

The U.S. Marine Corps will host Connections 2020 4-7 Aug at Quantico, Virginia. More information and registration to be posted to https://connections-wargaming.com/ as event gets closer.

The 2019 conference theme was “Futures of Wargaming” and consisted of twelve seminars, three panels, thirty-six game labs, three working groups, and two wargame testing and demonstration sessions (game nights). Appendix 1 contains the full agenda.

Dr. Steven Stoddard, Senior Executive Service (SES), Deputy Director for Force Management, Headquarters Department of the Army G-3, and Dr. ED McGrady, Monk’s Hood Media were the keynote speakers.

The working groups were:

- Wargaming the Future (chair: Dr. Stephen Downes-Martin)
- Future Of Wargaming (chairs: Dr. ED McGrady and Mr. Mike Ottenberg)
- Wargaming for Future Leaders (chairs: Mr. Mike Dunn and Dr. James Morningstar)

The following page includes a summary of conference agenda and photographs of events.
# Conference Agenda Summary

<table>
<thead>
<tr>
<th>Time</th>
<th>Tue 13 Aug</th>
<th>Wed 14 Aug</th>
<th>Thu 15 Aug</th>
<th>Fri 16 Aug</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Morning</strong></td>
<td>Orientation Seminars I &amp; II</td>
<td>Keynote: Dr. Steven Stoddard, SES, Army G-3/5/7</td>
<td>Upcoming Events</td>
<td>Keynote: Dr. ED McGrady, Monk’s Hood Media &amp; Outbriefs</td>
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<tr>
<td></td>
<td>Panel: Futures Gaming</td>
<td>Panel: Modeling &amp; Wargaming</td>
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<tr>
<td><strong>Afternoon</strong></td>
<td>Seminars III &amp; IV</td>
<td>Game Lab Sessions I &amp; II</td>
<td>Seminar V</td>
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<tr>
<td></td>
<td>Panel: Wargaming Methods</td>
<td>Gaming Showcase and Poster Session</td>
<td>Working Groups</td>
<td></td>
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<tr>
<td><strong>Evening</strong></td>
<td>Wargames Testing and Interactive Demonstrations (Game Night)</td>
<td>Wargames Testing and Interactive Demonstrations (Game Night)</td>
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<td></td>
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</tbody>
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## Photographs of Conference Events

- **Game Lab**
- **Game Demonstration**
- **Panel Presentations**
- **Game Demonstration and Poster Session**
CONFERENCE PARTICIPATION AND FEEDBACK

Participation
Connections 2019 had 177 participants (not including U.S. Army War College support staff) representing 89 organizations and 10 countries (including the USA). The post-event survey results section provides more detailed analysis of both participant demographics and survey responses (66 total for a 37% response rate).

Figure 1 below shows composition of all 177 participants by organization. The majority were from DoD organizations (68, 38%) followed by private citizens (24, 14%, mostly hobby gamers or retirees). Within DoD, most came from DoD agencies (19, 27%), followed by the Army (17, 25%) and Air Force (14, 21%). Forty-five percent of survey respondents (30 people) reported this was their Connections conference.

Feedback
The majority of the respondents rated the conference very favorably. Approximately 98% agreed they would recommend the conference to others (73% strongly) and 97% agreed that conference provided useful connections with other gaming professionals (77% strongly). Nearly all negative feedback was about content preferences. Opinion about whether content was appropriate for level of gaming expertise appears more divided, 42% strongly agreed, 42% agreed, and 11% were neutral.
WORKING GROUP SUMMARIES

OVERVIEW
The conference included three working groups which produced the summaries included in this section.

Dr. ED McGrady, Monk’s Hood Media and Mr. Michael Ottenberg, Group W, chaired “The Future of Wargaming” in which they considered how wargaming might be conducted in the near and distant future. Dr. Stephen Downes-Martin, Naval War College research fellow, chaired “Wargaming the Future” examining how to wargame future events. Mr. Michael Dunn, U.S. Army Command and General Staff College and Dr. James Morningstar, U.S. Army War College, chaired “Wargaming for Future Leaders”, explored how different audiences respond to wargaming.

Each working group conducted preliminary research leading into the conference and facilitated discussions with volunteer conference participants on the afternoon of 15 Aug. The Future of Wargaming and Wargaming the Future groups also wrote detailed reports summarized here and included full-length as appendices.

The Wargaming the Future group wrote 12 research papers for their report “Wargaming the Far Future” included in Appendix 5. The report also includes working group and workshop discussion summaries and an integrated bibliography. The papers and authors (listed in order from publication) are:

1. Using Futuring to Generate Better Wargaming Scenarios (Stephen Aguilar-Milan)
2. Common Pathologies and Pitfalls of Wargaming Future Technologies (Sebastian J. Bae)
3. Geopolitical Matrix Gaming in 15 and 50 Year Future Scenarios (Deon Canyon, Jonathan Cham)
4. Wargaming the Future: Developing Scenarios and Galvanizing Support (Thomas Choinski)
5. Break the Forecasting Horizon by Values Gaming (Stephen Downes-Martin)
6. Coming to Grips with Indeterminacy in the Practice of “Futures” Gaming for Strategy Formulation (John Hanley)
7. Brand New World (William Lademan)
8. Wargaming the Future Requires Rigorous Adherence to Best Practices (Graham Longley-Brown, Jeremy Smith)
9. Wargaming the Uncertain Future (Brian McCue)
10. From World War 3 to Starsoldier: Gaming design and gaming the future (ED McGrady)
11. War and Wargames Beyond the Event Horizon (Robert Mosher)
12. How To Think About The Future (Kristan Wheaton)
The Future Wargaming group created the summary report included in this section and an accompanying report “Stories of Future Gaming” included in Appendix 6.

The report sections and authors (listed in order from publication) are:

- Friendly Competition (Sebastian Bae)
- Augmented Reality (Jeremy Sepinsky)
- Game Day (ED McGrady)
- Matt Caffrey (all extracted from On Wargaming, Matthew B. Caffrey Jr., US Naval War College Press, 2019)
  - A Nice Game of Chess
  - The Last Peace Fighter
  - Not the Holodeck
- Resistance is Futile (Michael Bond)
- Brain Probes, Crocodile Clips, and Drugs (Stephen Downes-Martin)
WORKING GROUP SUMMARY: WARGAMING THE FUTURE

Working Group Chair: Dr. Stephen Downes-Martin

Executive Summary

Situation
Our most potent power projection and warfighting capabilities, developed in response to current and near future threats, are technologically advanced, hugely expensive, and have half-century service lives. The first of these characteristics gives us a temporary and possibly short lived warfighting edge. The second grants our political leaders short lived economic and political advantages. The last characteristic locks us into high expenses in maintenance and upgrades for many years in order to justify the initial sunk costs as though they were investments. This combination forces us onto a high-inertia security trajectory that is transparent to our more agile adversaries, providing them with credible information about that trajectory while giving them time to adapt with cheaper counter forces, technologies and strategies.

We must therefore wargame out to service life, the “far future”, to ensure our current and future weapons systems and concepts of operations are well designed for both the near term and the far future. However a 50 year forecasting horizon is beyond the credibility limit for wargaming. The Working Group and the Workshop explored and documented ways that wargaming can deal with this horizon.

Challenges
Working Group and Workshop participants selected the following broad challenges to wargaming the far future for examination – details are documented in this report:

Institutional
• Our national security institutions are short term focused.
• A peacetime military becomes inflexible in the face of massive surprise.
• Concern with the near term reduces motive to be rigorous when gaming the far future.

Process
• Wargaming in the far future is reactive.
• Command and control of advanced technology enabled forces is unclear.

Uncertainty
• Indeterminism and uncertainty grow as one looks out into the far future.
• There is a combinatorial explosion of possible interactions and futures.
• Credibility, Plausibility and Probability of far future scenarios are hard to determine.
• Discontinuous and black swan advances in technology will occur.
• Complexity of interacting causal factors grows as we look into the future.
Approaches
The following approaches covering these challenges were explored and are documented in this report along with their advantages, disadvantages and barriers to implementation. Since most of the approaches covered more than one challenge, there is not a one-to-one mapping between challenges and approaches.

Organizational
- Build an organization explicitly tasked and designed to wargame the far future.
- Reinvigorate best practices for wargaming and identify new ones required for gaming the far future.

Social Engineering
- Explore how wargaming influences military thought, not just how military thought influences wargaming.
- Use wargaming to increase people’s ability to handle the unknown far future.
- Take into account the psychology of how people think and worry about the future.

Futurism
- Embed futuring framework and foresight planning into the wargame process.
- Use systems thinking to design future scenarios.
- Base future scenarios on possible Revolutions in Military Affairs (RMAs) driven by changes in energy sources.

Process
- Wargame DoD acquisition to develop capabilities in months and years.
- Wargame trajectory from now to the far future using month/year acquisition wargames as inputs.
- Wargame our stable societal values versus our adversary societal values.
- Run wargames multiple times with a different game design each time.
- Run wargames multiple times for each game design.
- Wargame sensitivity analysis over many games to explore when assumed technology or capability levels become useful to the warfighting decision makers.
- Combine scenario planning and operational design into path gaming.
WORKING GROUP SUMMARY: FUTURE OF WARGAMING
Dr. ED McGrady and Mr. Mike Ottenberg, Working Group Chairs¹

What was the question?
We wanted to understand what wargaming might look like in 2030 or 2040. Would technology dominate? If so, what technology? How would we think about games? How would they be integrated, or not integrated into our decisions? Would we see the same old challenges, or would new ones arise?

The answers were:
• Yes, technology certainly dominates our thoughts about the future. Visualization, processing, and algorithms are the subject of a lot of interest and discussion whenever we think about the future of gaming. In this group they were seen as applying not only to visualization and adjudication, standard areas for technology, but also the whole game. Technology just might replace the whole game, both players and controllers.
• Immersion may be an important component of future games. As technologies allow game experiences to be increasingly immersive they raise a whole host of questions. They also open up a whole new series of possibilities for how to game non-kinetic subjects.
• Another challenge is how to build games and simulations, particularly for training, that address the key skills and issues, without adding costly requirements that do not increase effectiveness.

How did we go about answering our questions?
We took a three-pronged approach. First, we held a more or less open call for fictional stories describing wargaming in the unspecified future. These stories ranged from corporal level stories of games as training tools, to games used to run the whole war. Some were gritty, and some were dystopian. They are collected in a separate document that is attached to this one (appendix 6). In this document we draw the stories together to see what we can discern from the fictional worlds that were created.

Second, we invited speakers to help baseline us on new technologies and concepts. A representative from VT-MAK discussed simulation, while Prof. Lucien B. Parsons from the University of Maryland’s MAVRIC (Mixed/Augmented/Virtual Reality Innovation Center) program gave a wide-ranging presentation on new technologies and their impact on gaming. In this document we briefly summarize the implications of those presentations.

After the presentations, participants took up the third part of our effort: a scenario planning exercise. The primary purpose of this document is to explain what we did, and describe the results.

¹ Working group team moderators were: Dr. Jeremy Sepinsky, Dr. Justin Peachey, Mr. Nate Fritz and Mr. Paul Bussard
In the end what we discovered is that thinking about the future tells us more about what we are worried about now than what the future will actually look like. Seen through that lens, this becomes a fascinating way of understanding what the community is interested in, and what forces they see as driving us forward.

**Stories of Future Gaming**

Attached to this document is a companion piece containing fictional stories describing future games (appendix 6). Taken together what can we discern from these stories?

The first observation is that the stories closely track with the author’s personal point of view. These include:

- **How games can be used for training at the tactical unit level?** We had two stories that focused on the tactical unit level of operations. They tried to show that gaming could be used profitably as a training and motivation tool for the line infantryman. The authors saw a deficiency: current gaming practice seems to focus on either digital media for training or face-to-face gaming for policy and operations.

- **The role of technology in games, particularly virtual and augmented reality (VR/AR).** Several stories focused on the role that technology might play, with VR/AR dominating one and artificial intelligence (AI) dominating the other. The ability to incorporate both player interaction as well as digital display and recording were seen as important advantages throughout the working group discussions.

- **The interaction between technology, constraints, and bureaucracy.** One story focused on the dystopian potential for large-scale social deployment of AI, including augmented command decision-making and individual AI’s that augment personnel. Another story focused on biological augmentation and the potential for instrumenting the biological element in games. Those stories suggested it’s important to remember the challenges that technology brings, along with the advantages.

- **On a happier note two stories focused on the redemptive power of games when used by leaders to shape social and political landscapes.** Whether they are used to identify exceptional decision-makers (players) or to shape political movements through digital game products, the focus was on how games could shape and affect the real world. This was also a theme seen in one of the working groups (Group 2).

The stories show the range of topics and points of view that you can arrive at when considering the future of gaming. The role of technology, including AI, is something that is of obvious concern to many who have to execute games on a daily basis. But the bigger picture, that the potential of games has not yet been fully tapped by the national security establishment, suggests that games have a long way to go before they maximize their potential.
Describing the future
We had two baseline presentations. The first presentation from VT-MAK\(^2\) was Peter Swan with an example of current wargaming technology. His focus was constructive simulation as used in military training. VT MAK builds and deploys a suite of rapid scenario development, combat simulation, and data collection tools. These tools can interface with and drive standard DoD command and control systems or be used in a networked, stand-alone mode to support command node training wargames. VR-Forces is their primary ground and air combat simulation tool. This computerized tool accommodates high fidelity combat from the tactical to the joint level of resolution.

The second presentation, by Lucien Parsons from the University of Maryland’s MAVRIC program, gave an in-depth look at industry trends in immersive technology. Immersive technology consists of augmented or mixed reality (AR/MR) where digital media are superimposed on the real world (think Pokémon Go\(^3\)) and virtual reality (VR) where the real world is replaced by the digital. MAVRIC works on applications and technologies in the AR and VR spaces for both serious and gaming applications.

From the perspective of someone inside the virtual media and gaming environment the scale, scope, interactivity, and variety of tools are all growing rapidly. For example, from 2004 to 2019 the number of players has gone up an order of magnitude from 300 million to 3 billion. The diversity has increased and the scope of games has expanded beyond the dozen or so genres available in 2004.

But the potential for technology to shape the gaming experience has grown as well and will likely continue to grow. Specific systems he discussed include:

- **AR contacts.** Contacts would allow players to dispense with glasses and have a much more integrated AR/MR experience. This would have significant implications for games, as well as society at large.
- **Holograms.** The implementation of true holographic displays and the ability to project holograms outside of the displays (as in Princess Lea in Star Wars: A New Hope) would allow for virtual gaming pieces and boards that did not depend on physical objects.
- **Location based AR/MR.** Examples include the Jeff Koons balloon dog in Central Park\(^4\) and team AR games like Ingress Prime.\(^5\)
- **Augmented/Mixed mapping** where location information is overlaid with mapping information to provide real time navigation.
- **Tele-everything** where telepresence and real-time virtual presence becomes common.
- **New interaction mechanics including:**
  - Natural language processing
  - Hand, arm, and gesture following

\(^2\) [https://www.mak.com/](https://www.mak.com/)
\(^3\) [https://www.pokemongo.com/en-us/](https://www.pokemongo.com/en-us/)
\(^5\) [https://www.ingress.com/](https://www.ingress.com/)
Tagging of apparel and other items to allow for in-game interactions
Next generation glasses and goggles that are less intrusive and have augmented sensors (motion, sound, etc.)
- New ways to build games including image and motion capture, graphics and software production, and data management tools.
- New players. As games and the digital space diversify different players and participants will bring varying expectations and understandings.
- New types of outputs. With 3D printing and robotics, the interaction between the game world and the real world may become increasingly blurred.
  - The ultimate example of that in wargames is Ender’s Game⁶, something that was also examined in working group 2.

The presentation painted a picture of a technology future where smaller, more integrated technologies will enable enhanced visualization during wargames. Smart tools for development and graphics production may also streamline the development process for integrating those tools into games.

**Planning the future**

After the discussion we broke into four groups for a brief facilitated scenario planning event. The goal was to identify two variables that the group thought was going to drive gaming into the future, and then conduct a short scenario planning exercise to identify how those variables might interact to give us different futures. Figure 1 shows the process we used.

![Scenario planning](image)

**Figure 1 – Scenario planning process**

How did it work?

What do we mean by “variables”? They are anything that can have a significant impact on future gaming. This could include technology, or attitudes, or funding. For some variables we will want to be a bit more specific. For example, we may want to define which type of technology we are discussing. Digital construction tools (software development) are different than visualization or artificial intelligence. Our variables should not lock us into a particular future, rather they should set up the next event with a rich set of possibilities for discussion. In Appendix 1 we give a list of variables that were given to the participants as a starting point.

After identifying the variables participants were asked to examine how the two variables might interact in the future. Using these interactions, they were to create simple futures by extrapolating those variables into the future. Figure 2 illustrates this process for one set of variables.

![Scenario matrix](image)

Figure 2 – Scenario process

As can be seen in the figure the two variables are Funding/Interest in gaming, and Kinetic vs. Non-kinetic emphasis in warfighting. The latter variable roughly compared to peer competitor conflicts vs. small-scale contingencies (SSC), Afghanistan/Iraq, and humanitarian assistance/disaster response (HA/DR) operations. If funding/interest is “high” then gaming
becomes an essential advisor. If the emphasis is on “peer conflict” then gaming will be an essential advisor inside of the warfighting decision-making logic. Likewise, if the emphasis is on less intense conflicts and HA/DR then gaming may be seen as a way to relieve suffering and better deliver services to those in need. At the other end of the spectrum, if gaming is simply a backwater “hobby shop” with little influence it will be left outside the decision-making process, or end up focused elsewhere, such as hobby games. This, of course, is just an example that we used to explain the process to the participants.

As mentioned previously participants broke into four groups. Each group developed its own character and point of view, to include whether the participants stood up or sat down, and how the participants interacted with the facilitator. Most groups used some sort of voting process to decide which variables they wanted to use. Groups had approximately 10-15 people in each group, with only small variances.

The following sections describe the results for each discussion group.

**Group 1: A cost effective world**
This group chose cost and effectiveness as their two variables. Other variables considered by this group are given in the report’s Appendix 2. They were suggesting that in the future the funding, or cost, of the wargames would drive what kind of games were developed, and the types of games could influence the effectiveness of the game. Figure 3 shows this variable graph.

Comparing the sample matrix variables to those that were chosen, and the choosing process, suggests the sample variables and the matrix in particular had an influence on participants as to which variables they would consider. The kinetic vs. non-kinetic variable was popular, but interpreted in several different ways.
As can be seen in the figure, the group was primarily interested in finding cost effective ways to have the most effective game. High cost options, such as MMORGs, flight simulators, or other digital type training aids were thought to be generally effective, but the requirement to digitize them at high levels of fidelity made the cost high.

The bottom, right, quadrant was the most important quadrant, with systems that had a high degree of effectiveness but at a reasonable cost. An example would be a driving simulator that used only VR goggles and simple input controls to provide training. If studies showed that such minimalistic approaches worked, and some do, then significant cost could be avoided. The term used here “focused fidelity” sums up the intent. For this group what is needed in the future are games and digital simulations that have their focus on the right set of parameters to achieve the objectives. Currently that area is occupied by traditional manual games. Without the need for digital development, manual games are low cost, but they don’t exceed the requirements for the analysis or training. By adding some low cost features, such as VR, training games in particular can still be low cost, but also have higher degrees of success.

Finally, the high cost/meets requirements quadrant was characterized as “Corporate Welfare” by the participants, still meets requirements but can lack focus, lack high fidelity, while still incurring high costs due to the cost of digital development. Examples included simulations like JWARs (Joint Warfare System) and large-scale exercises. While large-scale exercises meet requirements, they can also be extremely expensive and may not be necessary if there are lower fidelity, but sufficient, ways to use wargames to replace many of their training elements.

For this group the way games move forward in the future is to work the cost/effectiveness curve. By introducing the right technology into traditional, manual, gaming techniques the training and analytic value may increase substantially, while at the same time avoiding the cost pitfalls with extensive, high fidelity, complex digital products.

**Group 2 – The matrix**
Group 2 created a very different world than group 1. For this group is was all about the way in which games interacted with players and organizations, and the complex, intermingled, results.

This group chose wargaming methods and the nature of war as their variables. In one potential future, war remained mostly a physical pursuit. The winning side in wars could provide greater force to achieve their objectives. At the opposite end of the spectrum, future wars are won by targeting the adversary’s “hearts and minds,” i.e., in this future one could win the physical realm and lose the war. Other variables considered by this group are given in Appendix 3.
This group had perhaps the most conceptual view of the future. They were trying to understand how current games involving information and force-on-force would evolve as methods of gaming changed. While the methods were not specified, the force-on-force games become increasingly digitally driven as time goes on, while new methods for dealing with information increasingly draw on social sciences, and social media, techniques. This really divides the worlds into two paths, one where conventional force-on-force combat dominates, and the other where information operations dominate. Both could be seen as running in parallel tracks, related, but independent in the methods used to include them in games.

For the force-on-force track, the scenarios range from what we do today, the traditional quadrant, to new methods and techniques. This evolves gaming from where we are today, with global wargames and manual games into an increasingly digitally mediated form of gaming.

The methods to incorporate information in games, from information warfare to cyber to PSYOPS, are not something that is widely or well understood today. This means we are moving from a place where our understanding is incomplete and rely on outdated theories (Freudian) to a place where new techniques have been created to better address the problem. In the new (Inception) world created in the future games may find ways to more completely immerse the players in the game experience. In that case the players will literally lose themselves in the game, raising a number of ethical and analytical issues. Is it ethical to subject players to an immersive artificial reality in order to analytically understand a problem? And if we do it, how will be conduct analysis on the outcome? Will fields like anthropology, psychiatry, and sociology be more applicable than traditional analytical techniques?
In this set of variables technology allows for games to evolve in two different ways. One simply moves the traditional force-on-force techniques into the digital realm, while the other revolutionizes the experience of games through immersion. The role that immersion and player perception have in games, and what technology as well as new gaming techniques, will do for that in the future is both an important, and interesting, topic.

**Group 3: Automation and Adjudication**

This group chose to examine how automation would interplay with adjudication. The other variables they considered are given in appendix 3. Figure 5 shows this matrix.

Automation was the driver in these discussions. Just how automated could you get in a game? Could even the players and controllers be automated, and could that be done within the context of a highly complex, real world adjudication process? This group considered full automation to be the “holy grail” scenario where automation combined with highly realistic and accurate models to give an environment where replication and variable space mapping could occur.

On the other hand, without high-speed automation the play bogs down the more detailed and complex the adjudication. In this world, the ability to adjudicate outstrips the ability to automate the game (including interfaces and visualization) resulting in the Turtle world. An obvious example of a turtle style manual game is Campaign for North Africa\(^8\) arguably one of the most complicated and detailed games ever produced. JANUS is an example of a simulation that has a tremendous amount of detail. The challenge with complex, detailed simulations is that can take a long time to run, and are often dependent on a large number of input variables describing the systems and scenario.

\(^8\) [https://boardgamegeek.com/boardgame/4815/campaign-north-africa](https://boardgamegeek.com/boardgame/4815/campaign-north-africa)
Typically, professional game designers put on a much less complicated or detailed game than Campaign for North Africa. While sticking to manual adjudication, the games increase playability to nearly tolerable levels through the use of various forms of abstraction including having the facilitator internalize many or most of the key adjudications and outcomes. This is the "Now" world or the speedster, sacrificing complexity and detail for playability in manual games.

If you automate the abstract games you get into the "toy" world. Here the simplifications clash with the automation to structure the game like commercial computer games. Fully automated toy games would be able to address certain, abstract, research problems in information, cognition, and communications but would be less believable (by observers and consumers) on complex subjects such as a major theater war.

The group also considered the elements of what could be automated:

- Participants. The group asked if humans are fully necessary for every game.
- Information. This is a challenge in human/computer games. How do you manage display, content, and input from players and controllers while not bogging a complex game down with endless data entry?
- Structure. How to players function and interact with the game? Participants suggested that different player roles might have different game interfaces.
- Data capture. Automation greatly enhances data capture.

The relationship between automation and the complexity of wargames was identified as an important consideration for how games will evolve in the future. This, ultimately, is a trade-off between playability and human factors in the games (keeping them short and making interactions easy) with the desire for complexity as a marker for realism. The more complicated the models and game requirements, the more likely they will be automated, with the concurrent loss of playability. During this working group we saw some technologies that may address some of the playability issues, such as VR and AR, as well as technologies like AI development environments which may address issues of cost and time to implement advanced interfaces.

**Group 4: Hard power, soft ware**

This group chose Power and Media type as their two variables. By “power” they meant hard (kinetic) vs. soft (non-kinetic) power. In that sense they had the same variable as the example, and as Group 2 (who called it “media”). By “media” they meant digital vs. “traditional” or manual gaming. This, again, was the same as Group 3 (automation), and similar to Group 2’s “methods” (new vs. traditional).
Figure 6 shows this matrix

In the case where digital predominates and the challenges are mainly hard power, this gave rise to the Skynet of Games scenario. Here a globally integrated information environment (GIG) allows for COCOMs to continuously game scenarios, including soft power issues like information warfare. The scenario is predicated on large-scale availability of fast networks, and the infrastructure to support the gaming.

If the focus is instead soft power, then “Digital Diplomacy” becomes the focus of the games. With the kinetic de-emphasized the challenge becomes developing digital tools (models and simulations) that address some of the issues associated with soft power. One way to deal with that is to use people to represent the soft power base in a game, but that may require access to high speed networks and integration of video teleconferencing, including classified teleconferencing, into games.

Traditional games deal with soft power through mechanics that allow players to either experience or emulate the effects of soft power. In this scenario, labeled “Diplomacy 2 – the Board Game” players interact with the game through traditional mechanics and materials. This is little different than the type of deterrence and diplomatic games we conduct now.

Moving to hard power we arrive at “Maps, Counters, and Smartphones”. This is the current state of hard power gaming, where players are presented with a map and pieces and then must figure out what they want to do. Technology may have a role, such as using smart phones to capture player actions and map configuration during an unclassified game.

A unique consideration for this group was the inclusion of a “hybrid” approach to the games, a place where technology, traditional techniques, and the challenges of incorporating soft power into hard power games all met. The use of conventional, small-scale, games with some digital
enhancement currently provides a low-cost way to deal with both the conventional hard power game, along with the incorporation of soft power into play. This hybrid approach has a lot of advantages, but can be overlooked when digital is considered as a variable in game design.

Discussion
In this section we discuss the overall course of the working group, with particular emphasis on the scenario planning exercise. What can we learn from all four groups? Did any broader themes emerge? What do our discussions imply for the future?

What variables were chosen?
If you look at the variables that the teams chose you see some of the trends and issues that concern game developers today:

- Cost/Effectiveness
- Game media (kinetic vs. non-kinetic)/Methods (traditional vs. digital)
- Adjudication/Automation (manual vs. automation)
- Power (kinetic vs. non-kinetic)/Media (traditional vs. digital)

Clearly the role that the “media” the game is expressed in seems to matter as we think about the future of gaming. The incorporation of digital tools and techniques was a dominant theme in the conversation about the future of gaming, in the stories, the briefings, and in the participant discussions. The adaptation of digital into professional games will need to account for several limiting and accelerating factors:

- Cost. Digital simply costs more.
- Fragility. Digital techniques and hardware have a fixed shelf life. Maintenance costs can often dominate the overall cost profile for digital.
- Pace of change. Digital is changing fast. New hardware, software, and development environments are coming on line. These, as we saw in the MAVRIC presentation, have the potential to revolutionize how players interact with the game.
- Real world intrusions. One place where digital is accelerating is the intermingling of digital with the real world. Whether through AR or 3D manufacturing techniques, digital is increasingly able to reach out and touch the real world in ways it has not been able to in the past.
- Distribution. The ability to conduct games over networks was raised by several groups, but is not something routinely considered in the discussion of future gaming.

Equally important to the groups was the distinction between hard and soft power, also expressed as kinetic and non-kinetic warfighting options. For the past decade US forces have been involved in counter-terrorism and counter-insurgency operations which rely heavily on non-kinetic means for resolving conflict. With the emergence of Russia and China as near peer competitors focus as changed to higher-end, kinetic warfighting. Non-kinetic has not gone away, just shifted to become a component of the high-end warfight as seen in the Russian involvement in Ukraine and Crimea. Because these are current concerns, and frequently addressed in today’s wargames, they are also topics of concern to the participants. The fact
that kinetic and non-kinetic operations were used in the example matrix may have also influenced participants’ choices.

Cost and effectiveness were a very specific pair of variable choices that were designed to get at the problem of how to develop games that were both effective, and low cost. This is a counter to the traditional concept of digital as being both all encompassing, covering every aspect of the problem being simulated, as well as costly to build and maintain. Examples of low cost, but highly effective, digital implementations mean that more consideration may need to be given to alternative ways of building games and simulations. Examples given include no-motion flight simulators, or truck driving training using over VR goggles as opposed to a full-scale truck simulator with motion. Here it appears that expectations of the contracting agency as much as the designers or implementers understanding will need to be managed. Convincing the sponsoring organization that a less capable or advanced system is just as effective as a complex, full-scale, simulation may take time, and may not be in the interest of those who build such systems.

Scenarios
The interaction of the variables built different scenarios. In turn, the scenarios can themselves spark discussion about some of the more interesting insights gained from the exercise. Here we discuss several interesting outcomes that we, as the overall moderators for the working group, would like to highlight.

Ender’s Game and Inception.
While kinetic vs. non-kinetic operations were raised in several groups, group 2 extended the meaning of non-kinetic beyond what we would traditionally think of in terms of non-kinetic operations. They called out one of their variables as “game media.” In the previous section I described that as simply “kinetic vs. non-kinetic”. However, the intent behind that variable was much subtler and more complex. While it was interpreted by the participants as “kinetic vs. non-kinetic” in some cases in others they interpreted it as “a way in which players and the game system interact.” This led to their “Ender’s Game” and “Inception” futures.

In this interpretation, new methods (their other variable) draw players into the game in ways that they currently don’t. This could include VR/AR but also techniques and procedures that immerse players in the game more fully than what is currently available. In our interpretation of this set of future methods, designers use stories and visuals to completely immerse players in the game, with the consequential emotional and mental effects. As players become more and more entwined in the game the “soft” aspects of what they bring to the game (emotional, agendas, politics, points of view, etc.) come more and more to the forefront of game play. As they do in the real world.

This can have implications for the players and designers. For example, what are the ethics of immersing players so fully in the game? Or, how do you collect data and information from such a wholly immersive world? While digital enables collection about action, immersive digital will give you all the same problems you have in the real world about understanding intentions,
decisions, and understanding. In this case digital does not enable collection any better than what you would have in a non-digitized, real world, environment of an operation or exercise.

Moving up the scale of cognitive to physical you get to the other scenario: “Ender’s Game”. As you will recall, in the story Ender’s Game by Orson Scott Card, students gifted in game play and decisions were recruited as trainees for commanding fleets against an alien race. What they were not told was that their training exercises eventually became real, as they “played” with real fleets in real engagements.9

The role of games in planning for, and possibly executing, operations in the real world were not only explored here, but also in the fiction stories “The Last Peace Fighter” and “A Nice Game of Chess” (both by Matt Caffrey) in the “Stories of Future Gaming” piece associated with this working group. The idea of gaming moving out of the “laboratory” of analysis and decision support and into a practical tool to shape real world decisions, is something that is clearly on the minds of some participants in the working group.

Why might this work? How would it work? One clue is in Ender’s Game, where participants in the game did not know they were actually controlling real forces. Therefore, they felt freer to take risks, and adopt strategies, that they might not if they knew the situation was “real.” At the same time if the game is produced without constraints and limitations imposed by real world considerations, of course the strategies may be more effective but at a higher cost in other areas. In the case of Ender’s Game much of the human fleet was sacrificed, and the war was won through a genocidal elimination of the enemy. Without incorporation of limiting values and expectations into games, any game, the results can be biased in ways that are impossible to execute in the real world.

While immersion and integration, whether simply cognitive or with the real world, is an interesting possibility for gaming, the implementation of such integrative games will most likely need to consider limitations and constraints that are not commonly implemented in other, more limited, games today.

Focused fidelity
In Group 1 “focused fidelity” was the clear preference for how digital could be economically introduced into gaming. The concept was to identify that which is essential for the gamed action to succeed, and then remove all of the other considerations from the implementation. This is clear for training games where data can be used to assess which elements of the activity need to be incorporated into training, and which don’t. If the goal is to exercise coordinated fighter and shot tactics then aircraft movement may be irrelevant in a simulator. If, however, muscle memory for emergencies or maneuvers is the objective, aircraft movement may need to be simulated. Defining the objectives for the training elements can produce significant cost savings in some cases.

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The case for focused fidelity becomes more complex when analytical or exploratory games are considered. Here the goal is concept development, creating a new way of fighting or testing a war plan. The question of what to leave out and what to include in the game is a question of game design. Given the number of design options open to the designer, which combination of design elements can be brought together to minimize overall cost and effort in the game while still allowing players to explore the question. This becomes less a cost/effectiveness question and more of a design/effectiveness question, though in some cases cost issues may occur.

*Diplomacy and State Craft*

By “Diplomacy 2” in their scenario name group 4 was referring to the Avalon Hill game *Diplomacy*\(^{10}\). The larger issue was how to include “soft power” or “non-kinetic” actions in games. This was also raised in the “Freudian” scenario of group 2\(^{11}\). Given the requirements of the past 10 years to explore counter-insurgency and nation-building operations these issues have been required to be incorporated into games for a long time. However, game designers still struggle with how to quantitatively, or even qualitatively, incorporate soft power issues into games. Participants clearly saw that as an issue that would continue in the future. Even if hard power/kinetic operations are the primary focus, operations like Ukraine, Hong Kong, or the recent interference in Western country elections, suggests that soft power will still be an element of power use by great powers.

Reading between the lines in the working groups there were two thoughts to incorporating soft power into games. One was to rely on players, whether real or automated, to generate actual data on how soft power elements will be processed by the targets. For example, political parties can be played in games, with players representing the various agendas and factions in the population.

Or soft power can be simulated. In this case programs are designed to replicate population behaviors and attitude’s and players must act against those programs with their soft power maneuvering. This simulationist approach has all of the same problem as any simulationist approach to gaming: data set up, interfaces, and model validation all present difficult and costly challenges.

*The Turtle and the Grail*

How far can we go with automation? Is it possible to have a game with no players? Can all adjudication be turned over to a simulation, with players playing against the simulation?

Group 3 asked these and other questions as they considered the boundaries of complexity and simulation in games and in particular game adjudication.

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\(^{10}\) [https://boardgamegeek.com/boardgame/483/diplomacy](https://boardgamegeek.com/boardgame/483/diplomacy)

\(^{11}\) The “Inception” scenario of group 2 was focused on a different set of cognitive questions than the “Freudian” scenario.
Taken to the extreme, a highly complex adjudication problem, perhaps involving hundreds of aircraft, thousands of missiles, and hundreds of different types of targets is virtually impossible to adjudicate manually\textsuperscript{12}. Some sort of simulation would be needed in order to manage the outcome in any sort of detail. However, the process of building the database, inputting the initial conditions and other interface factors may make even a fast running simulation impractical.

At the other extreme a rigid-Kriegsspiel board wargame is simply an algorithm that is being manually adjudicated by the players. If a program had all of the inputs then managing a manual wargame would be relatively straightforward for a computer\textsuperscript{13}.

So, abstraction of the game elements may also help with the input problem, and alleviate some of the difficulty in interfacing between the game board and the players.

But automation does not have to stop with automating the adjudication process. As group 3 discussed, you could also automate just about every feature of the game, including players. For example, an agent-based program, with each agent representing a decision-maker on the battlefield, could be placed in the same synthetic environment you are placing the players in. If the agents were artificially aware, then their play would be parallel to what you could expect from a human player. In fact, the AI could be “trained” on the game in question through repeated play throughs, in ways that human players could not.

The key challenge in such systems today, and apparently for the foreseeable future\textsuperscript{14}, is building an AI system that does not introduce some sort of systematic bias in the results. If the game is considered as a very large, complex, variable space, then the training process for AI's using deep learning is essentially exploring that complex variable space, looking for local minima and maxima in whatever value condition you impose on the AI. Examples of value conditions might be number of units lost or geographical gains. In training the AI you will be assuming that the variable space has been explored to some extent. Any areas that have not been explored, and thus are not part of the AI’s cognitive landscape, will be difficult to explore once the AI is moved from training to game execution.

Using traditional agent-based or expert-based programming also has the potential to introduce biases in the play of the agents. This could be from programmer bias, or bias from how the experts used play the game.

\textsuperscript{12} Here we make a distinction based on what players are willing to put up with. Hobby players are often willing to put up with extremely long and complex adjudication or other mechanics, while professional players tend to be put off by such shenanigans.

\textsuperscript{13} In miniatures gaming there is a system for computerized game management and adjudication, however it requires a systematic set of player and controller actions to make sure the table and the computer are kept synchronized. http://www.carnageandgloryii.com/index.htm

\textsuperscript{14} Strong AI is almost always predicted to be at least 20-30 years in the future, no matter what year the prediction is made.
As is usually the case, it depends on the purpose of the game. If the purpose is not to explore a set variable space, but open up the problem to new concepts and ideas, AI’s playing the game will not be able to do that, at least at the current state of technology. Only players will be able to add new variables and conditions to the mix, invading Belgium even though it’s a neutral country, to get around perceived operational or tactical limitations.

**WORKING GROUP SUMMARY: WARGAMING FOR FUTURE LEADERS**

**Working Group Chairs: Mr. Mike Dunn and Dr. James Morningstar**

This working group discussed the challenges in finding, developing, and employing the next generation of wargamers. We defined a priori what constitutes a wargame: a universal, broad term that encompasses any activity that combines simulations (i.e., models iterated over time) with human decisions for some purpose. We defined the future as that period of time within the next 20-30 years that the current generation are no longer participating in professional wargaming. Finally, we defined leaders as those that inspire, lead, or direct others to achieve the stated goal of a wargame. As such, we further defined wargame leaders as anyone that plans, participates in, or consumes the results of a wargame.

The conclusions of the working group found:

- Wargaming encompasses elements of both profession and activity
- Wargamers are largely self-selected based on interest in the activity
- To further development of the field, be open to those that express an interest in wargaming
- Encourage and foster a multidisciplinary approach to wargaming
- To be a wargamer, wargame – practice, practice, practice

In sum, current planners, practitioners and consumers must consciously create opportunities for future planners, practitioners, and consumers in order for the practice to thrive in the future.
GAME LAB SUMMARIES

OVERVIEW
Game labs consisted of 36 facilitated small group discussions lasting approximately one hour about a specific gaming-related question. Several game lab facilitators provided the discussion notes included in this section. Topics ranged from wargame theory to organizations and applications to tactical mechanics for drones and message traffic. Conference participants selected which game labs to attend from the lists shown in appendix 2. Appendix 7 contains a standalone game lab report on “Addressing the Decision-Effect Time Gap” (facilitator: Mr. Ken Shogren).

HOW CAN WE DESIGN TACTICAL CYBER GAMES?
Facilitator: Dr. ED McGrady

In this game lab we discussed the challenges associate with gaming tactical cyber operations. We had a wide-ranging discussion and participants ranged from game designers to experienced cyber security professionals. Tactical cyber games were described as covering topics from the CIO/CYBERCOM level and below, particularly issues associated with intrusions and execution of different types of operations. This included social media and information operations. It would also logically include funding and resource allocation, since developing cyber capabilities takes time and resources. This differentiates cyber tactics from other tactical situations, time in cyber may be quite fluid, ranging from the very fast to months or years.

Topics discussed included:

- The use of the ARES platform15 as a tool to virtualize a cyber environment. This includes virtualizing the network and servers, which allows malware and other actions to also be virtualized, creating effectively a virtual cyber range. As a training platform it was thought to have some uses, however it also had challenges in its implantation, particularly for games. A participant also asked what the difference was between a virtualized cyber “game” and a cyber exercise, since the native operational space for cyber is in fact on computers.

- In discussing tactical cyber games the issue of whether we were really trying to establish a red team came up. This was in response to questions about the utility of games to identify new techniques, tactics, or surprises in the cyber domain. One question was whether it might be useful to focus on red team operations and develop a game specifically targeted towards red team operations.

- Participants observed that most commercial or hobby games on the market tend toward simplistic mechanics and lack effective simulation of the broad range of choices and options that tactical operators have in conducting cyber operations. They tend to focus

15 https://www.circadence.com/products/project-ares/
on the cyber kill chain and accumulation of “points” or other attributions as you proceed along the kill chain.

- Tom Mouat described his cyber-attack on a port game. In particular it was noted that his game focused on entry points and integration of different capabilities to develop effective attack patterns. The game gives players decisions between different types of attacks, resource allocation, and risk trade-offs.

- A series of other hobby games were also discussed, including Android Net Runner,\(^{16}\) which a participant indicated had been re-purposed as a present-day cyber game. Likewise, Castle Assault\(^{17}\) was put forward as having mechanics that may be useful for cyber games. Another title mentioned that may have mechanics of use to cyber was Starship Battles.\(^ {18}\)

**GAMING URBAN TERRAIN AND MEGACITIES**

Facilitator: Dr. ED McGrady

This was a forum where we could continue the discussion from the previous day’s session on gaming Urban Terrain. Like the previous day’s discussion most of the time was devoted to better understanding how to game and represent urban terrain or megacities at the operational level.

While the discussion ranged widely there were some common themes that threaded through all of the various topics. The most important dealt with the nature of warfare in urban terrain and megacities. In general, this divided the problem into three broad categories:

- **Humanitarian situations and operations.** This could either be a straightforward humanitarian operation in a large urban area, working on infrastructure, security, and provision of humanitarian services, or an in-extremis humanitarian emergency brought on by a broader problem of conflict. Either way dealing with the humanitarian problem requires the design to include infrastructure such as water and power, as well as human terrain and population response.

- **Insurgency or gray zone operations.** Tied to but possibly separable from humanitarian operations is the problem of responding to a complex security environment within an urban area. In a failed or failing state a response might be required to engage insurgents in an urban area. This could be either in support of humanitarian operations or in response to third power gray zone operations.

- **Conventional/air-land battle in urban zones.** This would result from conflict between peer or near peer forces operating in urban areas. This scenario emphasized the challenges of targeting and maneuver warfare in a dense urban environment against a well-equipped enemy. The intersection of these operations with the previous two types

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\(^{16}\) https://boardgamegeek.com/boardgame/124742/android-netrunner

\(^{17}\) https://boardgamegeek.com/boardgame/154674/castle-assault

\(^{18}\) https://boardgamegeek.com/boardgame/151020/starship-battles
of operations introduced even more complexity into the real-world problem as well as the problem of simulating the conflict.

Other issues that were discussed included asymmetry of ROE between western and other forces, with constraints on civilian casualties and infrastructure damage possibly limiting the ability of western forces to use fires in this environment.

Another issue was why not just bypass these areas like conventional armies might enemy strongpoints. In addition to the potential humanitarian issues it was noted that urban areas are ideal locations for concealing indirect fire capabilities such as TELS as well as air defense vehicles. The ability to avoid surveillance sensors, but retain the ability to execute fires, would make urban areas ideal locations to interdict air and ground operations. In addition, it was noted that structure shadowing might limit fires with depressed lines of fire from actually hitting targets, even if you could see them.

Because urban areas were so complex and difficult it was suggested that this may require the COCOM to create a separate joint command to deal with them. This would create a regional task force commander to handle the complexity of the urban environment. Interestingly this would give game designers the ability to segment the urban area off of the larger battlefield, allowing players to focus all of their attention on the urban fight as opposed to the larger context of the overall conflict.

The large numbers of forces required for urban operations was also discussed, with questions about how increasing force density within urban areas might be counter-productive due to the lack of places to put them out of fires. Use of SOF and/or local partners might be a better way to handle the urban environment, rather than inserting large numbers of conventional forces.

Participants also discussed the type of terrain. In some cases, such as old medieval wall or forts, it might be virtually impossible for fires to penetrate those structures. While other structures such as row houses might give clear fields of fire but would be vulnerable to breaching from the sides. And modern steel and glass structures would have unique responses to conventional weapons, with the possibility of rockets or high caliber rounds simply flying right through them. This detailed set of terrain effects was seen as a challenge for game designers.

A lot of the discussion focused on the challenges of urban terrain, without a lot of clear ways to incorporate those challenges into games. One proposal was to segment the urban battle from the main battlefield. This was seen as a logical possibility for situations where megacities or large urban areas would be involved. It was also likely that an operational turn on a modern battlefield, typically between three days and a week, would allow the battle in the city to be synchronized with the overall battlefield without disrupting the overall flow of the game.
A hobby game identified as possibly being a useful example of megacity warfare was *Götterdämmerung*, a game on the fall of Berlin in 1945.\(^{19}\)

**INCORPORATING ISR INTO OPERATIONAL LEVEL WARGAMES**

Facilitator: Mr. Mike Ottenberg

**Discussion:**

The objective of this group is to explore and develop approaches to incorporate C4ISR into operational level wargames.

By way of background, questions concerning information warfare are coming to the fore in defense analysis. Current wargames use a ‘God’s eye view’ of the battlefield with little to no play of hidden information, electronic warfare, cyber operations, influence operations, explicit C3, signature management, and ISR.

The group accomplished two and part of a third of the four steps required to incorporate ISR into wargames during the time allotted to the Game Lab (Figure 1).

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### What is ISR?
- What should a conceptual model of ISR look like?
- How should the ISR conceptual model be incorporated into wargame elements?
  - Participant responsibilities
  - Information & Displays
  - Adjudication
  - Turn structure
- What are the advantages/disadvantages of each approach?

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**Figure 1. Group 8 Analysis Steps**

The first step is to define ISR. The group generally agreed that ISR is composed of collection platforms, processing, and dissemination. Platforms and sensors include, but are not limited to: AWACS, SIGINT, JSTARS, national space, cyber, and other systems or capabilities. Joint and combined sources must be included to accurately reflect current operational level warfare.

Accurate modeling of ISR systems is required to support the incorporation of ISR into wargames. For example, probability of detection should be partially a function of sensor range.

Classification is an issue in defining ISR but intelligence type or form is probably independent of classification. Usable ISR performance and related data could be classification and wargame objective dependent.

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\(^{19}\) https://boardgamegeek.com/boardgame/2474/gotterdammerun
Under this definition, ISR provides available, usable information to commanders and their staffs for command and control as well as for targeting. It is part of the collect, analyze, decide, and directing processes of command and control.

**Conceptual Model:**

The second step is to convert the definition into a conceptual model suitable for implementation within an operational wargame design. The group concurred that C4ISR is a system of systems that collect, process and disseminate intelligence information. Pursuant to this characterization of C4ISR as a system of systems, the group reviewed three different, but complementary architectural depictions of C4ISR from generic, operational, and functional perspectives.

![Figure 2. Generic C4ISR Perspective](image)

Figure 2 provides a generic perspective of nodes (facilities, weapons, sensors, munitions, and communications nodes), and links (communications). Information (enemy, friendly, and common) is transformed at nodes by personnel, systems, and procedures and is conveyed between nodes by communications networks.
Figure 3. Operational C4ISR Perspective

Figure 3 depicts a simplified operational perspective of multiple nodes, sensors, and communications links on a ground battlefield within the context of a hierarchical organizational structure assigned to accomplish a combat mission.

Figure 4. Functional C4ISR Perspective

Figure 4 depicts a functional perspective by showing the similarities between, the connections between, and the differing purposes of sensor information collected and processed to support operational decision making as well as driving kinetic/non-kinetic kill-chains.
The group concurred that all three perspectives are necessary to adequately define a C4ISR conceptual model. Others noted that elements of counter-C4ISR need to be incorporated into the conceptual model in addition to representations of the environment in order to have a complete conceptual model. A high level depiction of the resulting ISR conceptual model is presented in Figure 5. One member noted that the United Kingdom uses a mix of the operational and functional perspectives to characterize C4ISR.

**Incorporating an ISR Conceptual Model into Wargame Elements:**

How should an ISR Conceptual Model be integrated into a wargame? The third step is to convert an ISR conceptual model into discrete wargame elements such as participants' responsibilities, information and displays, adjudication, and turn structure. The group addressed this issue in general before it desired to examine it in detail.
One approach is to model types of ISR systems in a theater of war to produce probabilities of detections against specified threat unit signatures as a function of time as well as unit sensor performance, threat signature strengths and additional environmental conditions. At some level of resolution, the game would have to fuse the combined effects of multiple different types of sensors and would have to present the resulting sensor-driven perceived Common Operating Picture to each team. (Figure 6). The granularity and specifics would be determined by the scenario and the situation within the wargame.

In particular, the participants would need to manage scarce intelligence assets in order to capture the quantity of information in the desired location(s) and thus support participant decision. Thus the distribution, type, and capabilities of sensors will determine the amount of information available to the participants. By definition the ability of the opponent to conduct operations to kill, blind, or deceive the opponent’s sensors will also drive the accuracy and timeliness of the COP for participant decision making.

This generic approach would require several new wargame design elements to be successful. Wargame participant quantities, skill sets, and roles will need to be modified. At a minimum, an Intelligence Officer participant would be required to actively translate the commander participant’s intelligence needs into the management and tasking of the team’s sensor assets. Also, wargames must incorporate hidden information and multiple perceptions: Red, Blue, and Ground Truth. Red and Blue operational situation information displays must be based solely upon what has been sensed by that side. Additional adjudication methods must be incorporated into the wargame. These methods must accommodate sensor capabilities against
signatures within specific environments. Classification and abstraction of the data must be commensurate with the objectives of the wargame. Mission models may provide predetermined results to support sensor adjudication. Moreover, turn structures will need to be modified to accommodate the results of ISR. Finally, the group concurred that computers may be able to handle hidden information more easily than a traditional physical map and counters game. (Working hypothesis: explicit and efficient incorporation of ISR into operational level gaming can only be accomplished through the use of computer assistance. [Group Lead Opinion])

While the scope of this game lab is the operational level of war, the group discussed several elements that apply to the incorporation of ISR into tactical level wargames and other potential caveats. At tactical echelons, the group feels that C4ISR can be more detailed and specific especially in the areas of what sees what, how and where and how quickly intelligence information is disseminated. C4ISR might be part of the scenario input where intelligence information is sensed outside of the game and injected into the game at the correct time by the White Cell. It was noted that at the brigades rarely have organic ISR assets commensurate with the area of the brigade’s area of interest and must rely upon less than perfect organic assets or sensor assets attached/placed in direct support of the brigade by higher echelons.

Conclusions:

The group successfully developed a working definition of ISR, a conceptual ISR model, and the broad aspects of implementing ISR within an operational wargame. The third step of defining a detailed approach was not completed.

<table>
<thead>
<tr>
<th>Detection Level</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hidden</td>
<td>None</td>
</tr>
<tr>
<td>2a. Acquired: Not Classified</td>
<td>Geolocation ellipse (e.g. multiple hexes)</td>
</tr>
<tr>
<td>2b. Acquired: Classified</td>
<td>Size (est); Type (est); Geolocation ellipse (e.g. multiple hexes)</td>
</tr>
<tr>
<td>3. Identified</td>
<td>ID; Size; Type; Status; Unit Values; Geolocate to actual location</td>
</tr>
<tr>
<td>4. Targeted</td>
<td>Geolocate to weapons accuracy</td>
</tr>
<tr>
<td>Decoy Unit</td>
<td>Projected vs actual unit</td>
</tr>
</tbody>
</table>

Figure 7. An Implementation Approach – Unit Detection Levels
<table>
<thead>
<tr>
<th>Detection Level</th>
<th>Previous Detection Level Required</th>
<th>HUMINT</th>
<th>IMINT</th>
<th>SIGINT</th>
<th>MASINT</th>
<th>Cyber</th>
<th>Other (National, COCOM, Scenario, IPB)</th>
<th>Logic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Hidden</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2a Acquired: Not Classified</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>OR</td>
<td>-</td>
</tr>
<tr>
<td>2b Acquired: Classified</td>
<td></td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>-</td>
<td>-</td>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>A single INT is sufficient to acquire</td>
<td></td>
<td>-</td>
<td>-</td>
<td>Y</td>
<td>-</td>
<td>-</td>
<td>OR</td>
<td>OR</td>
</tr>
<tr>
<td>3) Identified</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>OR</td>
</tr>
<tr>
<td>A combination of SIGINT or IMINT to identify</td>
<td></td>
<td>Y</td>
<td>-</td>
<td>Y</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>OR</td>
</tr>
<tr>
<td>4) Targeted</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>OR</td>
</tr>
<tr>
<td>Additional INTs required to target</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>-</td>
<td>2 x Y</td>
<td>Y</td>
<td>-</td>
<td>OR</td>
</tr>
</tbody>
</table>

Figure 8. An Implementation Approach – Example Intelligence Fusion Table

![Infantry Battalion (+)](image)

<table>
<thead>
<tr>
<th>INTELLIGENCE TYPE</th>
<th>SIGNATURE RATING</th>
<th>SIGNATURE RANGE</th>
<th>SENSOR RATING</th>
<th>SENSOR RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIGINT</td>
<td>4</td>
<td>25</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>IMINT</td>
<td>2</td>
<td>50</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>HUMINT</td>
<td>8</td>
<td>3</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>MASINT</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

Notional Data

Figure 9. An Implementation Approach – Example Unit Sensing and Signature Values
1) Sensing Unit Rating + Signature Rating = Detection Chance Modifier

2) Compare Detection Chance Modifier to 20.
   a. If DCM = 20, then 50% chance of detection either way.
   b. If DCM > 20, then sensor is favored.
   c. If DCM < 20, then target is favored.

3) Incorporate Modifiers (Every “point” is equal to 2.5% change)
   a. For every point DCM exceeds 20, the probability of detection increases by 2.5% (and vice versa).
   b. If DCM is equal to 20, then 50% chance of detection.

4) Use a Stochastic Method against the Probability of Detection

---

**Figure 10. An Implementation Approach – Example Sensor Success Adjudication Method**

<table>
<thead>
<tr>
<th>Environment Modifiers</th>
<th>Sensing Unit Vs. Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrain (+/-)</td>
<td>Decoys (+)</td>
</tr>
<tr>
<td>Jamming (-)</td>
<td>OPSEC/EMCON (+)</td>
</tr>
<tr>
<td>WX (-)</td>
<td>Camouflage (+)</td>
</tr>
<tr>
<td>Day/Night (+/-)</td>
<td>Level of Detection (-)</td>
</tr>
<tr>
<td>Range (+/-)</td>
<td>Radiating (?+)</td>
</tr>
<tr>
<td></td>
<td>Posture (+/-)</td>
</tr>
</tbody>
</table>

**Figure 11. An Implementation Approach – Example Vignette**

Random Result = .65

.65 < Pd (67.5%) so...

SUCCESS!!

Therefore:

SIGINT = YES!!

---

Current DL

<table>
<thead>
<tr>
<th>DETECTABILITY</th>
<th>SIGNATURE RATING</th>
<th>SIGNATURE RANGE</th>
<th>SENSORS RATING</th>
<th>SENSORS RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DETECTABLE</td>
<td>4</td>
<td>6</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>DETECTABLE</td>
<td>2</td>
<td>2</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>HUMANITY</td>
<td>1</td>
<td>8</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>CYBER</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>DETECTABLE</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Sensing

Random Result = .65

.65 < Pd (67.5%) so...

SUCCESS!!

Therefore:

SIGINT = YES!!

New DL for Threat

---

Detection Range

Signature Range

<table>
<thead>
<tr>
<th>DETECTABILITY</th>
<th>SIGNATURE RATING</th>
<th>SIGNATURE RANGE</th>
<th>SENSORS RATING</th>
<th>SENSORS RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DETECTABLE</td>
<td>4</td>
<td>6</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>DETECTABLE</td>
<td>2</td>
<td>2</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>HUMANITY</td>
<td>1</td>
<td>8</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>CYBER</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>DETECTABLE</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Sensing (Base) vs Signature Size (Base +/- Sensor Modifier +/- Signature Modifier)

Environment:

- Sensor: Range to target < Pd50 range = +10
- Signature: Poor SIGSEC Measures = +5

Step 1: 8 + 10 (Blue Sensor Rating) + 4 + 5 (Red Signature Rating) = 27 (Detection Chance Modifier)

Step 2: 27 (DCM) > 20, so Sensor is favored (probability of detection is decreased).

Step 3: 27 is greater than 20; 7*2.5=17.5, so 17.5% increase in probability of detection, giving us a 67.5% probability of detection, a 32.5% probability the target is not detected.

Step 4: Utilize stochastic method to determine using derived probabilities

Fusion

<table>
<thead>
<tr>
<th>DETECTION LEVEL</th>
<th>PREVIOUS DETECTION LEVEL REQUIRED</th>
<th>HUMANITY</th>
<th>SIGINT</th>
<th>DETECTABLE</th>
<th>CYBER</th>
<th>OTHER ECOSYSTEM, SCENARIO, PLOT</th>
<th>LOGIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Acquired: Classified</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>20 Acquired: Unclassified</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>
The fourth step of evaluating multiple specific implementation approaches was not completed. Elements of one approach implementing the conceptual model of ISR in an operational level wargame (Figure 6) was tabled for discussion just as time ran out (Figures 7 – 11). There was no time to discuss or evaluate this approach. It is anticipated that this topic will be re-visited during next year’s game lab at CONNECTIONS 2020.

**HOW MIGHT ONE GAME A CONFLICT BETWEEN GROUPS OF AUTONOMOUS DRONES?**

Facilitator: Mr. Gordon Bliss

**Introduction**

Some of the discussion related to the scope of the question. As I deliberately left the question very general, the initial discussion ranged considerably including civilian situations and various anti-drone measures. The scope I had in mind when I wrote the question was a purely military situation, aerial drones that could range in size from meter-long class down to insect sized swarms, and strictly drone-on-drone conflict. The drones could have a variety of mission profiles. Bringing this up led to a more focused discussion of the question and a mention at the end that the scope of the problem needs the context that it is for.

The following are the brief notes I took during the session.

One of the first specifics mentioned is the problem of recognizing opposing drones. There may be very limited sensor capability on each drone and if image recognition is necessary a probability estimate is necessary of the chances of a drone even noticing and then recognizing another drone as an enemy one. Plus the chances of a false positive (friendly fire).

This led to the composition of the drone force and it was agreed by all that the force composition could itself be a subgame – a drone construction game allocating “build points” to determine the size, number, and capability of the drone force.

It was also agreed that the game should include weather effects, random external events, and anomalous events (I don’t have details on what anomalies that might be covered).

We didn’t get to discuss how to handle the actual combat/conflict between the drones. One possibility is that if it is a swarm, this could be done as a simple force-on-force attrition model that determines the number that make it through.
THE GAMIFICATION OF WARGAMING
Facilitator: Dr. Tim Moench

Disclaimer: The views expressed are solely the views of the game lab participants and do not in any way represent the views of the departments/agencies/businesses to which they belong.

Game lab participants discussed how “gamification” might be used with wargaming. Not the same thing, but similar, how to put gaming back into wargaming.

According to Wikipedia, “Gamification is the application of game-design elements and game principles in non-game contexts. It can also be defined as a set of activities and processes to help solve problems by using or applying the characteristics of game elements.”

Gamification leverages people’s natural desires for learning, mastery, competition, achievement, status, etc. Several examples of this exist in the commercial world, from banking to airlines, many offering perks for those who reach certain levels, for example, bronze, silver or gold status. Gamification can also take the mundane and make it interesting.

It may not be obvious on how we can reward wargame players with badges, achievement, points, and the like. You can show contributions made by players – best idea, longest held position, etc. This can backfire if someone is favored with points to the detriment of the game, or suffer from the law of unintended consequences. There doesn’t always have to be a winner.

An example of gamification was using it for onboarding of personnel new to a wargame control team. In this particular case, those new to analysis learned how to accomplish analysis against the backdrop of the Matrix mythology. Each game part represented a Matrix character. Levels were also allowed, so analysts could progress upward or hold.

With regard to gaming, in some cases, wargames have become nothing more than staff drills or mission planning. The gaming part has largely dropped out. So, how do we put “game” back into war-game. How do we keep the “play” that is inherent in gaming.

According to the book, Play to Learn, “A game is an activity that has a goal, a challenge (or challenges), and rules that guide achievement of the goal; interactivity with either other players or the game environment (or both); and feedback mechanism that give clear cues as to how well or poorly you perform.”

Immersion in the wargame is a goal worth seeking. Participants remain engaged and give more of themselves. The wargame should set players free to explore and discover. Instead of slides to accomplish, the wargame should seek to provide a variety of means to communicate findings and have them captured by the game organizers.

---

20 Gamification, Wikipedia entry, sourced 27 September 2019
21 Play to Learn, Sharon Boller and Karl Kapp, ATD Press, 2017
If there is “fun” to a game, you keep them coming back. Some may also attend if they are going to be recognized. So do some type of scoring, but don’t wait until the end when possibly no one cares by then. Keep them engaged, keep them challenged, and expect great things.

**HOW DO WE DEFINE EXPERTISE FOR WARGAME PARTICIPANTS?**

Facilitator: Dr. Tim Moench

_Disclaimer: The views expressed are solely the views of the game lab participants and do not in any way represent the views of the departments/agencies/businesses to which they belong._

A key component of wargame planning is deciding who should participate, as participants heavily influence wargame outcomes. Included among the participants are experts, called upon to provide subject matter expertise. You might think of an expert who is well versed in foreign policy, or naval warfare, or adversary capabilities, etc. The question worth asking is “how do we measure expertise.” Is there some way to qualify expertise and ensure that it is value-added?

It is important that experts brought in be well versed in the subject at hand and have the ability to make significant contributions to the conversation. We often under or over-estimate our own expertise and those of others. Known as the “Dunning-Kruger effect,” we sometimes have those who claim to be experts, but are not and don’t realize it; and those that are, but who devalue their expertise based on the normalizing of their expectations with others.²²

Why does this happen? First, one of the reasons for this phenomenon may be that the more skilled you are in some complicated task, the more you understand that there’s stuff you don’t understand, or that you haven’t mastered. Those at the bottom are blissfully unaware. Second, top tier experts see every misstep and every missed opportunity for better wargame play, and beat themselves up for it. While the bottom tier experts bumble along missing all that but getting the occasional correct answer, and think they are doing all right for themselves.²³

What can we do to help alleviate the Dunning-Kruger effect? Some suggestions include: First, divide into subsets of expertise. Identify specifically what kind of expertise is needed. Second, survey self-assessed level of expertise. Can’t be an expert in more than 4-5 subjects, and that is really stretching it. Third, color code expertise in a cell; identify the cells that might be one or two deep with experts and make adjustments as needed.


²³ Ibid.
Other similar considerations to help mitigate the Dunning-Kruger effect include: pre-test experts using some sort of measure, set by someone who is really a recognized expert, and use scores to make expert assignments. The higher the score, the more likely that expert will be given more weight. On a group/event basis, it could be possible to make a matrix of subjects and expertise levels, basically a cross-reference and post in prominently. The group can fill it in collectively. Putting this out in open forum will possibly defuse any overzealous “self-appointed experts” from taking the lead in the discussion where their credentials are weaker than those of others.

It is not about eliminating the lesser experts, but adjusting the wargame to fit who is coming since, in most cases, wargames do not have the luxury of turning away willing participants. It often gets worse the longer the duration of the game, more people can make a one-day game as opposed to a week-long game. It may also be important to place experts in such a way that they live with their decisions, which may restrain them from stepping too far outside their expertise.

It could be helpful to have a culture within the analytic community that helps build expertise. In this case, include relevant experts in player cells as well as control (adjudication, analysis, etc.). Also, put experts as advisors to the wargame, to review what the players decide and them make their own judgment. Finally, be sure to include expert facilitators throughout the game cells. Facilitators can be instrumental to getting the most out of the group.

The article, “A Multi-Criteria, Network Analytic Approach to Wargame Participant Selection,” from the Journal of Defense Modeling and Simulation advocates for the “ideal participant.” In this case, ideal participants are constructed using a set of attributes based on the needs of the wargame. Attributes can include areas of professional expertise, academic background, military experience, languages spoken, etc. The more attributes that a potential participant shares with the ideal participant; the more likely they will be selected for the wargame.24

Often for teams of experts to be effective, they must work together well as each must have complimentary personalities, similar work ethics, understand wargame role, etc. In this case, the Myers-Briggs personality profile can be useful. Knowing personality profiles can help the team to know how to engage with one another. It doesn’t necessarily take into account the level of expertise, but what kind of engagement can be designed in using the experts. This allows the group and control staff to monitor and somewhat mitigate personality traits that may sway a decision or a group dynamic to an extreme.

Finally, what also can help is considering four core skills: oral communication, technical expertise, problem-solving, and decision-making. The core skills allow wargame managers to

assess a candidate’s suitability in the face of uncertain, unreliable, and objective qualification information. Remember, the group is more than the sum of its parts.

Have wargames succumbed to what is described in Tom Nichols’ Federalist article, “The Death of Expertise,” and book by the same name, that we are witnessing the “death of expertise,” the collapse of the division between professionals and laymen, students and teachers, knowers and wonderers – in other words, between those of any achievement in an area and those with none at all. What Nichols fears has died is any acknowledgement of expertise as anything that should alter or change what we believe to be true.

In the case of wargames, research shows that older and more experienced people tend to be overconfident in their ability to control events that are in fact outside their own control. Their success in the past leads to confidence which in competitive situations can mask their lack of competency through successful bluffing. Their successful control of past situations leads them into the mistake of believing their competency applies to current situations.

How do we defend against opinion, rather than professional judgment? Are thumbs up or down good enough to draw a consensus? Does consensus make a finding even more valuable? Bias can influence decision-making (trying to support a predetermined narrative, come up with preconceived idea and find evidence to support it). Sometimes we don’t realize there is bias and the need to take measures to dissuade it.

Experts can heavily influence game results, therefore, it in the best interest of game organizers to consider how best to use experts and make accommodations. Too often, game results are briefed to leadership with giving them any idea who came up with the findings and how oversight was provided. On one end, we might have a group of vetted experts who stayed within their lane of expertise, and on the other end, a huge personality with lots of opinions but little expertise. Let’s ensure that wargame organizers keep with the vetted experts and make use of the tools suggested in this article.

25 Ibid.
26 “The Death of Expertise,” Tom Nichols. The Federalist, January 17, 2014
POST-CONFERENCE SURVEY ANALYSIS

This section summarizes the online post-conference survey results (66 responses or 37% participation rate). Caveat: all responses are voluntary, self-reported, and anonymous. This analysis assumes self-reported data is accurate and reasonably representative of the Connections participant population.

PARTICIPANT DEMOGRAPHICS

Participant Organizations and Roles
Out of 199 people who registered online for the conference, 177 participated (actually attended conference for at least one day). The 177 participants do not include U.S. Army War College conference support staff. The majority of the participants were from DoD organizations (68, 38%) followed by private citizens (24, 14%, mostly hobby gamers or retirees). Within DoD, most came from DoD agencies (19, 27%), followed by the Army (17, 25%) and Air Force (14, 21%).

Of the participants, 66 responded to the online post event survey for a 37% response rate. Figure 4 shows the survey respondents’ self-identified primary role in wargaming. Seventeen (25%) identified as commercial gaming professionals, followed by other private sector professionals (14, 21%) and DoD civilians (12, 18%). Note: within educational professionals and students, only one identified as a student (undergraduate).
Participant Connections and Wargaming Experience

Figure 5 shows the number of Connections conferences attended. Responses could include Connections conferences other than USA, such as Connections United Kingdom (UK) or Connections North (Canada). The majority of uniformed military, non-DoD government civilians, and educational professionals reported this was their first Connections conference.

Note: in order to show how responses vary among groups, the colors on the bars display the primary roles in wargaming for responses while the label at the end of the bar shows the total (across all roles). Most of the following charts also use colors to show differences (if any) in how role groups responded. For example, we see from Figure 5 that 45% of all respondents reported this was their first Connections conference including 6 commercial gaming professionals and 6 other private sector professionals.

Figure 5: Number of Connections Conferences Attended

Figure 6 shows wargaming experience for each respondent. Approximately 70% identified as experienced, expert, or master with 30% beginners or amateurs.

Figure 6: Wargaming Experience

Primary Role in Wargaming

- Commercial gaming professional
- Defense gaming contractor
- Other government agency civilian
- DoD Civilian
- Other private sector professional
- Educational professional or student
- Uniformed Military
PARTICIPANT ASSESSMENTS OF CONFERENCE

Summary of Event Ratings
Figure 7 summarizes participant ratings for all eight of the major conference event types. Highest rated event types were seminars (91% useful or very useful) followed by keynote speakers (89%) and panel presentations (83%). Lowest rated were working groups (24% not useful), gaming showcase (21%), and game lab (17%). Lowest attendance were game night (17% did not attend) followed by demo & poster sessions (15%), and gaming showcase (14%). Figures 6-8 provide a breakout for each rating category. Figure 13 on page 48 provides a more detailed breakout of event ratings.

![Figure 7: Summary of Event Ratings](image)

**Primary Role in Wargaming**

- Commercial gaming professional
- Defense gaming contractor
- DoD Civilian
- Educational professional or student
- Hobby gamer
- Other government agency civilian
- Other private sector professional
- Uniformed Military
Most Useful, Least Useful, and Most Skipped Events
Figures 8-10 below summarize the event ratings for most useful, least useful, and most skipped (in decreasing order by percentage across all roles).

Observations: defense gaming contractors, commercial gaming professionals, and other private sector professionals gave the most unfavorable overall ratings (not useful or did not attend). Uniformed military, educational professionals, and non-DoD government civilians gave the highest ratings overall.

Figure 8: Event % Rated Useful or Very Useful

Figure 9: Event % Rated Neutral, Not Very Useful, or Definitely Not Useful

Figure 10: Event % Did Not Attend

Primary Role in Wargaming

- Commercial gaming professional
- Defense gaming contractor
- Hobby gamer
- Other government agency civilian
- Other private sector professional
- Educational professional or student
- Uniformed Military
Overall Conference Assessments
Figure 11 and Figure 12 show overall assessments of the conference. Approximately 98% agreed they would recommend the conference to others (73% strongly) and 97% agreed that conference provided useful connections with other gaming professionals (77% strongly). However, opinion about whether content was appropriate for level of gaming expertise appears more divided, 42% strongly agreed, 45% agreed, and 11% were neutral. Most of those neutral were other private sector professionals, DoD civilians, and/or beginner, experienced, or expert gamers. However, all master gamers at least agreed content level was appropriate, so appears there is some disagreement among seasoned gamers. Among lower experience levels, all amateurs at least agreed content was appropriate, but 20% of beginners were neutral.

**Figure 11: Conference Assessments by Primary Role in Wargaming**

**Bar Label:** % of responses within statement (across all roles)  | **Color Label:** % responses within statement segmented by role

**Figure 12: Conference Assessments by Wargaming Experience Level**

**Bar Label:** % of responses within statement (across all levels)  | **Color Label:** % responses within statement segmented by level
Details of Event Ratings

Figure 13 on page 48 shows details of ratings for each event type segmented by respondent role. As noted in the summary, the highest rated event types were seminars (91% useful or very useful) followed by keynote speakers (89%) and panel presentations (83%). Lowest rated were working groups (36% not useful or did not attend), gaming showcase (35%), and gaming showcase game lab (26%).

Not surprisingly, we see that participants assessed events differently based on their roles in wargaming. Non-gamers generally rated academically-oriented events (game labs, poster sessions, panels) are generally higher rated with non-gamers. However, gaming professionals, particularly from the commercial sector, generally rated academic and supporting events lower or did not attend them. Hobby gamers appear to be the most satisfied with conference overall; the only event that some viewed negatively were the poster sessions or keynote speeches.

Observations for each event type:

- **Demo & Poster Session**: the only event to be rated 100% very useful by a segment (educational professionals) and to be rated low by hobby gamers.
- **Game Lab**: only educational professionals rated by as very useful by more than 50% and were lowest rated by non-gaming industry (other) private sector professionals.
- **Game Night**: lowest rated by other private sector professionals (46% neutral or did not attend) and 25% of DoD civilians and 18% of commercial gaming professionals did not attend. Most highly rated by non-DoD government civilians (80% very useful) and popular with other groups (67-100% useful or very useful except defense gaming contractors).
- **Gaming Showcase**: lowest overall very useful rating (27%); was least useful for commercial gaming professionals and hobbyists and appealed most to educational professionals, uniformed military, and non-DoD government civilians.
- **Keynote Speakers**: highest rated for other private sector professionals, uniformed military, and DoD civilians and lowest neutral or negative ratings of any event.
- **Panel Presentations**: 83% rated as useful or very useful except for commercial gaming professionals (30% neutral or did not attend) and other private sector professionals (23% neutral or did not attend).
- **Seminars**: Best attended event (97%) and overall most highly rated (91% of all respondents rated as useful or very useful)
- **Working Groups**: Hobby gamers (100% rated as useful or very useful) and uniformed military (83%) gave the highest ratings while non-DoD government civilians (60%) and educational professionals (50%) had the lowest.
## Figure 13: Rating Details by Event Type

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Very Useful</th>
<th>Useful</th>
<th>Neutral</th>
<th>Not very useful</th>
<th>Definitely not useful</th>
<th>N/A (not attended)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demo &amp; Foster Session</td>
<td>15%</td>
<td>60%</td>
<td>100%</td>
<td>50%</td>
<td>35%</td>
<td>25%</td>
</tr>
<tr>
<td>Game Lab</td>
<td>31%</td>
<td>40%</td>
<td>33%</td>
<td>50%</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Game Night</td>
<td>31%</td>
<td>40%</td>
<td>33%</td>
<td>50%</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Gaming Showcase</td>
<td>31%</td>
<td>40%</td>
<td>33%</td>
<td>50%</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Keynote Speakers</td>
<td>23%</td>
<td>40%</td>
<td>33%</td>
<td>50%</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Panel Presentations</td>
<td>31%</td>
<td>40%</td>
<td>33%</td>
<td>50%</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Seminars</td>
<td>31%</td>
<td>40%</td>
<td>33%</td>
<td>50%</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Working Groups</td>
<td>31%</td>
<td>40%</td>
<td>33%</td>
<td>50%</td>
<td>25%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Bar Label: % of responses within event type (across all roles) | Color Label = % responses within event type segmented by role

### Primary Role in Wargaming

- Commercial gaming professional
- Defense gaming contractor
- DoD Civilian
- Educational professional or student
- Hobby gamer
- Other government agency civilian
- Other private sector professional
- Uniformed Military
ANALYSIS BY PARTICIPANT GROUPS (SEGMENTS)

This section summarizes ratings for participants segmented into seven groups based on role and experience. The preferences of these groups should inform content for future conferences.

Figure 14 shows the quantity of respondents by wargaming experience in each group. Gamers are those who self-identified as experienced, expert, or master in wargaming. Beginners are those who self-identified as beginners or amateurs.

The seven groups are (from largest to smallest number of respondents):

1. **Commercial gamers (23%)**: commercial gaming industry representatives who identify as at least experienced in gaming
2. **Defense sector gamers (18%)**: uniformed military, DoD civilians, and defense contractors who identify as at least experienced in gaming
3. **Other industry gamers (15%)**: representatives of academia, businesses, and other non-government organizations that are not primarily or officially focused on gaming but who identify as at least experienced in gaming
4. **Other industry beginners (14%)**: representatives of academia, businesses, and other non-government organizations that are not primarily or officially focused on gaming but who identify as beginners or amateurs in wargaming
5. **Defense sector beginners (14%)**: uniformed military, DoD civilians, and defense contractors who identify as beginners or amateurs in wargaming
6. **Hobby gamers (9%)**: gamers not affiliated with a professional gaming organization
7. **Government (non-DoD) gamers and beginners (8%)**: representatives of government organizations not including the Department of Defense (includes all experience levels).

For 2019, consisted of three experienced gamers, one beginner, and one amateur.
Figure 15 summarizes the participant group ratings for each event type (combined ratings into 3 categories). While seminars and keynote speakers remain the highest overall rated events and working groups and gaming showcase the lowest, the data show that there are several significant differences in preferences among groups on different events. Overall, non-DoD government gamers were most satisfied with event content (85% of responses were “useful” across all event types) and defense sector beginners (83% useful) and least satisfied were defense sector gamers (72% useful) and other industry gamers (69% useful).

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Commercial Gamers</th>
<th>Defense Sector Beginners</th>
<th>Defense Sector Gamers</th>
<th>Government (non-DoD) Gamers</th>
<th>Hobby Gamers</th>
<th>Other Industry Beginners</th>
<th>Other Industry Gamers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Useful</td>
<td>Useful</td>
<td>Useful</td>
<td>Useful</td>
<td>Useful</td>
<td>Useful</td>
<td>Useful</td>
</tr>
<tr>
<td></td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td></td>
<td>Not Useful</td>
<td>Not Useful</td>
<td>Not Useful</td>
<td>Not Useful</td>
<td>Not Useful</td>
<td>Not Useful</td>
<td>Not Useful</td>
</tr>
</tbody>
</table>

Note: Useful = rating of *useful* or *very useful* | Not useful = rating of *not useful, definitely not useful, or did not attend*
Figure 16 shows details of ratings for event types (includes full rating scale summarized in Figure 15). Interesting to note are the variation between useful and very useful ratings and how only a single defense sector gamer rated events definitely not useful.

![Figure 16: Participant Group Rating Details by Event Type](image)

Figure 16: Participant Group Rating Details by Event Type
Figure 17 summarizes assessments of conference by participant group. Nearly all 66 respondents agreed or strongly agreed they would recommend the conference (1 response neutral) and that it provided useful connections (2 neutral). Government (non-DoD) gamers and hobby gamers were the most satisfied overall (agree or strongly agree to all statements). There were some differences in opinion about whether content was appropriate for level of gaming expertise (overall, 88% agreed or strongly agreed). Defense sector gamers gave the most neutral responses (3 or 25%). Only one respondent (a commercial gamer) disagreed that content level was appropriate (7%). All other non-agrees on content level were neutral responses (1 each for other commercial gamers, industry and defense sector beginners, and other industry gamers).

**Figure 17: Participant Group Assessments of Conference**

<table>
<thead>
<tr>
<th></th>
<th>I would recommend the Connections Wargaming Conference to others</th>
<th>The conference provided content appropriate for my level of gaming expertise</th>
<th>The conference provided me with useful connections to other gaming professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Gamers</td>
<td>Strongly agree: 30%</td>
<td>Agree: 23%</td>
<td>Neutral: 9%</td>
</tr>
<tr>
<td></td>
<td>Agree: 7%</td>
<td>Neutral: 1%</td>
<td>Disagree: 2%</td>
</tr>
<tr>
<td>Defense Sector Beginners</td>
<td>Strongly agree: 32%</td>
<td>Agree: 26%</td>
<td>Neutral: 2%</td>
</tr>
<tr>
<td></td>
<td>Agree: 3%</td>
<td>Neutral: 1%</td>
<td>Disagree: 2%</td>
</tr>
<tr>
<td></td>
<td>Agree: 3%</td>
<td>Neutral: 1%</td>
<td>Disagree: 2%</td>
</tr>
<tr>
<td>Government (non-DoD) Gamers</td>
<td>Strongly agree: 28%</td>
<td>Agree: 28%</td>
<td>Neutral: 1%</td>
</tr>
<tr>
<td></td>
<td>Agree: 4%</td>
<td>Neutral: 1%</td>
<td>Disagree: 1%</td>
</tr>
<tr>
<td>Hobby Gamers</td>
<td>Strongly agree: 26%</td>
<td>Agree: 29%</td>
<td>Neutral: 1%</td>
</tr>
<tr>
<td></td>
<td>Agree: 6%</td>
<td>Neutral: 1%</td>
<td>Disagree: 1%</td>
</tr>
<tr>
<td>Other Industry Beginners</td>
<td>Strongly agree: 24%</td>
<td>Agree: 27%</td>
<td>Neutral: 1%</td>
</tr>
<tr>
<td></td>
<td>Agree: 7%</td>
<td>Neutral: 1%</td>
<td>Disagree: 1%</td>
</tr>
<tr>
<td>Other Industry Gamers</td>
<td>Strongly agree: 24%</td>
<td>Agree: 27%</td>
<td>Neutral: 1%</td>
</tr>
<tr>
<td></td>
<td>Agree: 7%</td>
<td>Neutral: 1%</td>
<td>Disagree: 1%</td>
</tr>
</tbody>
</table>
QUALITATIVE DATA SUMMARY
The survey contained ten questions with optional free text responses which the Connections planning team reviewed in detail (eight for comments on specific events and two general questions). Comments on specific event types contained a range of opinions about utility and time allocated, generally consisted with quantitative data. The bullets below summarize themes in responses to the general questions “What are your top 3 takeaways from Connections 2019?” (51 responses/77%) and “Any Additional Comments?” (34/52%). The [brackets] show the number of comments and % of all responses.

- The conference improved understanding of theory and applications of wargaming [17/26%]
- The conference highlighted tensions between manual/physical and computer-based gaming communities and between gaming and analysis, modeling, and simulation [15/21%]
- Value of in-conference networking and making ‘connections’ with other wargamers [14/21%]
- Positive feedback on of conference venue and execution [13/20%]
- Need to increasing diversity of event (age, gender, and/or organizations) [9/14%]
- Need to increase content for people with little or no (war)gaming experience [3/5%]

CONCLUSION AND RECOMMENDATIONS
Based on the data, the 2019 conference was well-received by nearly all participants. Nearly all respondents (98%) agreed they would recommend the conference to others (one neutral). All but two event types received >70% favorable ratings. Potential areas to improve include demonstrations/poster sessions, gaming showcase, game night, and working groups.

Recommendations for Future Connections Conferences

- Decide who are the primary audience(s) and structure content accordingly. There are differences in content preferences by professional background and wargaming experience level.
- Assess whether to increase efforts to increase participation from non-government and non-defense sectors or focus on the defense sector and experienced wargamer base.
- Maintain emphasis on seminars and keynotes as the highest value events.
- Consider changing or restructuring gaming showcase, working groups, demos and poster sessions, and game nights since these received the most unfavorable ratings and/or lowest participation rates.
- Continue to attract first-timers (45% of survey respondents this year) and retain them.
- Continue efforts to increase survey participation to better inform future conferences (37% response rate this year).
# APPENDIX 1: CONFERENCE AGENDA

**Enduring Mission:** Advance and Preserve the Art, Science, and Application of Wargaming

**2019 Theme/Goal:** Futures of Wargaming

## Day 1: Tuesday, 13 August

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>0715</td>
<td>Registration Opens</td>
<td>AHEC Lobby</td>
</tr>
<tr>
<td>0830 - 0900</td>
<td>Welcomes and Conference Orientation</td>
<td>Room 1</td>
</tr>
<tr>
<td>0900 - 0920</td>
<td>Break</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>0920 - 1020</td>
<td>Seminar Session I</td>
<td>See seminar schedule on page 2</td>
</tr>
<tr>
<td>1020 - 1040</td>
<td>Break</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1040 - 1140</td>
<td>Seminar Session II</td>
<td>See seminar schedule on page 2</td>
</tr>
<tr>
<td>1140 - 1240</td>
<td>Lunch</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1240 - 1340</td>
<td>Seminar Session III</td>
<td>See seminar schedule on page 2</td>
</tr>
<tr>
<td>1340 - 1400</td>
<td>Break</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1400 - 1530</td>
<td>Panel: Wargaming Methods</td>
<td>Room 1</td>
</tr>
<tr>
<td></td>
<td>Programming with People</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Jeremy F. Sepinsky</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Center for Naval Analyses</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incorporating Structured Analytic Techniques into Business Wargaming</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Kenneth Sawka</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Crumpton Group</em></td>
<td></td>
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<tr>
<td></td>
<td>U.S. Army War College Wargaming</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Jim Markley</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>U.S. Army War College</em></td>
<td></td>
</tr>
<tr>
<td>1530 - 1550</td>
<td>Break</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1550 - 1650</td>
<td>Seminar Session IV</td>
<td>See seminar schedule on page 2</td>
</tr>
<tr>
<td>1730-2200</td>
<td>(Pre-registration and ticket required)</td>
<td>Desperate Times Brewery</td>
</tr>
<tr>
<td></td>
<td>Wargames Testing and Interactive Demonstriations/No Host Social</td>
<td>1201 Carlisle Springs Rd, Carlisle, PA (10 min drive from AHEC)</td>
</tr>
</tbody>
</table>
### Seminar Schedule (Sessions I – IV on Tuesday 13 Aug, Session V on Thursday 15 Aug)

<table>
<thead>
<tr>
<th>Session</th>
<th>Room 1</th>
<th>Room 2</th>
<th>Room 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tuesday 13 Aug</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Seminar Session I (0920 - 1020) | Introduction to Wargaming  
Matt Caffrey  
Air Force Research Lab | PLA Wargaming: Chinese Writings on Bingqi (兵棋)  
Mr. Dean Cheng, Senior Research Fellow for Chinese Political and Security Affairs  
The Heritage Foundation | Computer-Assisted Wargaming (with Microsoft Office)  
Mark Leno  
U.S. Army War College |
| Seminar Session II (1040 - 1140) | Introduction to Combat Modeling  
Michael W. Garrambone  
InfoSciTex Corporation, a DCS Company | Logistics; the Red Headed Stepchild of Wargaming  
George F. Nafziger, PhD, Captain, USNR-Ret |
| Seminar Session III (1240 - 1340) | Topics on the Theory of Games And Play  
ED McGrady  
Monk's Hood Media | Megagame Design and Development  
Merle Robinson | On Wargaming – Book Talk  
Matt Caffrey  
Air Force Research Lab |
| Seminar Session IV (1550 - 1650) | The Use Of Design Thinking for Designing Wargames  
Yuna Wong  
RAND | Gaming Urban Terrain and Megacities  
ED McGrady  
Monk's Hood Media | WAR CRY! - Combat Force Cohesion & Cognitive Capacity Disintegration  
Uwe Eickert  
Academy Games |
| **Thursday 15 Aug** | | | |
| Seminar Session V (1230 - 1330) | Data Collection and Analysis  
Christopher Weuve  
Air Force Research Laboratory | A Wargaming Approach to Computational International Relations  
Karl Selke  
Group W Inc. | How to Improve Your Communication Skills  
Dana Lombardy  
Lombardy Studios |
### Day 2: Wednesday, 14 August

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>0830 - 0840</td>
<td>Welcome</td>
<td>Room 1</td>
</tr>
<tr>
<td></td>
<td><em>Matt Caffrey</em></td>
<td></td>
</tr>
<tr>
<td>0840 - 0940</td>
<td>Keynote 1 – Dr. Steven Stoddard</td>
<td>Room 1</td>
</tr>
<tr>
<td></td>
<td>HQDA G-3/5/7 Deputy Director for Force Management</td>
<td></td>
</tr>
<tr>
<td>0940</td>
<td>Break</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1000 - 1130</td>
<td>Panel: Futures Gaming</td>
<td>Room 1</td>
</tr>
<tr>
<td></td>
<td>CNO Strategic Studies Group Gaming</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>John T Hanley Jr, PhD</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Naval War College Non-resident Research Scholar</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Matrix Gaming, Scenario Planning, and Systems Thinking</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Deon Canyon</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Experimental Gaming at the Nuclear Threshold</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Kiran Lakkaraju</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Sandia National Laboratories</em></td>
<td></td>
</tr>
<tr>
<td>1130 - 1230</td>
<td>Lunch</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1230 - 1320</td>
<td>Game Lab Session I</td>
<td>See game lab schedule</td>
</tr>
<tr>
<td>1315 - 1330</td>
<td>Break</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1330 - 1420</td>
<td>Game Lab Session II</td>
<td>See game lab schedule</td>
</tr>
<tr>
<td>1420 - 1440</td>
<td>Break and Demos Set-up</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1440-1700</td>
<td>Gaming Showcase &amp; Demos and Poster Session</td>
<td>Room 1/Central Corridor</td>
</tr>
<tr>
<td>1700-1730</td>
<td>Dinner</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1730-2200</td>
<td>Wargames Testing and Interactive Demonstrations</td>
<td>Rooms 1-3</td>
</tr>
</tbody>
</table>
# Day 3, Thursday, 15 August

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>0830 - 0900</td>
<td>Upcoming Wargaming Event Announcements</td>
<td>Room 1</td>
</tr>
<tr>
<td>0900-0920</td>
<td>Break</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>0920-1130</td>
<td>Panel: Modeling and Wargaming</td>
<td>Room 1</td>
</tr>
<tr>
<td></td>
<td>Online serious gaming: Developing wargames for the crowd</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kiran Lakkaraju</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sandia National Labs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jake Tibbetts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UC Berkeley</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toward Automating the Course of Action Generation and the Staff Wargame</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Michael K Robel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>StrongPoint Simulation and Modeling, LLC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>War Game Networks for Digital Distribution and Collaboration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brian Kirkpatrick</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ExoAnalytic Solutions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modeling the player: A requisite for structured wargaming</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Karl Selke</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Group W Inc.</td>
<td></td>
</tr>
<tr>
<td>1130-1230</td>
<td>Lunch</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1230-1330</td>
<td>Seminar Session V</td>
<td>See seminar schedule on page 2</td>
</tr>
<tr>
<td>1330-1350</td>
<td>Break</td>
<td>Cafeteria Seating Area</td>
</tr>
<tr>
<td>1350 - 1650</td>
<td>Working Groups</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The Future of Wargaming (ED McGrady and Mike Ottenberg)</td>
<td>Room 1</td>
</tr>
<tr>
<td></td>
<td>Wargaming the Future (Stephen Downes-Martin)</td>
<td>Room 2</td>
</tr>
<tr>
<td></td>
<td>Wargaming for Future Leaders (Mike Dunn and James Morningstar)</td>
<td>Room 3</td>
</tr>
</tbody>
</table>
# Day 4: Friday, 16 August

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
</tr>
</thead>
</table>
| 0830 - 0930 | Keynote 2 – “The Future of Gaming. It’s up to you!”  
*ED McGrady* | Room 1               |
| 0930 - 0950 | Break                                                       | Cafeteria Seating Area |
| 0950 - 1020 | Game Lab Outbrief  
*Scott Chambers* | Room 1               |
| 1020 - 1130 | Working Group Outbriefs  
*Stephen Downes-Martin*  
*ED McGrady and Mike Ottenberg*  
*Mike Dunn and Dr. James Morningstar* | Room 1               |
| 1130 - 1140 | Closing Remarks  
*Matt Caffrey, Tim Wilkie, and Mark Leno* | Room 1               |
| 1140 - 1200 | Hotwash  
*Matt Caffrey and Tim Wilkie* | Room 1               |
## APPENDIX 2: GAME LAB SCHEDULE

### Game Lab Session 1
**Wednesday 1230 - 1320**

<table>
<thead>
<tr>
<th>Table</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gaming modern or future combat in megacities: what are the possibilities?</td>
</tr>
<tr>
<td>2</td>
<td>How do you decide that a game is the most appropriate technique for inquiry into a particular subject, and what do you expect to get out of the game?</td>
</tr>
<tr>
<td>3</td>
<td>How can you realistically simulate live, incoming message traffic with limited/restricted resources?</td>
</tr>
<tr>
<td>4</td>
<td>How do you quickly educate players to understand differences in how opponents from different cultures examine problems in decision making scenarios?</td>
</tr>
<tr>
<td>5</td>
<td>How do we incorporate gamification into wargaming? (I will use, as example, a final project I did for a recent gamification course I attended. The project examined the onboarding of game analysts. I will also define what gamification is and is not and how we may use it in wargaming.)</td>
</tr>
<tr>
<td>6</td>
<td>What are the most valuable sources of information on current and past wargaming - both on wargaming within the United states and wargaming world wide? Matt Caffrey is working on the second edition of On Wargaming. He would value insights on what materials should be used to gain new insights for second edition, be added to the Documents Appendix, added to the Bibliography, or used in multiple ways. It would be useful, but not essential, for participants in this Game Lab to have reviewed the Bibliography and the Documents Appendix before the game lab.</td>
</tr>
<tr>
<td>7</td>
<td>Strategy formation and planning require decision-making in the present with an eye to the future and with an understanding of the uncertainties that will unfold between the time of the decision and the realization / implementation of that decision. We can call this the decision-effect time gap. Under real-world conditions this gap can be quite extensive, leading decision-makers to make partial and/or non-committed 'decisions' that may exhibit a confidence bias. In contrast, under game conditions the decision-effect time gap is quite small and decision-makers (often necessarily) make committed decisions under a fair degree of uncertainty, but decisions may be criticized as unrealistic and/or non-representative. This raises several questions to explore: 1) What effect does the decision-effect time gap have on the quality of decisions? 2) What are the best methods to simulate large decision-effect time gaps in a compressed game time? 3) How can in-game decision-making gain credibility and improved acceptance as valid representations of real-world decision-making, especially to those without prior knowledge of the benefits of game play? 4) How might games explore the distinction between pivotal (i.e. critical) decisions and course correction (i.e. adjustable / tuned) decisions?</td>
</tr>
<tr>
<td>8</td>
<td>How would you design a game to analyze C4ISR at the operational level of combat?</td>
</tr>
<tr>
<td>9</td>
<td>How best to model civilians/reactions in a constructive simulation of modern warfare? [social media, ethnic deltas, flight or fight (good/bad), refugees/traffic management, acceptable losses, intel/intecepts, GPS beacons, logistics, etc.]</td>
</tr>
<tr>
<td>10</td>
<td>How might one game a conflict between groups of autonomous drones?</td>
</tr>
<tr>
<td>11</td>
<td>Follow-up to &quot;Waves of Destiny&quot; (now &quot;Destiny's Horizon&quot;) game design project</td>
</tr>
<tr>
<td>12</td>
<td>How can you use games as an experimental platform? Wargames are a powerful tool for exploration and training, but we believe games can also be used as a &quot;lab&quot; to understand the impact of different variables on human decision making. To use a game as a lab, we need to make the game replicable, unbiased, and controllable. In addition, we need to develop methods to collect and analyze data from wargames. In this discussion I would like to talk about how to do this.</td>
</tr>
<tr>
<td>13</td>
<td>How can we structure games to help with the testing and development of tools that use AI technologies?</td>
</tr>
<tr>
<td>14</td>
<td>How to model logistics in a tactical/operational game without bogging down game-play?</td>
</tr>
<tr>
<td>15</td>
<td>How would you structure a multi-institutional scheme to recruit &quot;strategic thinkers&quot; for the service academies, similar to the national spelling bee?</td>
</tr>
<tr>
<td>16</td>
<td>Is a Slack Workspace an appropriate form for distributed Matrix Wargaming?</td>
</tr>
<tr>
<td>1</td>
<td>What is a tactical cyber game and how do we design one?</td>
</tr>
<tr>
<td>2</td>
<td>What are the criteria for a game intended to inform government action to be considered a success?</td>
</tr>
<tr>
<td>3</td>
<td>How do you create a game that reinforces &amp; assesses specific skills (training) and also encourages applied critical thinking?</td>
</tr>
<tr>
<td>4</td>
<td>How will the advances in surveillance technology impact COIN activities in built up areas? What challenges do multiple public and private networks add to the problem?</td>
</tr>
<tr>
<td>5</td>
<td>How do we define expertise for game participants? (I will splice together the book/article, &quot;The Death of Expertise&quot; with the cognitive bias &quot;Dunning-Kruger effect.&quot; We often underestimate or overestimate our expertise and those of others. What can we do to help fix this.)</td>
</tr>
<tr>
<td>6</td>
<td>What have been the key events in the advancement and application of wargaming? Matt Caffrey is working on the second edition of On Wargaming and would value insights adding key dates and improving current entries the appendix wargaming timeline. It would be useful, but not essential, for participants in this Game Lab to have reviewed this appendix before the game lab.</td>
</tr>
<tr>
<td>7</td>
<td>What are some best practices to teach wargaming to people new to the field?</td>
</tr>
<tr>
<td>8</td>
<td>How to Wargame Artificial Intelligence and Autonomous Systems?</td>
</tr>
<tr>
<td>9</td>
<td>How best can Wargaming work with other techniques such as Modeling &amp; Simulation in Campaign Analysis to best serve DoD? This question is at the heart of a on upcoming MORS Special workshop in November on the revitalization of Campaign Analysis to support a flagging analytic capability within DoD.</td>
</tr>
<tr>
<td>10</td>
<td>How can the King’s Wargaming Network best connect with and support the wargaming community to further wargaming as a method of inquiry? Context: the King’s Wargaming Network launched in December of 2018 to further wargaming as a method of inquiry and to provide a hub of wargaming knowledge in London. The Network has put on a series of public lectures on wargaming, an academic working group on developing an academic theory on wargaming and an analytic strategic gaming session, both featuring professional wargaming speakers and attendees from around the world, and has designed, executed and hosted with external partner organizations a multitude of wargames in London. The Network is looking to expand its activities and to strengthen its connections with the wargaming community to ensure those activities are of the greatest benefit to the community and to the practice of wargaming.</td>
</tr>
<tr>
<td>11</td>
<td>How should we represent economic impacts (mobilization of the industrial base, economic sanctions, economic blockades, cyber attacks on financial institutions) in modern day or near future wargames?</td>
</tr>
<tr>
<td>12</td>
<td>NATO recently conducted a matrix style wargame to challenge it’s Military Deterrence Response Options concept. This was the first time a wargame was introduced to the newly formed deterrence group and was designed and organized in a relatively short time frame. But what other types of wargame could be designed to support the Deterrence Group at the military strategic-operational level in the future? What are the advantages and disadvantages of these potential types of games for exploring issues related to deterrence?</td>
</tr>
<tr>
<td>13</td>
<td>How could you create a matrix game to explore solutions for water scarcity/competition in a shared watershed?</td>
</tr>
<tr>
<td>14</td>
<td>How would you design a game optimized for critical infrastructure protection?</td>
</tr>
<tr>
<td>15</td>
<td>This session will explore how games can be used to develop people’s creativity (outside of the game). What gaming approaches currently exist in this area? What new approaches could we use to enhance creativity?</td>
</tr>
<tr>
<td>16</td>
<td>How would you develop a typology of wargames that breaks games into very fine sub-elements that could be used for prediction of player inclination towards a particular game or type of games?</td>
</tr>
</tbody>
</table>
APPENDIX 3: FUTURE OF WARGAMING WORKING GROUP SUGGESTED VARIABLES

This list of variables and descriptions was provided to participants prior to their arrival at the conference. Participants were free to use these variables, or develop their own.

Construction tools. Currently there is a lot of overhead in digital game development. Despite engines like Unreal and Unity designers and developers still have to assemble teams with specialized knowledge, hire graphic artists, and build for specific platforms or systems. This could easily change in the future with automation, artificial intelligence, and other developments that ease conversion of designs into digital formats. A key issue for this variable is how to overcome the overhead imposed by graphics (for example, outsourcing as opposed to digitization). For an overview of these types of technologies see:


http://news.mit.edu/2013/writing-programs-using-ordinary-language-0711


https://www.fiverr.com/categories/graphics-design/digital-illustration

Interaction tools. This technology goes hand in hand with digitization. How will we interact with games in the future? This includes how we get information from games, and how we place information into games. Visualization technology is clearly one of the most interesting facets of this variable right now with the advent of virtual and alternate realities. But information can flow through many different mechanisms. Sound, voice, touch, reading, movement, and non-verbal expression are all ways we communicate. For some imagination cueing examples see:

https://arxiv.org/pdf/1801.07481

https://pdfs.semanticscholar.org/0004/f72a00096fa410b179ad12aa3a0d10fc853c.pdf

Digital vs. manual. I actually don’t think this is a valid variable because the medium is not necessarily independent of the design requirements. For an organizational game looking at how different groups work together a digital game might be exactly the wrong way to approach the game. For a training game digital might be absolutely required. However, this is a variable, just one I don’t think works for our discussion.
Integration. How integrated is gaming into the day to day enterprise of the Government? Does DoD use it the same way it uses simulations to examine future systems? Does it integrate gaming into all kinds of planning and decision-making? Or are games special, one off, events that occur only occasionally?

Funding and interest. Is there a high level of funding and interest available for gaming? Do creative gaming styles continue to be sought after and used in DoD gaming?

Creativity in design. Do we continue to innovate game designs and ways to conduct games? This is beyond simply slapping digital skins of existing types of games, rather it involves re-thinking the fundamentals of the game mechanics. The advent of matrix games is one example of this kind of innovation, but there are likely to be others coming in the future. How creative are we going to be in the future with our games, scenarios, and game mechanics?

Automation. You would think this is wrapped up in digitization, but here I mean automation of tasks that are currently done by people in games: players and controllers. Can we use various kinds of AI to automate certain functions that are currently done in games by people?

Topics. Right now, we can probably think of the mix of topics covered by games for the US Government, with “operations” dominating, followed by “intelligence development” and “interagency” or “intragovernmental” planning. There are also the occasional organizational or topical games. Is this a variable? And if so where is it coming from and where is it going? You could envision gaming being used for direct decision support in real time, or in systems testing and acceptance. What does it mean to move beyond the “standard” topics of interest to sponsors and into a new set of tasks and ideas that need to be gamed?

Kinetic vs. non-kinetic. Prior to the emergence of the peer competitors much of DoD’s and the interjacenties focus was on operations short of war: counterinsurgency, counter-terrorism, and HA/DR. What is the implication for games if one or the other trend amplifies? Will we be stuck doing the same kinetic games over and over till we can do them in our sleep? Or will emerging mission requirements challenge our ability to do the same games in ways that we have always done them? It’s the difference between a world of nothing but Blitzkrieg and a world of the COIN series.
APPENDIX 4: FUTURE OF WARGAMING WORKING GROUP VARIABLES

Some groups used voting systems to develop their variable sets. Here we present lists of variables considered by groups 1, 2 and 3.

Group 1 – A cost effective world

This group associated its variables in pairs, and then voted on the pairs. Here we present them groups as pairs of variables. Ultimately the group chose Cheap/Expensive and Effectiveness as their variable pair. Because some variables were paired with more than one other variable we list some variables twice. Because Cheap/Expensive was paired with so many other variables we do not list that first anywhere. The last two variables were not paired with any other. The pair that was used won the voting by an overwhelming majority of votes (7, all other pairs got 2 each)

Imaginative – Analytical (Solutions)
Government – Civilian (Users)

Digital – Real (Interface)
Cheap – Expensive (Equipment/Facilities)

Minimally Effective – Maximally Effective (Effectiveness)
Cheap – Expensive (Equipment/Facilities)

Tactical – Strategic (Scale)
Abstract – Faithful (Fidelity)

Simple – Complex (Design Elements)
Cheap – Expensive (Equipment/Facilities)

Manual – Automated (Adjudication). (Not paired)

Fun – Control (Gamification/Purpose) (Not paired)

Group 2 – Inception

This group did not pair up variables, and used the two highest vote-getters.

Cognitive warfare – Physical warfare (4 votes)

Manual adjudication – Automated adjudication (1 vote)

Traditional – New Paradigm (3 votes)
Bio-enhanced – “Normies” (2 votes)

Physical currency – Digital currency

Highly regulated – Unregulated (1 vote)

Tailored – Untailored (1 vote)

Individually created – Enterprise created (1 vote)

**Group 3 – Automation and adjudication**

This group had a relatively small number of variables. But they elaborated on automation.

Adjudication

- Could enable replication
- Increase both playability and rigor

Automation (of everything?)

Visualization

Funding/Interest

- If you could build it, would they come?

Peer/near peer, or not?
APPENDIX 5: WARGAMING THE FUTURE WORKING GROUP REPORT

This appendix contains the final report for the Wargaming the Future Working Group chaired by Dr. Stephen Downes-Martin.

The report is also available at this link: https://paxsims.wordpress.com/2019/11/05/wargaming-the-far-future-working-group-report

The report contains the following chapters which contain the twelve research papers (listed below) written by the working group, their discussions while they wrote and refined those papers from November 2018 to June 2019, and the discussions at the workshop held during the Connections US Wargaming Conference in August 2019.

Working Group Research Papers
1. Using Futuring to Generate Better Wargaming Scenarios (Stephen Aguilar-Milan)
2. Common Pathologies and Pitfalls of Wargaming Future Technologies (Sebastian J. Bae)
3. Geopolitical Matrix Gaming in 15 and 50 Year Future Scenarios (Deon Canyon, Jonathan Cham)
4. Wargaming the Future: Developing Scenarios and Galvanizing Support (Thomas Choinski)
5. Break the Forecasting Horizon by Values Gaming (Stephen Downes-Martin)
6. Coming to Grips with Indeterminacy in the Practice of “Futures” Gaming for Strategy Formulation (John Hanley)
7. Brand New World (William Lademan)
8. Wargaming the Future Requires Rigorous Adherence to Best Practices (Graham Longley-Brown, Jeremy Smith)
9. Wargaming the Uncertain Future (Brian McCue)
10. From World War 3 to Starsoldier: Gaming design and gaming the future (ED McGrady)
11. War and Wargames Beyond the Event Horizon (Robert Mosher)
12. How To Think About The Future (Kristan Wheaton)

Working Group Discussions
1. Implausible and Possible Futures
2. Consistent Terminology for Futurism and Gaming?
3. Scenario versus game mechanics balance?
4. Common Pitfalls of Wargaming Emerging Technologies
5. Low Entropy and Schrodinger’s Tiger
6. False Information as Uncertainty?

Workshop Discussions
1. Dealing with Indeterminants
2. Efficacy of command and control processes
3. What Technologies will Affect Warfare in 50 Years?
4. Resilient, Adaptable, Extensible, Flexible System of Systems
5. Construct an Interdisciplinary Futures Game Group
6. The Character of Future Warfare

Integrated Bibliography
Wargaming the Far Future

Working Group

Connections US Wargaming Conference 2019
US Army War College
Carlisle PA

Working Group Chair
Stephen Downes-Martin

Final Report, 5th November 2019

The content of this document represents the opinion solely of the contributors and does not represent the policy of any organization. Working Group members maintain full and exclusive intellectual property rights over their contributions. They have granted permission for their contributions to be included in this report.

Any errors, misrepresentation or misinterpretation in this document are the sole responsibility of Stephen Downes-Martin.
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Executive Summary

Situation

Our most potent power projection and warfighting capabilities, developed in response to current and near future threats, are technologically advanced, hugely expensive, and have half-century service lives. The first of these characteristics gives us a temporary and possibly short lived warfighting edge. The second grants our political leaders short lived economic and political advantages. The last characteristic locks us into high expenses in maintenance and upgrades for many years in order to justify the initial sunk costs as though they were investments. This combination forces us onto a high-inertia security trajectory that is transparent to our more agile adversaries, providing them with credible information about that trajectory while giving them time to adapt with cheaper counter forces, technologies and strategies.

We must therefore wargame out to service life, the “far future”, to ensure our current and future weapons systems and concepts of operations are well designed for both the near term and the far future. However a 50 year forecasting horizon is beyond the credibility limit for wargaming. The Working Group and the Workshop explored and documented ways that wargaming can deal with this horizon.

Challenges

Working Group and Workshop participants selected the following broad challenges to wargaming the far future for examination – details are documented in this report:

Institutional

➢ Our national security institutions are short term focused.
➢ A peacetime military becomes inflexible in the face of massive surprise.
➢ Concern with the near term reduces motive to be rigorous when gaming the far future.

Process

➢ Wargaming in the far future is reactive.
➢ Command and control of advanced technology enabled forces is unclear.

Uncertainty

➢ Indeterminism and uncertainty grow as one looks out into the far future.
➢ There is a combinatorial explosion of possible interactions and futures.
➢ Credibility, Plausibility and Probability of far future scenarios are hard to determine.
➢ Discontinuous and black swan advances in technology will occur.
➢ Complexity of interacting causal factors grows as we look into the future.
Approaches

The following approaches covering these challenges were explored and are documented in this report along with their advantages, disadvantages and barriers to implementation. Since most of the approaches covered more than one challenge, there is not a one-to-one mapping between challenges and approaches.

Organizational

➢ Build an organization explicitly tasked and designed to wargame the far future.
➢ Reinvigorate best practices for wargaming and identify new ones required for gaming the far future.

Social Engineering

➢ Explore how wargaming influences military thought, not just how military thought influences wargaming.
➢ Use wargaming to increase people’s ability to handle the unknown far future.
➢ Take into account the psychology of how people think and worry about the future.

Futurism

➢ Embed futuring framework and foresight planning into the wargame process.
➢ Use systems thinking to design future scenarios.
➢ Base future scenarios on possible Revolutions in Military Affairs (RMAs) driven by changes in energy sources.

Process

➢ Wargame DoD acquisition to develop capabilities in months and years.
➢ Wargame trajectory from now to the far future using month/year acquisition wargames as inputs.
➢ Wargame our stable societal values versus our adversary societal values.
➢ Run wargames multiple times with a different game design each time.
➢ Run wargames multiple times for each game design.
➢ Wargame sensitivity analysis over many games to explore when assumed technology or capability levels become useful to the warfighting decision makers.
➢ Combine scenario planning and operational design into path gaming.

This Document

This document contains the papers written by the working group, their discussions while they wrote and refined those papers from November 2018 to June 2019, and the discussions at the workshop held during the Connections US Wargaming Conference in August 2019.
Working Group Research Papers

Using Futuring to Generate Better Wargaming Scenarios  
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7

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Sebastian J. Bae  
19

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How To Think About The Future  
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Using Futuring to Generate Better Wargaming Scenarios

© Stephen Aguilar-Milán
Research Director, European Futures Observatory

Executive Summary

Wargaming can be seen as an act of anticipating future events to expose weaknesses in current thinking and to help develop strategies to overcome those weaknesses. Within this conceptual framework, the process of thinking about the future in a more systematic way can be used to help design better wargames.

From the perspective of the present, the future can be a vast space to populate. There is an extremely large, almost endless, number of possible futures that could emerge. In order to bring structure to this very large number of possibilities, futurists have developed a number of techniques to help view the future in a systematic way.

If a wargame acts as a generative vehicle for multiple futures, then playing the wargame multiple times will test the underlying assumptions of the game and provide us with a heat map of results. The heat map would help us to assess the robustness of the results. This process starts by putting the future into the wargame design. We need to start with the purpose that the wargame is to serve before we begin to think about inserting a futures approach to the design of a wargame. We need to be clear about the scale and scope of the wargame.

Whether or not such a game produces results that are convincing is neither here nor there. An unconvincing game can tell us as much about the future as a convincing game if we conduct a rigorous review of why the game is unconvincing. In many ways, that is where the injection of futures into wargame design can be useful. It forces us to identify our conscious and unconscious assumptions, and to subject them to a rigorous challenge.

In determining these issues, the wargame designer would have to confront the assumptions, which are often tacit, that are being brought into the game structure. It is by confronting these assumptions that we reduce the possibility of being blindsided by an emerging future that we hadn’t previously considered. In that sense, we would become better equipped to deal with an emerging future. And that is how futuring can be used to generate better wargame scenarios.

Introduction

At the professional level, wargaming is an act of anticipating future events to expose weaknesses in current thinking and to help develop strategies to overcome those weaknesses. Within this conceptual framework, the process of thinking about the future in a more
systematic way can be used to help design better wargames. We can think of this advantage from two perspectives – wargames that better expose the key issues facing future conflict and wargames that give better insight into how future events will unfold.

Wargames that better expose the key issues of the future are by their nature quite speculative. In their construction, much will depend upon the assumptions made by the game designers in terms of the key actors and the key relationships within the game. These assumptions are given form within the rules of the game. A more speculative approach would lead us to question the rules themselves in terms of their reasonableness in reflecting possible future events. An unfettered approach to the questioning of assumptions would provide some doubt over the validity of the game. It would be better to question the base assumptions in a more systematic way, in order to retain the structure of the game, but to vary some key elements within it. The study of the future can provide a framework in which these elements could be varied, whilst retaining the integrity of the game. It is to this framework that we shall return in the next section.

Once we have identified the key issues of future conflict, we need to consider how that could give us a better insight into future events. Using the futuring framework, we can identify a set of core uncertainties around which our studies can turn. Given the vast number of uncertainties that could arise in any future state, the study of the future has developed a number of techniques to undertake that search in a more systematic way. Obviously, much will depend upon the focus of the study, but it distils down to selecting the right tool to undertake the job in hand.

Of course, selecting the right tool is one thing, but using it properly is another. We will then move on to our final task of examining how futures can be put into game design. Professional wargaming tends to be fairly utilitarian in its approach. The game is either useful in uncovering insights or it isn’t. If design futures are adequately inserted into game design, then the chances of obtaining a set of useful insights are heightened. It increases the chances of a successful game.

Wargaming the future can be really difficult. It is likely to involve uncertain entities that have access to differing and uncertain technologies, that may be organised in uncertain ways. The aim of wargaming the future is to reduce those uncertainties. This can be achieved best by introducing an element of futuring into the wargame. Using this future framework is the best place to start our enquiry.

The Futuring Framework

From the perspective of the present, the future can be a vast space to populate. There is an extremely large, almost endless, number of possible futures that could emerge. In order to
bring structure to this very large number of possibilities, futurists have developed a number of techniques to help view the future in a systematic way. This futuring framework is used to help us tease out what we know about the future, and to help us identify the gaps in our knowledge and understanding.

The most basic form of examining the future is to assume that the future will consist of present trends extrapolated into a future space. For example, we know that the planet is warming. If we assume that the planet continues to warm, at about the same rate as experienced in recent years, then a number of consequences of that warming might be felt. To continue the example, it may cause the Arctic ice cap might melt, and that has a number of geo-strategic implications which we may wish to game.

Futurists label this type of futuring as trend analysis. The technique is very simple – identify a trend that has moved from the recent past into the present and simply assume that the trend will continue into the future. This is a pathway future, that describes how we get to from the present into the future. We may also wish to consider what the future looks like when we get there. This is an end state future. If we use trend analysis to generate end states futures, we are said to be engaged in horizon scanning. From the perspective of game design, we would use the process of trend analysis to establish the premises of the game and horizon scanning to develop the content of the game.

An example of this approach was provided at the Connections NL conference in 2018. The plenary game on Day 2 was set in 2050. The basic premise was that global warming had led to sufficient ice melt for the Arctic Ocean to be navigable. This was the result of an exercise in trend analysis. It was further built into the game that the Arctic Ocean could become a contested space between the various actors who had an interest in that contested space. That was the result of horizon scanning. A game was worked up from these basic contentions that, as it played out, yielded some interesting results. Whether it would lead to adjustments at the policy level is a matter of conjecture, but many of the participants found that it gave them food for thought about how they conceive of the future. That is the mark of a good futures project.

Whilst trend analysis and horizon scanning is one approach to the future, it is not the only one. The major problem with trend analysis, over the long term, is that trends bend and break. The trajectory of the recent past to the present is not necessarily a good guide to the trajectory from the present into the future. Circumstances have a habit of changing, and trend analysis assumes that they don’t. A different set of techniques have been developed by the futures community to address the weaknesses of trend analysis.

The key vulnerability of trend analysis is that it doesn’t cater for parametric change. It assumes that the future will develop broadly within the parameters currently observed. That could be a problem if there is a sudden and profound change to the parameters. For example,
there could be a change within the political sphere that calls into question the fundamental assumptions on which policy is based. Country X could be relying upon a security guarantee provided by Country Y, there is an election of a government in Country Y that calls into question the guarantee given to Country X. It is interesting to note that, in common discourse, we would see such a policy shift as a ‘game changer’. We would see it that way because the fundamental assumptions of the trend analysis would be called into question.

One way to address these issues would be to see the future as a combination of various systems. The political system, the economic system, the social system, and so on. All of these systems interact with each other in the present and will continue to act upon each other into the future. A systems approach allows us to identify the key actors within the system, to determine the relationships between the actors within the system, and to determine the boundaries of the system.

We can then inject change into the various systems. We could change the actors, either suddenly or gradually, to account for the appearance of some actors and the fading of others. We could change the nature of the relationships within the systems to allow for parametric change. And we could change the boundaries of the system to account for a different world emerging in the future. This would allow us to draw a richer portrait of the future. We could set the exercise to uncover a pathway into the future, or we could set the exercise to develop an end state.

The systems approach to the study of the future fits well into the wargaming environment. This can be seen if we were to change slightly the key concepts of the systems approach. The system is the wargame. Just as a systems approach to the future would have a focus on the question to be examined, so does the wargame have a purpose to be addressed. The topic under consideration would determine the key systems to be examined, just as the focus of the wargame determines the core components of the game.

A systems approach would need to identify the key actors within the system. It would have to give them a degree of agency to exercise choice as they move into the future. Within a wargame, the actors are the players. The design of the wargame would determine what the actors could or could not do, from within a range of possibilities open to them. These could be physical limitations – despite how much we want to fly unaided, the laws of physics and the human form prevents us from doing so. These could be organisational limitations – for example, the adherence to the Geneva Convention. These limitations could apply to one set of players, but not another. In the case of the Geneva Convention, one set of players has to respect it, whilst another set of players might not.

A key aspect of a wargame is that the players play against each other. Within a systems approach to the future, we would have determined not only the key actors within the system,
but also the key relationships between the actors. This is akin to the issue of wargame design in determining how the players will play with each other. The combination of agency and choice, with conflict and cooperation, makes the game, a game. These relationships are then bounded into a ruleset for the game which determines how the wargame is played. This is directly analogous to the boundaries of a system. It provides a limit to what we can do and what we cannot do.

It is highly unlikely that a single wargame, if played more than once, will yield the same results each time. This is the result of human agency. If we then allow for changes to the players in the game and how they react to each other, we will be able to derive an even larger set of possible results. If we then allow for a degree of flexibility to the boundaries of the wargame, then we can create yet a larger set of possible results.

The question arises of how we can manage this large number of possible future outcomes. The futures community has developed a number of methods to order the uncertainty. It is to this that we shall now turn.

**Limiting the Possibilities**

From the perspective of the present, there are an exceptionally large number of possible futures. Each individual decision in the present has a consequential knock on effect that helps to determine the range of choices available in the future. These choices are made by billions of different actors in the present, as decisions today feedforward into future possibilities. If we are to examine future possible events, we need to bring some form of order to the range of possible events so that we can study them in a structured way.

The futures community has a number of concepts that can be used to assist in this ordering. Of all of the vast range of possible futures, not all of them would be plausible. For example, one possible future could involve the consequences of a significant asteroid strike upon the Earth. Whilst this may lay in the boundaries of possibility, this possible future event is often seen as relatively implausible. For this reason, we tend to discount implausible futures.

We need to note two points about implausible futures. The first is that they are not entirely uninteresting. The category of possible - but implausible – futures is where the wild cards lie. Wild cards are a category of future which have an incredibly low probability of happening, but an extremely large impact if they were to happen. The possibility of an asteroid strike is a case in point. It has a very low chance of happening, but if it were to it could lead to an extinction event.

The second point to note is that the boundary between possible futures and implausible futures is not fixed. It can change over time. For example, in the 1990s, the security futurist Marvin Cetron alerted his principals in Washington to the possibility of recently fuelled aircraft
being flown into tall buildings in the United States. The warnings were discounted as being too implausible to act upon. After 9-11, this boundary of implausibility shifted to account for a threat that was now very plausible. This example highlights why we ought to keep in touch with implausible futures, but it is customary for them to be the subject of a separate study that is added to a main study.

If we return to the plausible futures, there are two further types of future that need to be accounted for. The first, which is more easily recognisable, are the probable futures. These are the futures that we see as most likely to occur. They are strongly linked with trend analysis and horizon scanning but are usually modified to cater for the disruption of the existing trends. They allow for a systems approach to be grafted onto the horizon scanning to yield a richer consideration of the future.

The second type of plausible future is the preferable future. This is the range of futures that we would like to see happening. Preferable futures introduce a normative element to the study of the future. However, it becomes difficult to distinguish between a normative preferable future and just plain wishful thinking. We often see this in wargaming, where the Blue Team are given almost super-human powers, and the Red Team are portrayed as overly inept. It is useful to have an idea of how we would like the future to turn out, but we need to guard against channelling our thinking into making it appear to happen. For this reason, most futures studies concern themselves less with preferable futures than probable futures.

The range of probable futures tends to act as the core of a futures project. However, despite discounting the implausible futures, wild card futures, and normative futures, there are still a very large number of probable futures to be engaged with. If a study is likely to deal successfully with this complexity, another form of refinement needs to be introduced. It is at this point we would normally turn to our systems analysis.

The purpose of a systems approach to the future is to introduce an element of structure to our enquiry. We can do this by identifying a number of generic systems that need to be accounted for. The simplest classification given by futurists is the PEST analysis. The critical Political, Economic, Social, and Technological systems are identified and introduced as variable elements to the future. By itself, it will give us a range of actors – players in terms of a wargame – and a set of relationships that can govern the player’s interaction. This needs to be scaled and adapted according to the game in question. For example, in the context of a platoon-based wargame, the bond market may be of limited importance, whilst it may be fairly central to an economic wargame that examines conflict between two or more central banks. We tend to abstract away from, and exclude, those factors that are of minor importance.

As we undertake the process of abstraction, we need to focus more clearly on the key elements that are the subject of our examination. Futurists call these the critical uncertainties.
There may be a number of critical uncertainties to be examined. It is generally helpful to distil these into as few as possible in order to keep the study to manageable proportions. The simplest form of study here would be to distil the issue in question to two key uncertainties and to develop four probable futures using a 2x2 matrix, very similar to the ‘Prisoner’s Dilemma’. However, the process of distillation can cause important factors to be overlooked and discounted. One way of guarding against that possibility would be to conduct a number of iterations of the scenarios to test for the robustness of the results.

This is something that gaming can easily do. If a wargame acts as a generative vehicle for multiple futures, then playing the wargame multiple times will test the underlying assumptions of the game and provide us with a heat map of results. The heat map would help us to assess the robustness of the results. This process starts by putting the future into the wargame design.

**Putting Futures into Game Design**

We need to start with the purpose that the wargame is to serve before we begin to think about inserting a futures approach to the design of a wargame. We need to be clear about the scale and scope of the wargame. For example, a platoon-based wargame will require a different approach to a grand strategic wargame. Equally, a wargame whose game time represents, say, a few days, will require a very different approach to a wargame whose game time represents a few decades. Again, a wargame set in the near future, where most aspects of the game are already evident, will be a very different prospect to one set in the deep future, where very little can be taken as fixed. The determinant of these dimensions will be the question that the wargame is to address. It will also help to shape which systems are to be highlighted and which systems are of lesser importance.

The question of which systems would be better included in a wargame depends largely upon the question that the wargame is to address. If the wargame is to examine the use of financial and monetary instruments to exert state power, then the game is likely to be better delivered as a relatively high level, even abstract, game. If, on the other hand, the wargame is to examine the relative operational degradation of a two-platoon company compared to a three platoon company, then the game is likely to contain a greater degree of granularity when compared to a grand strategic game.

Part of the skill of the wargame designer is to understand the necessary degree of abstraction that a particular game requires, and to then select a game accordingly. For example, in the case cited of the economic wargame, a Committee Game or Matrix Game format might be best to yield some interesting results. Equally, the question of company effectiveness might be better resolved using a more traditional figures game or board game. The point is that the type of game designed is determined by the question to be addressed, which influences the scale and scope of the game in question.
Perhaps this can be best demonstrated by way of an example. Suppose that the question to be addressed concerns the potential for conflict in an unfrozen Arctic Ocean in the second half of the twenty-first century, say, at the year 2070. How would we begin to address that question?

One starting point would be to consider the systems that might have an impact upon that question. The key premise of the study would be that global warming had been sufficient to melt the Arctic ice cap, rendering it largely navigable for a good portion of the year. We might begin by asking what political systems govern the Arctic Ocean, who might have legitimate interests in the navigation of the Arctic Ocean, and what mechanisms of governance may be in place concerning the Arctic Ocean by 2070. We then need to ask ourselves if these would be sufficient to prevent the outbreak of open conflict. If they are, we can end the study. If they are unlikely to be, then we need to continue with our study.

Our next port of call, in the PEST analysis, would be the economic systems governing the Arctic Ocean. We have to ask why it matters from an economic perspective. We may find that the Arctic has significant economic potential for mineral deposits – especially hydrocarbon deposits, as a major trade route in international shipping trade, and as a significant fishery for Europe and North America. These three areas of potential might be mutually exclusive in some areas. For example, hydrocarbon extraction might impact upon the fishery aspect of the Arctic Ocean. This provides an overlay of potential flashpoints that we can add to the political overlay of potential adversaries.

Moving on to the social systems in the PEST analysis, we need to account for the changes in the composition of society by 2070, much of which is evident today through demographic trends, and changes to social attitudes by 2070. For example, we know from demographics that most northern hemisphere nations will be older than they are today. Could that lead to young people being given greater social value? Might that have an impact on an aversion to casualties? We cannot assume that the armed forces of the potential adversaries will have the same social context in 2070 as they do in 2020. We also cannot assume that this differential impact will occur evenly between the potential adversaries. This analysis should give us an overlay of the social system which we can add to the overlay of the political and economic systems.

The final element of our PEST analysis concerns the development of technological systems. It is important here to incorporate models of long-term technological change into this system. One such approach can be found in the work of Carlota Perez, who is very influential in futurist circles. According to the Perez model, the current technological wave – the ICT, or fifth, wave – will have burned itself out by 2050. If so, then the next technological wave, the sixth wave, will be establishing itself by 2070. There is much speculation about the content of the sixth wave, so this is the area in which the greatest degree of imagination can be exercised whilst remaining in
the boundaries of plausible futures. We can expect the technology to be autonomous, remotely controlled, possibly space borne, capital rather than labour intensive, and fairly fast reacting. It could well act at the NBIC (Nano, Bio, Info, and Cognitive) levels. Whatever we decide about the technological systems, they can then be overlaid on top of the political, economic, and social systems.

Once we have a picture of the operational world in which the base question is set, we then need to return to that base question to gain some appreciation of the scale and scope of the wargame. If our question is concerned with naval design, we may choose to produce a fairly granular wargame, possibly a figures game or board game that tries to find some traction in this decision frame. Equally, if the wargame is concerned with where to invest in naval port facilities, then we may like to have a longer time scale to represent the time it takes to build and develop port facilities and the attendant infrastructure. Normally, this would be represented in the turn structure, with the operational world being represented in the rule structure of the game.

Before we finalise the game, we might like to spend a little time thinking about wild card futures. These can yield very interesting results to the game if introduced at the right time. For example, in the case of a geo-strategic level Arctic conflict game, might there be a technology that renders the game moot? What if the development of additive manufacturing (3D and 4D printing) were such that goods were manufactured on demand at the point of consumption? Would we need a trans-Arctic trade route in such circumstances? Ought we to allow this possibility into the wargame? The point here is that at some point towards the design process, we need to determine what are permissible game moves, which, *ipso facto*, makes all other game moves inadmissible.

Whether or not such a game produces results that are convincing is neither here nor there. An unconvincing game can tell us as much about the future as a convincing game if we conduct a rigorous review of why the game is unconvincing. In many ways, that is where the injection of futures into wargame design can be useful. It forces us to identify our conscious and unconscious assumptions, and to subject them to a rigorous challenge.

**Conclusion**

The study of the future has a number of techniques that can be incorporated into game design to generate better wargaming scenarios. Trend analysis and horizon scanning are useful techniques to generate near future scenarios. The key element of near-term scenarios is that much of the operational environment is either fixed, or can be determined relatively easily. For example, when considering near term scenarios, it is relatively easy to determine who the near-term potential adversaries might be. In many ways, we are describing the world in which we currently live, only a bit further into the future.
When looking at far term scenarios, it would be more appropriate to use a form of systems analysis and modelling. By definition, far term scenarios are those in which many of the operational elements are not fixed. To continue the example, above, when considering far term scenarios, the wargame designer would have to give careful consideration to who the potential adversaries might be. We cannot assume that the current range of nations, with their current territorial limits, will not have changed in the longer term. To place a sharp point here, can we assume, in 2070, that China will not have expanded or contracted in territorial terms? Could the United States have expanded to include parts of Canada? Would Europe be a federated superstate or a collection of squabbling minor powers? When designing a wargame for 2070, the designer would have to give some consideration to how these questions could be answered.

The answers to these questions, in the far term wargame, would be written into the fabric of the game. It would help to determine the identity of the players, the scope of their operation, and the boundaries within which they have to operate. In determining these issues, the wargame designer would have to confront the assumptions, which are often tacit, that are being brought into the game structure. It is by confronting these assumptions that we reduce the possibility of being blindsided by an emerging future that we hadn’t previously considered. In that sense, we would become better equipped to deal with an emerging future. And that is how futuring can be used to generate better wargame scenarios.

References


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Common Pathologies and Pitfalls of Wargaming Future Technologies

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Abstract

As the strategic focus of the United States has steadily shifted towards great power competition and near-peer adversaries, defense wargaming has increasingly emphasized wargaming the future. This shift is reflected in the significant wargaming efforts surrounding the U.S. Army’s Multi-Domain Operations (MDO) concept and the U.S. Marine Corps’ Expeditionary Advanced Base Operations (EABO) concept. Central to many future-oriented wargames, such as MDO and EABO wargames, is the role and effects of emerging and speculative technologies. Generally, future-oriented wargames can involve any number of technologies such as artificial intelligence (AI), additive manufacturing, energy-based weaponry, autonomous combat systems, and advanced forms of cyber and electronic warfare.

When wargaming the future, there exists considerable obstacles ranging from pervasive uncertainty to the difficulty of fostering creative thinking. Building upon Wargame Pathologies, a joint report by the Center for Naval Analyses (CNA) and the Naval War College (NWC), some of the identified pathologies are common to all wargames but are amplified in their severity in future-oriented wargames. Other pathologies are unique to this specific genre of wargaming, which focuses on the future and speculative technologies. This paper seeks to assist wargamers, their sponsors, and their players in avoiding or tackling some of the pathologies and pitfalls involved in wargaming future technologies.

By its nature, uncertainty is inherent in wargaming. This uncertainty is only increased as the focus of the wargame moves away from the present or reasonably known to the more unknown future – in terms of quality and degree. Two fundamental problems arise: 1) By definition, people lack experience with the future since they have not been there 2) The possible technology environment has a combinatorial explosion of outcomes and possibilities generating enormous uncertainty. In future-oriented wargames, these two fundamental problems create vulnerabilities in wargame validity, such as the technology victory machine. These vulnerabilities can be addressed by a combination of (i) sequential gaming (sequences of games leading further into the future, sequences that incorporate different levels of technology, sequences that focus on specific technologies, portfolio games that combine technologies, and each game in the sequence informing the next game), (ii) careful selection of players and adjudicators that combine imagination and experience, and (iii) wargames designed to reward players for imagination and innovation independent of who wins.
Managing Uncertainty

Uncertainty is a critical and unavoidable element in wargames. On the surface, uncertainty seems antithetical to the notion of a rigorous, analytical wargame. Yet, in Rules of Play, Zimmerman and Salen emphasize that uncertainty is “a key component of meaningful play” (Zimmerman and Salen 2003 p. 181). Uncertainty is necessary to imbue the decisions of players with power – the ability to interact and affect the simulated world of the wargame. Typically, uncertainty in wargames exists on two levels: on the macro- and micro-level. The macro-level uncertainty involves the unknown outcome of the wargame itself, while the micro-level uncertainty involves the unknown of results involving specific interactions and operations within the wargame (Zimmerman and Salen 2013 pp. 181-182).

In wargames involving future technologies, the micro-level uncertainty explodes as interactions involving emerging or future technologies. For instance, how does a designer define the effects of an amorphous technology like AI into a table-top exercise (TTX)? Similarly, how does a game system adjudicate the engagement between a drone swarm and traditional air defense? Or how does a game quantify or adjudicate a kill chain involving quantum encryption and hypersonic missiles? The number of uncertain interactions is seemingly infinite – ranging from the effects of electronic warfare to quantifying the range of future weaponry. Without real world examples or experimental data, the task of examining future technologies is plagued with micro-level uncertainty. This is only further exacerbated when conceptual thinking about said technologies principally resides in vague, high-level PowerPoint presentations or hazy graphic illustrations. Ultimately, the fundamental challenge is to create a future world where players, sponsors, and designers can collectively accept.

This does not mean the task is insurmountable. Future-oriented wargames do not predict the future nor should they attempt to. Instead, they attempt to understand the underlying logic of future interactions and elements of strategic uncertainty. To that extent, designers can mitigate uncertainty in at least four ways.

1. Designers always have the fundamental choice of utilizing different types of wargames, from matrix games to more rigid rule-based games. This approach allows designers to select the type of uncertainty the wargame will emphasize and examine.
2. Another method involves assuming a capability or technology will work just as imagined or advertised. This method incorporates the core assumption into the world of the wargame, enabling players to examine a scenario where this is true.
3. Borrowing a standard method of futurism, wargame designers can draw upon historically analogous examples and computer models in an attempt to extrapolate a range of outcomes or parameters. Subsequently, these parameters can be used to guide
subject-matter experts in adjudication or be converted into a type of combat engagement table, similar to more rigid, rule-based wargames.

4. Another method is for designers to change the performance parameters of a single technology over successive wargames, allowing for the examination of various possible scenarios. For instance, one iteration can imbue next generation aircraft with 70% chance of going undetected, while the following iteration can reduce it to 50%. This method allows a wargame to examine a range of possibilities and how it affects operational choices. This type of sensitivity analysis in wargaming could be beneficial in capabilities development and concept refinement. By altering the performance of a specific technology, wargaming can reveal trends in how such variance can affect operational tactics and employment.

None of these techniques are perfect, each presents their own set of assumptions and challenges. A myriad of factors are involved in determining the best method for each respective wargame, such as expense, time, and the character of a specific technology. The danger surrounding uncertain technologies is three-fold. The first danger is creating an illusion of certainty where there is none. If a wargame is not explicit in its assumptions or conveys the impression that a technology will consistently perform at optimal levels all the time, audiences and players can arrive at dangerously faulty conclusions. This can lead to the age-old pathology of “declaring victory,” where audiences or players assume a wargame validated the importance or value of a specific technology or concept (Weuve et al. 2004 p. 39).

The second danger can occur when the $P_k$ or probability of outcome is fundamentally controversial, particularly at the micro-level. Inherently, $P_k$ values in wargames attempt to represent a range of outcomes and decisions. However, if players perceive that the $P_k$ values do not characterize the technologies as they view them, they will routinely reject the wargame and its results. As a result, future-oriented wargames benefit greatly from a deliberative adjudication process where the process is transparent. This facilitates open discussion and minimizes the perception that the ‘game is rigged.’ The last danger is overreacting to uncertainty with unwieldy game mechanics. In an effort to limit uncertainty around a technology, designers can overcompensate by creating thick technical manuals or overly complicated game mechanics. Consequently, players can struggle to absorb the mountain of new information, technologies, and related rules, which results in ineffective play. Alternatively, overwhelmed players can default to technologies that they are most familiar with and ignore other options.

**Plug and Play Fallacy**

The plug and play fallacy is not a misstep in wargame design, but a lack of imagination by both designers and players. When designing the simulated world of the wargame, designers can
fall into the plug and play trap by augmenting and introducing new technologies, while the geopolitical situation remains unaltered. Depending on the technology, the effect of a new technology can have varying levels of influence. The emergence of AI could potentially alter everything from the labor force to command and control. In the Korean Peninsula, the introduction of hypersonic missiles or a reliable, futuristic missile defense system could drastically change the political calculus in the region. Thus, designers must resist the temptation of simple substitution.

When participating in future wargames, players often merely substitute or augment an existing capability with the new technology. This reflex is completely understandable and reasonable. Military officers, which make up the vast majority of participants for defense wargames, are fundamentally trained to think and solve problems in a specific manner. This is the essence and strength of a professional military, which relies on process-based thinking and uniformity. So, it is unsurprising when military officers simply swap one capability out with an updated version, while leaving the other elements of their thinking unexamined.

Autonomous combat systems offer a perfect example. In visions of the future, autonomous combat systems come in a range of sizes and purposes. An amphibious combat system, resembling a gun turret on tracks, may augment or replace the combat power of a Marine infantry company. However, to view autonomous systems as robotic substitutes for their flesh and blood counterparts ignores a range of new tactical and operational opportunities. For example, in amphibious landings, amphibious combat systems can be delivered to shore in mass in modified torpedoes unlike their human counterparts. Comparably, in defending against a beach landing, they could hide in shallow waters to execute a pincer attack against a landing force. Unlike humans, amphibious combat systems do not need to breathe or rest, given that they are sufficiently waterproofed.

This is not to imply military officers are lacking in any way. It is a natural and fundamental human instinct to use one’s own experiences to inform one’s decisions. The wealth and breadth of experience and knowledge is the chief reason why military officers are chosen to participate in wargames in the first place (Downes-Martin 2015a). Who is better to play a 2030 brigade combat team commander than a military officer who has commanded a brigade combat team in the past? However, the key to meaningful gameplay in future-oriented wargames requires players not to be prisoners of their past. This applies to all players, not only military officers. A precarious balance is required where players are informed by their experiences and expertise, but not limited by them to the point where they cannot recognize or utilize opportunities new technologies create. Wargame designers and sponsors can help by carefully selecting participants and encouraging and rewarding informed free-play. In this regard, failure should not be demonized, but accepted as a meaningful step towards innovation (Downes-Martin 2015a).
Another method to mitigate the “Plug and Play Fallacy” is to allow participants to form a concept of operation prior to the wargame. The notion is not to create an answer before the game, but to establish a baseline to work with within the game. Participant briefings, read-aheads, and tangible assignments can encourage pre-game conceptual thinking. However, as most experienced wargame designers know, pre-game assignments rarely ever get completed by participants, who are often absorbed in their daily duties. Nevertheless, the point remains to allow participants as many opportunities to familiarize themselves with the technologies prior to the wargame.

An Overabundance of Technology

When asked to envision the future battlefield, a common reaction is to fill future with a myriad of technologies, such as hovercrafts to railguns. Whether one is science fiction writer or a military officer, the impulse to fill the unknown with fanciful technological marvels. Therefore, it is not surprising when future-oriented wargames are flooded with a plethora of technologies. Yet unlike science fiction where a future brimming with speculative technologies creates a sense of wonder and awe, in wargaming, an overabundance of technology can be detrimental.

Professional wargaming is an analytical method that seeks to examine human decision-making in simulated conflict. And like other methodologies, a surplus of variables can create confusion and muddle clarity in analysis. In The Complete Wargames Handbook, Dunnigan commented that, “It is very difficult to keep a game-design project simple. Once you get going, there are tremendous temptations to add this and that” (Dunnigan 1992 p. 114). This is particularly true for wargames utilizing future technologies. The temptation to add a whole host of technologies seems natural, almost necessary. To build a comprehensive world within the wargame, one can easily fall into the cyclical logic of: if we have lasers beams, we should also have hypersonic missiles and quantum radar. In other cases, sponsors can be overly ambitious in the number of technologies they want to wargame. In both cases, this unavoidably leads to a massive list of technologies.

When a wargame is laden with a dozen or more technologies, the analytical task of distinguishing the effect of one technology from another becomes near impossible. The surplus of variables hinders the ability to make any meaningful connections between a specific technology and the decisions of the players. At the same time, amidst an overabundance of technology, players often ignore significant portions of the assigned technologies -- frequently focusing on the technologies they are most familiar with.

Limiting the number of variable technologies in a wargame is easier in theory than in practice. Let’s say a sponsor wants a wargame that examines future urban warfare. This opens the door to a myriad of technologies from digital camouflage to swarming drones. The problem is further complicated by the fact that future warfare, as the Department of Defense envisions
it, involves a tremendous level of interconnectedness and interoperability across domains and functions. However, there are ways to avoid falling down the technological rabbit hole. First off, the gaming objectives should be focused and feasible, limiting the set of technologies examined to one to three. This can be facilitated by limiting the scope of the wargame to a specific warfighting function, such as long-ranged fires or sustainment. This will naturally help scope the technologies the wargame is concerned about including. Lastly, a disciplined lead designer can help keep a wargame stay focused and on task and manage sponsor expectations and desires, which can prove critical.

The Technology Victory Machine

With the prominence of the Third Offset (Walton 2016) and the Pentagon’s fervor to develop and acquire new technologies (Esper 2018), it is unsurprising that the US military has adopted a technology-centric approach to addressing both its present-day gaps and anticipated future challenges. This can lead to the belief that new, emerging technologies can serve as a panacea to a host of problems. And when these assumptions collide with wargaming, a technology victory machine is inserted into the very heart of a wargame. Similar to the logic victory machine, where a series of logical steps guarantee victory, the technology victory machine ensues a one-sided technological dominance and subsequent success on the battlefield (Downes-Martin et al 2004).

In a Naval War College presentation, entitled “How Not to Not Analyse Wargames,” Downes-Martin offers an example where Blue possesses “photon torpedoes, transporter beams, and replicators,” while Red is limited to “1960’s Scuds and rotary dial telephones” (Downes-Martin 2015b). Obviously, the example is purposefully extreme to illustrate a point. However, it is not uncommon for future wargames to fall into this trap to varying degrees, especially so if a game’s sponsor has a pet project. The technology victory machine can take various forms, for example:

➢ It can manifest in an unrealistic technological disparity, especially between near-peer adversaries. For instance, Blue’s soldiers are equipped with battle suits that make them near-invincible, while Red is running around in traditional body armor.

➢ Other times, a speculative technology or a suite of technologies can be tailor-made to solve a specific problem with overly optimistic estimations in terms of performance. For example, to address the fog of war and the challenges of command and control of distributed forces, Blue is given an unfailing and near omniscient AI.

➢ A subtler form of the technology victory machine is the ‘last say mechanism.’ In this context, both Blue and Red are given seemingly comparable technologies. Yet, in the micro-level action and reaction engagements of the wargame, Blue is consistently given
the last say, usually in the form of a technology that counter-acts or diminishes Red’s technologies. For instance, when Blue’s future battle tanks advance on Red’s position, Red responds with precision artillery fire via micro-satellites, but Blue perfectly counteracts with drones that intercept artillery shells.

➢ The technology victory machine is typically most acute during the last move of the wargame. Knowing that the wargame will end, players can be incentivized to make unrealistic or uncharacteristically risky actions. The absence of meaningful consequences can encourage players to press their technological advantages in controversial ways. This can manifest in various ways, such as the use of nuclear hypersonic missiles against a near-peer adversary. To avoid this, the actions of the players should be thoroughly adjudicated in the final move and players should be required to justify it, both operationally and strategically.

Unsurprisingly, the technology victory machine in all its forms can lead sponsors and audiences to conclude that a specific technology is a requirement for the military (Downes-Martin 2016). To avoid the temptation of the technology victory machine, designers can strive for balance, making reasonable assumptions about how each side could develop and utilize various technologies. For instance, given historical trends, the Chinese military could invest in technologies that complement its strategy of long-ranged fires and area denial, while the US Navy and Marine Corps could invest in technologies that enable maneuverability, precision, and combat power. Furthermore, designers can incorporate reasonable limitations on future technologies, allowing for trade-off analysis. In the case of an energy-based cannon, the designers may impose operational costs like energy consumption or cool-down periods. Thus, players are forced to decide whether the energy-based cannon is too unwieldy or only useful in specific scenarios.

Conclusion

There is no single solution to all of the pathologies and pitfalls involved in wargaming future technologies. Each challenge poses a unique dynamic, which can be solved in numerous ways. Yet, as a rule of thumb, when wargaming future technologies, designers should conduct iterative wargames as part of a series. Each wargame can be tailored to examine or explore different aspects of a complex problem set. For instance, the first wargame can be a matrix game designed to elicit creative, out-of-the box thinking (Project Cassandra 2018). The subsequent wargame can be a more rigorous wargame that incorporates realistic limitations and capabilities to a handful of future technologies. Then the outputs from the wargames can inform other analytical efforts or serve as inputs for follow-on wargames.

The wargaming efforts involving Multi-Domain Operations (TRADOC 2018), such as Unified Quest (UQ 2018), has adopted a similar series approach, where smaller wargames examine
specific warfighting functions and their related concepts and technologies. The effort culminates in a longer final wargame, which utilizes the results from the preceding wargames. The Marine Corps has also shifted to serial wargames, such as MAGTF Warrior and Expeditionary Warrior, to examine its own capstone concept. Through its Fight Club wargaming initiative, the Marine Corps University (MCU) and Marine Corps Warfighting Lab (MCWL) is also examining littoral operations in the near future. The wargames examine a range of technologies, mix varying adjudication styles, and encourage creative thinking through competition (Jensen 2019).

Ultimately, despite the pitfalls that exist, one should not shy away from examining the future and how technology can transform the contours of warfare. When done right, wargaming can empower operators, scholars, and policy-makers to ask the right questions about the future of warfare and the role technology will play.

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Wargaming the Far Future


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Geopolitical Matrix Gaming in 15 and 50 Year Future Scenarios

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Abstract

In a world where crises and disasters are increasing with frequency and intensity, few options exist to facilitate an adequate understanding of the underlying complex causal factors and driving forces. Fewer yet exist that permit us some insight into the potential and plausible future outcomes of these events. This paper describes the development of four Matrix games through a process involving threat identification, systems mapping, analysis of the driving forces of change, and foresight-based scenario planning. The games cover the topics of major power rivalry threats in Northeast Asia and climate-environmental threats in the Indo-Pacific over mid-term (15-year) and long-term (50-year) periods. Two of the most interesting insights were: (i) Technology is evolving so fast that it was difficult for participants to extrapolate or imagine what the long-term future might hold; and (ii) When people think about environmental change of an existential magnitude, they mitigate it by prioritizing the improvement of the economy, which provides more options down the track. Similar themes emerged in all groups, including the value of multi-mindedness in evaluating complexity, difficulties in committing to collective action under imperfect information, identification of core values and interests in geopolitical negotiations, and insights into possible levers of influence.
Introduction

Well-functioning security systems are vital to sustaining and expanding the management of national challenges. However, the inherent complexity of many types of crises places decision makers in the uncertain position of having to make difficult choices with limited information. Other factors, such as urgency, growing threat, and increasing pressure from stakeholder groups, the media and public all interact to expand situational complexity. Crises seldom provide managers the time they need to conduct extensive analysis to understand the problem, and so, familiarity with rapid and easy to use analytical methods is essential to ensure a higher proportion of appropriate decisions.

Preparedness is the key to facilitating rapid, evidence-based decisions during acute crises. The work environment of a national security professional constantly evolves and errors in judgement can result in significant impacts on crisis responders and communities. Maintaining the peace and keeping in front of problems requires an understanding of relationships, collaborative thinking, and awareness of system complexity. Several methods and tools exist that can help decision makers understand complex problems before they tip into chaos. Having an idea of how these problems might change in the future and what people might do in these situations is key to averting disastrous ripple effects.

This paper documents a methodology for exploring possible futures in the medium and long-term. In a four-step process, security practitioners complete a guided set of seminar discussions and simulations designed to help them understand threat systems, reveal underlying driving forces of change, create future scenarios and explore these scenarios using situational wargaming.

Facility and Participants

The Daniel K. Inouye Asia-Pacific Center for Security Studies (DKI-APCSS) is an executive education institution that offers courses for experienced security practitioners from over 35 countries in the Indo-Pacific. Fellows collaborate in a shared learning environment on issues like advanced security cooperation, comprehensive crisis management, and countering violent extremism. DKI-APCSS offers its Fellows a high-tech educational facility with an auditorium, a large lecture hall and a dozen 16-person breakout rooms with four whiteboards, a smartboard and two 50” screens. In the case assessed by this paper, participants (Table 1) were separated into eight groups of 12 to 13 people. Each group had only one person from each country or location and proportionately distributed gender. Two faculty members facilitated process and discussion for each group in dedicated breakout rooms.
Table 1: Participant details

<table>
<thead>
<tr>
<th>Total participants</th>
<th>101</th>
</tr>
</thead>
<tbody>
<tr>
<td>Countries</td>
<td>34 (Australia, Bangladesh, Bhutan, Cambodia, Colombia, Fiji, India, Indonesia, Iraq, Republic of Korea, Laos, Lebanon, Malaysia, Maldives, Marshall Islands, Mexico, Micronesia, Mongolia, Myanmar, Nepal, New Zealand, Nigeria, Papua New Guinea, Peru, Philippines, Solomon Islands, Sri Lanka, Thailand, Timor-Leste, Tonga, Turkmenistan, United States, Vanuatu, and Vietnam)</td>
</tr>
<tr>
<td>Locations</td>
<td>2 (Taiwan, and Hong Kong)</td>
</tr>
<tr>
<td>Organizations</td>
<td>4 (Japan Platform, Myanmar Red Cross, Pacific Islands Forum, UNOCHA)</td>
</tr>
<tr>
<td>Gender: Male</td>
<td>71%</td>
</tr>
<tr>
<td>Gender: Female</td>
<td>29%</td>
</tr>
<tr>
<td>Profession: Military</td>
<td>33% Major to Colonel</td>
</tr>
<tr>
<td>Profession: Law enforcement</td>
<td>10% Police equivalent</td>
</tr>
<tr>
<td>Profession: Civilian</td>
<td>57% Civilian equivalent to O3-O6 with several directors of national disaster management organizations</td>
</tr>
<tr>
<td>Origin - International</td>
<td>89%</td>
</tr>
<tr>
<td>Origin - United States</td>
<td>11%</td>
</tr>
<tr>
<td>Game staff</td>
<td>Game preparation was assisted by staff from the DKI-APCSS Visual Information unit. Game training was facilitated by the course management team. Each instance of the Matrix game was run by an experienced facilitator with the assistance of a scribe</td>
</tr>
</tbody>
</table>

Method and Results

The learning methodology documented in this paper is broken down into four steps: threat identification, domain mapping, system mapping using causal loops, exploration of driving forces of change, generation of future scenarios and Matrix gaming.

Step 1: Threat identification, Domain mapping, and System mapping

The eight groups independently went through a process to identify common threats in the Indo-Pacific region and prioritized these threats based on their experience and national priorities. Each group dealt with this step in their own way with most splitting into two or even three subgroups. The top four threats are shown below in order of (frequency).

1. Geopolitical instability and major power rivalry (5)
2. Natural disasters and climate change (5)
3. Transnational organized crime (3)
4. Terrorism and violent extremism (2)

Variables and factors associated with geopolitical rivalry were:

Sovereignty, diplomacy, stability, population growth and aging, migration, development, investment, military spending, aggressive policies, international aid, resource competition, risk of conflict, political dominance, diplomatic dominance, natural resources, economic growth, trade-war, culture, domestic politics, expansion, military strength, technology development, military buildup, conflict, negotiations, investment, island building, international actors, public opinion, enemies, dispute, allies, ideology, markets, airspace control, shipping, resources, hegemony, Super power influences, geopolitical instability, international laws and norms, political will, national interests, regime change, domestic disturbances.

Variables and factors associated with natural disasters and climate change were:

**Coordination:** NDMO, MOUs (engineers, doctors, builders, technicians, etc.), bilats, multilats training, logistics, plans, policies, budget, human resources, sharing tech and info, capacity building, disaster planning, responder training, impact assessment, resource allocation, civ-mil cooperation, timely response, info security, communication, humanitarian assistance

**Infrastructure:** roads, hospitals, power, ports, airfields, shelter, infrastructure breakdown, building codes, reconstruction of infrastructure

**Technology:** communication, equipment, networks, early warning, weather forecast, training

**Political:** impact, political will, legislation, regulation, national strategies, budget, capacity, lack of resources, resilience, mitigation, donor mandates, trust, cost, infighting

**Economic:** wealth, livelihood, corruption, aid, domestic, foreign, NGO, IO, taxes

**Social:** culture, demographics, education, resilience, health, security, food, shelter, WASH, community engagement/awareness, poverty, crime

**Environmental:** climate change, conservation of natural resources, education, population displacement, food security, mitigation of climate impacts, dev of adaptation policies, quick response, awareness, robust infrastructure, warning systems, warming, storms, flooding, access, displacement, migration, water, food production, shelter, safety and security, industrialization, deforestation, epidemics, pollution, hazards, resource scarcity, wildlife, agriculture
Domain mapping gets participants to look for general overarching relationships between categories of threats (Figure 1). This intermediate step greatly assists participants before they begin the arduous task of constructing a causal loop.

![Domain map example from a group working on geopolitical rivalry.](image)

Figure 1: Domain map example from a group working on geopolitical rivalry.

Causal loop mapping facilitates systems thinking and the development and testing of theories of change by (i) making explicit the inter-relationships between factors; (ii) identifying and tracing anticipated effects of interventions; and iii) anticipating and monitoring unintended intervention impacts (Figure 2) (Campbell 2018).

The basic building blocks of systems mapping are:

- **Key causal factors**: Conflict and disaster analyses generate many interconnected, dynamic factors that are necessary for a crisis to exist, but causal loop maps only use the most important.

- **Relationships**: Links that join factors represent directional influence and show how an increase in one factor can cause an increase or decrease in another factor.

- **Feedback loops**: All relationship links must eventually connect to form loops and these may be balancing (each iteration flips from negative to positive) or reinforcing (each iteration repeatedly makes things better in a virtuous cycle or worse in a vicious cycle).
Step 2: Exploring the driving forces of change behind the key threat

The systems mapping exercise in Step 1 helped participants to visualize and understand problem complexity. In Step 2, participants identified and categorized the basic trends and information that are currently or expected to drive future change. Using their threat prioritization, groups identified the most disruptive driving forces of change for one priority threat and rated these drivers according to their potential future impact and level of uncertainty. The results for geopolitical rivalry and disasters/climate are presented below.

Geopolitical rivalry

- High impact and uncertainty
  - Clash of cultures, financial and monetary policy, foreign affairs, capitalist investment potential, national policies, security concerns, domestic/regional instability
- High impact and low uncertainty
  - Nationalism, safeguards of constitution, education, trade, resources, stability, national defense capability, international agreements, ideology, belief, value, increase of people moving to cities/urban area, invention & innovation, energy use in industry and manufacturing, consumerism, ethnic, religion, culture, gov change, natural resource possession, information, computation
- Low impact and high uncertainty
  - Innovation, technological advancement, international agreements, pressure groups, international law, research, funding, industry
Low impact and uncertainty
  ○ Policy to promote technology advancement, new-found awareness, energy storage and generation, R&D, international politics, international trade, innovation and capability

Disasters/Climate

High impact and uncertainty
  ○ Diversity in energy production, bi/multilat agreements, strong legislation, clean energy, academic influence on policy making, innovation, social media, lifestyle/attitudes, preparedness, migration/displacement, cyber and network security, access to technology, foreign aid, private sector, civil society, food security, inflation

High impact and low uncertainty
  ○ Government funding, globalization, political will, economic goals, implementation of international laws, public awareness, education, preparedness, resilience, awareness, community participation, consensus, law and order, innovation, early warning, data collection, forecasting, budgeting, recovery planning, cooperation between private civil and military sectors, national crisis frameworks, good governance, interagency cooperation, international initiatives, local commitment, policy planning, budget for vulnerable communities

Low impact and high uncertainty
  ○ Increase national reserves, international laws and standards, religion, culture and values

Low impact and uncertainty
  ○ Change in leadership

The Political, Economic, Social and Technological (PEST) analysis is a commonly used tool for identifying and categorizing basic trends and information about a range of different contextual issues that influence the future (Shoemaker 1995, Henry 2008). In business, PEST is used to analyze the macro environment around organizations to gain insights into market movement. In the context of security strategies, a PEST analysis can help us understand the external drivers that potentially affect outcomes. The process produces a list of drivers that require consideration when formulating a new strategy or intervention. More in-depth analyses may include consideration of Environmental, Legal and Ethical drivers (STEEP and STEEPLE). Participants contemplated each of these categories in preparation for Step 3.
Step 3: Planning and generating future scenarios based on key drivers

Strategic foresight helps crisis managers to understand complex problems, which guides decisions and planning (Vecchiato 2012). Foresight does not predict the future, but rather provides insight into plausible future situations. It empowers planners by providing them with new ways of thinking about and implementing strategies that engineer a preferred future (UNDP 2018).

Scenario planning is a foresight tool that overcomes biases, simplifies complexity, and reduces uncertainty to foster rapid and effective decision-making (Bootz 2010). Corporate decision makers have used this tool since the late 1970’s to guide decisions in times of uncertainty, to overcome cognitive limitations and to improve mental agility (UNDP 2018). In practice, it brings together managers with stakeholders to generate insights as they explore the implications of alternative futures (Horton 1999). Likewise, crisis managers find scenario planning a useful tool for managing uncertainty, risk, and opportunity because it provides a framework for understanding future needs and prioritizing near-term actions.

Scenario development requires consideration of how each of the change drivers and relevant system factors might behave under each scenario. The simplest and most commonly used approach to scenario creation is to use a two-way matrix that derives from contrasting the two most powerful or disruptive drivers. This ensures that participants explore a range of plausible, but distinct alternative futures.

In Step 3, participants created two-way matrices comprised of medium and long-term time periods vs. threat growth or decline. The two-way matrices produced four distinct scenarios for analysis (Figure 3). Each group then divided into two subgroups to develop each of the four scenarios.

![Figure 3: Future scenarios derived based on future time period and threat level.](image-url)
Participants were asked to pretend that they were living in their assigned future scenario and brainstorm what it looked like. They considered the success or failure of social, technological, economic, environmental and political (STEEP) drivers and reflected on the possible changes that each driver might cause. Taking all factors into consideration, they selected four of the most relevant and highest ranked driving forces and listed associated actors for each driver.

**Threat Growth 15 and 50 (normal 15; italics both; underlined 50)**

**Political:** instability, rivalry, sophisticated corruption, leader change, noncompliance with international agreements, talks go wrong, poor leadership

**Economic:** foreign investment, unsustainable urbanization and industrialization, unbound consumerism, trade with China sours, lack of R&D, recession, online commerce, increased sanctions

**Environmental:** resource exploitation, contamination, climate change, energy use, scarcity

**Social:** clash of cultures/religions/ethnicity, social media, migration, less community participation, labor issues, social inequity, lower living standards, deteriorating services, lack of law enforcement

**Technical:** invention, innovation, AI weapons, AI abuse, unregulated, cyber warfare, cyber crime

**Threat Decline 15 and 50 (normal 15; italics both; underlined 50)**

**Political:** stability, better national policies, enhanced defense capabilities, stronger foreign affairs, enforcement of laws, interagency cooperation, planning and resourcing, anti-corruption, establish and regulate international law, institutional safeguards, zero tolerance, growth in multilateral agreements, UN leads strong international law

**Economic:** better financial policies, free and open trade, consumerism, no/lower sanctions, resilience, smaller economic divide, rising costs, international currency, online commerce, infrastructure investment, social security

**Environmental:** sound management of natural resources, improve regulation and protection, unsustainable urbanization

**Social:** education for all, more aligned beliefs and values, generation change, resilience, greater public awareness

**Technical:** tech and cyber regulation and laws, R&D and alternative energy, denuclearization, replace old hazardous tech, common information sharing platform, innovation and invention, smarter energy use, AI growth, cyber warfare, mega connectivity
Step 4: Matrix games set in four different future scenarios

Among the best ways to do futures research is through the experience and analysis of serious games (Dator 2017). Repetition of a serious game with diverse participants can be very effective in revealing alternative futures. While this technique does not provide a prediction of the future, it permits a glimpse of what may occur, which aids decision makers in identifying the potential effects of policies in advance.

Matrix games are a type of global, strategic, serious game (Perla & Curry 2011). Matrix games are different from normal wargames in that there are few limitations on player behavior, the decision-making is crowd-sourced, the adjudication process is transparent, and the gameplay rarely produces clear winners or losers. These games employ a broad range of political, social, military and economic dimensions. Matrix games are particularly useful in analyzing complex geopolitical issues involving multiple stakeholders with different goals, strategies, motivations and values. Such issues include potential hostilities, diplomatic standoffs, transnational threats and geopolitical negotiations. Their purpose is to expose participants to broad perspectives, test strategies, identify key issues, and promote the exchange of ideas. Their output tends to be a qualitative narrative and interpretation rather than a quantitative prediction. They are thus useful when the game space is not well understood (Curry & Price 2017).

Based on the outcomes of Steps 1-3, the facilitators selected the two most often mentioned threats that were identified by most groups at some stage in the process: “Major Power Rivalry in Northeast Asia” (Actors: China, Japan, Russia, US, Unified Korea, Taiwan) and “Climate and Environmental Change in Asia and the Pacific” (Actors: US Global Corp, Papua New Guinea, Philippines, Unified Oceania, Indonesia). Two scenarios were developed for each threat – medium term (15 years) and long term (50 years). Each scenario included a blend of outcomes based on threat increase and threat decline. Two groups were assigned to each of the four resulting scenarios. In each Matrix game, five 45-minute turns were scheduled, separated by breaks during which negotiation was encouraged. The games concluded with a 45-minute reflection session. Actions within an actor’s power were largely successful and outcomes were determined via the Pros and Cons method followed by percentage cards and dice. When an action was proposed that was beyond an actor’s power, both the occurrence and outcomes were determined using the pros and cons method with percentage cards and dice.
Matrix Game Briefs

Matrix Game 1: Major Power Rivalry in Northeast Asia in 15 years

A rebellion broke out in North Korea and the people overthrew President Kim Jong Un’s government. North Korea and South Korea united in a search for co-prosperity and founded the Federated States of Korea (FSK). The FSK halted denuclearization, became a world nuclear power, and rapidly developed into an economic giant due to cheap labor in northern Korea.

Working behind the scenes, China manipulated the eviction of the US from the FSK and Philippines. However, this backfired when FSK turned to Russia for assistance, aid and close diplomatic ties. To maintain influence in the region Japan disregarded Title IX and began a massive military buildup with the help of the US. The US and Japan strengthened diplomatic ties and the US spearheaded international support for Japan.

China pushed forward to complete their One Belt One Road Initiative. Asia and Europe are now connected creating a flow of economic prosperity with China at the center of the network. As China rapidly became the wealthiest nation in the world, a huge gap developed between the minority rich and majority poor. Riding the momentum of progress, and in a Blitzkrieg-like move that took the world by surprise, China took a bold step and annexed Taiwan to advance their sovereign rights and secured the South China Sea once and for all.

Matrix Game 2: Major Power Rivalry in Northeast Asia in 50 years

In addition to the text in the 15-year scenario, the following text was included.

The population in China exploded because of economic growth. Cities stretched to the limits and can no longer support their populations. In search of more space and riding on the wave of imperialism, China annexed Mongolia and began a major infrastructure upgrade to their new state. The international community condemned the action, but only harsh verbal condemnation occurred in world media.

China’s move into Mongolia put Russia on high alert. Despite its weak economy, Russia implemented a large military response to signal China not to encroach further. Tensions are high as Russia seeks to keep an aggressive and wealthy China at bay.

Japan converted its Self Defense Force into an offensive three prong military force with Army, Navy and Air. With technological advancements, assistance from the US, and their new platform, Japan nuclearized and reclaimed the Kuril Islands. Already stretched to the limit on their border with China, Russia did not mount a military response, but resorted to extensive and debilitating cyber-attacks. Russia’s weakening hold in the region is clear to all. Japan and the US prepare for a Chinese border conflict. FSK warns China to respect their border and threatens fire and fury should they invade.
A large and well-resourced separatist movement emerged in China a decade later. At their core were those from Taiwan and Mongolia who initiated a civil war that has made China very unstable. All other nations view this as a significant opportunity...

Matrix Game 3: Climate and Environmental Change in Southeast Asia and the Pacific in 15 years

Over the past 15 years, the sea level has risen by a meter (3 ft). Weather events and flooding in most coastal cities are becoming increasingly destructive. Worsening climate conditions have driven mass migration and the cost of housing, food, and transportation are rising as resources become scarce.

China: While China maintains the largest economy in Asia, its economic growth slowed to 4.8% this year, which was blamed on rising energy prices and an aging workforce. The median age of Chinese nationals is now 44. Chinese companies and universities are globally recognized as innovators in new technologies. Their climate research has produced promising breakthroughs for cleaning the atmosphere, cutting down on greenhouse gas emissions, and restoring the ozone layer. However, China’s use of new technologies like automation and artificial intelligence have increased unemployment in all sectors of its economy.

US Global Corp: Corporations now wield unprecedented influence in international politics, with many holding assets equal to mid-sized countries. Five of the top 10 largest companies are in China. Business leaders use their vast wealth to influence policymakers through lobbying and coercion. The US Global Corp in the Indo-Pacific (USGCIP) is an industry representative for US corporate interests in the region. The organization sponsors development in Indonesia, the Philippines, and Papua New Guinea. US Global Corp competes with China for access and influence in the Indo-Pacific.

Papua New Guinea: Rising oil and gas prices have resulted in robust economic growth. While Australia remains a major player, China invests heavily in PNG and is the country’s largest purchaser of Liquid Natural Gas. China has many infrastructure projects in PNG, and it equips and trains local security to protect these interests. Many have expressed concern on PNG over reliance on oil and gas sales to China, which constitute 40% of the country’s GDP. PNG was recently accepted as a member of ASEAN. However, its relationship with the ASEAN Chair, Indonesia, remains rocky due to disagreements over West Papua.

Philippines: The Philippines is experiencing severe food shortages due to increased tropical storms, flooding, and the loss of agrarian land. Ocean acidification has reduced the Pacific Ocean’s fish supply, thereby raising the price of food. Manila often suffers from flooding and businesses have begun to leave. The Philippines benefits from having a young, capable, and multilingual workforce, and many US Corporations invest in the country. However, this
workforce often finds work abroad and sends remittances back home. In the face of climate change, the Philippines urgently needs outside economic support.

**Oceania:** With rising sea levels, many Pacific islands have become uninhabitable due to inundation and saltwater intrusion. New Zealand and Australia have stepped up to receive several waves of migrants, some legal and some illegal. Both countries would like Papua New Guinea to absorb a portion of those migrants. However, Papua New Guinea has been reluctant thus far. Based on their new collective identity as the final refuge of the Pacific, New Zealand and Australia have agreed to form together under a federated state called “Oceania.” Oceania is concerned about the rising influence of China in the region. However, it also blames transnational corporations for their role in driving climate change.

**Indonesia:** Indonesia has seen massive growth in both its economy and population. Jakarta in particular has grown rapidly, and with 38 million people, it is now the largest city in the World. Indonesia has positioned itself at the center of ASEAN and is this year’s ASEAN Chair. The country also regularly attends Pacific Island Forum meetings as an observer. However, increasing urbanization and pollution, along with a growing population, have reduced the available agrarian land in Indonesia. Lower yields in rice lead to frequent food shortages. In response, Indonesia has increased its economic presence in West Papua.

**Matrix Game 4: Climate and Environmental Change in Southeast Asia and the Pacific in 50 years**

In the past 50 years, the sea level has risen by 4 meters (12 ft). Shanghai, Jakarta, Manila, and Melbourne are now partially underwater. With rising temperatures, all coastal cities, including Port Moresby and Auckland have seen more frequent hurricanes and tropical storms.

**China:** Heavily affected by climate change, Yangtze and Yellow River flooding partly submerged many cities along their paths and Shanghai is underwater. Coastal city inundation has driven mass migration to inland cities like Chongqing and Chengdu. China faces severe economic and social problems due to low birth rate and an aging population. From 2049, China accepted regional climate refugees to bolster its dwindling workforce. Now, China’s cities suffer severe overcrowding from migrants and the internally displaced. Chinese elite continue to purchase land and resources in Australia and now own 50% of all Australian mines. Over 30 mil Chinese migrated to Australia, easily outnumbering the local population of 27 mil.

**US Global Corp:** Global corporations have grown greatly in size and influence in the past 50 years. The largest corporations are based in the United States and China. American corporations are predominantly privately held while China’s largest corporations are state-run. The US Global Corp in the Indo-Pacific (USGCIP) is an industry representative for US corporate interests in the region. The organization manages financial assets comparable to a highly developed nation. While their primary interest is in improving business conditions, they also
invest in the development and security of nation-states. USCGIP has invested heavily in the security and development of Indonesia and the Philippines.

**Papua New Guinea:** Benefiting from the rising price of oil, gas, and precious metals, and with substantial investment from China, PNG has gained the infrastructure to exploit many of its previously untapped natural resources. For example, China funded several seabed mines to extract minerals from the surrounding shallow seas. Large portions of PNG have been deforested to make room for Chinese-funded mines and towns. China has trained and equipped PNG’s military and police in anticipation of a conflict with Indonesia.

**Philippines:** Devastated by climate change, all coastal cities in the Philippines are partially or entirely submerged, while the rest have been ravaged by hurricanes. Frequent tropical storms, acid rain, and saltwater intrusion have ruined rice cultivation throughout the country. The Philippines now faces dire food shortages and its population has begun a mass migration to the United States, Australia, and China.

**Oceania:** Oceania hosts the world’s largest population of illegal migrants. Most Pacific Island nations are now uninhabitable, and their people have moved to Australia and New Zealand. Rising sea levels partly submerged New Zealand’s northern island and the large Australian coastal cities of Melbourne and Sydney. More extreme weather conditions cause severe drought and storms across Oceania. Overfishing and ocean acidification wiped out the Pacific fisheries. The entire Indo-Pacific region faces severe food shortages. At the same time, the majority Chinese population in Australia fundamentally reshaped the platforms of Australia’s political parties heavily in favor of pro-China policies.

**Indonesia:** Indonesia’s major coastal cities are inundated with water and the majority of Jakarta is now submerged. Rice production has declined dramatically due to rising sea levels, salt-water intrusion, and acid rain, leading to malnourishment across the country. Due to flooding in major cities, Indonesia moved a large portion of its population to new settlements in West Papua. These settlements are continually under attack from West Papua armed insurgency groups that appear to have external support. Indonesia’s military presence in West Papua has escalated tensions with Papua New Guinea that threaten to spiral into a border war.
Matrix Game Outcomes

The outcomes reported here are only the events that happened and not those that were attempted and failed due to stronger opposition arguments or dice rolls (Tables 6-13).

Table 2: Matrix Game 1: Group 1 – Major power rivalry in Northeast Asia in 15 years.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Successful actions</th>
</tr>
</thead>
</table>
| 1    | ● Trade agreements: PRC and Russia; Japan and Taiwan; Taiwan and Korea  
     | ● Russia builds agricultural capability in Korea |
| 2    | ● PRC purchases military technology and equipment from Russia  
     | ● Russia makes agreement with Korea to not use nukes on each other  
     | ● Japan and Korea host joint exercise in the Pacific  
     | ● Taiwan executes maritime exercise with US and Japan |
| 3    | ● Russia returns disputed territories to Japan  
     | ● Korea gives up nuclear weapons in exchange for US security umbrella  
     | ● Trade agreement between Japan and Korea  
     | ● Taiwan rebels against China and moves towards independence |
| 4    | ● US coalition will go to war to ensure Taiwan’s independence  
     | ● Trade agreement between Korea and PRC in return for HADR support  
     | ● Japan military coalition exercise with Korea, Japan and US near Chinese border  
     | ● Taiwan starts influence campaign in China to support independence |
| 5    | ● Trade agreement between US, Japan and Korea who all stop trade with Russia and China  
     | ● PRC deploys forces to Taiwan to reestablish Chinese sovereignty  
     | ● Russia deploys troops on Korea border  
     | ● Korea makes treaty with US and invites return of US troops to Korean peninsula  
     | ● Taiwan independence granted by UN, Japan, Korea and US |
Table 3: Matrix Game 1: Group 6 – Major power rivalry in Northeast Asia in 15 years.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Successful actions</th>
</tr>
</thead>
</table>
| 1    | ● China provides more aid and loans to Korea to make it more dependent on China  
      ● Japan succeeds in breaking apart China and Taiwan again  
      ● US deploys more troops to Japan |
| 2    | ● Japan builds alliance with Korea and Russia  
      ● Russia succeeds in getting all nations to sign a Kumbaya / World Peace agreement  
      ● US works with Japan to de-annex Taiwan from China  
      ● Taiwan implements economic reforms with help of US and Japan  
      ● Korea builds up military and nuclear power with Russian help |
| 3    | **Facilitator inject: Japan militarily takes over Dokdo Islands**  
      ● China establishes defense treaty with Korea  
      ● Japan calls on Taiwan and US to help defend the Dokdo Islands  
      ● Russia arbitrates peace between Korea and Japan  
      ● US takes control of South China Sea away from China  
      ● Taiwan – build up military strength with help from US  
      ● Korea regains full control of the islands through use of military force |
| 4    | **Facilitator inject: Russia attacks USN carrier in SCS and conducts cyber-attack against Japan’s power grid**  
      ● Japan restores electric power grid but Russian hackers remain in Japanese networks  
      ● Russia makes defense treaty with Taiwan  
      ● US conducts cyber surveillance against Russia  
      ● Taiwan and Korea sign a bilateral economic treaty |
| 5    | ● Japan establishes bilateral trade with Russia  
      ● A Russian citizen becomes UN Secretary General  
      ● US succeeds in a Motion to remove China from the UNSC  
      ● Korea reduces diplomatic ties with PRC |
### Table 4: Matrix Game 2: Group 4 – Major power rivalry in Northeast Asia in 50 years.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Successful actions</th>
</tr>
</thead>
</table>
| 1    | - China develops infrastructure in Mongolia and Taiwan to stabilize population growth  
      - Korea does joint-military exercise with Russia  
      - Taiwan signs alliance with Japan |
| 2    | - Japan signs trilateral trade and fishing agreement with Russia and Korea  
      - Round 1 secret move 10% chance: Chinese economic bubble bursts. Mongolia freed from Chinese control. Taiwan remains part of China however economic downturn causes instability in China as people continued to struggle to survive  
      - Russia joined Korea to support and legitimize the new China gov which was effective in stabilizing the country  
      - Taiwan supported the interim PRC gov in return for a free and independent Taiwan, but facilitator did not allow Taiwan to become free  
      - **Facilitator injects elections in China**  
      - China holds elections and becomes the Democratic Federation of China (DFC) |
| 3    | - Japan’s trilat boosts resource management and removes tensions over disputed areas  
      - Northern province of China Xinjiang separates from the DFC and becomes independent  
      - Taiwan takes independence with military aid of US and Japan and succeed with a high casualty rate on all sides |
| 4    | **Facilitator inject: Asteroid lands in North East Sea resulting in damage to the coastal China, Korea, Japan and Taiwan**  
      - Terror cells identified in Japan are confirmed as Chinese not Russian which improved Russian and worsened Chinese international relations  
      - US offers aid to China and relations grow stronger  
      - Korea managing the crisis internally officially refusing international aid but offers aid to China and Taiwan. China accepts aid and Korea resources become stretched |
| 5    | - China creates free trade zone known with Japan, Russia and Korea and regional economic growth accelerates  
      - Regional 6 party HADR security pact signed and all conduct regular non kinetic military exercises which helps to promote free trade  
      - Russia opens up to international development and regional GDP improves  
      - US increases investments in China and Taiwan which improves trade  
      - Korea discovers cheap renewable energy source and sells technology to China which develops nuclear fusion  
      - Secretariat of the 6 party talks moves to Taiwan with no significant impact |
Table 5: Matrix Game 2: Group 8 – Major power rivalry in Northeast Asia in 50 years.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Successful actions</th>
</tr>
</thead>
</table>
| 1    | ● Japan improves border security  
      ● Russia creates deterrents to military occupation  
      ● US Navy Strike Group moved to North Pacific  
      ● Taiwan overthrows Chinese puppet government |
| 2    | ● Air force base opened in Taiwan  
      ● Russia, Korea, US Japan conduct joint exercise in Sea of Japan  
      ● 5 Allies (excl. China) free trade agreement - military and economic ties are formalized |
| 3    | ● 5 Allies share intelligence information  
      ● Strike carrier group relocates off China coast  
      ● Russia signs security agreement with China |
| 4    | ● US trade embargo against Russia  
      ● Korea cuts economic ties with Russia  
      ● 4 remaining Allies support trade embargo with Russia |
| 5    | ● 4 Allies setup air defense systems in SCS and ECS  
      ● US and Taiwan remove trade embargo against Russia |

Table 6: Matrix Game 3: Group 3 – Climate and Environmental Change in Indo-Pacific in 15 years.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Successful actions</th>
</tr>
</thead>
</table>
| 1    | ● China exports new solar technology  
      ● US Gov gets US companies to reduce CO2 emissions  
      ● ADB and WB give loans to Philippines  
      ● US Corp agrees to invest in Oceania companies  
      ● Indonesia increases resource development in West Papua |
| 2    | ● PNG invites US Corp to invest in agriculture to diversify the economy  
      ● Philippines gets US Corp to invest in education and industry  
      ● Indonesia gets US Corp to invest in green energy and agriculture |
| 3    | **Facilitator inject: Economic crisis in China and US. Typhoon in Philippines and Indonesia**  
      ● China cancels solar deal and focuses on home business  
      ● PNG provides aid to Indonesia  
      ● Philippines requests aid from US and ASEAN for recovery/rescue operations  
      ● US to increase investment in Oceania’s fishery industry |
| 4    | **Facilitator inject: Unrest in US mining companies in PNG**  
      ● PNG accepts Pacific refugees |
| 5    | **Facilitator inject: US and Pacific environmental extremists hijack a Chinese fishing boat with casualties on all sides – demand the US-China deal on capping CO2 emission**  
      ● Indonesia negotiates as Chair of ASEAN with China and US and gets them to collaborate to seek release of hostages China works with US and Oceania on counter-terrorism and provides military assistance to Oceania nations  
      ● US Corp get US and China to lower CO2 emissions |
Table 7: Matrix Game 3: Group 7 – Climate and Environmental Change in Indo-Pacific in 15 years.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Successful actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PNG signs free labor movement agreement with ASEAN</td>
</tr>
<tr>
<td></td>
<td>Philippines-US oil/gas venture in disputed territory wildly successful</td>
</tr>
<tr>
<td></td>
<td>Oceania convinces transnational corporations to build floating islands in the Pacific</td>
</tr>
<tr>
<td></td>
<td>Indonesia reduces pollution with support from ASEAN and China and successfully influences the world to address climate change</td>
</tr>
<tr>
<td>2</td>
<td>Indonesia and USGC work on agricultural tech and modernize urban environments</td>
</tr>
<tr>
<td></td>
<td>Indonesia and China cooperate on mining and eco-friendly technology R&amp;D</td>
</tr>
<tr>
<td></td>
<td>US Corp agrees to provide 65% of support and utility services to artificial islands</td>
</tr>
<tr>
<td></td>
<td>China starts very successful mining operation in Chinese Spratly Islands</td>
</tr>
<tr>
<td></td>
<td>China and Indonesia joint infrastructure project in West Papua and China receives favorable mining rights</td>
</tr>
<tr>
<td></td>
<td>PNG hosts land/ naval military exercise with US, Japan, S. Korea, Philippines, Thailand</td>
</tr>
<tr>
<td></td>
<td>PIF raises the cost of fishing licenses</td>
</tr>
<tr>
<td>3</td>
<td>Joint China-US State and private exploration and exploitation of minerals in space</td>
</tr>
<tr>
<td></td>
<td>Indonesia agrees to a Chinese naval base in West Papua</td>
</tr>
<tr>
<td></td>
<td>China and Philippines agree to a tech cooperation agreement on pollution mitigation and sustainable farming technology in Manila</td>
</tr>
<tr>
<td></td>
<td>US Corp develops international airport in PNG</td>
</tr>
<tr>
<td></td>
<td>China develops international airport in PNG</td>
</tr>
<tr>
<td></td>
<td>Taiwan embraces One Country Two Systems, but insurgency remains active in mountains</td>
</tr>
<tr>
<td></td>
<td>PNG becomes a tourist hotspot and regional flight hub</td>
</tr>
<tr>
<td></td>
<td>Indonesia conducts separate joint naval exercises with both US and China</td>
</tr>
<tr>
<td>4</td>
<td>China takes over operation of US Corp aquaculture in China’s EEZ, using Chinese labor, ports and industry</td>
</tr>
<tr>
<td></td>
<td>Philippines takes over operation of US Corp aquaculture in Philippine’s EEZ, using Filipino labor, ports and industry</td>
</tr>
<tr>
<td></td>
<td>China assists Oceania with reinvigoration and protection of the Great Barrier Reef</td>
</tr>
<tr>
<td></td>
<td>China launches space station with global environment monitoring capabilities</td>
</tr>
<tr>
<td></td>
<td>China secretly monitors military movement, migration patterns, and fish stocks</td>
</tr>
<tr>
<td></td>
<td>US Corp sells 10 sixth generation fighters and training to Indonesia</td>
</tr>
<tr>
<td></td>
<td>Philippines votes to reopen US Military bases on Luzon</td>
</tr>
<tr>
<td></td>
<td>Oceania partners with US Corp to build fisheries, but US Corp takes 65%</td>
</tr>
<tr>
<td>5</td>
<td>China adopts US Corp technology capable of capturing carbon emissions</td>
</tr>
<tr>
<td></td>
<td>PNG purchases two squadrons (32) of sixth generation fighters from US Corp</td>
</tr>
<tr>
<td></td>
<td>Philippines shifts energy sector to renewables</td>
</tr>
<tr>
<td></td>
<td>PIF declares Oceania a nuclear weapon free zone</td>
</tr>
<tr>
<td></td>
<td>Indonesia pushes automation and AI in West Papua with US support</td>
</tr>
</tbody>
</table>
### Table 8: Matrix Game 4: Group 2 – Climate and Environmental Change in Indo-Pacific in 50 years.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Successful actions</th>
</tr>
</thead>
</table>
| 1    | ● 10,000 Chinese troops stationed in PNG  
      | ● PNG conducts very effective military training with Chinese operatives  
      | ● Oceania policy facilitates migration of refugees to central Australia and China |
| 2    | ● China establishes open migration policy with Australia  
      | ● Philippines invests in agriculture to assist Indonesia with food security  
      | ● Oceania receives 10 b in agriculture investment from China  
      | ● Indonesia signs rice import deal with Thailand with US Corp support |
| 3    | ● China removes its One-Child Policy to mitigate aging population  
      | ● China invests in PNG reforestation, but funds are diverted due to corruption  
      | ● Australian Navy successfully guards against illegal fishing and protects marine resources  
      | ● Indonesia enhances economic cooperation with US Corp – results in great increase in US investment in mining West Papua  
      | ● China improves domestic mood with more aged home facilities |
| 4    | ● US Corp buys PNG minerals to decrease tensions with Indonesia with marginal success  
      | ● Philippines enacts a free trade agreement with Indonesia and Oceania – lucky win  
      | ● Oceania makes Mandarin 2nd official language to improve integration |
| 5    | ● PNG clamps down on cross-border armaments to improve relationship with Indonesia and improve trade relations  
      | ● Attempts to promote peace and harmony largely unsuccessful  
      | ● Indonesia establishes new organization of friendly nations (FNO), headquartered in Indonesia for peace and harmony in the region (China, PNG, Oceania, US Corp, Philippines) – different from the UN because it is smaller, different from ASEAN because it is larger – successful and initiates a new era of cooperation in the region |
Table 9: Matrix Game 3: Group 5 – Climate and Environmental Change in Indo-Pacific in 50 years.

<table>
<thead>
<tr>
<th>Turn</th>
<th>Successful actions</th>
</tr>
</thead>
</table>
| 1    | ● China provides military support to PNG  
      | ● US Corp invests in Indonesia  
      | ● China overextension in the region causes tensions with Australia  
      | ● Philippines establishes educational and employment ties with Oceania and US Corp |
| 2    | ● Heightened internal tensions in Australia due to Chinese migrants  
      | ● China achieves internal stability  
      | ● Indonesia invests in and improves internal infrastructure  
      | ● Oceania is open for business while Philippines continues to sink economically |
| 3    | ● US Corp successfully invests in Australia/New Zealand factories  
      | ● China agrees to invest in Oceania and “New Tonga” |
| 4    | ● PNG successfully seeks int’l assistance to break Chinese influence  
      | ● Philippines received US Corp investment  
      | ● Controlled immigration increases to “Club Oceania”  
      | ● Indonesia signs political agreement to stabilize relations with PNG |
| 5    | ● On PNG Independence Day, the Chinese military are pushed out of the country  
      | ● Philippines invests in internal infrastructure  
      | ● Oceania invests in internal economic development |

Participant Takeaways

Following five rounds of gameplay, participants were given 45 minutes to reflect on lessons and takeaways from the game. The ensuing discussion brought out similar themes across all groups, including the value in multi-mindedness in evaluating complexity, difficulties in committing to collective action under imperfect information, identification of core values and interests in geopolitical negotiations and insights into possible levers of influence. Participants also provided facilitators with candid feedback for improving future iterations of the game.

Some participants lamented about their limited knowledge of some of the countries in the game. In this format, with eight games running simultaneously, it was not possible to provide additional subject matter experts to supplement knowledge deficits. However, this was not necessarily a problem because prior experience is not essential when people are asked to solve new problems (Salomon & Perkins 1989).

Faced with new situations, such as novel player moves, experts may fail to recognize when their expertise becomes irrelevant (Klein 1998).

Ultimately, participants observed that national interest takes priority and that military power is still a dominant factor on the international stage, regardless of economic status. The
game mechanics ensured that “every dog had its day” and that everyone experienced Murphy’s Law as their strategic planning continuously failed when exposed to the transparent decision-making environment.

**Perspective**

Most reflections on the games addressed issues with understanding other stakeholder perspectives. Participants noticed the presence of many different opinions that they related to different job positions or country positions and the influence of media. Some noted the value in hearing different perspectives on familiar issues and the utility of wearing different hats to examine a problem from different perspectives. Participants noted that the availability of multiple perspectives was effective in countering inaccurate assumptions that can result in ineffective decisions.

**Information and Relationships**

All decision makers have to sort through imperfect information that limits their capacity to make fully rational decisions. To mitigate this, the participants used various methods, such as disclosing confidential information, soliciting group feedback, and investigating the unknown. However, they found it very difficult to build trust and noted how hard it was to predict the actions of other actors. While they sought more clarity and completeness of information on the strengths and vulnerabilities of other actors, they realized that these only come with improved mutual understanding and stronger relationships. International negotiations are complex, and leaders have strong influence on meeting dynamics. Thus, having clear strategies and identifying shared and common interests were essential in improving national-level negotiations.

**Technology**

There was a clear relationship between highly ranked drivers and game moves (Tables 10-11). One notable exception, however, was technology, which was virtually absent in 50 year games. This category includes the myriad applications of technology within areas such as cyber, military and agriculture, while possible arguments might include investments in research and development (R&D), human capital, or technological interventions through the Internet of Things (IoT). The failure of technology to emerge as a powerful force in most games points to the difficulties in projecting long-term technological trends. Participants were significantly more active in leveraging technology within 15 year scenarios compared to their 50 year counterparts. Other limitations may have included a lack of participant familiarity with cyberwarfare options, suggesting that “the success of a global crisis wargame depends in no small measure on assembling in one place people with different talents and backgrounds to confront dynamic and complex issues” (Herman, Frost & Kurz 2009).
The pace of technological advancement presents crisis managers with one possible hurdle in foreseeing what the long-term future might hold.

**Table 10:** Top four categories of drivers in each foresight scenario.

<table>
<thead>
<tr>
<th>Threat Growth 15</th>
<th>Threat Growth 50</th>
<th>Threat Decline 15</th>
<th>Threat Decline 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Technology</td>
<td>Economic</td>
<td>Technology</td>
</tr>
<tr>
<td>Instability</td>
<td>Instability</td>
<td>Technology</td>
<td>Energy</td>
</tr>
<tr>
<td>Society</td>
<td>Governance</td>
<td>Governance</td>
<td>Law</td>
</tr>
<tr>
<td>Economics</td>
<td>Society</td>
<td>Int’l Relations</td>
<td>Governance</td>
</tr>
</tbody>
</table>

**Table 11:** Total numbers of Matrix game moves in each driver category by game scenario.

<table>
<thead>
<tr>
<th>Driver Category</th>
<th>Geopolitics 15y</th>
<th>Geopolitics 50y</th>
<th>Environment 15y</th>
<th>Environment 50y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>5</td>
<td>1</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>Stability</td>
<td>11</td>
<td>12</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Economics</td>
<td>9</td>
<td>12</td>
<td>22</td>
<td>16</td>
</tr>
<tr>
<td>Int’l Relations</td>
<td>15</td>
<td>13</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Society</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

**Economics**

Economics offered participants with a commonly leveraged tool in building relationships and opening new opportunities. Participants saw mutually beneficial trade as a driver of stability and prosperity, as well as a vehicle to access other domains.

Trade and investment deals were the most common moves within this category, followed by those aimed at promoting internal and external stability, such as the provision and expansion of government services. However, any agreement required adequate commitment and enforcement, otherwise it would fail due to subversion or corruption. Small states recognized their need to bandwagon to become significant economic players but required assistance to do this effectively. While more meetings and dialogues (negotiation time) helped to improve stability and decrease hostilities, they were also viewed as a source of future problems because improved relationships sometimes resulted in groupthink.

Within the environmental games, economic trade deals often lacked resilience or preparedness components. This suggests that decision makers, when confronting the existential topic of climate change, may choose to mitigate it by prioritizing improvements in their economy, which opens more options down the track.
Systems Thinking

A systems approach is a “management strategy that recognizes that disparate components must be viewed as interrelated components of a single system” (GWU-ICDRM 2009). Experts have long recommended systems thinking as a means for understanding slow and fast burning complex crises. For instance, the World Health Organization and the Institute of Medicine recommend a systems approach to strengthen health systems as a means to respond to incidents that exceed the normal capacity of existing health and medical services (de Savigny & Adam 2009, Hanfling et al 2012), and accrediting bodies for public health masters programs in the US list systems thinking as a core competency (ASPPH 2007).

Our training often encourages us to solve problems in a reductionist manner by breaking them up into convenient pieces. Other approaches to coping with complexity include: a) improving awareness of known and unknown information; b) broadening analysis and expanding options; c) preparing for categories of threats rather than individual threats; d) narrowing the focus by discarding irrelevant information; e) identification of driving forces; and f) framing by entity and interest and through messaging (Canyon 2018). However, if an initial attempt to understand a whole system is absent, reductionist approaches are dangerous because complex challenges involve many branches of knowledge and interrelationships that require a systems approach. Awareness of the components of a system does not equate to understanding the whole system. Far more important are the relationships between these components and how they react to each other.

Knowledge of five different types of inquiry models can assist in the appropriate implementation of systems thinking (Canyon 2013):

1. Consensual (Glass 1965): Inputs are processed by a group of experts who all agree on a single answer – suitable for simple, well-bounded and well-structured problems (Mitroff & Linstone 1993)

2. Analysis (Hume 1975): Inputs are processed using an agreed upon formula and a single numerical answer results – suitable for simple, well-bounded and well-structured problems or pieces of problems for which single numbers can serve as answers

3. Multiple Realities (Churchman 1971): The analysis of many models and observations will shed the best light on an issue because more angles will be covered – suitable for analyzing complex problems but assumes that each reality is unbiased (Churchman 1968).

4. Conflict (Mason & Mitroff 1981): Contrasts opposing expert views assuming that stronger arguments and truth will emerge from the resulting conflict – suitable for
complex problems since it challenges faulty assumptions, however, simplistic since each presenter does not have equal arguing capacity.

5. Multiple Perspectives (Mitroff & Linstone 1993): Inputs are complex ‘messes’ and everyone is biased so problems must be viewed from a variety of perspectives, such as expert, epistemic, ethical, aesthetic and even spiritual – suitable for highly unstructured, unbounded, complex problems.

Upscaling from simple Consensus or Analysis models, that are based on a single truth, to a more complex model, that incorporates many truths cannot be done because belief in a single truth cannot be upscaled. A sound systems approach begins with Multiple Perspectives and downsizes when warranted. Using the right inquiry model is essential for systems thinking and can provide good insights. Whereas the use of simplistic inquiry models can result in incorrect problem formulation and bad decisions.

Modern versions of Matrix games are discovery games in the sense that they create, rather than share, knowledge, and they work on ill-defined complex problems (Bartels 2018). As Curry and Price noted, they employ Hegel’s thesis vs. antithesis approach as represented by the Conflict inquiry model in that players provide arguments and counter arguments and the strongest arguments result in decisions and actions (Curry & Price 2014). However, if the players represent a group of similar experts, the Consensual inquiry model is also in play and the outcomes will be less reliable. Ideally, the players are representative of the Multiple Realities or even the Multiple Perspectives inquiry models. When players have the background and capacity to take into account multiple disciplines and intangibles such as culture, beliefs and perceptions, the outcomes become more reliable and valid.

Conclusions

The case laid out in this paper demonstrates the utility and limitations of a comprehensive foresight exercise. Participants used systems thinking, strategic foresight and wargaming to simulate and explore the politics of dealing with plausible future events in a complex environment. Through this participatory process, participants developed transdisciplinary visions and scenarios that showed them how to achieve the future they preferred or avoid the future that they did not (Inayatullah 2008). The limited guidelines and ruleset offered participants the freedom to innovate and generate a broad variety of initiatives and responses.

This methodology also revealed several limitations and obstacles in the foresight process. While participants gained practical insights into technological drivers at the 15 year mark, they showed difficulty in extrapolating those trends to a 50 year future. Within seminar discussions, participants readily expressed the importance of technology in managing long-term crises and speculated on what that technology might look like. However, when faced with a 50 year scenario, participants were unable to apply technological levers in advancing their interests.
Additional elements in this methodology could aid participants in developing possible use cases for new technologies, either before or after the Matrix game.

The same could arguably be said for economic moves, which relied heavily on models of economic engagement used by national-level actors today. Participants understood the importance of economic levers in advancing their interests and expanding their capacity to confront future challenges. Additionally, participants gained an appreciation for how asymmetric power dynamics affected, and often undermined, stable and mutually beneficial economic relations. However, few meaningful insights were gained into new applications of economic principles.

By contrast, participants gained several useful insights into relationship building and power dynamics. This was particularly true in the 50 year scenarios where the scenario explicitly altered the geographical characteristics of many nation states. While cognizant of the cultural and historical contexts of each actor, participants became unconstrained by the biases of geography. Within the environmental game in particular, participants were forced to deal with the real consequences of rising sea levels that radically redefined national identities through the physical displacement of peoples. In response, participants imagined new forms of cross-national organization to compete or cooperate in resolving transnational problems.

The benefits of foresight gaming extend far beyond engaging course and workshop participants or delivering custom learning outcomes. They are a proven method for amplifying “plurality, diversity and multiple perspectives, which are essential for understanding and steering through post normal conditions” (Sardar 2015). Futurists find utility in games and simulations because they “embody some of the core tenets and long-standing practices of futures: systemic, yet playful, inquiry; engaged and collaborative curiosity; and anticipatory action learning through experiential approaches” (Sweeney 2015).

While they have their limitations and are not an exact replica of reality, situational, role-playing games foster the application of creative and innovative thinking on challenges that cannot be analyzed using conventional statistical methods and provide the opportunity to investigate possible reactions. Before embarking on a potentially precarious course of action, it is useful to have insight into potential command and control issues, as well as actions that may escalate or de-escalate tensions and hostilities. Leaders need methods that not only provide systems-level knowledge, but which actively challenge assumptions, positions, expectations, perceptions, facts and procedures to improve decision making in multidisciplinary, interagency and complex settings.
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Wargaming the Future: Developing Scenarios and Galvanizing Support

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Abstract

Two principal actions need to occur to wargame the future. First and foremost, some semblance of plausible futures needs to be identified. Secondly, the wargame has to be designed around those plausible futures; more importantly, people need to interact under the context of those plausible scenarios within the context and stage that wargaming creates. Wargames serve as a stage for human interaction at four levels: before the conduct of the wargame as it is being designed; just prior to the wargame as people become acclimated to the game; during the game as moves and decisions are made; and finally after the game as people carry forward the experience and knowledge they gained during the game. When wargames are used for futuring the last level of human interaction may very well be the most important simply because the results from the game will only be seen many years in the future. People carry this knowledge forward; therefore, the people interacting must be carefully selected to reap the full benefit of the game. In addition, futuring cannot be accomplished simply with one single game or scenario, rather a series of games must be designed and conducted to sort through the ambiguity and complexity that the future presents. Conducting a series of games also enable interdisciplinary groups of people to engage, increasing the chances that some of the knowledge generated from the wargame will actually stick.

This paper discusses wargaming the future by describing futuring and an approach to generate future scenarios, as well as providing insights to factoring human interaction into the design and conduct of the wargame.

Generating Future Scenarios for Wargaming

Any discussion on “Wargaming the Future” needs to start with the concept of futuring, in general. Recognize that forecasting and futuring are two different approaches for dealing with the future. Forecasting focuses on prediction in terms of a probabilistic space and using an assortment of analytical tools, e.g., simulation, modeling, Monte Carlo analysis, Bayesian conditional probability theory, Kalman filtering, etc. These forecasting tools work best for predictions with relatively short time horizons because variance grows with time. On the other hand, futuring techniques do not attempt to predict the future; futuring techniques work to distill plausible outcomes rather than probabilistic ones. These techniques work to a longer time horizon characterized by ambiguity and complexity. The lack of structure rules out the use of simulation and modeling tools. Similarly, futuring techniques cannot determine structure. However, futuring can reveal trends, opportunities, challenges and desirable outcomes worthy
of investment of resources. Some people maintain that these investments contribute to the realization of future outcomes, making futuring a self-fulfilling prophesy. In fact, our motto at the Chief of Naval Operations Strategic Studies Group (CNO SSG) was *Generare Futurum.*

Ironically, although futuring techniques address unstructured problems and cannot determine structure, people have structured techniques that lead toward the generation of plausible outcomes. Dr. Richard Lum (Lum 2016) discussed his approach at the *Alternate Futures Study Workshop* held at the Naval War College. He consulted numerous organizations on futuring and holds a Ph.D. in political science from the futures studies program at the University of Hawai‘i. Dr. Lum advocates *4 Steps to the Future*:

1. Past
2. Present
3. Futures
4. Aspirations

The first step concerning the past, confronts the three essential approaches to history that include relative positivism, narratives and anti-narratives. Relative positivism seeks to establish cause and effect relationships, i.e., causality, by attempting to outline structure. However, we can never know all the facts or relate to them from the context of the time. The narrative approach to history seeks to weave reason, literary skill, politics, real life and moral awareness to build a bridge to the past and to the underlying story. The narrative approach seeks to translate knowing into telling without simply recounting events.

Far from being a problem, then, narrative might well be considered a solution to the problem of fashioning human experience into a form assumable to structures of meaning that are generally human rather than culture-specific (White 1987, 1).

The anti-narrative approach views societies as a complex living organism without addressing causality or the narrative (Hoffer 2008, 181). The anti-narrative just presents the facts without any presumptions of causality or extraction of meaning from narratives. Unfortunately, the anti-narrative approach leaves little to carry forward for future generations.

Nevertheless, the past is important for a number of reasons. For one thing, the past gives us a sense of the plausible and what could happen simply because it did in fact happen, albeit within a different context. We may not be able to prove causality from deductive reasoning, but inductive reasoning, i.e., preponderance of evidence, bolsters plausibility.

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1 The author served as the ONR Science Advisor to the CNO SSG from August 2001 to August 2003 under ADM (ret) James Hogg.

2 At the request of NAVSEA 08 NR, Dr. Will Bundy, Director of the Gravely Group at the Naval War College, conducted an Alternate Futures Study in collaboration with the Naval Undersea Warfare Center from 29-31 August 2017.
Developing a better understanding of the past doesn’t tell us what will happen in the future, but it does give us an appreciation for the patterns that recur, the cycles that might be at work, and the roles that chance and randomness have played in creating our present (Lum 2016, 9).

In addition, a look at the past helps us determine what meaningful parts of the past we wish to carry forward, i.e., traditions, culture and ethics. A look back at the past helps us shape the platform we can build upon.

The second step concerns the present. In this step, we build a foundation with the relevant drivers from the past and the platform that we built. We add the signals for change we think we are detecting, along with any challenges that might slow down or prevent change, to the foundation (Lum 2016, 17). Quantifiable data from the past and/or present validate strong signals as trends. Emerging issues present themselves as weak signals often from fringe thinkers. Whether these issues ever develop the critical mass to reach a tipping point often becomes a question of faith. Other factors in the present that can potentially shape the future entail new technologies, concepts and policies. Moreover, the combinatorial effects that can arise from all these factors make the assessment of the present more challenging.

Lum states that the third step takes the building blocks from the first two to construct plausible alternative futures. The emphasis here is on the word plausible. We can build the first two steps from data by reading history and talking to subject matter experts working in different fields today; however, constructing plausible alternative futures requires more thought. Lum recommends developing scenarios in terms of continuity, perceived incremental change and potential abrupt change. We can evaluate these scenarios in terms of critical uncertainties.

Peter Schwartz proposes an alternative approach to developing scenarios, i.e., the Lum’s step 3 for the future, by starting with the identification of a focal issue for a decision. Schwartz’ provides a more pragmatic approach that help to reduce the myriad of possible scenarios that people can easily generate, many of which will not be plausible or relevant. His approach to scenario development incorporates 8 activities (Schwartz 1991, 241):

1. Identify a focal issue for a decision
2. List key forces in the local environment
3. Determine the driving forces in the macro environment
4. Rank the key and driving forces to determine which are most important and uncertain
5. Select scenario logic whose difference is relevant to decision makers
6. Flesh out the scenarios by weaving the key and driving forces into a narrative
7. Assess the scenarios in terms of the focal issue to down select and shape robust ones
8. Identify a few leading indicators to monitor in an ongoing way
The advantage of Schwartz’ approach derives from the ability to identify several key dimensions that can exercise the plausible scenarios for the future. In this manner, the futuring process emphasizes an analysis of the principal forces, rather than the actual scenarios themselves.

For example, the nature of the design of a future naval platform may be the focal issue to address in a futuring event. After going through the 8 activities prescribed by Schwartz the three key driving forces were determined to be whether the industrial base is primarily commercial or national; operations will be conducted by humans or autonomous systems; and if the competition will be primarily military or across the national spectrum of DIMEFIL (diplomatic, information, military, economic, financial, intelligence or legal). Figure 1 provides the type of information that might fall out from the activities prescribed by Schwartz.

![Figure 1. Generic Strategic Context for a Future Naval Platform](chart)

The cube in figure 1 portray the dimensions of the problem, not necessarily a particular scenario; however, plausible futures for a naval platform, or fleet of naval platforms, can be derived from the illustration. For example, one country could select the path of building platforms based on national infrastructure, for purely military purposes and with humans operating the systems. This approach might be termed an “Armada.” That future would exist in the top-left-font part of the cube. Similarly, another country may decide to build naval platforms to with commercial systems, for operations across the broad range of the DIMEFIL using fully autonomous unmanned systems. This approach might be termed an “Insurgency.” This future would exist bottom-right-back part of the cube. The competition that emerges from these selections may never occur, but does enable people to exercise the thought process behind the dimensions of the industrial base, geopolitics and human interaction relatively quickly and easily.
Whether Lum’s approach or Schwartz’s approach is used for step 3 dealing with the future, we can return to Lum’s step 4 for aspirations. After choosing alternative scenarios, e.g., from the cube, they can be prioritized in terms of plausibility and relevance. The scenarios that bubble to the top serve as aspirational ones for further analysis in terms of strategic planning and developing a vision to pursue. Lum notes that the greater and more positive the effect on the broader community the better the chance of inspiring people to pursue it and galvanizing support.

**Gaming the Scenarios**

A single wargame alone cannot distill plausible futures. A campaign or series of wargames can accomplish this goal. Moreover, wargames provide a venue to support all four of Lum’s steps to futuring. The initial wargame design process can incorporate lessons learned or scenarios from history, as well as from previous wargames. Similarly, the wargame design phase integrates trends and drivers. Wargames can evaluate weak signals from the present to assess potential impact or relevance from a qualitative perspective. Irrelevant weak signals can be eliminated from future discussions. The first two steps can be accommodated by focusing on the design of a single wargame; however, step 3 requires a significant level of interaction to plausible futures. A campaign or series of wargames can accomplish the futuring step in Lum’s approach. Moreover, wargames can serve a powerful role in the 4th aspirational step described by Lum.

The reason why wargames can support Lum’s 4 steps is because human interaction takes place at four levels in wargames: before the conduct of the wargame as it information is gathered and people are consulted to prepare for the design of the wargame; just prior to the wargame as people become acclimated to the game; during the game as moves and decisions are made, plausible futures are uncovered and inconceivable futures are discarded; and finally after the game as people carry forward the experience and knowledge they gained during the game (Choinski 2017, 319).

Engagement with subject matter experts and history serve as a primary mechanism for the first step in futuring, i.e., engage the past. For example, after the Washington Treaty of 1922 the Naval War College began to conduct a series of wargames with different colors depicting different nation states, e.g., blue for the U.S., red for the U.K., orange for Japan, etc. These and other historical wargames can assist in game design, as well. The world’s geography changes over very long periods. Many of the geographical locations are revisited in wargames under a different context. Sometimes the historical contexts can be very similar, as well. In fact, the Naval War College replayed similar games repeatedly after WWI and leading up to WWII. During the 1990’s the Office of Naval Research collaborated with the Naval War College to conduct a series of wargames referred to as the Technology Initiatives Games (TIG). The
scenarios and results from many of these games are readily available through the archives at the Naval War College and are relevant today.³

Wargaming serves Lum’s 2nd step for futuring by providing a reason and venue to collect information about the present. An example from the past entails CAPT Hinds lecture on the knowledge he gained about the geo-political situation in the Pacific, specifically Japan, based on the knowledge he gained while serving as acting governor of Guam from September 23, 1913 to March 28, 1914. In addition, Prof. Reginald Fessenden, Submarine Signal Company, gave a lecture to student officers at the Naval War College on submarine signal receiving (the reference to today’s sonar systems) practice (Choinski 2017, 329, 383). CAPT Tompkins also visited the Naval War College to provide students and faculty with a lecture on Submarine Signaling in Peace and War (Tompkins 1924). Subject matter experts and reference material on present drivers and trends serve to inform wargame design.

Lum’s 3rd step for developing plausible futures starts by conducting a dimensional analysis using techniques such as those articulated by Peter Schwartz. Given the identification of prioritized trends, drivers and weak signals, the actual wargames can be conducted. Peter Schwartz’s approach, resulting in the dimensional analysis depicted by the cube in figure 1, can be used to select the context and scenarios for a campaign or series of games to distill plausible futures.

Dramaturgical theory argues that people are motivated to take action based on meaningful situational interaction. Wargames can be characterized through dramaturgical theories of action. Given dramaturgical theory, games are predominantly conducted based on what is taking place (act); in a given environment or situation in which the act is taking place (scene); using people acting in defined roles (agent); with tools, technologies, technologies, instruments and/or means at their disposal (agency); and for a specified reason (purpose) (Choinski 2017, 209). The chart in Table 1 serves as a framework to generate wargame context for the campaign of wargames by taking the dimensional analysis represented in the cube in figure 1 and correlating it with the five areas of dramaturgical action.

An example of the context for one wargame in a campaign series of wargames to distill the plausible futures might look like the information in Table 2. The context is extrapolated from the convoy escort scenario from the 1924 wargame with red using current commercial technology (Choinski 2017, 301-305).

The paper does not address the process of actual detailed wargame design. Other highly experienced authors in this working group are much better suited to engage in that conversation. However, it is worth emphasizing the need for incorporating an approach for extensive data collection and analysis, preferably integrated into a final narrative form. Here

³ The author accessed the list of these wargames through Record Group 5 on November 9, 2016.
again lessons learned from history provide insight. The author of this white paper conducted research from wargames conducted from 1919-1924. Tactical Problem IX (TAC. 49 Mod 1) contained participant commentary in the final report (Naval War College 1920). This information proved to be quite valuable for any post wargame analysis. Two other wargames provide less post wargame information for review: Tactical Problem IV (Tac. 85) and Tactical Problem III (Tac. 93 Mod 1) (Naval War College 1922 & 1923). The sparse information in the report made any post wargame analysis more problematic. On the other hand, CAPT Harris Lanning provided an extensive narrative based report with observations and commentary in Tactical Problem III (Tac. 96) (Naval War College 1924). This type of data collection, analysis and narrative generation was a high mark for wargame reporting during that period. CAPT Harris’ would go on to become President of the Naval War College during his career. For this reason, wargames for futuring should include a well-developed plan for data collection, analysis and narrative generation. This plan includes subject matter experts capable of distilling the important and relevant information.

When wargames are used for futuring, the last level of human interaction may very well be the most important, especially in terms of Lum’s aspirational step 4, simply because the results from the game will only come to fruition many years in the future. People carry this knowledge and decisions forward; therefore, the people interacting must be carefully selected to reap the full benefit of the game depending on the time horizon of interest. In addition, futuring cannot be accomplished simply with one single game or scenario, rather a series of games must be designed and conducted to sort through the ambiguity and complexity that the future presents. Conducting a series of games also enable interdisciplinary groups of people to engage, increasing the chances that some of the knowledge generated from the wargame will actually stick. Conducting a campaign or series of games is not only important to distill plausible futures, but also to develop a cadre of people to carry these ideas forward in the future. Again, the Naval War College graduating class of 1924 serves as a high mark because it included notable figures such as ADM Stark, who was the Chief of Naval Operations at the beginning of WWII, and ADM Nimitz, who became a Fleet Admiral in the Pacific during WWII. All in the graduating classes of 1919, 1922, 1923 and 1924 produced 37 officers who were still on active duty during WWII; nineteen of these held flag rank by 1941 (Choinski 2017, 391-392).
<table>
<thead>
<tr>
<th>Category</th>
<th>Blue</th>
<th>Act</th>
<th>Scene</th>
<th>Agent</th>
<th>Agency</th>
<th>Purpose (Mission)</th>
<th>Red</th>
<th>Act</th>
<th>Scene</th>
<th>Agent</th>
<th>Agency</th>
<th>Purpose</th>
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<tr>
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<td>National-Commercial</td>
<td>Siargao Sea</td>
<td>Military Organization</td>
<td>Battle Fleet</td>
<td>Convoy Escort</td>
<td>Commercial Acquisition</td>
<td>Disrupt Siargao Sea</td>
<td>Military/Civilian Mix</td>
<td>Fleet/Squadron of UxVs</td>
<td>Mission Kill</td>
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<tr>
<td>Human Interaction</td>
<td>Human-Fully Autonomous</td>
<td>Siargao Sea</td>
<td>Military Organization</td>
<td>Battle Fleet</td>
<td>Convoy Escort</td>
<td>Fully Autonomous</td>
<td>Disrupt Siargao Sea</td>
<td>Military/Civilian Mix</td>
<td>Fleet/Squadron of UxVs</td>
<td>Mission Kill</td>
<td></td>
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</tbody>
</table>

Table 1. Wargame Contextual Development

<table>
<thead>
<tr>
<th>Category</th>
<th>Blue</th>
<th>Act</th>
<th>Scene</th>
<th>Agent</th>
<th>Agency</th>
<th>Purpose (Mission)</th>
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<th>Purpose</th>
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<td>Military Organization</td>
<td>Battle Fleet</td>
<td>Convoy Escort</td>
<td>Commercial Acquisition</td>
<td>Disrupt Siargao Sea</td>
<td>Military/Civilian Mix</td>
<td>Fleet/Squadron of UxVs</td>
<td>Mission Kill</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Context for Wargame #1 in the Campaign Series
Summary

Two principal actions comprise wargaming the future. First plausible futures must be identified within a framework of a campaign series of wargames. Second, people need to interact in wargames within the context of those plausible scenarios. Dr. Richard Lum identified four steps for futuring that include the past, present, futures and aspirations. Wargames can serve each of these steps through the levels of human interaction that occur during the games.

A combination of approaches from Dr. Lum’s 4 step approach and Peter Schwartz’s “Art of the Long View” was presented in this paper to conduct a dimensional analysis to identify and prioritize key drivers, trends and signals. The dimensional analysis was combined with a dramaturgical description the encompasses the act, scene, agent, agency and purpose to develop a way to generate scenarios for a campaign series of wargames. Plausible scenarios can only be generated through a campaign series of wargames; single wargames do not lead to the development of plausible futures. The data collection, analysis, and narrative generation prove to be essential parts of wargame design and execution.

Wargames serve as a stage for human interaction at four levels: before the conduct of the wargame as it is being designed; just prior to the wargame as people become acclimated to the game; during the game as moves and decisions are made; and finally after the game as people carry forward the experience and knowledge they gained during the game. When wargames are used for futuring the last level of human interaction may very well be the most important simply because the results from the game will only be seen many years in the future in terms of Lum’s aspirational step 4. People carry this knowledge forward; therefore, the people interacting must be carefully selected to reap the full benefit of the game. In addition, futuring cannot be accomplished simply with one single game or scenario, rather a series of games must be designed and conducted to sort through the ambiguity and complexity that the future presents. Conducting a series of games also enable interdisciplinary groups of people to engage, increasing the chances that some of the knowledge generated from the wargame will actually stick.

This paper discusses wargaming the future by describing futuring and an approach to generate future scenarios, as well as providing insights to factoring human interaction into the design and conduct of the wargame.

References


Naval War College 1920. Naval War College Archives, Record Group 4, Box 5, File 4.

Naval War College 1922. Naval War College Archives Record Group 4, Box 14, File 4.

Naval War College 1923. Naval War College Archives, Record Group 4, Box 19, Folder 7.

Naval War College 1924. Naval War College Archives, Record Group 4, Box 23, Folder 9.


About the Author

Dr. Choinski has over 40 years of experience encompassing management, professional engineering and science & technology culminating in the conception of an interdisciplinary approach to technological innovation. Tom is currently the Deputy Director for Undersea Warfare at NUWC Headquarters (1176 Howell Street, Newport, Rhode Island 02841), stood up the Emergent and Transformational Systems Division (Dolphin Works), served as Science Advisor to the CNO’s Strategic Studies Group (SSG) and held other leadership positions. He conceived a course in innovation strategies and has published/presented more than 70 papers though professional journals, conferences and academic institutions. Prior to NUWC, he held senior engineering positions in industry and served as an adjunct professor at the New York Institute of Technology. Dr. Choinski earned his Ph.D. defending a dissertation entitled Dramaturgy, Wargaming and Technological Innovation in the United States Navy: Four Historical Case Studies, in addition to completing an MBA, engineering degrees and an MIT Seminar XXI fellowship in Foreign Politics, International Relations and the National Interest. He received a Meritorious Civilian Service Award for his contributions to the CNO’s SSG. The National Society of Professional Engineers selected him as one of the Top Ten Federal Engineers of the Year in 2008. He may be contacted at Thomas.Choinski@navy.mil.

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Break the Forecasting Horizon by Values Gaming

© Stephen Downes-Martin, PhD
Research Fellow US Naval War College

Abstract

Many of our most expensive platforms and weapon systems acquisitions have service lives of about half a century, forcing us onto a high-inertia security trajectory that is transparent to our more agile adversaries who can then plan around that trajectory with cheaper systems based on our research and development expenditures. We must wargame out to service life to ensure our major systems and concepts of operations are well designed for both the near term and the far future. A 50 year forecasting horizon is beyond the credibility limit for wargaming. So instead of attempting to create 50 year scenarios based on what technology or geopolitical changes might occur and then reactively wargaming in those future scenarios, I propose that we define the future we want to be a favorable world order consistent with our values. We then annually game from the current year out 50 years to explore what capabilities we need to ensure we maintain that world order. These desired capabilities can then be used to inform the upgrades and enhancements to our power projection and warfighting military platforms and their concepts of operation. This paper describes the process for values gaming as an approach for breaking the forecasting horizon barrier for national security objectives.

Why Wargame 50 plus years?

Some of our national security related acquisitions in response to current and near future threats are technologically advanced and hugely expensive. The first gives us a temporary and possibly short lived warfighting edge, the latter locks us into high expenses in maintenance and upgrades for many years in order to justify the initial sunk costs. They commit us to a high inertia security trajectory from which it is extraordinarily difficult to diverge for both political (jobs for building large platforms) and economic (sunk costs mistaken as investments) reasons (Seligman 2019). Our high inertia security trajectory provides our adversaries with credible information about that trajectory while giving them time to adapt with cheaper counter forces, technologies and strategies.4

4 “There appears to be a cultural disposition to double down on previous expenditures of blood and treasure rather than cut losses and walk away.” Comment by Robert Mosher on April 1, 2019.
“Is this disposition cultural or a cognitive bias valid for all cultures? Is it more prevalent in democracies than dictatorships? And by culture do we mean true of our nation and political system or embedded in the various military communities to different degrees? Including the sunk cost error on one side in a wargame versus an opponent who is willing to cut losses might be an interesting game.” Response by Stephen Downes-Martin April 4, 2019.
Three good examples of this dilemma are the Navy Ford Class Aircraft Carrier Program each at $13B with a near 50 year commissioned life (CRS 2019), the $1.5T F-35 program with its 55 year lifespan (GAO 2017, Zazulia 2018) and the $122B Columbia SSBN program with a service life for each in excess of 40 years (CRS 2018). The three step “Big A” process of requirements, budgeting and developing and buying adds one or more decades to the lifespan (CRS 2014, page 3). Replacing major systems with modern versions adds around an additional 20 years for the “Big A” acquisition process, leading to a need to plan and wargame out 70 years.

Once we have paid the sunk cost of acquisition we are politically and economically committed to a half-century of costs along with power projection and warfighting methods that are now publicly available to our adversaries. We must assume our adversaries will counter our initial technology advantages by closing the gap via investment (Dyer 2016) and exploiting the commercial and academic proliferation of rapidly advancing and cheap dual use technologies (Kaspersen 2015, 2016). They will continue to counter our military power superiority by fighting against our weaknesses in the non-military domain such as information, social disruption and cyber, and possibly by reverting to a modern post cold war version of proxy wars (Byman 2018) such as in Syria (Shapiro 2014) and Russia’s use of Hybrid warfare (GAO 2010) in Ukraine.

We can and will use technology advances to upgrade the onboard capabilities of our platforms. However each platform is massively expensive and in the case of an aircraft carrier the question we face is how many can we lose in a major war before continuing the war becomes politically if not militarily impossible? Our adversaries understand this question and will be working on cheaper technologically advanced ways to kill our platforms and on ever more sophisticated methods to disrupt critical elements of our social center(s) of gravity (such as the legitimacy of our democratic elections and popular support for our democratic freedoms) in the decades ahead to exploit these kills. They have what in business and game theory is called a “second mover advantage” (Dixit 2015, pages 62 & 188-190) in which they can exploit the technologies we have paid to research and develop and plan how to respond to our high-inertia security trajectory.

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5 The most recently decommissioned US Aircraft Carrier, the USS Enterprise (CVN-65), had a service life of over 55 years. CVN-78 (USS Gerald R. Ford) has an estimated acquisition cost of approximately $13B not including the support ships, aircraft, sailors and capital costs for shipyards and construction. The daily operating cost is approximately $2.5M. Follow on acquisitions will be cheaper thus introducing a pressure to buy more.

6 “Recognizing that the large platforms will be around decades, the challenge is in changing the payloads at a rate consistent with security challenges and technological opportunities; hopefully in years. Sometimes this means changing the principal mission of the platform. I question the efficacy of gaming to drive designs for the distant future.” Comment by John Hanley May 29, 2019.

“We should be thinking out 70 years as far as mission and capabilities of the platforms, where capability of platform is instantiated by what the platform carries on-board (weapons, drones, sensors, software, etc.). Trouble is the initial investment in the platform and its initial capabilities is huge, and the platform is around for 50 years plus.” Response by Stephen Downes-Martin June 16, 2019.
The rate of technology advance means the time period that our forces remain technologically dominant has shrunk to less than the lifetime of our warfighting platforms, and the same technologies place our adversaries on a level playing field with us on the both military and non-military domains. It would be foolish to believe our adversaries are not thinking decades ahead about how to exploit our high-inertia security trajectory. Having committed ourselves to a 50 year trajectory we must therefore also think ahead, plan and wargame over the entire far future trajectory of 50 years and more.

The Forecasting Horizon

Attempts to forecast or wargame the far future face three major obstacles;

1. the sheer proliferation of possible futures along with the proliferation of relevant variables with the consequence that any single future has an ever dropping likelihood the farther out one looks,\(^7\)
2. the difficulty of taking discontinuous or black swan changes and their effect on society into account (Taleb 2016), and
3. the human inability to analyse the interacting effects of even small numbers of variables and their feedback loops (Dorner 1989).

These difficulties lead to the forecasting horizon (Tetlock 2015 page 244), which for the purposes of this document I define not as “how far does the forecast claim to look” or “the time period of the forecast project”, but rather “how far the forecast can credibly look”. Futurists have developed a range of excellent tools for dealing with these problems and generating categories of future scenarios within credible forecast horizons, across which plans are made with the intention being that these plans are robust across the categories (Schwartz 1991, Tetlock 2005, Chermack 2011, Tetlock 2015, Aguilar-Millan 2019). Once this has been achieved one can then plan for these futures and wargame within them.

Unfortunately many of the organizations involved with national security have built in forecast horizons driven by bureaucratic requirements (primarily the budgetary cycle) rather than the context and objectives of the forecast and the credibility of the techniques used:

- US Government Accountability Office: “five or more years” (GAO 2018)
- US Joint Chiefs of Staff: 20 years (JCS 2016).
- US Marine Corps: 15 to 30 years (USMC 2016).
- UK MoD: 20 years (UKMOD 2015) and 32 years (UKMOD 2018)

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\(^7\) John Hanley has written extensively about the challenges of dealing with the proliferation of future states, and had categorized the classes of indeterminacy in very useful ways (Hanley 1991 pp 8-19, 2017, 2019).
Commercial organizations seem to have more nuanced approaches that are project or objectives based. See for example Shell Scenarios projects ranging from 5 year to 70 year forecast horizons (Shell).

The problem of wargaming 50 years into the future is one of credibility. A 50 year forecast horizon is reasonably considered not to be a credible horizon when compared to the number of variables of interest and rate at which they change. What important social, political and technological aspects of the worlds of 1920, 1970 or 2020 would a forecaster in 1870, 1920 or 1970 miss? Christopher Cerf and Victor Navasky provide a compendium of appallingly predictions by experts (Cerf 1984). No doubt one could find a forecast from 1970 that predicted something that could be interpreted as referring to one or more interesting novelties in the current world, however two questions must be asked. First, was that forecast considered credible and attention paid to it at the time, and second how many other accurate long range forecasts did that forecaster make? The first question addresses whether the forecaster was in fact successful, which means being both correct and listened to, and the second question addresses whether the forecast was correct by random luck. A good review of how fast the national security environment changes by decade from 1900 to 2000 is the memo written by Linton Wells in 2001 “Thoughts for the 2001 Quadrennial Defense Review” (Wells 2001).

**Values Gaming Objectives**

The traditional view of wargaming the future is to create a future scenario and then wargame within it. This is reactive, in that the future scenario is a given. Such a game provides insights into questions around how one might act in that world and insights into the usefulness or otherwise of proposed plans, conops and acquisitions. This is ideal for exploring the near term future, but is inadequate for the far term of fifty to seventy years. In addition to credibility problem of a fifty plus year forecasting horizon such a time period introduces the certainty that our adversaries are planning to mold the world to their advantage and will have a major effect on the future world. Although we should not assume a zero sum geopolitical competition, we have to consider that such a world would not be to our advantage.

We break the forecast horizon barrier by defining the game objectives to be future we want as a world order favorable to our society’s values. We then game our way from now to that future, instead of a game set in the future the game takes us from the present to that 50 year future.

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8 “There are also recognized change points – for example 9/11, the Soviet coup and collapse, 1970 hostage taking, Cuban missile crisis – transformative events that don’t fit a chronological cycle.” Comment by Robert Mosher April 1, 2019.
Values Gaming Variables

Instead of gaming with specific technologies or platforms, we take a lesson from military operational level planning and instead look at capabilities. The game and post-game analysis examines the capabilities we need, to carry out actions, which strengthen our values or disrupt our adversary values or defend against adversary actions, in support of a world order favorable to us.

<table>
<thead>
<tr>
<th>Bin</th>
<th>Some Possible Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political</td>
<td>Democratic, Legitimacy, Rule of law, ...</td>
</tr>
<tr>
<td>Military</td>
<td>Under civilian control, Volunteer, Freedom of Navigation, Homeland security, ...</td>
</tr>
<tr>
<td>Economic</td>
<td>Prosperity, Capitalist, Fiscally conservative, Free movement of capital and labor, Global trade, ...</td>
</tr>
<tr>
<td>Social</td>
<td>Liberal, Freedom of speech and movement, Privacy, Social welfare, Educated populace, Healthcare, ...</td>
</tr>
<tr>
<td>Information</td>
<td>Educated populace, Free press, Evidence based government policy making, ...</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Available for all to use, Funded maintenance, ...</td>
</tr>
</tbody>
</table>

The values are at the highest level of abstraction and are the foundation of our society. A good summary of them is given by the Preamble of the American Constitution, but similar values are held by many other societies. A rigorous analytic framework is desired that supports generation of actions and capabilities from values and incorporates allies and friends, and so I propose binning the values using the PMESII structure (Political, Military, Economic, Social, Infrastructure and Information) as a useful framework. Although often used for operational level military planning the PMESII framework is a good way of organizing (not identifying) our values and identifying their specific characteristics we need for gaming. Binning acts as a checklist to reduce the chance of missing a value. The interpretation of values allows one to place them in more than one bin, and values will overlap bins. This ambiguity provides the flexibility necessary to adapt the framework to the detailed objectives of a specific game.

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9 Robert Mosher (Mosher 2019) also makes the point that wargaming the future will have to focus on capabilities rather than platforms.

10 John Hanley commented that the writings of Francis Fukuyama (https://fukuyama.stanford.edu/), specifically on the origins of political order (Fukuyama 2012, Fukuyama 2015), provide a strong foundation for this approach. As John pointed out “National cultures require long times to change, if they ever do”, which seems to imply that these cultural characteristics are ones we can wargame with into the deep future.

11 Other reasonable frameworks can be used. See Canyon 2019 for descriptions of, and references to, PEST (Political & Legal, Economic, Social & Cultural, and Technological & Scientific), STEEP and STEEPLE (including Environmental, Legal and Ethical drivers), and their use in the context of security strategies.
This table raises the question of what capabilities are needed to defend, maintain and extend our values. From a military point of view DOTMLPF provides a starting point so long as one is careful to restrict to capabilities, not specific platforms or technologies. For example, instead of trying to game a specific collection of technologies (e.g. F-35) on a specific platform (e.g. a Gerald R Ford Class Carrier) the capability might be the ability to project a specific kinetic power over a given range from a mobile base.

Suggested Game Execution

The first move of the game is set in the present and each subsequent move progresses further into the future ending with the last move at fifty years. The game is played each year with the previous year’s geostrategic situation used to update and refine the first move. “Red” in this game are the obvious strategic competitors with the objective of molding the world to their values and disrupting our values. Our game objectives are to extend and defend a world order favorable to us in every move, and if we fail during a move to recover that favorable world order by the last move. What the length of each move should be for a long-run game is an interesting problem. One approach is descriptive where players role-play real decision makers. In this case (McGrady 2019) suggests the length of each move should match the decision cycles of those decision makers. Another is normative, players are not role playing and the move length matches geostrategic cycles, speed of research and development cycles, or some other length of time which could be varied move to move according to how the game is playing out. Five-year moves would result in a ten move game.

Adjudication by Values Based Systems Thinking Model

Since the game is dealing with novel future situations at the strategic values level, the game design is clearly inductive, rather than deductive, and therefore inductive adjudication will be used (Downes-Martin 2013).

Game adjudication has to be able to handle conflicting capabilities being used to support our values. Systems thinking, the qualitative precursor of quantitative systems dynamics, in the form of a set of interacting feedback causal loops is a possible approach (Sterman 2000). A formal disciplined process for generating systems thinking models was developed by the Center for Quality of Management called “Accelerated Rational Method for Effective Decision-making (ARMED)” (Mallis 2002) for commercial projects and was adapted for use during research projects at the Center for Naval War Studies at the Naval War College.13

12 The one-year Government budget cycle, the four year US Presidential election cycle, the five year DoD FYDP, and other possible cycles spring to mind.

13 See (Mallis 2002) for details on how to build the systems thinking models and see (Perla 2009) for details on how to use them for wargaming.
The key point is that the models are used for each move of the game to guide adjudication. The models do not necessarily change as the moves project further into the future since the values do not change and the capabilities are at the abstract level.

Assumptions

The argument relies on the assumption that our societal values will not rapidly change permanently or drastically. Note that we accept temporary suspensions of our values when under threat (certain political and military actions during World War 2 spring to mind) and we do not always agree on the interpretation or the implementation of our values (the Supreme Court handles some of these cases). The possibility of suspending values adds to the range of decisions available to the game players. A permanent change our values, while possible, is handled by realising that avoiding such a change is explicitly part of the game objective -- a world order favorable to our values that are in place today.

Conclusions

It is necessary to think fifty years into the future when investing in our power projection and fighting platforms and systems given their service life. If we define the return on this investment to be the maintenance of a world order, based on our values, favorable to our way of life, then wargaming can credibly inform strategic decision making concerning the interaction between available power projection and warfighting systems, the geo-strategic situation, and required development of further capabilities:

➢ The game and post-game analysis examines the capabilities we need to carry out actions which strengthen our values or disrupt our adversary values or defend against adversary actions in support of a world order favorable to us.
➢ Required capabilities implemented as added or changed systems carried by our long-term power projection platforms are then proposed and gamed.
➢ We need serious research into identifying those values and operationalizing them into a game system
➢ We should annually game out fifty years with first move length set at five years and the length of subsequent moves dynamically determined by the game’s trajectory.
➢ This requires an organization with institutionalized processes to support such gaming.
References


Wargaming the Far Future


About the Author

Dr Stephen Downes-Martin is a Research Fellow at the US Naval War College and is an independent scholar researching decision support methods (such as wargaming) applied to problems at the strategic, operational and tactical levels of warfare and business. A research focus is on how to manipulate decision support methods in general to deceive decision makers, how decision makers misuse such methods to deceive themselves, how to detect such attempts and protect decision makers from them. He works with and for a wide variety of government, military, aerospace, academic and commercial organizations in the US and internationally. His full bio is at: https://sites.google.com/site/stephendownesmartin/.

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Coming to Grips with Indeterminacy in the Practice of “Futures”
Gaming for Strategy Formulation

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Research Fellow, US Naval War College

Abstract

Gaming, as the literature demonstrates, conjures a wide spectrum of activities encompassing a wider range of purposes and uses. Here we focus on operational gaming to support strategy formulation. This form of gaming is a simulation of selected aspects of an impending or anticipated real-world contingency whose outcome is affected by multiple actors. The simulation is conducted within the context of a scenario, supporting data, a set of rules, and moves with consequences to provide information for choosing a course of action to prepare and implement initial plans, and to provide experience for adjusting actions when faced with the details of the actual contingency. The essential challenge in gaming in attempting to anticipate the future is the number of states of the world that could happen. Appreciating the kinds of indeterminacy in the underlying phenomena helps provide perspective on both the value of gaming and appropriate lessons that could and should be derived from a sound game. An exploration of various classes of indeterminacy establishes a foundation explaining why efforts at mathematical prediction quickly become intractable, and even mathematical precision provides many possible solutions for future states of the world. The future in essence is a “wicked problem.” Scenario planning, operational design, and path gaming are considered as techniques for addressing such wicked problems with time-horizons of decades. An example of an effort to explore the future security environment at the end of the Cold War is provided and evaluated for its insights and effects. A less successful example of using more traditional war gaming to explore and evaluate concepts for revolutionary naval warfare innovation decades into the future is also presented. Finally, reviewing the Department of Defense’s planning and procurement paradigms regarding the need to predict the future as opposed to adapt rapidly, and the possibility of using games to address that wicked problem, is proposed.

“It took me many moons to finally understand that long range planning takes place now and that there is a constant updating as information comes in. Furthermore, as new information comes in there is a considerable feedback between the information and the updating of the plans. Even more important, as the contingencies proliferate so fast as we go out in time there have to be methods for pruning the branches to be followed. Few long-range plans can afford the luxury of working out more than a few alternative paths. Once even the most staid of firms goes out more than a few years into the future, the planning becomes more of an exercise providing a broad definition of intentions and moral imperatives, than an exercise in operations research.” (Shubik 2001)
**Introduction**

Gaming conjures a wide spectrum of activities encompassing a wider range of purposes and uses. Games involve play, and may be designed for entertainment, training, teaching/professional development, research, and preparation for contingencies.\(^\text{14}\) Gaming applies equally well to contingencies in society, business, and war.\(^\text{15}\) Here we focus on gaming to support strategy formulation.\(^\text{16}\) This form of gaming involves a simulation of selected aspects of an impending or anticipated real-world contingency whose outcome is affected by multiple actors. The simulation is conducted within the context of a scenario, supporting data, a set of rules, and moves with consequences to provide information for choosing a course of action to prepare and implement initial plans, and to provide experience for adjusting actions when faced with the details of the actual contingency.

Using Sayre’s taxonomy, the games addressed here involve imaginary contingencies, are without troops (or the civilian equivalents), on a map or similar conceptual depiction, and involve strategic and/or tactical courses of action (Sayre 1910). The data used in them should come from field maneuvers and actual operations, of all the sides represented in the game, to the extent possible.\(^\text{17}\)

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\(^{14}\) All of these elements appear in sound gaming. Efforts to partition the uses contributes to missing opportunities to create new concepts and conduct research and analysis in training and teaching games used for professional development. If not entertaining, games for professionals should be intellectually exhilarating enough to capture the players mentally in their roles.

\(^{15}\) Shubik refers to games for strategy formulation as operational (Shubik 1975). The term strategy formulation is used here to reduce confusion between the strategy, operations, and tactics hierarchy and strategy as ways to accomplish ends with available means. Strategy here is used in the later sense as courses of action at strategic, operational, and tactical levels.

\(^{16}\) A previous version of this paper employed the term serious games. Reading and reviewing the literature, such as (Huizinga 1949, Lewin 2012, Sabin 2012, van Creveld 2013, von Hilgers 2012, etc.) provides an appreciation that just as animal cubs playing to develop skills for future survival, games for entertainment, professional development, and research can be serious; not only games employed to formulate strategy.

\(^{17}\) Operational games expose needs for additional information on one’s own capabilities, and for intelligence on others’ tendencies and capabilities.
Some Theory

Games solely for entertainment may be about the present, but otherwise games are about the future. One issue is how far into the future. The challenge is in the number of possible future states that could obtain. The number of possible states becomes intractable to address with any precision as one proceeds further into the future, and with even near-term complex issues for which well-founded theories and laws have yet to be established. Formalizing terminology will help clarify the following discussion.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>a world</td>
<td>the object [system, contingency, etc.] about which a person is concerned</td>
</tr>
<tr>
<td>a state of the world</td>
<td>a description of the world, leaving no relevant aspect undefined</td>
</tr>
<tr>
<td>the true state</td>
<td>the state that does in fact obtain; i.e. the true description of the world (Savage 1972 p. 9)</td>
</tr>
</tbody>
</table>

The world of interest depends upon the matter under consideration; the objective of the inquiry. Describing the state of the world requires an appreciation of the aspects that are
relevant to deciding upon a course of action.\textsuperscript{18} The level of precision in describing future states affects their number; e.g. when forecasting weather (temperature, probability of precipitation, and wind speed) rather than the climate being colder, warmer, or the same. Deciding some courses of action may depend upon forecasting the weather, where others may depend only upon climate change. Scenarios and supporting documents provide the relevant information setting the initial state for a game, and adjudication updates the state of the world based upon the actions of the players, the rules for adjudication, and the judgment of the umpires or control team.

Describing a state of the world involves mapping a substantive problem into a conceptual model that includes selected relevant aspects and the relationships between them.\textsuperscript{19} Conceptual models may be explicit representations of the system under study, such as descriptions and figures found in military doctrine or textbooks, but also incorporate implicit assumptions, understandings, and analytical paradigms of those creating the models.

Classes of Indeterminacy for Mathematical Techniques

Mathematic and related logical representations of phenomena are often used for prediction and optimization. The ability to predict the future, and the time over which that prediction remains accurate, depends upon the classes of indeterminacy inherent in the phenomena under study.

Decision makers select courses of action to accomplish some set of objectives within an available response time during which the objectives can be accomplished with the means at hand.\textsuperscript{20} The character of the indeterminacies inherent in the phenomena under study affects the ability to anticipate or predict the true state of the future world. If we know enough to represent the state of the world as an exact point in some state space\textsuperscript{21}, and can map the trajectory of the changing state of the world over time exactly for each decision alternative, the decision situation is deterministic.\textsuperscript{22} Using Newtonian physics, one can predict with great accuracy the motions of masses—i.e. the state transitions. Even though three or more masses

\textsuperscript{18}In military doctrine Commander’s Critical Information Requirements and Priority Intelligence Requirements are intended to capture relevant aspects of the world of interest.

\textsuperscript{19}Creating this ontology requires judgement of experts in the subject under study.

\textsuperscript{20}Even in formal terminology, e.g. (Chairman of the U.S. Joint Chiefs of Staff 2013), uses strategy both in the context of a hierarchy of strategy, operations, and tactics, and as ways for accomplishing desired ends with available means. The phrase course of action substitutes for the term strategy in the later sense.

\textsuperscript{21}Each relevant aspect represents a dimension of the state space, which results in high-dimensional state spaces for situations where many aspects are relevant to the decision maker. Deep understanding of the essence of the phenomena under study contributes to parsimony in identifying relevant aspects, making analysis more tractable.

\textsuperscript{22}Such state spaces underly the mathematical programming technique of Dynamic Programming (Denardo 1982).
with strong enough gravitational attraction behave chaotically, their motions can be predicted accurately over time frames needed for space flight using current capabilities. However, most phenomena of interest for the future rarely involve such deterministic behavior.

Now consider **statistical indeterminacy**. Here the initial state is set of a random variables, with one variable for each relevant aspect of the world. We do not know the world’s true initial state exactly, but we do know the probability distributions of the relevant variables, which may be described by their sufficient statistics. Monte Carlo simulations draw from this probability distribution to predict a distribution of future states. For any action taken, if the process is not chaotic, a small change in the initial state will result in a small change in the state at some future time. Either way, sufficient statistics for the initial distributions of states allows calculation of future the states conditioned upon the initial state. Regression analysis is a common technique used for forecasting, and is useful if the structure of the system is well understood and does not change.

Alternatively, we could know the initial state of the world exactly, but encounter stochastic indeterminacy in the system. In this case, many similar systems starting in the same state have the same proportion transition to a given later state at a given time. The system of states and their transition probabilities at each time constitute a stochastic process. Markov simulations were created to address stochastic processes. Obtaining data for the probabilities and times of transitions to future possible states, and requirements that the systems be stable in the sense that these values do not change, present challenges in using such techniques. However, if these conditions can be met, the system is stochastically determined. Since transition probabilities and times are prespecified, Markov simulations do not adapt from learning.

**Strategic indeterminacy** is created when more than one decision maker affects the outcome of the phenomena under study. In addition to the evolution of chess leading to militaries adopting war games involving more sophisticated representations of terrain and troops, chess and other two-player games also inspired efforts to determine mathematically the existence of a strategies that could not be defeated (Leonard 2010, Chapter 1). The mathematician John von Neumann initially published his minimax theorem in 1928 (von Neumann 1928) proving that an optimal strategy, or saddle point, existed in two-person, zero-sum games. Motivated by political turmoil in Europe in the 1930s, along with economist Oskar

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23 Sufficient statistics, such as a class of probability distributions (e.g. normal) with its sufficient parameters (e.g. mean and standard deviation), provide shorthand for describing a distribution with no loss of information. Note that power laws (associated with fractal characteristics) have a mean, but no standard deviation. By definition, a relatively simple equation specifies the distribution. Events that have low probability but high consequence are sometimes referred to as Black Swans, particularly when associated with power laws.

24 In zero-sum games the payoffs to all players add up to zero. However, in games with more than two players opportunities for collaboration exist.
Morgenstern, he went on to explore cooperative games with more than two players involving coalitions, publishing The Theory of Games and Economic Behavior in 1944 (von Neumann & Morgenstern 1944). Though the solution to strategic indeterminacy in two-person, zero-sum games is a point, solutions for more than two people and non-zero-sum games involve sets of solutions. The concept of a saddle point in zero-sum games was then extended to concepts of equilibrium in non-zero-sum games, which most often are sets. Just as solutions involving statistical and stochastic indeterminacy involve sets of points, solutions to all but a special form of game also involve sets of potential solutions.

When using mathematical techniques, the character of indeterminacies inherent in the phenomena under study suggest what techniques are most appropriate to use when conducting an inquiry. Table 1 highlights characteristics of phenomena under study for selecting an appropriate technique depending on the indeterminacy involved, and highlights techniques developed for that class of indeterminacy. Though employing a technique requiring more knowledge than is available can be very helpful in thinking through an issue and clarifying what is not known, any results from such an effort require caveats on how to interpret them.

**Table 1: Classes of Indeterminacy involving Mathematics**

<table>
<thead>
<tr>
<th>Character of the Subject</th>
<th>Deterministic</th>
<th>Statistical Indeterminacy</th>
<th>Stochastic Indeterminacy</th>
<th>Strategic Indeterminacy</th>
</tr>
</thead>
</table>
| **Character of the Subject** | 1. State space clearly defined  
2. Persistent data  
3. Units of measure understood  
4. Relationships determined  
5. Initial state known | 1. State space clearly defined  
2. Persistent data  
3. Units of measure understood  
4. Probability distributions or statistics are known | 1. State space clearly defined  
2. Persistent data  
3. Units of measure understood  
4. Relationships determined  
5. State transition probabilities & rates known, and are Markovian. | 1. Conflicting interests  
2. Players specified  
3. Rules: specify end and winnings/losses  
4. Information conditions well specified  
4. Probability distributions for “moves of nature” specified  
5. Player tastes and beliefs known  
6. Players consistent and logical (rational) |
| **Techniques** | Mathematic Analysis and Programming  
Regression, Analysis of Variance | Stochastic Processes: Markov, Monte Carlo | Game Theory |
| **Solution Characteristics** | Unique solution  
Unique distribution | Unique distribution | Saddle point for two-player, zero-sum; otherwise sets of solutions |
Quantitative analyses bear close scrutiny. Standards for computational reproducibility and replicability of analyses are rarely met, computer models may not adequately consider indeterminacies, and decision makers frequently are not aware of the assumptions and uncertainties inherent in a study’s results.\textsuperscript{25} Efforts to make analyses tractable tend to disguise uncertainties in all but simple mathematical models.

Only deterministic phenomena and two-person, zero-sum games have point solutions. Otherwise analytical results provide sets of solutions.\textsuperscript{26} During World War II, Operations Research Groups and the Manhattan Project came to recognize that an estimate of the range of outcomes of a process involving multiple random variables is the error (e.g. standard deviation) of a typical variable times the square-root of the number of variables (Koopman 1970). As figure 2 demonstrates, attempts to be more realistic by adding more variables to a simulation results in adding to the volume of uncertainty.\textsuperscript{27,28} Increasing the number of variables offsets the law of large numbers. Simple models that capture essential aspects of the phenomenon under study are much preferable to models that attempt to replicate reality by linking large

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Total Uncertainty as a function of number of variables.}
\end{figure}

\footnotesize
\begin{itemize}
  \item \textsuperscript{25} For examples, see (Operations Research Society of America 1971, Comptroller General of the United States 1973, National Academy of Sciences 2019).
  \item \textsuperscript{26} Even when the phenomenon admits a point solution, unless the analyst is the decision maker, the analyst should present the analysis to the decision maker, but not attempt to provide “the answer.” (Kent 1967 p. 50)
  \item \textsuperscript{27} The figure uses an order of magnitude of ten percent error in each variable, which is exceedingly generous considering errors typical in combat models for own much less enemy performance, and $1/n$ as the increase in accuracy by adding more detail by adding variables to the model.
  \item \textsuperscript{28} Volume of uncertainty refers to the n-dimensional space represented by each variable creating another dimension.
\end{itemize}

Complex Adaptive Systems

Game Theory was an early attempt to develop well-founded techniques for addressing sequences of decisions that alter social and economic behavior. With the advent of computers, social network and influence models attempted to provide insight into systems involving multiple nodes affecting each other. Combat simulation similarly contain network-like models of nodes and edges representing engagements (Koopman 1970).

Understanding network structure has been very useful in understanding a variety of phenomena from immunology to social behavior (Barabasi 2002). Social network models using mathematical programming techniques for networks have proven very useful in understanding relationships between individuals, as demonstrated by their use in countering terrorism and current Chinese efforts to establish social reliability indices for individuals. Since most individuals have routines, such models have been exploited successfully by advertisers and political analysts to predict individual preferences.29 Though the ‘big’ data used in the models is updated as individuals’ conduct new transactions, more than new data is required to model the interactions as a complex adaptive system to anticipate emerging behavior.

Social influence models have been developed to address how different actors in a system influence each other.30 Checking solutions of such models cannot be checked in a polynomial-bounded number of computational steps [nondeterministic, polynomial-time (NP) complete], meaning that the time to compute the problem increases with the number of nodes and states of each node to the point that computing the states of the world is impractical or impossible if feedback loops are allowed. Whenever problems become too complex to guarantee the best possible solution using exact methods, heuristics (rules of thumb) and analogies serve to provide practical methods for finding a solution that satisfies immediate goals.31

Using the philosophy that “all is computation,” another approach when computing the states of a system using mathematics is computationally infeasible is to use cellular automata using more general types of rules embodied in relatively simple computer programs (Wolfram 2002). Wolfram suggests approaches for addressing NP-complete problems (Wolfram 2002 pp. 1142-1147). Even simple rules can lead to orderly, chaotic, or complex systems behavior, including self-organization.

29 (Barabási 2010) refers to individuals who follow routines as having low information entropy. People with high information entropy come under suspicion for erratic behavior.

30 The Situational Influence Assessment Model is an example.

31 (Simon 1997) introduced the notion that decision makers satisfice rather than optimize in his 1947 dissertation.
Beginning with Edward Lorenz’s systems dynamics model for weather, physicists began to appreciate deterministic chaos from sensitivity to initial conditions, originally identified by Henri Poincaré in his work on the three-body problem in 1887 (Stewart 2002). Lanchester and Salvo equations represent such nonlinear systems dynamics models. The work of Benoît Mandelbrot on identifying phenomena best modeled by power laws and fractals rather than Gaussian probability distributions and continuous functions similarly presents challenges for models used in finance on the behavior of the stock market (Taleb 2007). Given the relatively recent appreciation of chaos, whether combat phenomena are Gaussian in nature and can be represented by an expected value and standard deviation or are better represented by power laws whose standard deviation is infinite is a topic worth studying.

Agent-based models of combat, where agents act on local information according to a specified set of rules, have demonstrated some interesting emergent behavior not produced by systems dynamics models (Ilachinski 1996). Cellular automata can also be used to explore basic behavioral properties of simple local rule-based combat models. The major challenge for these models is the degree to which the rules in the model replicate the rules that actual agents use. Models with simple rules have mimicked the behavior of flocks of birds and traffic flows and jams. When one programs the rules into the system, like a swarm, one can be assured that the simulated behavior of the system will be its actual behavior.

Genetic algorithms also suggest evolution of designs better fit to the environment in which the object exists (Mitchell 1996, Holland 1965, Kauffman 1993). Here a major challenge is in specifying the values that constitute greater fitness for the environment. One feature of evolution is the tendency to converge in a stable environment. Systems that evolved to be highly optimized for one environment, such as the Cold War, may be totally unsuited for environmental change that exceeds the rate of evolution, as we are witnessing with the extinction of species resulting from rapid climate change.

Like previous models not allowing for adaptation or chaos, these newer techniques are useful for providing insights and are of greater use the more closely they represent the phenomena under study. Table 2 summarizes techniques and their characteristics. The table includes second-order modeling that would allow rules and fitness values to evolve to study what types of behavior emerge. The practice of employing complex adaptive system models of emergent behavior to make policy-relevant predictions is not yet wide-spread, but has produced some important results.32

32 See https://necsi.edu/research for some examples.
Table 2: Chaos and Complexity techniques and characteristics.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterministic Chaos</td>
<td>Non-linear dynamic systems, fractals, power-laws.</td>
</tr>
<tr>
<td>Cellular Automata</td>
<td>Experimental computation to observe the effects of simple rules.</td>
</tr>
<tr>
<td>Agent Based Models (ABM)</td>
<td>Emergent behavior by agents acting on rule sets.</td>
</tr>
<tr>
<td>Genetic Algorithms (GA)</td>
<td>Emergent behavior (evolution) based upon enhancing fitness for the environment. Requires specification of fitness value.</td>
</tr>
<tr>
<td>Second-order ABM/GA</td>
<td>Emergent behavior resulting from evolving rules and fitness values.</td>
</tr>
</tbody>
</table>

Adding neural networks – using an analogy to the brain – that learn by changing the strength of relationships between each node based upon a correspondence of the network to the true state was one of the early techniques used to create artificial intelligence (AI). The field of AI now uses variations of many of the mathematical techniques mentioned above. Since humans typically have low personal information entropy (Barabási 2010) – i.e. they behave in predictable patterns – AI has been successful in anticipating people’s interests, tastes, and beliefs. Though AI programs have defeated humans in games like chess and go, it has had much less success in dealing with less structured competition. Current approaches to AI depend heavily upon matching patterns. Whether AI can out-perform human decision as rules and values evolve leading to the emergence of new behaviors is highly questionable, though it will extend human cognitive capacities. Gaming will continue to both stimulate the development of new rules that provide advantages to a player, and to be useful for understanding the rules and implicit assumptions that bound choice inherent in the game.

**Structural Indeterminacy**

Thus far the discussion points to the difficulty of using mathematical techniques when conducting inquiry into the future. These techniques are powerful for studying stable phenomena whose structure is well understood, but much less so for phenomena influenced by human interests, tastes, and beliefs; or systems whose structure or statistics change over time.

**Structural indeterminacy** encompasses the unknown. It includes issues lacking an established ontology of how to bound the problem, what elements to include, and unknown relationships and data needed to perform mathematical calculations – in any discipline. It applies particularly to wicked problems. Characteristics of wicked problems include:

- A tangle of conditions with no definitive way to formulate: different perspectives with no objective truth
➢ Cannot understand without proposing a solution
➢ Rarely can be solved conclusively [decisively]
➢ Have better or worse solutions, not right or wrong ones
➢ Any solution will generate repercussions, possibly creating new problems
➢ Every solution is a one-shot operation, changing the problem
➢ Solutions have to be created, not chosen, and may not be apparent
➢ Every wicked problem is a symptom of another problem
➢ Are interactively complex, highly sensitive to inputs, concatenations of causes and effects: a single cause may have multiple effects, while a single effect can be the result of multiple causes (Rittel & Webber 1973)

In conducting a review of 40 years of wicked problem literature, Brian Head notes how “the policy studies literature ... is providing important frameworks and insights concerning the theory and practice of policy design, policy deliberation, policy reform, effective implementation, policy evaluation, policy legitimation and the determinants of policy success and failure” (Head 2018). He suggests strengthening the analysis of wicked problems by drawing upon relevant public policy literature on problem framing, design, capacity, and implementation. This formulation provides a framework for addressing wicked problems.

**Problem Framing and Policy Design**

Framing involves “unpacking” the way in which problems are understood, including identifying key decision makers and stakeholders. Head provides a summary of literature on framing, including scenario planning. Operational design is also a useful technique for framing a wicked problem for further exploration.

“Scenarios are not concerned with getting the future “right”, rather they aim at challenging current paradigms of thinking and broadcast a series of stories in which attention is directed to aspects that would otherwise have been overlooked” (Chermak, Lynham & Ruona 2001). Hermann Kahn pioneered a technique that he called “future – now” thinking and coined the term scenarios while working at RAND in Santa Monica, California. His approach was to combine detailed analysis with imagination, producing reports as if written by people in the future to allow people to think about the “unthinkable,” such as the consequences of nuclear war. Kahn advocated his approach with industry and Royal Dutch/Shell adopted the technique. Shell credits its scenario planning with helping in anticipate dramatic changes in energy markets, beginning with the Yom Kippur war in 1973. Pierre Wack, who developed scenario
planning for Shell, found reliance on forecasts\textsuperscript{33} dangerous because, though often accurate, they were wrong when it hurts the most (Wack 1985). His approach was to develop an expected future along with two others, developed from enduring and conflicting trends, that would challenge existing policies. Considering wild-card events helps clarify assumptions about events that are excluded from consideration in planning. Shell Central Planning does no central planning, but uses the scenarios in planning exercises with the executives in each of its major production, refinement, transportation, and sales operations as a common framework for creating their strategies and plans. Wack’s successor Peter Schwartz went on to write a book on the practice (Schwartz 1991) and establish Global Business Network, Inc. employing scenario planning. Several other companies make a business of scenario planning.

Scenario planning has the reputation of requiring extensive time and large financial resources, long and short-term impacts not being fully understood, and having weak theoretical roots. The absence of strong theoretical roots “has led to something of a ‘club members only’ philosophy among practitioners (Chermak, Lynham & Ruona 2001). In these ways, the reputation of scenario planning resembles the reputation of gaming.

Along with framing, the concept of policy design emphasizes the creativity, innovation and learning dimensions of the search for policy alternatives. Noting that complex military operations present wicked problems, John Schmitt, a U.S. Marine Corps reserve officer and academic, proposed a systematic concept for operational design as a prelude to detailed planning for military operations (Schmitt 2006).\textsuperscript{34} “Design can be thought of as problem setting—locating, identifying and formulating the problem, its underlying causes, structure and operative dynamics—in such a way that an approach to solving the problem emerges.” A complex network involving a large number of diverse stakeholders is a feature of such problems. The “individuals come from different organizations—each with its own charter, function, objectives and chain of authority. As a result, stakeholders will bring differing perspectives and agendas to the problem-solving process.” Human problem-solving involves individuals intuitively jumping back and forth between conceiving the problem and thinking of possible solutions. Group problem-solving requires close communication as different members of the group are at different stages in conceiving solutions. Therefore, problem-solving is fundamentally a social process. Schmitt recommends that the design process “should be compatible with natural cognitive and communication processes so that the methods they adopt are not at odds with natural human behaviors.” Games provide such a venue.

\textsuperscript{33} Typically using regression analysis.

\textsuperscript{34} Joint doctrine had called for operational design as part of the planning process. Schmitt helped improve techniques employed in current doctrine (Joint Staff 2017).
The process involves abductive reasoning—inferring best explanations from limited facts—to create a logic system that establishes a context for planning and execution. Schmitt’s process calls for designers to develop a counter-logic that would defeat the sequence of interactions envisioned to produce the desired state to understand the resilience of their scheme. The opposition in a game performs this function. To implement the design, Schmitt goes on to address:

➢ Conversational discourse, the basic mechanism by which the design team designs
➢ The design process, the general pattern of cognitive activities that occur during design
➢ The composition of the design team
➢ Systems thinking, the mental discipline the design team follows
➢ Model making, the central activity of systems thinking
➢ Intuitive decision making activated by conscious reasoning that builds the necessary insight
➢ Continuous assessment, by which the design team tests its conceptual models
➢ Structured learning, which describes the essential outcome of the design process

He suggests that the design team should consist of a relatively small group of key stakeholders with a compelling interest in the outcome of the situation, including the senior decision maker responsible for implementing the resulting plan to ensure that his conception of the problem is addressed and that the framework meets the “commander’s intent”. Schmitt concludes:

“To the extent that we face socially complex, wicked problems, we should design before we plan and execute. Design is essentially the process of rationally formulating the problem to be solved out of the mess that confronts us, and doing it in such a way that the logic for solving the problem emerges intuitively. We design by holding a conversational discourse among stakeholders during which an image of the problem and the solution emerges gradually through the collective intelligence of the group subjected to critical argument. During operational design, we think systemically—we imagine the problem as a system driven primarily by its own purpose, structure and processes, but also influenced by the broader environment within which it exists. We do this by developing, testing and modifying conceptual models hypothesized to explain the workings of the system in its environment. Because we cannot observe the physical causality that underlies the situation, we test our hypothesis heuristically through action. We observe the results of our action to see if they conform to the expectations of our
design, and we redesign accordingly. In this way, design provides the basis for assessment and for adapting our operations to the situation through learning.”

Schmitt’s operational design closely aligns with the elements needed to design rigorous and objective operational games, and conduct a cycle of research. Schmitt’s illustration of the design process employs influence models of the type discussed above that defy calculation, but clarify thinking about the elements driving the system and the relationships between them.

Policy Capacity and Implementation

Policy capacity includes not only competence in policy design advice but also competences in the implementation, coordination and evaluation of ongoing programs. Building on others’ work, Head emphasizes that:

“the collective or ‘social’ nature of working with wicked problems and adaptation strategies requires a ‘holistic and process-oriented approach’ that is ‘adaptive, participatory and transdisciplinary’. Working through an ‘open and heuristic process of collective learning, exploration and experimentation’, such an approach promises to be ‘efficacious in fostering collaborative behavior, reducing conflicts, building trust among all stakeholders and communities involved and ultimately producing better and more satisfying results.”

Gaming as a Partial Technique for Addressing Wicked Problems

Developing policies and strategies for wicked problems calls for mastering complexity, enhancing communication, stimulating creativity, and building consensus that leads to a commitment to action. Gaming is a powerful method for simultaneously doing each of these (Duke & Guertz 2004), but requires action to provide additional evidence and feedback to continually refine courses of action based upon new learning and evolving circumstances.

Mastering Complexity

Formulating models of the phenomena under study involves imagining a depiction of factors and elements believed to be relevant and the relations between them.\(^{35}\) Where the model involves a process with little or no feedback, and one cause produces a deterministic effect (including those that are statistically, stochastically, or strategically determined), isolating individual causes and effects and stringing them through the flow of the process allows one to calculate a normative prediction of the behavior of the system.

\(^{35}\) This model may involve language and Boolean logic, mathematical symbols tied to the elements of the phenomena, or objects, as in object-oriented programming. The choice of “language” usually depends upon the skills and norms of the discipline that the analyst is using.
When interactions are complex, behavior is highly sensitive to context, and a single effect can be the result of multiple causes, though reductionist analysis is needed to address the constituent parts, it is inadequate for predicting the behavior of the overall system.

Well-designed games begin with the study of history and historical thought regarding the phenomena under study to inform the elements and interactions to incorporate into the game design. Game design and adjudication involve conjectures regarding factors having the greatest effects. Having subject matter experts from different disciplines along with decision makers involved in the game helps ensure that it includes a sufficient set of relevant factors. Both the game design and play contribute to framing the contingency accurately.

“… games are intensely stimulating, ideas and conjectures get tossed around and analyzed by a highly motivated group of people; a great deal of expertise is collected in a single room, expertise that is not often collected together; and people discover facts, ideas, possibilities, capabilities, and arguments that do not in any way depend on the game but nevertheless emerge from it. … Players discover important facts that may never have occurred to them or are counter to what they understood (e.g. unprecedented acts excite attention, jurisdictional seams and overlaps), and ways that players not represented in their usual thinking affect the feasibility and acceptability of possible courses of action.”
(Levine, Schelling & Jones 1991 pp. 23-24)

Games lift the participants up from the perspective of their daily endeavors to see a bigger picture and present interactions more clearly. As McCarty Little (the founder of gaming at the Naval War College in the late 19th century) observed:

A walk on the deck gives no idea where the ship is, but a glance at the chart in the cabin does. In like manner it is on the chart that the admiral plans and conducts his cruise. Even on the tactical field with the enemy in sight, the picture on the retina is a distorted representation, which in the mind must be reduced to a proper diagram…Even the actual witness to a battle does not have a clear idea of what has taken place until it has been reduced to a diagram. (Little 1912 p. 1219)

Enhancing Communication

Language uses a set of symbols that expresses ideas and allows people to think and communicate with each other. It can be verbal or non-verbal. Examples of language extend beyond written versions of verbal languages to include mathematical symbols and computer languages, and to maps and pieces used in gaming; which are more precise than spoken language. Gaming for strategy formulation employs natural discourse and social interaction enhanced by tangible symbols; underlying mathematical and computer languages in the background. used for adjudication are often beyond the ken of most game participants.
Bradley Fiske (a Naval War College graduate and Rear Admiral during World War I) identified the value of gaming for enhancing communication by providing a common context for communication among those within and beyond the borders of an organization.

“When the game board is not used people conferring on naval problems can do so only by forming pictures in their own minds, endeavoring to describe those pictures to others (in which endeavor they rarely perfectly succeed) while at the same time trying to see the pictures that are in the minds of others – and then comparing all the pictures. The difficulty of doing this is shown in a little paragraph in “The Autocrat at the Breakfast Table,” in which Dr. Holmes points out that when John and Thomas are talking there are really six persons present – the real John, the person John thinks himself to be, the person Thomas thinks him to be, the real Thomas, the person Thomas thinks himself to be, and the person John thinks him to be. The conditions surrounding John and Thomas are of the simplest kind, and the conversation between them of the most uncomplicated character. But when – not two people but – say a dozen or more, are considering highly complicated questions, such as the House Naval Committee discuss when officers are called to testify before them, no two of the twenty congressmen can form the same mental picture when an officer uses the word – say “fleet.” The reason is that very few of the congressmen hearing that word have ever seen a fleet; none know exactly what it is, and everyone forms a picture which is partly the result of all his previous education and experience; which is different… “ (Fiske 1918 pp. 201-202)

He goes on to say:

No man ever lived who could describe a complicated machine accurately to a listener, unless that machine differed but little from a machine with which the listener was acquainted. But hand a drawing of even a complicated machine to a man who knows its language – and the whole nature of the object is laid bare to him … So, when the forces representing a complicated naval situation are placed upon the game-board, all of the elements of the problem appear clearly and correctly to each person; the imagination has little work to do, and the chance for misunderstanding is almost negligible. (Fiske 1918 pp. 206-207)

Stimulating Creativity

In the free and safe activity of play, individuals can go beyond the limiting forces of everyday life (Huizinga 1949). Again, discussing naval gaming, Little stated:

“The game offers the player the whole world as a theater, and puts no limit to the forces, either in numbers or kinds. Any time of ship may be had for the asking, the only requirement being to state its qualities so they may be expressed in a game
convention. The ships can do what in time of peace is impractical to the real ships—
for example they can ram him or destroy him with gunfire; they can run all sorts of
risks, nay, they can be destroyed to prove the inefficacy of a poor plan, and in a
twinkling they can be restored for a new trial. And all of these things are at the
disposal of any group of officers gratis.” (Little 1912 p. 1219)

As in mastering complexity, competition fosters creativity when preconceived notions of
what will accomplish objectives fall short.

Operational games also expose previously unrecognized logic hidden in the contingency.

“If I draw a face with a hidden picture there is no way for me to tell how hard it is
to see the face except to show the picture to somebody.” ... “It is this peculiar
element of collaboration, communication, and bargaining, that is involved in any
crisis game, that cannot be captured by “straightforward” unilateral analysis.”
(Levine, Schelling & Jones 1991 p. 32)

Building Consensus that Leads to a Commitment to Action

Operational games put people in roles upholding certain interests and positions and
distribute resources as in real life. The fact of planning for a contingency anticipates that the
day-to-day rules for existing interactions could change in threatening ways, and open new
opportunities. These challenges and opportunities require a new consensus about how an
organization is to proceed.

The shared gestalt communication and experience in exploring the feasibility of objectives
and suitability, feasibility, and acceptability of courses of action that enhance the chances of
accomplishing objectives provides a foundation for consensus on a way ahead. It also aligns the
myriad of organizations required for a successful strategy.

People sensitive to a variety of responsibilities collaborate, applying the criteria
that are relevant to their own interests, making estimate that reflect their own
kinds of knowledge, and putting themselves in a mood to worry about
probabilities rather than just a list of possibilities. They really live through a
simulated crisis and not only learn things about their plans and their prediction
but learn something about the nature of crisis. (Levine, Schelling & Jones 1991 p.
27)

When seeking consensus while using traditional perspectives, there is a danger that only
easy-to-implement strategies consistent with extant policies will be discussed. The competitive
aspect of gaming mitigates against this form of “group think” in reaching a consensus (Duke &
Guertz 2004 p. 31).
“Now the great secret of its [the games] power lies in the existence of the enemy, a live vigorous enemy in the next room waiting feverishly to take advantage of any of our mistakes, every ready to puncture any visionary scheme, to haul us down to earth, ...” (Little 1912 p. 1230)

Those with differing objectives or approaches for achieving those objectives will provide evidence for whether the conjectures in the design and adjudication are correct and highlight factors not included in the design or adjudication that provide them an advantage. Competition in gaming also helps to ensure that the complexity of the contingency under study is fully explored and depicted in the process of reaching a consensus.

Ideally, the game should involve those who make decisions on the commitment of resources and courses of action. If not, it should involve deputized representatives who can commit to actions based upon the findings from a game.

Continuing Assessment

The game is only a partial technique for dealing with wicked problems (Levine, Schelling & Jones 1991 p. 22). Just as one cannot infer too much about the game of baseball from watching teams play once, the inferences taken from an operational game require further study – a cycle of research (Perla 1990 pp. 287-288). As Schmitt stated above, we test our conjectures heuristically through action, and redesign according to how well additional evidence aligns with our expectations. The most successful gaming efforts in the years between World Wars I and II by the German Army and U.S. Navy, and by the U.S. Navy in implementing concepts for the 1980s Maritime Strategy (Hanley 2014), involved taking concepts developed for and examined in games into field and fleet exercises, and using these exercises both to evaluate the feasibility, suitability, and acceptability of the concepts, and to collect data needed for follow-on gaming and analysis.

Path Gaming and Seminars to Explore the Future

The Chief of Naval Operations’ Strategic Studies Group provided examples of scenario planning and futures gaming that demonstrated both the value of limitations of such endeavors. Admiral Frank B. Kelso II became Chief of Naval Operations in 1990 facing demands for a peace dividend and, shortly after, for preparations for operations DESERT SHIELD and DESERT STORM. Recognizing that the decisions that he was making would affect the Navy for 30-50 years and needing a better justification for the Navy, he tasked his Strategic Studies Group (SSG) over the next two years to study trends driving the future security environment and its implications for the Navy and Marine Corps.

Noting that new technology took about 20 years to incorporate into major platforms, the SSG negotiated that time frame with the CNO. The SSG also noted that the energy industry, like
the Navy made multi-billion-dollar investments intended to last about 40 years. Therefore, the SSG studied techniques that major companies in the industry used in their strategic planning and adopted Shell’s scenario planning approach. Over two years SSG X and XI\textsuperscript{36} studied future trends and their implications for the security environment, national security, the Defense Department, and the Navy.

These studies involved extensive interactions with thought leaders in government, academia, and industry in the U.S., Europe, and Asia to frame issues driving the future security environment. Trends that the SSG found influential in 1991 included:

- **Globalization of commercial enterprises and finance.**
- **Demographic pressures resulting from the world population increasing by over 2 billion people in 2010 from a bit over 5 billion in 1990 with 93 percent of the growth coming from developing nations.** This growth would result in youth bulges\textsuperscript{37} in the Middle East, Central and South Asia, Africa, and Central America leading to severe migration pressures and civil strife. All the while developing nations would face significant increases in their populations aged over 65.
- **A widening have/have-not gap with the rich getting richer and the poor getting more people.**
- **An explosion in information technology and global communication with political, economic, and cultural impacts creating more opportunities and challenges, and reducing the response time for formulating and implementing public policies.**
- **Regions of chronic tension, exacerbated by the above trends, becoming more unstable as nations seeking to redress grievances became free of Cold War constraints.**
- **Continued oil dependency and competition over resources.**
- **Environmental degradation affecting water, clean air, and unpolluted habitable spaces. Atmospheric “greenhouse” warming presenting “monumental uncertainty,” in conjunction with loss of biodiversity requiring unprecedented international cooperation to address.**

\textsuperscript{36} The CNO Strategic Groups were comprised of typically six Navy officers selected for their potential to advance to three and four-star rank selected by the CNO. The Marines assigned two or three officers, and the Coast Guard Commandant selected one officer to serve with the group following the downfall of the Soviet Union as peacekeeping and transnational operations became prevalent. Each group served for a year, working on subjects tasked by the CNO. SSG X and XI were the tenth and eleventh groups. About 50 percent of the Navy officers were selected to Flag rank, about 20 percent of the SSG alumni advanced to three-stars, and 10 percent advanced to four-star rank, resulting in half of the Navy four-star officers in 2000 being SSG alumni, in addition to one Marine four-star.

\textsuperscript{37} A youth bulge is when over 20 percent of the population is 15-24 years old.
➢ Questioning whether the U.S. educational system would allow the U.S. to retain the extent of the technological lead that it had since World War II.

➢ A trend toward reduced ideology and increasing democratization, with significant eddies and counterflows resulting from religious and ethnic differences in societies with disenfranchised segments of the population.

➢ Arms proliferation decreasing in high-end platforms while increasing in missiles and less expensive weapon systems. The ability of small groups and individuals empowered by information technology, and globalized commerce and transportation to acquire weapons that could cause levels of mass destruction formerly restricted to major powers.

➢ Decreasing force structures and numbers of people under arms in developed states as major weapons platform and manpower costs increased.

The group also provided a short list of wild-cards to hedge against while conducting planning. These included:

➢ a global depression;

➢ use of nuclear weapons;

➢ catastrophic terrorism damaging U.S. democratic institutions, assassination of national leaders, large-scale loss of civilian life, or undermining the global economic structure;

➢ global warming or a major environmental disaster;

➢ pandemic; or

➢ an inexpensive alternative energy source that would fundamentally and rapidly change social and security interests. (Chief of Naval Operations’ Strategic Studies Group 1991)

The group considered an asteroid striking earth as another wild-card, but did not include it in the report. The group used these trends in path games to explore the interests and likely policies of major actors and implications for U.S. strategic vision, national security, defense resources, naval warfighting, and organizational issues. Like Shell, they then conducted scenario exercises to promote a common vision leading to consensus on policies and strategies to action.

Path Games

In the late 1980s, Mr. Andrew Marshall, Director of Net Assessment in the Office of the Secretary of Defense, sponsored “path games” exploring implications of the future rise of China. Charles Wolf, a leading economist at RAND, had projected that the growth of the Chinese economy since Deng Xiaoping’s reforms in 1979 could result in China’s economy
exceeding the U.S. in the foreseeable future. These games were similar to other games involving sides representing the major actors affecting outcomes in the world under consideration. Each move took five years. During each move, each team outlined its political aims, economic approach and actions (e.g. investment in social programs, national infrastructure, education, military, technology, etc.), international initiatives, and military policies and actions. Net Assessments games used an economic model to suggest national and global economic developments.

Noting that a principal uncertainty in the security environment of 2010 was associated with the actions of governments and social movements, for two years the SSG conducted path games based upon its understanding of major trends shaping the future security environment. The SSG employed its research into trends as a basis for having teams form their policies. Teams of Americans and foreign nationals expert in national economic and military policies and international relations represented U.S., Europe, Japan, Russia, and developing countries with an emphasis on China, the Middle East, and Central and South America. Each team would have a day to formulate its move, including diplomatic exchanges with other teams. After the teams submitted their moves, a control team would adjudicate the updated state of the world and provide a short newspaper describing developments over a five-year period to initiate the next move. Beginning five years in the future and having three five-year moves provided results out to the 20-year horizon. The convergence of interests on the Mideast was notable, though the mix of reasons for each major power’s interest varied.

The SSG used the results of the game to find that the policies and actions of the U.S., the major powers of Europe (Germany, France, U.K.), Russia, China and Japan held major sway over the strategic environment of 2010. No major power viewed armed conflict as a viable instrument for dealing with other major powers, particularly considering the implications of nuclear weapons use. The breakup of the Soviet empire was likely to leave a Russian/Central Asian core beset with economic, demographic and nationalities problems and unhappy with their reduced status. The Chinese historical vision of itself as the Middle Kingdom (spanning Manchuria, to Mongolia, to Indonesia) remained. These situations would provide the seeds for future conflict as the nations involved would try to extend their influence beyond their borders. The need to remain part of the world could temper Russian and Chinese designs to extend their influence. They concluded that conceiving the circumstances where major powers would become in armed conflict with each other by 2010 was difficult given the emphasis on economic growth. However, U.S. economic and security policy would have a large role in shaping the military policies and postures of traditional U.S. allies over the coming decades.

Regarding regional powers, they noted that concepts of the limited utility of armed conflict between nations had yet to take hold in the Mideast, Africa, South and Southeast Asia. Strongmen leaders could still devote major portions of their nations’ economy to military
expenditures and force their countries to war on their neighbors. Additionally, the Cold War thaw was bringing traditional Eastern European ethnic and national rivalries out of the deep freeze.

Regional powers would also serve as catalysts in the differing interests of major powers, affecting the security policies of major powers vis-à-vis each other. The Arab-Israeli conflict being a prime example. Even relaxation of tensions could give rise to other challenges. The unification of Korea (particularly if nuclear armed) would affect the regional balance of power in the Northwest Pacific. Harder to envision was the emergence of a sizable regional power or coalition challenging a major power with military means, such as a Sino-Indian conflict.

Regarding social movements, the combination of a growing disparity in wealth between developed and developing nations across short geographic distances with improved communications could foster movements within and between nation’s societies. Arab, Islamic, and Latin American militancy were examples that could provide future security challenges.

Seminars

Mimicking Shell’s use of scenario-to-strategy seminars, SSG X used the results of its research and gaming to develop scenario planning exercises for a wide variety of organizations involved in U.S. national security. They conducted scenario planning exercises with over 20 organizations, from the national security council and select U.S. government executive departments (Energy, Commerce, etc.), to allies, to various groups within the Pentagon, and think-tanks and the Pentagon press corps. The aims of these exercises were aimed at validating and complementing the research done by the SSG and identifying additional implications of the scenarios, and to begin generating a common vision as a framework for shaping/hedging national security policies. Individual seminars were four to six hours in duration with an average of twelve participants, including four SSG members. The seminars began with a detailed briefing by SSG members on the wide range of plausible future strategic environments to get the participants thinking in terms of the future circa 2010. Once the participants were familiarized with the issues bounding the future environment, they were asked to comment on specific implications of the future for their respective community and the naval services. The group used two approaches.

One team chose to focus on a wide-ranged, bounded, strategic environment designed for the year 2010. The choice was simply a plausible (neither optimistic nor pessimistic) future security environment. During the first half of the seminar the environment was briefed focusing on military, economic, and political descriptions and trends. The participants were invited to fine-tune their interpretation of the fairly general description during a focused brainstorming
In the second half of the seminar, four excursions involving Japan, Germany, the USSR, and Mexico were briefed and discussed in some detail. Using the previous discussion as the framework, participants were asked to look at these various strategic situations in order to identify the challenges, opportunities, and implications that would unfold during each excursion. The excursions served as a means to generate detailed discussions in order to highlight the forces that would shape future U.S. national policy, and defense and naval strategy necessary to deal effectively with unexpected events.

Two other teams presented a seminar that consisted of a briefing and an information gathering session. The objective of the briefing was to familiarize the audience with major trends and important issues that could determine the future. Each team used the same two unique strategic environments that had been crafted to accomplish this objective. These were not extreme boundary conditions, but were plausible and contained some common and some unique aspects. These futures were not predictive, but were tools to help the audience quickly identify both those aspects that were common to a wide range of scenarios, and those aspects that would shape unique outcomes. The briefings included a moderator-led discussion that attempted to identify and discuss those major aspects that were unpredictable but had the potential to dramatically change the course of events. The objective of the information gathering session was to harvest the audience’s ideas of the major aspects and trends that may shape the future, and identify implications, issues, and options.

A major finding of SSG X’s effort was that intelligence assessments provided an insufficient basis for national security and defense planning in that the foreign intelligence community was prohibited from assessing developments within the U.S. and U.S. actions were a dominant force in shaping the future security environment. SSG XI (1991-1992) picked up on SSG X’s work, focusing it more specifically on trends involving allies and potential adversaries with an emphasis on military forces. As with SSG X, they found that the role of the U.S. was a major determinant of the future and explored ways to shape the security environment as the U.S cut its military forces and the U.S. economy and population became a smaller portion of the world’s total. The Navy had just had its end-strength cut from a target of 600 two years before to 451 ships. SSG XI told the CNO that the Navy continuing to do business the way that the military-industrial-congressional enterprise (MICE) had done since WWII, cost growth and expected Defense budgets would result in a Navy approach 250 ships by 2012 (Hanley, Swartz & Steinitz 2016). The cost growth trends resulting from the structure of the MICE admitted reasonably accurate prediction absent significant changes.

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38 (Downes-Martin 2019) cites (Lehrer 2012) in questioning the value of brainstorming and suggests alternative methods more appropriate for conducting such seminars based upon recent research.

39 Increased DOD budgets following the terrorist attacks on 11 September 2001 and allowed the Navy to procure and maintain a modestly larger number.
SSG XI continued to conduct path games as part of their research, with even greater foreign participation – including Russian officials – but did not conduct the scenario-to-strategy seminars.

An Assessment of the Techniques

These SSG efforts followed many of the precepts for addressing wicked problems. Individually, in games, and in scenario exercises the group employed a wide variety of stakeholders from a broad range of disciplines to frame the future and understand the implications of various drivers. They were effective in mastering a complex issue, enhancing communication, stimulating creativity and creating a consensus on future developments and implications that were uncommon at the end of the Cold War (if familiar now). They were less successful at creating a commitment to action on the part of the Navy and the Pentagon.

SSG X and XI's descriptions of major trends and their implications for the future security environment were largely accurate over the next two decades. The terrorist attacks on 11 September 2001 represented a limited version of one of their wild-cards, with detrimental effects on U.S. privacy and spill-over effects on democratic processes. The U.S. invasion of Iraq represented a strategic set-back in legitimizing armed aggression in an effort to advance national objectives, though their judgment of the limited utility of force for that purpose remained valid. Initiating armed aggression is never as easy or productive as some would wish. Their expectation that Navy operations would be in the littoral supporting land operations against weaker opponents remained true, with the caveat of growing Chinese naval power emerging toward the end of their horizon. They noted challenges contributing to migration and refugees, but did not explicitly address the political reactions from more developed countries that weaken democratic processes and respect for international law. In general, their effort demonstrated that researching trends and conducting path games to frame wicked problems inherent in future security could provide valuable insights into future the character of the future security environment.

However, efforts to implement change were less successful. SSG X recommended to the CNO that the Navy adopt Shell’s approach of conducting scenarios-to-strategy exercises with its various organizations and commands. However, the CNO had adopted Total Quality Leadership, a variation of W. Edward Deming’s Total Quality Management, and had established an office to promote the program that used different strategic planning techniques. Though some of their recommendations for items like reorganizing the Navy staff were realized, their findings on the need to change Defense acquisition paradigms and practices had little effect, as did their broader findings regarding cost growth of health care and Social Security putting ever greater pressure on Defense budgets, and the need for greater cooperation among the Services, government agencies, and the U.S. and foreign governments and their militaries to address
transnational security challenges that none could effectively address on their own. Those required to take action on the SSG’s findings were not involved or invested in their gaming and seminars.\textsuperscript{40} Insight is insufficient for implementation absent specific efforts to generate a broad organizational consensus and commitment to agreed action among those setting policy and controlling resources, particularly when confronting well established paradigms and processes.

Though the Navy did not fully embrace SSG recommendations, as Schelling pointed out, the intense common experience in joint problems solving provided SSG fellows with social networks that resulted in ongoing collaboration to implement their concepts as they advanced to three and four-star ranks (Levine, Schelling & Jones 1991 p. 25; Hanley, Swartz & Steinitz 2016).\textsuperscript{41}

Revolutionary Naval Warfare Innovation

In 1995, CNO Mike Boorda changed the mission the SSG to serve as the nucleus of what was intended to be a process for the generation of innovative naval warfare concepts underpinned by emerging technology (figure 3).\textsuperscript{42} The SSG expanded to include officers from the Naval War College and Naval Postgraduate School to bring younger minds to the effort and to man concept generation teams studying different aspects of naval warfare (e.g. power projection, force protection, command and control, logistics, etc.). The intention was for the Naval War College to game concepts generated by the SSG, Navy Doctrine Command and Marine Corps Concept Development Command (MCCDC) to further develop the concepts and conduct operational experiments, and the Naval Postgraduate School to conduct additional research and analysis. Systems and doctrinal concepts adding significant value would then go into the formal acquisition and doctrine publication processes to create new operational capabilities.

The first innovation SSG in 1995-1996 identified the promise of information technology, integrated propulsion systems, unmanned vehicles, and electromagnetic weapons (rail guns), among other things. They laid out a progression from extant, to information-based, to networked, to enhancing cognition through networks of human minds employing artificial intelligence, robotics, biotechnology, etc. for warfighting command and sustainment. They proposed a netted system of numerous functionally distributed and physically dispersed sensors and weapons to provide a spectrum of capabilities and effects, scaled to the

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\textsuperscript{40} Navy leaders had been directly involved in the SSG’s gaming of campaigns for implementing the Maritime Strategy in the early 1980s, leading to rapid changes in war plans.

\textsuperscript{41} For example, Admiral Ed Giambastiani, USN worked with Amory Lovins from the Rocky Mountain Institute to improve energy efficiency in his commands and Vice Admiral Dennis McGinn, USN worked with Lovins to improve energy efficiency in ship designs as Deputy CNO for Naval Warfare, and following his retirement became a fellow at the Rocky Mountain Institute and President of the American Council On Renewable Energy (ACORE).

\textsuperscript{42} CNO Executive Panel briefing to CNO Boorda, January 1995.
operational situation. To begin, they recommended airborne advanced radar, advanced hull forms, prototyping unmanned platforms, tactical ballistic missile (TBM) counterbattery systems using AEGIS-ship like cooperative engagement to provide dynamic control of fire support for ground forces ashore, and developing an undersea cooperative engagement capability (Chief of Naval Operations Strategic Studies Group 1996).

Admiral Boorda passed in the Spring of 1996 and the envisioned innovation process never came to be. While the SSG continued to generate innovative naval warfare concepts over the next 20 years, the linkages to Naval War College gaming, the Naval Doctrine Command (later Naval Warfare Development Command) and MCCDC, and the Naval Postgraduate School never materialized. Boorda had envisioned allocating on the order of $100 million per year to each of several of the SSG’s concepts. However, the OPNAV staff decided that all of the SSG’s concepts either required more study, or that current investments were sufficient (Hanley 2018). Over two decades later, almost all of the concepts proposed in 1996 are now in vogue.

![Figure 3: Naval Warfare Innovation Process](image)

Gaming Naval Warfare Innovation

The SSG’s couple of months from concept generation to gaming had always been a challenge for the Naval War College’s War Gaming Department’s schedule and processes. By the late 1980s, the SSG was designing and conducting their own games, with facilities,
administrative, and some analytical support from the War Gaming Department. The SSG’s program typically called for three games. The first game was to introduce the SSG fellows to gaming and to current operational concepts. A second game was to explore initial concepts generated by the SSG. A third game was to evaluate refined concepts before recommending then to the CNO. Whether the SSG chose to conduct these scheduled games was each group’s prerogative.

The concept generation teams each set their own research agenda and spent the majority of their time visiting laboratories to enhance their understanding of emerging technologies. Getting the teams to focus on game preparations was challenging. Addressing the operational impacts of concepts for command and control, operations, and sustainment using greatly enhanced information technology was particularly challenging. Absent a clear adversary, the scenarios used for the games were fanciful.

Before the games the teams had not mastered the complexity of their concepts to the point that they had a common language or could draw a “diagram” of the type that Little and Fiske suggested. Though having many faults, the games were useful to the SSG for developing their language for mastering the complexity of diverse concepts working together, enhancing communications among the concept generation teams, and stimulating creativity. The kinds of insightful observations and that came from the games included:

➢ Red saved their most capable weapons for major Blue combatants. This allowed the minimally manned, small ships operating forward to conduct strike, reconnaissance, and freedom of navigation with relative impunity.

➢ One SSN equipped with an Advanced Deployable [underwater acoustic surveillance] System operating with each forward deployed battle group would allow rapid covert deployment.

➢ Tagging Red submarines, transporter erector launchers (TELs), and high value assets prior to their dispersal more effective than searching large areas.

➢ An ability to deploy unmanned underwater vehicles (UUVs) by air would be valuable.

➢ Innovative Blue forces were used primarily in traditional “force-on-force” applications.

➢ Using technical means to exploit or block enemy communications is challenging, particularly as encryption increases. Cutting off commercial service may be more effective, recognizing the legal challenges.

43 The author was the Deputy Director of the SSG during the period discussed here, responsible for the details of the SSG’s program within the Director’s intent.
➢ Need at sea transfer of missiles to keep platforms forward.  

As part of an outreach initiative, the SSG suggested three types of games for broader Navy participation: The SSG efforts to employ computer-based games and to reach out to partner organizations to create games supporting naval warfare innovation had limited success.

➢ A tactical tic-tac-toe that developed by the Naval Postgraduate School would allow teams to play against each other, but with delays in communication and without perfect knowledge of opponents’ moves, to provide insights into the effects of asymmetrical knowledge. It would also get officers into the habit of playing games.

➢ Theater level games run by NWC that would allow Red and Blue teams to try innovative concepts against each other, with the NWC gaming staff providing adjudication. The SSG would monitor these games for promising concepts.

➢ A third kind of games would be put on the net, targeted at evaluating ideas provided by the Concept Generation Teams (CGTs). The CGTs would help create new models needed to evaluate their ideas properly. The models would be available to the Navy office responsible for assessments to further evaluate any concepts brought forward for demonstration.

The SSG’s outreach initiative came to naught as the naval warfare innovation process lacked funds and failed to organize coherent efforts.

In working revolutionary naval warfare innovation, the SSG fellows never truly accepted the need for analytical justification of their concepts. The concept generation teams used the analysis if it supported their positions, but ignored it if it did not. The wargames were too cumbersome without giving clear results. An assessment from 15 years with the SSG was that though every SSG had an analytic component, overall, SSG analysis and games had been weak and except for a few cases had negligible impact on the final SSG product.

The SSG did pursue one initiative of employing the electronic game Fleet Command to explore different fleet designs. Though graphics were difficult to change, the game used Excel spreadsheets for platform characteristics that were relatively easy to modify. Other aspects of the game presented additional challenges. However, though some SSG fellows fiddled with

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44 Lieutenant Commander Brent L. Boston memorandum to Dr. John Hanley, Subj: SSG 2020 Wargame Observations, 19 April 1996.

45 Dr. John T. Hanley, Jr. memorandum to Admiral Jim Hogg, Subj: Topics for Discussion with CNO, 12 January 1996.


47 Alan H. Krulisch, SSG Wargaming Review Follow-Up, 10 April 2010.

Fleet Command over the years, the group changed their exploration and evaluation exercises to techniques like Quality Functional Deployment to rank concepts rather than employ them in operational games.

Gaming is part of a wider ecology. In the 1980s, the CNOs and the Navy leadership paid close attention to war gaming as part of a cycle of research, resulting in rapid changes to war and contingency plans. In a speech to the International Seapower Symposium at the Naval War College in 1984, CNO James Watkins extolled the virtues of gaming and offered War College gaming to the heads of international navies (Hanley, Swartz & Steinitz 2016). As “non-traditional” security challenges came to dominate in the 1990s, military challenges and opportunities became even more wicked. The models and underlying language of gaming became more abstract, to the point where games became more like seminars. Effectively, this level of abstraction made gaming more like chess before the von Reisswitz’s depictions, as von Müffling said, closed the gap between “the serious business of warfare” and “the more frivolous demands of a game.” For games to affect the serious business of warfare, or analogous situations in society and business:

➢ scenarios must be compelling,
➢ mental maps must be clear enough to know how the “terrain” affects speed of interactions of the units involved,49
➢ scouting/intelligence and communications dictating which actor knows what, and when, needs to be accounted for,
➢ rules for the outcomes of interactions need to be established by knowledgeable umpires, using exercise and operational data wherever possible.

These are the features of Reisswitz the older and the younger’s that turned chess-like games into substantive war games. These are the features that need to be incorporated in a game to master the complexity of the contingency under study and create consensus and a commitment to action. The gaming environment will enhance communication and stimulate creativity even in the absence of the features needed to compel action.

The further into the future that games project, including games aimed at informing today’s resource allocations for decades out horizons, significant effort is required to ensure that above the above features are compelling to compete with established processes and programs. If the organization does not share a different conceptual depiction of challenges and opportunities, it will not change course.

49 In cyber gaming this includes physical, logical, persona cyber terrain. In bureaucratic games this involves the bureaucratic terrain.
Gaming to Change the Futures Paradigm

A major premise for futures gaming in the Department of Defense is that it takes 20 years to field the next generation of major platforms (aircraft, ships, armor, etc.). Acquisition process call for intelligence to projects threats into the distant future and significant efforts go into the Services developing future scenarios against which to assess the value of their investments. This system was developed during the Cold War when projected force structures were a major aspect in maintaining deterrence and the international situation was largely frozen by relations between the U.S., Soviet Union, and their allies and partners. Technology development and adoption is advancing at a super-exponential pace. Whether this pace can be sustained depends upon continuous innovation (West 2018). Rather than attempting to peer out to the distant future, the structures that underlie the MICE, particularly Defense program planning and acquisition practices need to adopt a paradigm of providing capabilities in months to years, rather than decades.

Gaming can play a useful role. Here the stakeholders are the military with its acquisition professionals, industry supporting the military or that the military needs to support it, and their legislative authorizers and appropriators in the roles of champions, sponsors, gatekeepers, and transition authorities. The games would be addressing the wicked problems involved in rapidly acquiring military capabilities.

Again, sound practice will require games to be part of a cycle of research. The cycle should include experimenting with concepts that show promise in games, and further modeling and analysis. Given the complex nature of the acquisition system resulting from the interactions of many stakeholders operating under different rules and incentives for providing value, using agent based models and genetic algorithms could suggest system rules and values leading to better outcomes.

More effort needs to go into studying the systems for preparing for war as DoD puts more effort into analyzing “war proper,” to paraphrase von Clausewitz.

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About the Author

John T. Hanley, Jr. served as a nuclear submarine officer after receiving A.B. and M.S. degrees in Engineering Sciences from Dartmouth College. Following active duty, in 1977 he joined the Navy Reserve, and worked with a small consulting firm on fleet exercise analysis. This led to his becoming affiliated with the Chief of Naval Operations Strategic Studies Group for 17 years where games provided a major technique for exploring and evaluating concepts. The effects that his modeling and analysis work were having on Navy strategy convinced him to pursue a Ph.D. in Operations Research and Management Sciences at Yale University while working with the SSG. He wrote his dissertation on war gaming and graduated in 1991. Following the SSG he served as Special Assistant to Commander-in-Chief U.S. Forces Pacific, at the Institute for Defense Analyses, and in various senior positions in the Office of the Secretary of Defense and the Office of the Director of National Intelligence. Following his retirement from government in 2012 he has returned to the study of serious gaming and supporting various projects as an independent consultant. Dr. Hanley is a Non-resident Research Scholar at the Naval War College.

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Brand New World
(with apologies to Aldous Huxley)

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“He who is everywhere is nowhere” (Seneca the Younger)

The future cannot be predicted with any degree of certainty or accuracy. A wargamer is well able to construct and consider a future operating environment but must consider both how this is accomplished and what benefit such an endeavor produces. The futurist brings methodologies that allow for the identification of variables that can be fashioned into a plausible representation of the future. The key in wargaming the future is thus the fusion of the talents of the futurist and the wargamer in the construct of a game that both represents a plausible future and permits the identification of the governing factors which shape that future. Identification of these governing factors can support intelligent speculation upon what action must be initiated in the present in preparation for what is to come. Work must be undertaken to specify the best practices necessary to fuse the fields of the futurist and the wargamer in the art and science of gaming the future.

Frederick the Great, a student of Roman literature, may well have adopted his famous “He who defends all defends nothing.” from Seneca. If so, we may take the liberty to say that “He who prepares for all contingencies prepares for none.” And yet, prepare one must. This implies a sense of the future and a reasonable appreciation of the competitive environment that will exist and the advantage that must be acquired for success. Thus, preparation for the future requires the identification of ends, the selection of ways, and the securing of the means based upon the projected conditions for success in a future operating environment. The key is to “learn fast enough to sustain a competitive advantage.” (Mason 2009 p. 1)

What then is the future? The answer to this question is to be found in understanding the past. History can be understood as the marriage of events and their causes which merge and emerge to produce the trends that comprise the present ... the here and now. Trends are “concrete forces that...have high impact on the strategic environment and are highly predictable over the planning horizon” (OPNAV N51 2010 p. 2). Examples of trends are such major muscle movements as Demography, Technical Proliferation, and Information as a Weapon. The present is the synthesis of these past trends and their consequences which have been modified by the friction of an historical context (political, economic, military, cultural, etc.) that both limits and shapes the extent of what goes forward. In recognizing this dynamic, the future is understood to be a continuation of this process marked by the sensitivity, variation, and uncertainty which are characteristics of a complex process....a process determined by the
interaction of time, historical context, available material, operative ideas, and human action that makes for a capricious path forward. This complex process means that it is easy enough to identify the current general trends and an approximation of the principles that drive them, but difficult to gauge the resulting trajectory in time. This is so because, as obvious as general trends can be, they are connected by interlocking dynamics that are immersed in change, disruption, and hidden details so as to prevent precise calculation.

Thus, the future represents an evolving contingency marked by the extremes of uncertainty, sensitivity, and variation with confluences at critical junctures which can exaggerate or suppress estimated deviations and deflect expected trajectories. The attempt to predict the future is marked by certain miscalculation, accident, and frustration. The secret to considering the future is to forsake the standard of perfection and seek plausibility based upon a defined spectrum of probable outcomes. In this endeavor, wargaming can be of assistance.

As a wargamer considers applying his art to the problem of the future, he quickly realizes that the problem is not “can I wargame the future?” but “how do I wargame the future and to what benefit?” A wargame that considers the future can be designed with any competitive environment desired and with a proposed problem to be addressed. You want to examine a future interplanetary war driven by conflict on Mars? Simply construct the environment and state the problem. In short order, a scenario and supporting design can be assembled and the study can commence. SPI’s “BattleFleet Mars” from 1977 is an instructive example.

However, the problem here is obvious. Because the game is separated from all but the most universal of trends and is finally based upon construct, supposition, and speculation, the results of the game are of dubious benefit to an analysis of future environments and their requirements. This is so despite the fun one may have had commanding a battle fleet of spaceships. Again, the problem is not “can” I wargame the future but “how and for what benefit.”

At this point, a synthesis of skills must be proposed. Separated, the futurist and the wargamer are devoid of the necessary skills to examine the future and extract both insights and direction. The futurist is one who possesses the skill and foresight methodologies necessary to both construct and evaluate an ever receding set of plausible alternative futures based upon general trends and associated assumptions that exhibit both a rate and level of change. The wargamer can then take these proposed futures, abstract problem, hypothesis (if...then), and objective statements based upon the projected operational environments, and design the vehicle necessary to consider this dynamic context and the associated proposed responses required to operate successfully in those environments. In a word, the wargamer can employ the work of the futurist in a construct that permits the examination of a future and the responses to that future given a definition of what constitutes success. This is “how” to wargame the future.
Complexities will abound in this process because of the need to coordinate intelligence estimates, political, cultural, economic, and demographic trends, government policy, scientific and technical progress, and shifting relations in power. Thus, a futurist and a wargamer must experience a fusion of both purpose and talent in projecting the future environment and designing a wargame to consider it. The wargame will become a kind of solvent in which disparate elements, estimates, and speculations about level, kind, rate of change, and interaction among variables will have to co-exist. A good futures wargame will require many coordinated qualifications that address assumptions, account for factors, and define contingencies. The futurist and wargamer will have to live in each other’s fields and this confluence should have the added benefit of strengthening the understanding and reinforcing the cooperation between these two fields of practice.

Like the wargamer, the futurist relies upon a stable process for considering the future but is confronted with a spectrum of ways in which that process can be employed in the service of trends and objectives. An initial consideration is to distinguish between forecasting the future, which entails following a collection of trends with estimated deviations and arriving at a point, with the development of alternative futures, which entails developing a collection of alternative strategic environments that bound a region of plausible outcomes each characterized by an overarching descriptive title that is developed in detail in the accompanying scenario document. Figure (1) provides an example of the possible alternative strategic environments that might emerge in a hegemonic world in which economic or military power is the driving force (the scope) and the extremes (the scale—dominant or straitened) of the US position in such a world are the matters to be considered.

**Hegemonic World**

<table>
<thead>
<tr>
<th>Economic</th>
<th>Military</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dominant</strong></td>
<td></td>
</tr>
<tr>
<td>Front Row America</td>
<td>Trump Card</td>
</tr>
<tr>
<td><strong>Straitened</strong></td>
<td></td>
</tr>
<tr>
<td>Place In the Sun?</td>
<td>Sleep of Reason...</td>
</tr>
</tbody>
</table>

Figure 1. An example of U.S. alternative strategic environments in a hegemonic world.
Peter Bishop (Bishop 1998 pp. 29-42) poses a series of questions and answers that act as a guide to the selection of a methodology for thinking about the future. Without exploring the deep value contained in this approach, several highlights will serve to establish some parameters. A defining idea is that the best way to think of the future is not to expect to be right, but to avoid being surprised. This strengthens the desirability of considering alternative futures rather than trying to achieve a precise forecast. Thus, one is led to consider the value of probable, plausible, and preferable futures. He states that a probable future is one in which surprises don’t greatly affect the trajectory of time; a plausible future incorporates the consideration of and emphasis upon selected variables which expand the range of outcomes; a preferable future is the definition of an optimum future state in which advantage and benefit are maximized. The latter represents an interesting condition in which context, material, and ideas coalesce to define a consensus goal which informs concerted action. This suggests a systematic way in which action today determines outcomes tomorrow. In a word, while it is not possible to obtain an accurate prediction of the future, it is certainly possible to deliberately influence the future and achieve what is preferable to a degree. The point here is not that this idea is new, after all planning is an ancient art. The point is that by systematically considering alternative futures, assumptions can be refined, implications can be anticipated, and a design and priority of work can be arranged and coordinated such that a preferable future is more likely to result. Peter Bishop concludes by emphasizing the importance of the result of this process … the establishment of a general direction for fundamental change.

From a wargamer’s perspective, how might the identification of this advantageous fundamental change be achieved and the path to attainment be established? One course of action, which can be considered in the fusion of the futurist and wargamer’s methodology, involves the identification of the future operating environment and the advantages required for success (futures process) combined with the ability to formulate, examine, and assess the direction to be taken, the advantages to be gained, and the exploitation to be achieved (wargame). A wargame will permit a close inspection of the core principles needed to influence the environment and obtain advantage. These core principles are the governing factors which drive the dynamics of the future environment. Governing factors delineate the operational functions and trends that must be capitalized upon to achieve success. The definition of success and its associated metrics provide the basis for assessing the misdirections and distractions that can be induced by the kaleidoscope of future events, patterns, and tendencies exhibited in the competitive operating environment. Knowledge of this dynamic, if not understanding of the mechanism, is what can convert governing factors into operational acts of persuasion or imposition that generate conditions for exploitation. Thus, while the core principles specify the dynamics of an environment, the governing factors are those elements that can be manipulated, combined, and arranged to impose, persuade, induce, or deceive an adversary into a commitment that can be exploited. This places an adversary in a counterintuitive position.
where direct actions arrayed against him can organize an environment in unpredictable ways, cause risks to be exaggerated or obscured, turn strength into weakness, and cause counter action to be miscalculated and so generate transitory moments in which counter strikes can prevail. This is the “benefit” derived from a wargame that considers the future.

Thus, a productive fusion emerges. While the futurist identifies the trends that will produce an operating environment, the wargamer sets this environment in motion driven by appropriate dynamics to identify the governing factors whose proper arrangement and utilization become the key to understanding and anticipating the conditions required, the preparation necessary, and the consequences expected in gaining advantage and success in the future operating environment. This is the “how” and the “benefit” fused. This process is made more powerful when several alternative futures are examined in an integrated series of wargames and governing factors common to a set of or to the whole of the alternatives are identified. Figure (2) below is a preliminary illustration of the proposed fusion between the art and science of the futurist and the wargamer.

![A Fusion: The Futures Wargame](image.png)

**Figure 2.** The fusion of the art and science of the futurist and the wargamer.

The phases of this process establish a construct in which identified trends and attendant uncertainties are converted into a classification of prioritized criticalities and resulting projected environmental, operational, and functional consequences.

**Phase I (Synchronize Complexity).** From the perspective of the present, categories of trends and uncertainties are identified and ordered by the power and ability to drive change. This
becomes the basis for the development of a decision trajectory in which the futurist selects among weighted alternatives, evaluation of effects, and forward direction to define an emerging baseline future.

Phase II (Synthesize Complexity). Having established a baseline future, trends and drivers are now combined, organized, and arranged into constructs which produce alternate strategic environments (e.g. The Political World, The Technological World, The Resource Constrained World, etc.). These scenarios are developed using a planning process such as proposed by Jay Ogilvy (Ogilvy, J. 2015 pp. 1-10) and that creates environments which should be constituted to cover a spectrum of possible futures and may focus on plausible, preferable, and portentous futures which permit an examination of alternative possible strategic environments that are created by emphasizing different combinations of trends found in the baseline future.

Phase III (Classify Complexity). With the completion of an integrated series of wargames that examine the selected alternative strategic environments, assessments will produce the identification and isolation of the resulting governing factors which represent the key operational functions and trends in that particular environment. With governing factors in hand, the classification of the criticality and operational consequences in that environment can be identified. Finally, the identification of those governing factors that are common to all or a set of the strategic environments examined can be assembled.

With these three phases accomplished, a feedback mechanism is employed allowing for action to be initiated that can shape the strategic environment and influence the attainment of the preferable future. Incorporating the newly won understanding of the common governing factors into the previously constructed baseline future permits an approximation of what must be done to obtain a preferred result. Alternatives (What if?), meaning (So what?), implications (What’s next?), and imperatives (What must be done?) can be assessed and evaluated. From this, a resulting composite strategic baseline future environment can be constructed that contains both what is predictable and what is uncertain. This composite future environment becomes a basis for the action needed to identify “how to fight” in that environment, what capabilities and capacities are required, and what force structure is needed to operate, prevail, and successfully exploit that strategic environment.

The ability to generate, consider, examine, and respond to the Brand New World is dependent upon the fusion of the art and science of the futurist and the wargamer. Isolated, the futurist can propose environments based upon trends, uncertainties, and related dynamics; the wargamer can design and play “BattleFleet Mars”. But, the study of future environments without the ability to examine dynamic responses, propose outcomes, and consider initiatives is merely academic; the play of a game without an environment grounded in plausibility, oriented against a real problem, adopting an assayable hypothesis, and considering specified objectives is merely fun. Separated, the future process and the wargame lack animation; fused,
the combination is one of power and utility. The futures wargame will harness the ability to examine the science of the necessary with the art of the possible in a future operating environment. Most importantly, the futures wargame could be instrumental in dispelling the illusion of certainty that sometimes emerges in a bureaucratic rationality burdened by limited understanding and capacity, constrained information and vision, and driven by external urgencies that compress both time and deliberation. The more an organization can represent a future competitive environment and consider the dynamics of that space, the more likely that organization is to get the Brand New World “roughly right” instead of “precisely wrong”. It is much more profitable to shape a response to the former rather than the latter. Seneca the Younger would be pleased.

The question is now the practical one of how the skills of these two fields can be fused in the execution of a futures wargame. A way forward suggests itself….and Connections can lead the charge. The Marine Corps will host Connections ‘20 and will propose a workshop topic of “Practical Futures Wargaming” for discussion which can have as its basis the work accomplished in Connections ‘19. As part of that effort, academic and industrial futurists will be invited to explain the art and science of their field and consider the use of these principles in wargame design. A supporting line of effort can then be subsequently initiated in which a core group of futurists and wargamers can engage over the course of several months to design, execute, and assess a simple, focused futures wargame that will permit the concept to be examined and demonstrated. A report of progress, problems, and potentials can then be produced and delivered to Connections ‘21. In this way, the value of this fused approach can be practically considered, a methodology proposed, and the relationships necessary to continue the work can be forged.

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About the Author

Dr. William J. Lademan is a retired Marine infantry officer. After service, he spent over a decade in academia and the chemical industry before joining a consulting firm as a wargame designer. Currently, he is the Technical Director of the Wargaming Division, Marine Corps Warfighting Laboratory, charged with the execution of the Wargaming Program in support of examining Service concepts, combat development, and operational plans. He is also involved in the planning for the construction of the Marine Corps’ purpose-built wargaming center and the development of the Next Generation Wargame it will facilitate. He is a life-long lover of baseball, books, historical miniatures, and the wargaming hobby.

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Wargaming the Future Requires Rigorous Adherence to Best Practices

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“Games have one quality that separates them qualitatively from straightforward analysis and permits them to generate insights that could not be acquired through analysis, reflection, and discussion. That quality can be illustrated by the impossibility theorem: one thing a person cannot do, no matter how rigorous his analysis or heroic his imagination, is to draw up a list of the things that would never occur to him.” -- Thomas Schelling

Abstract

Because the future is uncertain and ill-defined, wargaming is an ideal tool with which to examine it. For the same reasons, wargaming must be applied simply and effectively. And a wargame that scrys even the furthest and dimmest future is still just a wargame, albeit with different variables involved. Technology will become ever more important and must feature in our games, but the future will still be shaped by humans. Wargames are people-centric in terms of their play, control and analysis. Computer-assistance (artificial intelligence, machine learning, agent based modelling etc.) has a role to play in supporting our wargames, but we cannot (yet, if ever) computerise the vital human ingredient. Rather, we should adopt a ‘back to basics’ approach to ensure that wargames make an effective contribution to future-gazing. Professional wargamers must ensure that they design, develop and execute their games applying wargaming best practice rigorously. This paper suggests that the following characteristics should feature in wargames that examine the future: appropriate adjudication; appropriate supporting technology; wargaming within a wider context; small, cheap and frequent wargames; rigorous analysis; the primacy of player decisions; freedom to fail; simplicity; including ‘soft’ and human factors; adversarial; oppositional; effective control; and fun. Perhaps surprisingly, chance and uncertainty are less important characteristics.

Introduction

Wargaming the future is hard! Gaming situations decades ahead intensifies the uncertainties inherent in every model, parameter and assumption. The technologies and factors involved will be different to today’s, and the combination of possibilities could easily cause our games to spiral out of control. ‘Black Swan’ events and discontinuous trends are, by definition,
unlikely to be identified and acted upon. However, wargames that examine the future are still just wargames.

The ‘so what’ from this is that to effectively wargame the future we must adopt a ‘back to basics’ approach to apply wargaming best practices ever more rigorously. The practices we suggest in this paper are based on the ‘Guidelines for good wargaming’ in the MOD Wargaming Handbook (MOD 2017). However, we have expanded these according to a forthcoming book (Longley-Brown 2019) and re-ordered them into an approximate priority order that relates to their application when wargaming the future. All points discussed are practical suggestions that pertain to all wargames. They are not new or revelatory, but they are writ large when we attempt to scry a dim and indistinct future. All must be considered and, unless there is good reason not to, rigorously applied when wargaming the future.

**Appropriate and ‘deliberative’ adjudication**

Adjudication is discussed under ‘Control’ and ‘Transparency’ in the Wargaming Handbook (MOD 2017). We think it warrants not only a separate discussion, but that it is top of the prioritised list of characteristics to ensure effective future-gazing wargames. Figure 1 shows adjudication approaches and methods, models and tools (MMT) that can be applied to wargames. A glance tells you that, when wargaming the future, we are on the left-hand side of the ‘real-world applicability’ area, considering ‘wicked’ (messy) problems that demand creativity and original thought. On the ‘levels of discovery’ continuum, we are trying to increase initial understanding, but hopefully eliciting the odd insight along the way. Wargaming towards the left side of Figure 1 suggests that appropriate adjudication approaches are ‘consensual’ and ‘free.’ Should any ‘semi-rigid’ adjudication be used (and we think that a stretch target), it is essential that this be presented in a *deliberative* style. I don’t know if ‘deliberative’ was coined by RAND, but I first heard it used by Stacie Pettijohn at Connections UK in 2016. It means ‘relating to or intended for consideration or discussion.’ In the vast majority of the wargames delivered by the authors (certainly the analytical ones), we present semi-rigid ‘outcomes’ completely transparently, and only as a starting point for informed group discussion, with an opportunity to moderate the outcome according to the collective examination and the wargame’s aim and objectives.

51 The outcome is discussed in a committee of several, or all, players and Control staff and a decision reached, ideally by consensus.

52 The outcome is determined by a lead adjudicator, but again after an informed and open discussion.

53 Based on look-up tables, but presented for discussion and potential moderation.

54 OED.
But this deliberative approach should also be applied to consensual and free adjudication. Firstly, by bringing the players into the adjudication process, it makes it clear that no outcome in the game is assumed to be valid, and must be discussed transparently. Just as important, the deliberative approach forces discussion. This as opposed to ‘open’ adjudication which is simply a transparent presentation of an already-determined outcome. As well as engaging everyone in the adjudication process, the forced conversation: assists player recall; enhances data capture; and reinforces the nature of the wargame as an act of communication.

**Appropriate supporting technology**

The MMT examples towards the left side of Figure 1 include role-play, argument-based, human-in-the-loop (HITL) determination and moderation. There is limited scope for Operational Analysis (OA) and almost certainly no role for computerisation (subsuming decision-making, adjudication and control functions wholly into a computer) until artificial intelligence (AI), machine learning (ML), agent based modelling (AMB) etc. advance considerably beyond their current state - and possibly not even then. Computer assistance will feature with respect to
data capture, distributing situational awareness etc., but these functions are discrete from computerised models that adjudicate outcomes, determine statuses etc. The point is that the most appropriate MMT when wargaming the future are manual and human. This, perhaps obvious, statement must be explicitly recognised to pre-empt the pro-technology biases prevalent in wargaming. Clearly, the future will be fundamentally shaped by emergent technologies, but the attributes of those cannot be programmed into a computer or turned into algorithms with any validity whatsoever, so considering their impact in wargames must remain a human function. MMT should include role-play because, while the future will be shaped by technology, the influence of humans will remain the predominant factor – until the machines eradicate us all.

**Wargaming within a wider context**

Wargaming towards the left-hand side of Figure 1 will increase our understanding and elicit observations and insights. This reinforces a basic truism of wargames: they raise questions, and do not provide answers. It is particularly important to recognise this when wargaming the future, and to ensure that any wargame is tightly bound into a wider ‘cycle of research’. Questions and insights arising from wargames are inputs into this wider cycle of research. As with all the points discussed in this paper, that should be the case now. But wargaming the future demands an even more long-term and enduring programme of activities. Any Integrated Analysis and Experimentation Campaign Plan (IAECP) must ensure the ‘campaign’ aspects. As now, the IAECP should interleave trials, field or at-sea exercises and other forms of analysis with wargames – but the timescales required and inevitable variances along the way demand a robust, enduring and stable programme of activities based on bold visions of the future. One direct read-across from other areas of an IAECP that we have found useful are ‘capability cards’. A lead SME (champion) is responsible for developing a specific capability or technology. During the wargame s/he can brief this prior to play starting, during execution and/or during post-game analysis. This informs player decisions and enables a greater understanding of the impact that capability might have - accepting that we are still addressing the vagaries of far-future technologies. However, we struggle to achieve the cycle of research now; such a long-term IAECP will be even more challenging.

**Small, cheap and frequent wargames**

One way to mitigate the vagaries of budget constraints and politics on such a long-term IAECP is to hold small, cheap and frequent wargames. Outputs from these could include:

55 Peter Perla introduced the “cycle of research” (Perla 1990) and updated this in Zones of Control (Perla 2016). Albert Nofi supplemented this (Nofi 2011) in the end-piece to the 2011 edition of The Art of Wargaming (Perla 2011). Cdr Phil Pournelle developed the concept further (Pournelle 2014).
generating scenarios and vignettes for subsequent examination; shaping and focussing future IAECP effort; and identifying topics for ‘deep dives’ or specific analysis. Any of these outcomes could feed into any part of the IAECP, including subsequent wargames. Player and SME time is always at a premium, with participants reluctant to devote lengthy periods to gaming. Instead of running a 2-week wargame, an alternative approach might be to run a series of 1-day games. These might start with a high-level game where players ‘world-build’ the scenario they will then wargame within. The next event could be executing a scenario to create a baseline (maybe using just contemporary capabilities) and identify key areas of interest. These two events require all players, and get everyone into the future world (which they helped build). Subsequent days could then concentrate on different environments (space, air etc. – some call these ‘domains’). These only require players and SMEs germane to that environment, plus a representative of the other environments for completeness.

Furthermore, restricting game play in this way limits new technologies and variables to a manageable number, pertinent only to the environment or facet of the future being examined on that day. Hence, ‘small’ applies to a bounded number of ‘subjects of analysis’ as well as the number of players.

Alternatively, a series of small, iterative games, each using the same starting situation, should elicit plausible ‘arcs’ (paths), and factors and observations that occur consistently enough to justify further examination with increased confidence in them, and which warrant greater effort. The current tendency to hold large, infrequent and expensive wargames does not deliver enough observations and insights to enable effective comparison and derive commonly occurring factors.

Rigorous analysis

Eliciting the required observations and insights demands rigorous analysis pre-game, in-game and post-game. Analysis starts on day 1 of project initiation and is constant throughout. But it is aspects of the in-game analysis that we want to highlight, in particular facilitating discussions and prompting data capture. Wargames are an act of communication. Getting all players to express their views, and then capturing these, can be a challenge. As well as mitigating the issues of group biases, dominant personalities etc., it is important that assumptions are explicit and captured: there will be many of these, and they will underpin the analysis, so they must be clear and apparent.

We also find it necessary to include in-turn agenda serials that explicitly demand the consideration and discussion (thus assisting capture) of observations and insights. These interventions detract from the story-living nature of a wargame, and so need consideration as players often do not want to be distracted from the developing narrative. The agenda items we use, either in-turn and/or at the end-of-turn, are:
Asking ‘What if?’ questions. This elicits insights, including ‘known unknowns.’

Asking ‘So what?’ questions. This drives innovation and elicits insights, including ‘unknown unknowns.’

Critical Thinking. This ensures that assumptions are challenged and biases are mitigated, as well as injecting diverse thinking and alternative perspectives and outcomes.

Consequence Management. We insist on exploring the second- and third-order effects of the players’ decisions and in-turn actions. This frequently reveals unintended consequences, and forces discussion of the potential impact of in-game activities on human terrain at all levels.

Furthermore, we have found it useful to constantly ask the simple question ‘Why?’ every time a player announces a decision until the necessity for them to explain their rationale is instilled and they do this automatically. It is tempting for players, analysts and Control staff to rush to find out what the adjudicated outcome of a decision is, without pausing to examine the crucial reasons why the decision was taken, the factors considered and the options rejected. All of these must be communicated and captured, even though this can break the story-living flow of the game.

The primacy of player decisions

The analytical and in-game data capture approaches discussed above are predicated on qualitative outcomes and insights. The quality of these depends on having the right players making the decisions that, along with their rationale and the insights elicited, are captured. Wargaming the future demands an even more rigorous approach to ensuring a high-quality player contingent. We find the following necessary:

Careful selection. Too many wargame players are selected using the sole criteria of whoever is available. More attention is required in this crucial area. As well as a thorough consideration of what cells and posts are required, it is crucial to have the right person allocated to the right job. Achieving this will have a cost implication, but is critical.

56 Aka Red Teaming. Both terms are extant, but the experience of the authors is that most people use ‘Red Team’ to refer to the enemy cell. Properly, that is the Red Cell, but the use of ‘Red Team’ as a moniker for the enemy is so widespread that we find it easier to use Critical Thinking to avoid confusion.

57 Stephen Downes-Martin notes that this is similar to the ‘5-why’s’ method in common use in management consulting. It’s an example of a good technique from elsewhere that wargamers should pay attention to.

58 Participant selection is starting to receive the attention it deserves, but more work is required. See for example (Bastian et al 2015, Brynen 2015).
➢ **Diversity.** This across and within player cells. It is often the least likely participant who tables the ‘killer insight’ or identifies the unknown unknown. Such insights must be enabled by facilitators (whose task it is to ensure everyone’s voice is heard) and sponsor (whose task it is to staff the wargame). As many areas of expertise should be covered as is practicable within the game’s objectives. While it is probably not feasible to cater to all of these, we find that it is particularly important to include the social and political sciences to counter-balance the assumption that future-gazing should focus on technical factors.

➢ **Briefings.** It is incredibly difficult for players to take the cognitive leap into the future, and any assistance to this end pays dividends. Who can truly project themselves into an immersive environment that features a world beyond NATO, 3D printing obviating shipping routes or 100% non-fossil fuel energy? Briefings as to what the future might hold can help players get into the required mindset.

➢ **Role-player preparation.** We have already discussed the importance of role-play. In order to actually put players into role (as opposed to the less-effective normality of asking people to merely play a role), significant effort is required to properly develop briefings and guidance for role-players.

Beyond all that, and with the right people in the room, it is then incumbent on the wargame facilitator, Game Controller, Game Director and sponsor to ensure that player decisions determine the course of the wargame. This is current best practice, but often skewed by personal or institutional agendas. Any instance of this will curtail the open-mindedness and innovation required when future-gazing.

### Freedom to fail

The ‘safe to fail’ open-minded and innovative mindset must further be engendered by making it absolutely clear that failure is not only permitted, but is preferred. Exhorting players to try everything they can possibly imagine, testing plans and assumptions to the limit, encourages players to break through their imagination’s glass ceiling into *terra incognita*. If we do not achieve that, our hide-bound assumptions that the future will be an extrapolation of current trends will limit our ability to elicit the required insights. Encouraging players by overtly recognising innovation over ‘victory’ works well, as do simple measures such as awarding a prize for the weirdest idea that might actually work.

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59 See (MOD 2017) for explanations of these roles.

60 See (Downes-Martin 2015).
Simplicity

The future is complicated enough already, without adding unnecessary complexity by way of superfluous wargaming mechanisms. Einstein, who knew a thing or two about the future, told us to ‘Keep everything as simple as possible, but no simpler.’ The ‘So whats?’ are: tend towards the left-hand side of Figure 1; examine topics in chunks that are small enough to be manageable; and keep any wargame that examines the far future as simple as is sensible.

‘Soft’, non-kinetic factors and human factors

Until the point when humans are assimilated into the Borg collective, farmed to power the Matrix, succumb to the Daleks or the Vogons destroy the Earth to make way for an interstellar by-pass the future, like warfare, will remain a predominantly human endeavour. Clearly, technology will increasingly feature, and might even be the principal factor in many wargame scenarios, but we ignore soft, human factors at our peril. Too many current wargames do this, somehow envisaging conflict that is not fought among the people. Such games, conducted in a sterile, kinetic environment risk undermining our understanding of conflict, not enhancing it. This will be the case as far into the future as we care to gaze. Wargaming the future must include representation and consideration of soft, non-kinetic factors.

Adversarial

‘Adversarial’ is at the top of the list of characteristics in the Wargaming Handbook, so why have we relegated it to so low a position? This is not because it is unimportant; it remains critical that our plans and grand schemes are exposed to a live adversary, trying to impose his or her competing agenda or world view on us. If we did not do this, we would not be

61 This might be a compressed version of lines from a 1933 lecture by Einstein: “It can scarcely be denied that the supreme goal of all theory is to make the irreducible basic elements as simple and as few as possible without having to surrender the adequate representation of a single datum of experience” (Robinson 2018).

62 The Borg are a civilisation of cyborgs (hence the name ‘Borg’) which seek to conquer or ‘perfect’ all life. The Borg have a singular goal, namely the consumption of technology and to ‘raise the quality of life’ of the species they ‘assimilate’. www.stratrek.com

63 The reality perceived by humans is actually the Matrix, a simulated reality created by sentient machines in order to pacify and subdue the human population while their bodies’ heat and electrical activity are used as an energy source. www.matrix.fandom.com/wiki/The_Matrix

64 The Daleks are one of the most feared races in the universe. Their creator, Davros only has one intention: destroying all life apart from Dalek life, www.thedoctorwhosite.co.uk/dalek/

wargaming. Furthermore, we must ensure that neither side has an inbuilt technological advantage.⁶⁶

Adversarial is placed low on the list because, if we do not get the basics right, any future-gazing wargame is likely to be sub-optimal. Hence the most wonderfully adversarial game play will likely be nugatory. Wargaming the future must feature innovative and determined adversaries, playing their anticipated capabilities to their full potential. However, the games must privilege the characteristics discussed above over adversarial game play.

**Oppositional**⁶⁷

So, too, with oppositional. We have discussed Critical Thinking, which is a primary mechanism for injecting oppositional factors. The point to add is that *all* players must be Critical Thinkers, scrutinising their own, and everyone else’s, plans and assumptions. The ‘Critical Thinking’ agenda item must be an invitation (demand) to all players – not just nominated Critical Thinkers – to employ the technique.

**Effective control**

All professional wargames are controlled (verb), usually by a Control (noun) organisation. The function of Control is to steer the wargame minute-by-minute to achieve the objectives (while taking full account of player decisions; a primary balancing act). But these objectives – which should be front and central – are too often forgotten, subverted or subject to mission creep. In wargaming the future it is even more important than usual to work towards well-considered and bounded objectives because the enormous number of potential variations and deviations from these can lead to a wargame that drifts into topics that are not relevant to the subjects of analysis being examined.

**Engaging – even fun!**

Although last on the list, the necessity to ensure that wargames are engaging, even ‘fun’ – if you’re allowed to use that word. We do not wargame *for* fun, but they can *be* fun. They must at the very least be professionally satisfying. Wargaming the future relies heavily on players’ imagination and inventiveness. If players are not engaged, these characteristics will not feature, with a resultant failure of the imagination and the likelihood that outcomes will be a linear extrapolation of current trends - something that history tells us rarely happens.

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⁶⁷ This is Clausewitzian ‘friction’, which has been defined as: the propensity of unexpected delays to occur during armed conflicts. See (Simpson 2016).
Exclusions

There are two characteristics of a successful wargame that we feel have a very low priority and, arguably, should not feature at all in analytical future-gazing wargames. These being ‘chance’ and ‘uncertainty’, we are sure that their exclusion will raise howls of ‘heretics!’ In our defence, we think that there is so much uncertainty and chance when future-gazing that to introduce more seems, at best, pointless and, at worst, dangerous. Chance and uncertainty must feature in educational/training wargames, and might have a place in near-future analytical wargames, but we do not think it sensible to divine probabilities and percentage spreads for capabilities that are, at best, conceptual prototypes. We recently wargamed novel technologies in the Arctic in 2045. One of these was autonomous submarine swarms. During an attack by one of these, a series of poor dice rolls resulted in no effect. This was not the expected outcome, which had to be emphasised to mitigate the players having witnessed the capability underperforming, and rating it poorly. We find it best to avoid such chance outcomes (which are based on questionable quantification) and present - as part of the deliberative approach - the expected, or assumed, outcomes. The future holds enough uncertainty; we should not amplify that and undermine our analysis.

Conclusion

Wargaming is an ideal tool for the task of scrying the future, but must be applied simply and effectively, and in conjunction with other techniques as part of an IAECP. And a wargame that peers into the far future is still just a wargame, albeit probably with different factors and variables involved. While technology will become ever more important and must feature in our games, the future will still be shaped by humans - until we reach that hypothetical point where the machines take over. Wargames are people-centric in terms of their play (players), control and analysis. Computer-assistance (AI, ML, ABM etc.) has a role to play in supporting our wargames, but we cannot (yet) computerise the vital human ingredients. Rather, we should adopt a ‘back to basics’ approach to ensure that our wargames make an effective contribution to future-gazing. Wargamers must ensure that they design, develop and execute their games applying wargaming best practice rigorously. This paper suggests what this best practice consists of, and how it might be applied.
References


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Wargaming the Uncertain Future

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War, Games, and Uncertainty 50 years from now

“The future’s uncertain/And the end is always near.”
Jim Morrison

Introduction

This paper addresses the question “How might wargaming influence military thought fifty years in the future?” We make an assumption that wargaming can influence military thinking; while arguments can be advanced in favor of (and also in opposition to) that view, they are not entertained here: we simply presume an affirmative answer. The next matter is how to use games to this end.

When attempting to address uncertainty in national security matters, one might imagine using simulation games to answer questions about technologies (which is better: a faster submarine or a deeper-diving one?), or about political-military issues (which country will most threaten the United States in 2070?), or about strategies (what should American cyber strategy be?), etc.

The nay-sayers would then object that “you can’t get anything out that you don’t put in,” “the future is too hard to predict,” and that “when the future comes, it will be too hard to understand.” Especially in games, one can certainly come out with facts that one has not put in, but it is more than plausible that a fifty-year time horizon is too long for the prediction of technology or international affairs.

Therefore this paper is not about using games to answer questions; at a 50-year time horizon, games are unsuitable for such an effort. The famous interwar Naval War College games (see also below) are said to have had predictive value, but on a time-scale of half as long, and arguably during a period of slower technological change.

Instead, this paper will address the use of games not to reduce the uncertainties that people will face, fifty years from now, but to increase their ability to deal with them.

68 For example, the inventor of chess (were there to have been such a unitary person) did not “put in” the fact one should put one’s Bishops on adjacent squares, nor yet did s/he “put in” the fact that Bishops are stronger if so deployed; rather, s/he put in the along-the-diagonal move of the Bishop, and the rest follows as an “emergent property.”

69 Or so it is commonly said, but maybe not. As pointed out by Randall Monroe, spaceflight is now older than airplane aviation was when spaceflight started.
The fifty-year time horizon

Some people, while granting the ability of wargames to influence thought, have expressed skepticism that the effort requires, or can even tolerate, a fifty-year lead time. But for an effort to influence thought, fifty years’ head start might be about right. John Forbes Nash Jr. identified his Equilibrium in a 1950 paper, but the idea did not gain serious influence until the publication of Robert Axelrod’s *The Evolution of Cooperation* thirty years later. In fact one could argue that the whole game theory enterprise (started in 1944 by von Neumann and Morgenstern), theretofore associated primarily with cute examples and disappointing results, finally gained influence about then.

Another important point is that people play games when they are young, and are important (while also perhaps still playing games) when they are old, about fifty years later. Admiral John Richardson (31st CNO) matriculated at the Naval Academy in 1978—forty years ago—and General James Mattis, who resigned as Secretary of Defense while this paper was in preparation, enlisted in the Marine Corps (while a college student) in 1969—forty-nine years ago. Given that wargaming can (and often does) start in one’s college years or earlier, a fifty-year lead time is not out of the question.

How people benefit from playing games

This paper is about games that will be of benefit by shaping patterns of thought.

So, if the games to be addressed in this paper are envisioned as having value because they benefit the people who play them, we have the more general question “How do people benefit from playing games?” A comprehensive answer would probably be a whole paper in itself, but let us list a few ways. Games help people exposing them to:

➢ Uncertainty, in accord with the topic and goals of this paper;
➢ Other players—thinking, scheming, conniving, unpredictable, inimical (not in a moral sense, but in the sense of having goals opposed to one’s own) human beings in their own right;
➢ Chance elements such as cards, dice, etc.;
➢ The need to envision a future, make a plan to get to it, and to know when to keep or abandon that plan;
➢ Given some long term objective (the game’s definition of victory), the experience of perceiving, working toward, and then perhaps abandoning shorter term goals;
➢ The experience of making, and then perhaps abandoning, agreements and coalitions;
➢ The observation (via repeated play) that things need not turn out as they did;
➢ The difference between a correct choice and a successful one (or, at any rate, the opportunity to argue for or against the proposition that there is such a difference);
What it’s like to lose.\textsuperscript{70}

Some of these can be experienced in other ways, but games provide a comparatively cheap, easy, and repeatable source of all of them. Of note, a person could, in our society, reach high levels of educational and cultural attainment with zero exposure to any of them. Many do, and some may rise to important national security positions. They will do a better job for having played games.

\textbf{Interwar wargaming at the Naval War College}

As is well known, the Naval War College conducted surface naval wargames, played with ship models on the floor of a large room, during the period between the World Wars; these are seen as having been highly influential. Like most accounts of them, that of Miller is quite positive, crediting the games with the debunking of the “through ticket” option of a direct strike on the Philippines from Hawai‘i (and thus the creation of the alternative “island-hopping” concept, which was actually used) and the invention of the light cruiser. Miller repeats Nimitz’s claim that the only aspect of the war against Japan not predicted by the games was the kamikaze, while also saying elsewhere that Japan’s Long Lance torpedo did not appear in the games either.

Miller commends the games for great training value, but touches on this point only intermittently and without giving great detail as to how individual officers benefitted from having played; his emphasis is on institutional learning.

Nor does he allude to the games’ role, if any, in the great intra-navy debate of the time (far greater than any argument about the “through ticket” vs. “island-hopping”): the long and bitter dispute\textsuperscript{71} over whether or not aircraft carriers would supplant battleships as the Navy’s capital vessels and main striking force.

We do not know how these games represented uncertainty, especially regarding Japanese capabilities. “Urban legend” and Subject Matter Expert opinion present three somewhat contradictory views:

\begin{itemize}
\item At all times, the games’ presentation of Orange incorporated the best available knowledge concerning the Imperial Japanese Navy.
\item Aware that their information was imperfect, the games’ creators deliberately included Japanese capabilities (or incapabilities) not supported by intelligence, just to see their effects.
\end{itemize}

\textsuperscript{70} I am indebted to Dr. E. McGrady for this entry.

\textsuperscript{71} Finally settled only by the Japanese, 7 December 1941.
➢ So as to prevent students from gaining unfair academic advantage from their predecessors’ experience, and/or to provide them with an opportunity to excel, the War College deliberately introduced variety by including unsubstantiated, or even counterfactual, details regarding the Japanese Navy.

The truth of the matter may never be known, because a great deal of material was apparently thrown out in the 1970s.

Games that play people

Nowadays, statements like “I’m working on a game” are frequently taken to refer to computer games, i.e., programs (or “apps”) that act as opponent, referee, board, and pieces for a person to play against. Except in the cases of traditional games that have been ported to the computer (e.g., chess), these games generally embody—and may even conflate, for all anyone can tell—uncertainty in the forms of chance, hidden information, and hidden rules. Many people find these games enjoyable to play, but their educational and experiential value is reduced by the fact that they are, almost literally, “black boxes” whose hermetic nature precludes post-game analysis because the conditions, the probabilities, and maybe even the rules themselves are unknown.

In a game played by two humans, a computer could be invaluable as the moderator of sighting and shooting, and it could have a play-back capability for after-action analyses. But its “black box” nature would inevitably engender a player belief that it contained deeply buried and ineffable processes, to which all events (including, especially, defeats!) could be ascribed, to the exclusion of actual learning.\(^{72}\)

Defenders of such games are quick to point out that their ultimate unknowability is realistic, because life itself is unknowable in much the same ways. Perhaps that’s true, but if so, one could just go back to learning from life itself and not bother with games that are no better explained than life.\(^{73}\)

Uncertainty, 2070-style

When considering the uncertainty of future war, especially in the middle-distant future that is a few decades from now, we tend to focus on the uncertainty caused by our inability to predict how technology will develop over that span of time. However, the effect of this

\(^{72}\) It is for this reason that the author has resisted all attempts to computerize his game SUBHUNT, co-designed with CNA’s Dr. Yousi Ma.

\(^{73}\) Also, and with particular reference to computerized war games, the idea that the player should learn from experience neglects the fact that real-life people enter into their wars with a large background knowledge gained from training, doctrine, and the like. They are not just pushed into a seat in an airplane, tank, ship, or command post and told to start learning.
technology uncertainty is easy to overrate, because by the time the war starts, we will have a far better idea of how technology has developed, and in fact we will probably have developed quite a bit of it ourselves.

So let us look only at the big picture, in which we can see two major sources of increased uncertainty, if not of change in the nature of uncertainty itself. We shall call these “Low Entropy” and “Schrödinger’s Tiger.”

**Low entropy**

In the decades since the Second World War, conventional weapons (to say nothing of nuclear ones) have become vastly more lethal—almost entirely because of huge increases in the probability of hit—and far fewer in number. *Entropy* being the negative of the sum over states of $p^*\ln(p)$, the great decrease in the number of entities brings about a decrease in the number of end-states, and thus of the entropy. Luck no longer “evens out” and uncertainty increases. An early version of this form of uncertainty was visible in WW II carrier battles, in which the numbers of airplanes were small (dozens, vice hundreds in the air war over Europe) but the damage they could do was considerable and because of the delicacy of aircraft carriers, the variation in outcomes was actually small—”no effect,” or “mission kill.” Entropy is also lowered (or, perhaps, it comes into existence at a lower level than is normally appreciated) because of the interdependence of probabilities that might, at first blush, appear to be independent.\(^74\)

**Schrödinger’s Tiger**

*Schrödinger’s Tiger* is uncertainty caused by our ignorance of ways in which one thing will (or will not) operate upon another: \(^75\) in future warfare, this uncertainty will be profound. In a measure-countermeasure duel, one side will win, but we have little means of predicting which one. This effect is most clear in cyberwarfare, and second-most in electronic warfare, but in fact it probably extends to physical weapons themselves, where the struggle between stealth and sensors, difficult or impossible to replicate in a test, much less an exercise, becomes close to imponderable.

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\(^74\) The path-breaking and sadly neglected “Configural Theory” of Timothy J. (“Jim”) Horrigan (Horrigan 1990) addresses this topic, primarily in regard to combat models.

\(^75\) The idea and the illustration are based on the Schrödinger’s Cat example in quantum physics, wherein the unfortunate feline is contained in a box that may or may not have, based on the random decay of a small radioactive sample, been filled with poison gas. Uncertain as to the creature’s fate, we are invited to think of it as having a *probability* (e.g., 50%) of being alive even though we know that it is either fully alive, or fully dead.
**All together, now**

Now consider the union of these two forms of uncertainty (plus any residual technology uncertainty that may remain): the upshot is that we have a sequence of interactions whose entropy, already low because of the small numbers of entities involved and the small numbers of end-states they can take on (mission-killed or no effect), is further reduced by the fact that some of the outcomes are in fact pre-ordained as Schrödinger tigers.

Moreover, post WW II war has become complex politically. In WW II, a large number of nation-states aligned themselves on two sides, but in today’s world (and probably even more so in the world of fifty years from now), relationships are not nearly as clear.

Finally, and bringing us to the realm of games rather than other uncertainty-dispelling activities (like jigsaw puzzles), the principle source of uncertainty in future wars will be the other side. In past wars, decision-makers felt great uncertainty about the weather, the positions of their own forces, the intentions of their subordinates, the state of their supply, and so on. Modern computing and communications have all but eliminated those uncertainties (and will certainly have done so completely by the time another fifty years have passed), leaving only the uncertainty that is introduced by the opponent. The pundits’ caricature of video-game-like “push-button war” leaves much to be desired, but one thing it gets right is that future wars are on a collision course with games, and much of the reason is the elimination of sources of uncertainty that games never represented particularly well in the first place.

Conventional wargaming does not lend itself to addressing opponent-created uncertainty of the Low Entropy and Schrödinger’s Tiger types, but other games do, and wargames could as well, if we were willing to conduct wargames somewhat differently from how they are conducted now.

**Realism, validity, and all that**

“Realism” is a frequent goal (or chimera, or shibboleth) in wargaming. It corresponding to “validity” in Modelling and Simulation, except that the wargaming community shows more awareness that realism (whatever it is) must be present at the outset, vice the M&S community’s apparent belief that validity is injected toward the end, in a “validation” step. By normal standards, realism and validity are unattainable for wars of 50 years hence: in light of the great rate of technological change, it would be futile to try to game future wars, a half-

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76 It took a while, and it need not have turned out quite as it did. In 1939, for example, France nearly came to the defense of Finland against the USSR, but in the end Finland was aligned with the Axis and both France and the USSR counted themselves among the Allies. H.P. Willmott has argued, with typical extravagance, that the Second World War did not begin until 1943, prior to which there were only widespread regional wars that involved overlapping sets of belligerents.

77 Some might argue that they are unattainable for wars of today, or even for wars that now lie in the past.
century in advance, by deeming some set of weapons, technologies, or even warfare areas to be ascendant and then designing a game about them or their future incarnations.

But there is no accepted standard of realism and/or validity. At one extreme, some hold that to be realistic or valid, a game or simulation must reflect all relevant facts. This is probably unattainable in any case and certainly cannot be had in a game about war in fifty years. At the other extreme, it is sometimes said that the game should at least be able to produce the historical outcome. That’s probably a good idea, for a historical game, but is it a standard of realism? What if the game can produce the historical outcome, but nothing else? What if historians agree (as in the case of the Battle of Midway, or even of Waterloo) that the historical outcome was unlikely? And what if, as in a game about the future, there is as yet no historical outcome?

I favor an altogether different standard: a game is realistic and valid insofar as the thought processes that it fosters in the players resemble those exercised by the participants in real life. On this basis we can jettison all attempts to define future wargaming in terms of the weapons and other technological features of the far-future landscape, which we cannot know and thus cannot simulate faithfully, or perhaps at all. Instead, we will try to focus on the thought processes that will occupy future commanders’ attention, and then create games that will foster those processes.

The plan of the work

In sum, we have concurred with the premise that wargaming can help dispel uncertainty, but we have reached the paradoxical conclusion that while a fifty-year lead time is too long for the prediction of technologies or capabilities (either friendly or enemy), it is about right for beginning to train decision-makers.

Therefore, the work will proceed as follows.

First, let us identify several extremely simple games (not necessarily wargames, and in fact probably not wargames, because of the simplicity requirement) that embody particular uncertainty-related thought processes that we deem likely to be needful in future conflict.

Second, let us combine these games into one or more larger games, which might be wargames, albeit possibly very different from those to which we are accustomed. The combination need not contain each constituent, though each should be considered in its creation.

Third, we must play these games, not only the final creation also the constituents and—above all—get others to play them, and record their reactions.

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78 Richard Westerman, personal communication ca. 1990, and E. McGrady, personal communication ca. 2015.
Fourth, iterate steps two and three, generating multiple games whose play we feel will benefit national security decision makers fifty years from now, especially if those individuals (presently somewhere in the grade school to college age range) start playing them now.

**Seven Easy Pieces**

“I don’t believe any game that can’t be played as a parlor game.”—Martin Shubik

Certain games now extant seem to me to be relevant to wars of fifty years from now, especially with regard to uncertainty. This section will examine them. For want of any other organizing principle, they are presented in the order of their invention. Probably not by coincidence, the first five are especially accessible because they do not use proprietary game sets; rather, they are played with commonplace chips, cards, coins, dice, and chess pieces, or with parts easily made on a copier. Most are also basic, or even rudimentary, in their rules: part of their interest is the complex play that their simple rules can engender.

To keep game-rules from getting in the way of the real point(s), this section only describes the games; the Appendix gives the actual rules.

**Kriegspiel**

_Kriegspiel_ 79 is double-blind chess, played with a referee. Its Deep Inner Meaning stems from the moves’ dual nature: they are explorations as well as attempts to take pieces or to checkmate, and in most instances the exploratory aspect is predominant. Illegal moves become supremely important, as their rejection (by the referee) provides information without cost or commitment; the King, being subject to check, becomes a sensitive probe of the other side’s position.

In some implementations, there is another channel of information: the ability to overhear the colloquy between the referee and the other player. For years I thought this was a bug, but the books by David Li made me decide that in fact it is a feature.

More recently, a commercial version of the game, dubbed _Infochess_, has been marketed to the military-analytic world as instructive in decision-making.

**Colonel Blotto (a.k.a. GOPS, Goofspiel)**

The “Colonel Blotto game” was propounded by Émile Borel in 1921. In it, the two players secretly pre-allocate resources (notionally, soldiers) to each of several competitive endeavors,

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79 Invented by Henry Michael Temple in 1889 (https://www.chessvariants.com/incinf.dir/kriegspiel.html). The word is German for “wargame,” but modern German, at least, would apply a declension to the first syllable, rendering the word as “Kriegsspiel.”
and then each endeavor is won by the player who devoted the most resources to it, and the
winner is the player who won the most endeavors.

The similar game GOPS (Game Of Pure Strategy) was invented by Merrill Flood (who would
go on to create the famous game-theory game Prisoner’s Dilemma) when he was an
undergraduate in the 1930s (Tucker 1985). A deck of cards is separated by suit; each of two
players receives one suit, one suit is laid out face-up on the table, and the fourth suit is set
aside. Players “bid” for the face-up King by each placing a face-down card next to it; these are
revealed and the player who placed the highest card wins the King. Play then proceeds to
the Queen and so on down through the whole face-up deck. Scores are then totaled—13 points for
the King, 12 for the Queen, and so on down to 1 for the Ace—and the higher score wins.

There are many variants, e.g., one in which all bids are made before any are revealed, and
commercial versions have been marketed. A great deal of academic research has also been
done.

There is no reason that only two people can bid on a card, and—especially given the kinds
of user interface now readily created on the Internet—Colonel Blotto has become a multiplayer
game, not only in just-for-fun contests but also in relation to lines of academic inquiry.

Various RAND-based “Tactical Air Games” can be seen as extensions of Blotto. In them,
the two sides each have a quantity of airplanes fungible across a set of missions such as
Bombing, Air Defense, and Fighter Escort. Each turn, each side secretly allocates airplanes to
these missions. Then their choices are revealed, and certain recipes are applied to determine
the numbers of survivors. For example, each side’s Air Defense planes each neutralize two
Fighter Escorts; un-neutralized Fighter Escorts destroy one enemy airplane, effective next turn.
Airplanes assigned as bombers drop their bombs, each of which adds one point to its side’s
score. Then any and all surviving airplanes are, regardless of their earlier roles, assigned new
missions for the next turn. Such games have received quite some attention over the years, on
account of the existence of solutions, some of which are “mixed,” i.e., the player needs to
resort to some form of randomization to implement them.

So Long, Sucker

This fiendish game, designed by a distinguished group (Hausner et al 1964) that included
John Forbes Nash, Jr. (subject of the book and movie A Beautiful Mind, and a winner of the
Nobel Memorial Prize in Economic Sciences in 1994), forces the players to make and break
coalitions. There’s no way around it, and because the game involves no cards, dice, or other
chance elements, some say the players ought to be able to see the betrayal coming.

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80 See for example Dahl & Bakken 2002 and Dresher 1961.
Yet often they did not. Shubik’s account is worth quoting at some length:

“Hausner, McCarthy, Nash, Shapley and I invented an elementary game called “So Long, Sucker” where it was necessary to form coalitions to win, but this alone is not sufficient. One also has to double-cross one’s partner at some point. In playing this game we found that it was fraught with psychological tensions. On one occasion Nash double-crossed McCarthy, who was furious to the point that he used his few remaining moves to punish Nash. Nash objected and argued with McCarthy that he had not reason to be annoyed because a little easy calculation would have indicated to McCarthy that it would be in Nash’s self-interest to double-cross him.”

During the game’s brief life (primarily among Nash and his colleagues at MIT and RAND) there were tales of couples who required separate taxicabs for the ride home. Anatol Rapoport devotes an entire chapter of his book *N-Person Game Theory* to a play-through of a simplified version of the game.

**George Gamow’s Tank Game**

Closer to wargaming, George Gamow invented a game that he called “Tin Soldier” and others called “Gamow’s Tank Game” (1951): played on hexagons with toy tanks and the trappings of a wargame, e.g., terrain types of Woods and Clear, its only point of non-triviality is its double-blind play. Gamow conceived of the game because he wanted something that could be played by (not just on, but by) a computer of the day. The game seems to have been a flop in that sense, but it represents a landmark of gaming in that it combined double-blind play with wargaming.

**The Multi-Armed Bandit**

The *Multi-Armed Bandit* game was conceptualized by Harold Robbins in 1952. The proverbial “one-armed bandit” being a slot machine with a fixed distribution of payoffs, Robbins’s hypothetical multi-armed bandit was an ensemble of slot machines, with fixed *but presumptively different* payoff distributions. At least one of the arms has the property that its expected payoff exceeds the cost of playing: the player’s task being to win as much money as possible, s/he must combine *experimentation* (the goal of which is to find the most fruitful machine) with *exploitation* (the goal of which is to milk the putatively best machine of its coins). Robbins created the problem as a vehicle for his various ideas on the *design of experiments*, and he and others have propounded many variants for that purpose.

81 Shubik, op. cit., quoted by Mirowski, page 344. Mirowski remarks that Nash’s “construction of rationality would dictate that nobody would ever voluntarily play this, or any other, game with him.”
For many purposes, a mere Two-Armed Bandit will suffice. Notionalized as a single machine, it has right and left arms with presumptively different payoffs, at least one of which is net-positive on an expected-value basis. A fully general solution of this game (i.e., an “effective method” for arriving, with any desired confidence less than unity, at a decision as to which arm is preferable) long eluded solution, and may to this day. Even greatly restricted versions (e.g., one in which all payoffs are either $0 or $1, and the arms differ only as to the probability of returning $1) are sufficiently difficult to assign to graduate students in Decision Theory.

The point of these “bandit problems” is that they encapsulate the task of conducting experimentation and production at the same time. In the real world, one example might be oil-prospecting, in which the goal of producing a lot of oil from known reserves is (or was once) combined with the goal of finding plentiful new reserve areas to exploit.

In the world of military procurement, similar problems abound. During the Rickover era, for example, The USN’s numerous one-off submarine designs embodied experimental new ideas, but they also had to be useful as undersea platforms in their own right.

There is even experimentation in combat, as related by Zuckerman in connection with his study of the bombing of Pantelleria.\textsuperscript{82} the target was to be destroyed, but knowledge was to be gained as well. Morse and Kimball describe some in-combat experimentation with an anti-ship missile that might be subject to jamming; there is an anti-jam device available, but it ought not to be used if it is unnecessary. So there begin simultaneous campaigns of anti-ship warfare and experimentation, rendered even more complicated (and game-like) by the consideration that once the enemy realizes his jamming has been defeated, he may discontinue it; therefore there needs to be continuing occasional use of non-anti-jam missiles, to be sure that the jamming has not ceased.\textsuperscript{83}

\textit{The Awful Green Things From Outer Space}

This commercial game (originally published in 1979) has the look and feel of a wargame, albeit perhaps not a very serious one. The board depicts a spaceship, whose human crew must try to fight off an infestation of The Awful Green Things—or, \textit{in extremis}, abandon ship.

Cartoon artwork and extremely fun play may distract from the game’s unique and instructive feature, which is that the humans’ weapons’ effects on the Green Things are initially unknown, and can be found out only by use. (In terms of game mechanics, the implementation is a chit-drawing system.) Some previous wargames had used such a thing, often called “untried

\textsuperscript{82} Zuckerman, pages 187 and 196

\textsuperscript{83} Morse and Kimball present this example as hypothetical, but maybe it is not, and in any case the Allies and the Germans engaged in similar measure-countermeasures throughout the Second World War, as related by R.V. Jones.
units,” but the in a historical game the potential for doing so was is limited by the history that the game represents: departure would be (in the words of a noted game designer and critic) “abhorrent.” In *The Awful Green Things*, however, there is no reality to which the design must be faithful, and the weapons effects can vary wildly from game to game. Some of them even act to the Green Things’ benefit.

**Zendo**

Despite the Eastern trappings of its name and first-edition (2003) packaging, *Zendo*’s topic is a decidedly Western version of logic and inquiry.

There are multiple players and a Master. The playing pieces are small plastic pyramids of various colors and sizes. In play, small numbers of pyramids are set out in groups, called *koans* after the famous riddles of the Zen Buddhist masters. Before the game, the Master has secretly written down some regularity, e.g., “Contains no yellow pyramids” that is present in some groupings and not in others. This is called the “Buddha Nature.” The players are trying to deduce this Buddha Nature by creating koans and seeing how the Master grades them.

At the start, they do so simply by observation: the Master has created two set-ups, one of which follows the Buddha Nature and one that does not. The players then (in turn) proceed to create their own set-ups, which the Master marks as conforming to the Buddha Nature, or not. Finally, they reach the stage of being able to propound a possible Buddha Nature in words: a successful attempt wins the game; an unsuccessful one receives a refutation from the Master, in the form of a counterexample.

Much of the game’s character stems from the lack of any list of possible Buddha Natures: some few were suggested, but they were intended as illustrative and the Master is urged to invent his or her own. In this way, *Zendo* differs fundamentally from the well-known *Mastermind*, in which the player strives to deduce which one of a large number of well-defined set-ups the Master had selected, and can do so algorithmically. In contrast, *Zendo*’s free-form structure forces the players into inductive reasoning, which is standard in real-world inquiry but

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84 In the non-themed second edition of the game, the Buddha Nature is simply called a “rule.” I can understand objections to the term “Buddha Nature,” on the grounds of “cultural appropriation, but I object to the substitution of the word “rule” in that it gives the impression that “*Zendo* is a game where you have to guess the rules,” which is misleading at best and untrue in reality. So here (and in teaching the game to groups) I used the terms “Buddha Nature,” and “koan.”

85 The second edition goes to the opposite extreme, furnishing so long a list that only the most fanatically motivated player would even consider memorizing it and creating a pruning algorithm for eliminating entries. The use of this list forestalls what is surely the number one failure mode for Masters: the creation of a Buddha Nature that is too difficult. See also later commentary in the text. But, conceptually, it alters the game from being inductive to being deductive, and inductive games are all too rare.

86 Knuth presents sophisticated algorithm.
quite rare in games,\textsuperscript{87} as well as obliging them to understand such concepts as \textit{counterexample} and \textit{equivalence}.\textsuperscript{88}

Players, and (even more so, novice Masters) sometimes have difficulty with these ideas, usually culminating in the complaint “that’s not the Buddha Nature, but I can’t think of a counterexample.”

**Commentary on the Easy Pieces**

> “\textit{In the whole range of human activities, war most resembles a game of cards.}”
> 
> Clausewitz\textsuperscript{89}

Pursuant to the discussion of our fifty-year time-horizon, the first thing to notice about the “Easy Pieces” is that five out of the seven are even now over a half-century old, and yet they retain their interest and importance.

The second thing to notice about the Easy Pieces, if at all possible, is what it like to play them. A common—almost standard, even among game-players—reaction to a new game is to say that the right course of action is obvious.\textsuperscript{90} Yet each person’s idea of the “obvious” is likely to be different, and not all are winning choices. The Appendix contains rules and/or a playable description for at least one variant of each of the first five games, and all are recommended.\textsuperscript{91} The role of the referee (needed in \textit{Kriegspiel}, \textit{Gamow’s Tank Game}, and \textit{Zendo}) requires a clear

\textsuperscript{87} An exception is Robert Abbott’s “Eleusis” (1956), presented by Martin Gardner in his July 1959 column in \textit{Scientific American}; a major revision appeared in Gardner’s column of the October 1977 column, and John Golden’s derivative Eleusis Express (2006; \url{http://www.logicmazes.com/games/eleusis/express.html}) resembles \textit{Zendo} even more strongly in that the game ends when somebody discovers the Buddha Nature. Some readers may also know Abbott’s uncertainty-related boardgame \textit{Confusion} (Stronghold games, 2012), in which the players do not—initially—know how their pieces move.

\textsuperscript{88} A \textit{counterexample} is a set-up of pyramids that refutes an incorrectly-guessed statement of the sought-after Buddha Nature by showing a difference between the guess and the real thing. There are in general two ways in which it can do this: by conforming to the guess, but not the Buddha Nature, or vice-versa. In some specific instances, however, the guess may include the true Buddha Nature, or vice versa, in which case only one form of counterexample is available. For example, if the Master’s Buddha Nature is “contains no blue pyramids” and the player has guessed “contains no blue or green pyramids,” then the only form of counterexample is a Buddha Nature-compliant set-up that contains a green pyramid. Two statements of a Buddha Nature are \textit{equivalent} if—no matter how differently they may be worded—they create identical sets of compliant and non-compliant set-ups. For example, small, medium, and large pyramids are marked with 1, 2, and 3 pips respectively, so “contains no medium-sized pyramids” is equivalent to “the product of all the pyramids’ pips is odd.”

\textsuperscript{89} Book I, chapter 21, tr. Howard and Paret.

\textsuperscript{90} This response is also standard in training exercises that offer choices to the participants.

\textsuperscript{91} The legendarily divisive \textit{So Long, Sucker} may be an exception. It should be played only by those who can attain total separation between their real selves and their player-selves (including especially the player-selves of the other players), or by complete strangers who will never meet again and are unarmed.
head and complete knowledge of the rules but should not be avoided: it is almost invariably described as “at least as fun as playing.”

A third thing to notice is the games’ distinguished roster of creators. Four out of seven games have designers known for multiple achievements in mathematics, physics, computer science, and/or economics.

**Stylization**

Most or all of the Easy Pieces, so disparate in many ways, embody *stylization*. Stylization can be described as the elimination of most detail and the extreme simplification of what remains.

For example, an argument could be made that the venerable game *Diplomacy* (1961) should appear as an Easy Piece, possibly to the exclusion of *So Long Sucker*. But the latter is simpler, clearer, cleaner, less asymmetric, and more to the point—in short, it is more *stylized*. Of note, the *Two-Armed Bandit* and *Zendo* are both stylizations of the research process, but they accentuate different aspects thereof.

The overt wargames, Gamow’s *Tank Game* and *The Awful Green Things*, are not as simple as the other games, but in accentuating the opponent’s agency in creating uncertainty they take on a complicated task, and are arguably as stylized as the other games, just less simple. The same could be said of *Kriegspiel*.

**Certainty for its own sake**

In *Zendo*, the players’ only goal is to dispel their uncertainty about the “Buddha Nature” the Master has propounded. Discussions of the game tend to take the form of scientific and/or mathematical discussion, starting with the ideas of example and counter-example, and moving to the notion that there is a “space” in which the possible set-ups (koans) are points, the Buddha Natures are [hyper-] planes, and a newly built set-up is most productive if it has a fifty-fifty chance of being deemed to follow the Master’s secret Buddha Nature. The quick recourse to real-world lines of reasoning is highly attractive to some players and highly repugnant to others; there does not seem to be much of a middle ground.

This effect is nowhere more visible than in discussions of how to handle a Buddha Nature such as “All the blue pyramids are big” when a koan has no blue pyramids. Mathematically trained players assert that if there are no blue pyramids, then all the blue pyramids are big (because there are no non-big blue pyramids) so the statement to be true, or “vacuously fulfilled,” whereas players who have experience with database programming invoke the idea of

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92 For the use of this word in application to games, and for the goal(s) it represents, I am indebted to my former CNA colleague Kevin Brown.
mu, which is neither true nor false, and those familiar with Bertrand Russell’s “King of France” example will categorize the proposition as false.

The surprise at the conclusion of almost any game of Zendo, especially one involving beginners, is the simplicity of the true Buddha Nature, as compared to the hypotheses that the players have entertained along the way. It is not unusual for the players to use all sixty pyramids and then some (obtained by dismantling set-ups that they expect to be able to remember), only to find that the Buddha Nature was as simple as “contains at least one pyramid of each size.” This occurrence brings out an important point about Low Entropy—it can be a lot lower than it looks.

Maybe all of this goes to support a contention that “Zendo [just] teaches people how to think,” with the “just” inserted by those who do not consider the teaching of thought to be worthwhile, compatible with a parlor game, or necessary for future national-security decision-makers and their present youthful selves. But experience with the game, and accounts of it, suggest that nearly all people are, if nothing else, sorely in need of being taught how to think. At the anecdotal level, members of the WW II generation often cited high school courses in Geometry and/or Latin as how they had learned to think. Now the latter is seldom taught and the former has been debased, so a substitute is needed, and a game will do.

Certainty as a means to an end

Kriegspiel, Gamow’s Tank game, the various Bandit games, and The Awful Green Things are a step closer than Zendo to real-world situations in that any resolution of their uncertainties is a means to an end, not an end in itself. They embody the kind of uncertainty that we have characterized as Schrödinger’s Tiger: reality is completely determined, but the player doesn’t know how.93 Just as Schrödinger’s original cat was truly dead or alive inside its box, but the outside observer could not tell which, the player of Kriegspiel 94 or Gamow’s Tank Game does not know the positions of the enemy pieces, the player of a Bandit game does not know the payoffs of the arms, and the players of The Awful Green Things From Outer Space do not know which weapon-effect chit is associated with which weapon.

Infochess, the commercial variant of Kriegspiel, adds a great deal of complexity by giving the players a budget that they can spend on pieces’ special abilities before the game begins. Plans for quick wins are thwarted mostly by even quicker wins.

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93 Kriegspiel, the Tank game, and Zendo create and maintain this uncertainty through the agency of the referee, and the Bandit games have something similar in theory, and certainly in classroom practice; The Awful Green Things does without a referee, through a clever chit-drawing game mechanic.

94 Actually, at the beginning of the game, s/he does, because the pieces are placed in their conventional set-up. Part of the fascination of this game is how this certainty decays, and then begins to return toward the end of the game, as pieces become fewer and checks become more frequent.
As a learning tool, *Kriegspiel*’s (or *Infochess*’s) starting point in chess can be problematic. Non-chess players feel that they are disadvantaged, and chess players sometimes assert that their expertise should be heeded, despite the major departures from the game they know. Either or both groups may be right, but in the on-side metagame of playing *Kriegspiel*, this debate can be salutary because it simulates the endless wrangles between soi-disants Subject Matter Experts and their skeptics.

Contact with the intelligence world\(^95\) suggests an important variant on the Bandit games. In it, one is dealing not with the actual Bandits or their multiple arms, but with a number of Tipsters, who supply the players with probabilistic recommendations regarding Bandit arms.\(^96\) Even though the Bandits and their arms do not change, the Tipsters’ recommendations do, because they themselves are basically also Bandits, only they pay off in recommendations, not in money. As is the case with the arms in the original game, it is stipulated that at least one Tipster has a distribution of advice whose outcome will result in a net positive return over the long run.

In a *Colonel Blotto* variant in which the prize cards are presented randomly and the conflicts are resolved (and revealed) one at a time, the player faces a new source of uncertainty—the order in which the cards will appear. While s/he might be tempted to argue that this change has no real effect (by mentally making allocations in advance, and then enacting them regardless of the order in which the prize cards appear), s/he would self-disadvantage by so doing, because s/he might (and almost certainly would) do better to make each allocation in light of which cards the opposing player had used up already.

Gamow’s *Tank game* and *The Awful Green Things* also involve wargaming’s usual source of uncertainty—the outcomes of individual attacks, customarily determined by mechanisms using dice, cards, or coin-flips. The player will likely notice that his or her reasoning therefore entails two entirely different forms of probability, i.e., of uncertainty. One is (to take the *Tank Game* as an example) the coin-based probability of one tank defeating another; the other is the Schrödinger-type probability that a given hex, non-adjacent to any friendly tank, contains an enemy tank. But the playing field is small and the tanks are few, so the outcome of one encounter can and does condition the future positions of the tanks,\(^97\) and thus the outcomes of later encounters. For example, Blue could destroy a Red tank in a Woods hex and then take possession of that hex—which constitutes advantageous terrain and thus makes Blue more likely to win the next combat—but Red knows that, so s/he could strongly suspect that when the Blue tank disappeared from view, it went into the woods. In Horrigan’s terminology, the

\(^95\) For a short and on-point example see *Wilderness of Mirrors* by David Martin.

\(^96\) Concatenation of multiple layers of Tipsters would, apparently, create a layered neural net!

\(^97\) If not, actually, their current positions!
entire configuration of the board and its past matters, and no analysis is possible at any level other than that.\textsuperscript{98}

\textit{Creating uncertainty}

So far we have addressed players’ (and real-world people’s) efforts to dispel uncertainty, but the disappearing-tank example points up the fact that in warfare (unlike in science) there can also arise the desire to create uncertainty. To that point, there is now an unstated assumption that nearly all the uncertainty of future war will be created by the enemy.

Players of Gamow’s \textit{Tank Game} and \textit{Kriegspiel} can, through their maneuver, try to create uncertainty, and even to create incorrect certainty (i.e., they can try to be deceptive), as to the location of their forces. Blotto players give the opponent information every turn, but the wise Blotto player will keep in mind what the opponent does and doesn’t know.

In \textit{Zendo}, the Master has considerable scope not simply for uncertainty, but for deception. For example, s/he could decide on two Buddha Natures, and make her original setups, subsequent pronouncements, and counterexamples, consistent with both of them. Only one of them is the real one (i.e., the one s/he has written down), there is at least an even chance that the players will focus on the other one, and perhaps more than an even chance if the counterexamples can be constructed in a cunning manner.\textsuperscript{99}

\textit{So Long, Sucker} is notably for producing uncertainty without any double-blindness, randomness, or unreadable written-down facts: the players mystify one another through their very acts, and by lying.

Three’s a crowd

\textit{So Long, Sucker} and \textit{Zendo} stand out as being multiplayer, vice two-player, games, but they are multiplayer games in different ways.

In the former, the multiplayer nature of the game is related directly to its whole point—the making and breaking of coalitions—while in the latter, the cooperation is rare but so is direct conflict. Any out-smarting tends to involve, one way or the other, the referee. The opposing players are usually considered simply as a collective, especially when deciding whether to try to

\textsuperscript{98} Mathematically, Horrigan defines a “configuration” as “a mapping of a set onto its power set.” His examples are quite convincing, and sometimes highly counter-intuitive; it is my belief that they hinge upon the interplay of these two forms of uncertainty, which I identify as the classical and the Bayesian notions of probability (the former being that probability is defined by long-run frequency, and the latter being that probability is defined by degree of belief). Horrigan explicitly does not endorse this interpretation (personal communication).

\textsuperscript{99} Normally no such excesses are necessary: the players will have plenty of difficulty with a simple Buddha Nature and straightforward counter-examples.
end the game by guessing the referee’s Buddha Nature, or to wait for one more round of play and then do so.

Though multiple people may, e.g., in a classroom setting, be exposed to the same Bandit(s) at the same time, the Bandit “game” is really a one-player dynamic puzzle, which people might compete (or cooperate) to solve.

**Low Entropy**

Our presumption that future war will have “low entropy,” while pessimistic from many standpoints, has the silver lining that it argues against one form of uncertainty frequently encountered in games: what might be called *combinatoric uncertainty*, i.e., the uncertainty created by a plethora of combinations, typically (in games) “exploding” exponentially as a function of the number of future turns that must be considered. Chess and Go embody this form of uncertainty, which is why they remain of interest as games even though they have no chance elements (other than assignment of the first move) and provide their players with complete information.\(^{100}\) The real world is doubtless more complex than any game, but even now, real-world decision-makers’ accounts of their difficulties do not cite “mind-boggling numbers of possible outcomes” as the source of their difficulties.\(^{101}\) And, finally, if the boggling of the mind were a problem, computers would be able to help.\(^{102}\)

Thus it is not a drawback of the “Easy Pieces” that, except for *Kriegspiel*, they do not embody the combinatorial catastrophe so strongly present in many other games; in fact, is an advantage.

That said, let us consider the Easy Pieces’ entropy in comparison to that of games in general.

*Kriegspiel*’s is higher than that of Chess, and therefore not low. *The Awful Green Things*, the *Tank game*, and *Zendo* are also about average for parlor games.\(^{103}\)

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\(^{100}\) Shannon approximated the number of possible Chess games at \(10^{120}\). He put the number of “sensible” games at \(10^{40}\); the number of sensible *Kriegspiel* games would be higher, because a great many things that would be completely nonsensical in regular Chess are very possible in *Kriegspiel*.

\(^{101}\) Au contraire, they frequently cite “information overload,” a misdiagnosis that goes beyond the topic of this paper.

\(^{102}\) Google’s Project Alpha Zero has lately made amazing inroads into *Chess* and *Go*, traditionally viewed as bastions of combinatoric complexity—especially *Go*. Of note, Alpha Zero has beaten the combinatorics not by brute force (as did the earlier Deep Blue, which defeated a world chess champion), but by the use of multi-layered neural nets that arguably deal in abstractions, as do people when faced with insurmountable complexity.

\(^{103}\) Based on the number of player-turns in a typical game, it has been estimated that the number of playable Buddha Natures is only about a million.
Colonel Blotto, So Long, Sucker, and the Bandit games have notably low entropies. We can do some calculations. In Blotto, there are 13! ways to assign one’s bidding-cards to the target cards, which is “only” about six billion. In So Long Sucker there are a chess-like number of possible moves available to a player at any one time (Shannon estimated 30, for chess), but games seem to be shorter than chess games. If a Sucker game goes 20 moves, there are 20^{30}, or a “mere” $10^{39}$ possible games.

Agreements

The two multiplayer games’ contrasting views of “the other players”—as potential partners/marks in So Long, Sucker or simply as other game populants, as in Zendo—have direct translations into real-world terms. There are rivals with whom we might compete or cooperate, and there are faceless others who operate in the same space as we do. In the presumably multipolar world of fifty years hence, the ability to wheel and deal in multisided situations may be very important indeed.

The most dangerous game

In Colonel Blotto, Gamow’s Tank Game, The Awful Green Things, and So Long, Sucker, uncertainty is created by the other player(s)—thinking, scheming, conniving, conspiring, and even mendacious creatures that they are. (In Zendo, contrastingly, the players are all trying to solve the same problem, with the competition being the race to be the first to do so.) And right here we have major benefits of game-play: the discovery of other people’s “agency” through the realization that they can and will act on their own in a competitive, if not inimical, manner, and the revelation that their actions therefore cannot be predicted with confidence, if only because they will resort to randomization when it suits them.\(^{104}\)

With other players involved, uncertainty can arise even in a “game of complete information” such as Colonel Blotto or So Long, Sucker.

Of the games discussed in this paper, So Long, Sucker is also unique in that it can (and, in practice, always does) entail the making (and breaking) of cooperative agreements. In fact, the necessity to do so was evidently “baked in” by the geniuses responsible for the rules, and apparently the point of the game.\(^{105}\)

\(^{104}\) To people used to playing games, these points seem obvious. But they are not, most especially to non-game-playing people newly exposed to games or, even more so, to conflict in the real world.

\(^{105}\) Given their stature and (at least in the case of Nash) predilections, it is tempting to speculate that the game is the simplest possible game to have this property.
Comparison of the Easy Pieces

Table 1 summarizes the similarities and differences we have identified in the “Easy Pieces” games.

Table 1. Traits of the Seven Easy Pieces

<table>
<thead>
<tr>
<th>Traits</th>
<th>Awful Green Things</th>
<th>Bandit Games</th>
<th>Colonel Blotto</th>
<th>Kriegspiel</th>
<th>So Long, Sucker</th>
<th>Tank Game</th>
<th>Zendo</th>
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<tbody>
<tr>
<td>Players</td>
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<td>1</td>
<td>2 or more</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2 or more</td>
</tr>
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<td>Low</td>
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<tr>
<td>Schrödinger’s Tiger</td>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<td>Present</td>
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</tr>
<tr>
<td>Chance elements (dice, etc.)</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<td>Means to an End</td>
<td>Means to an End</td>
<td>Means to an End</td>
<td>Means to an End</td>
<td>Point of game</td>
<td></td>
</tr>
<tr>
<td>Agreements/Betrayals</td>
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<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

It is worth noting that, by comparison to the real world, all of the games are so small that their entropy should be characterized as “low,” or maybe even “extremely low”: the “low” and “not low” descriptions given here are relative, not absolute.

Inasmuch as we are on the hunt for a wargame that will deal with uncertainty, it is important to verify that each of the games embodies at least one of the two forms thereof—“Low Entropy” and “Schrödinger’s Tiger”—that we have identified: they do. If any did not, we should question that they belonged on the list. And here the Bandit games shine, because they (uniquely) present the player with both forms of uncertainty.

Looking at the table, we can see that all seven games are “needed” in the sense that no two columns are the same. (The closest match is, as one might expect, between the wargame-like entries, The Awful Green Things and the Tank Game: these differ only in that the former does not have player-created uncertainty, and the latter does.)

Other games

Certain other games were considered as “Easy Pieces,” but did not “make the cut.” These include Stratego, Poker, Battleship (especially in its harder variants, e.g., the one in which five shots are fired each turn, and the report says only how many of them hit, not which ones), Chess itself, a plethora of commercial wargames other than The Awful Green Things, and any and all word games. Though these might inculcate some of the same lessons as the Easy Pieces, they are less stylized, i.e., they do not do so in ways that are as direct and obvious, and their
rules are more complex. But there is nothing wrong with them, and to play them would be better preparation for 2070 than not to play them.

Another category of games was omitted, perhaps too quickly—games that do not have turns, being instead played in real time. A number of commercial games have this trait, as does the venerable trading game *Pit*. Future reality being turnless, perhaps these games should have been included, but it was felt that some might find their free-form (and typically hectic) nature off-putting. On the other hand, future warfare is likely to be free-form and hectic.

Finally, and in contrast to a great many of today’s commercial games and nearly all games played under the auspices of the DoD, the Easy Pieces do not put the players into any role; even in the wargame-like *Tank Game* and *Awful Green Things*, the player is in no sense role-playing the tank platoon commander or the captain of an alien-infested spaceship. Role-playing games (of all kinds) can be instructive in many ways, but I do not see any as being applicable to a time fifty years in the future; arguably, we do not even know what roles will exist at that time.

**Games for Fifty Years From Now**

“It’s hard to make predictions, especially about the future.”—Yogi Berra

At last we now turn to the main business of the paper, which is to combine elements of the “Easy Pieces” into games that will help players (and maybe others) learn to deal with uncertainty in war. The examples presented here are meant to be inspirational, not exhaustive or definitive. It is important to note that none of them have been tested: this project’s next order of business would be to do so.

Again, all of the Easy Pieces have extremely low entropies as compared to the real world; the designations of “low” and “not low” given in Table 1 and in this section are relative. When we combine a game of “low” entropy with a game of “not low” entropy (as we do in most, but not all, of the cases below), we get a game of “not low” entropy.

Of the Easy Pieces, only *Blotto* and *So Long, Sucker* did not have the kind of uncertainly we have called Schrödinger’s Tiger; it is clear that if either of two games contains a Schrödinger’s...
Tiger then their combination will as well, and on this basis we find that all of the combinations presented here will have Schrödinger’s Tiger-type uncertainty.

*Bullo + The Tank Game*

This game is a Blotto-enhanced variant of Gamow’s *Tank game*. In it, the players each receive a deck of cards, from which they select a poker hand for each tank. (There being ten tanks on a side, two cards will be left over.) In each instance of combat between two tanks, a die is rolled. On a 1-3, combat is resolved per the usual Gamow rules (to include the case in which a tank in the woods automatically wins against a tank in the open), on a 4 or 5, combat is resolved by declaring the tank with the higher poker hand the winner, and on a 6, combat is resolved by declaring the tank with the lower poker hand to be the winner. These resolutions are all done by the referee (who will need a “cheat sheet” showing all the tanks’ assigned hands), and the participants are informed only of the outcome, not the means by which it was reached.

In a slight variant, the players compose the hands but the referee randomly assigns them to tanks. It is thus up to the players to deduce which of their tanks is which. This ignorance regarding one’s own forces is surprisingly rare in regular wargames, despite the fact that nominally equivalent units were in fact often grossly unequal, and part of a commander’s skill was to build up an appreciation of his forces’ individual strengths and weaknesses.

As a combination of games deemed as having “low” and “not low” entropy, this game has entropy that is “not low.”

*Bandit + The Tank Game (cf. Kriegspiel + The Awful Green Things)*

This game works exactly like *Bullo + Gamow*, except that the hands are dealt randomly and the players are not informed of them, bringing to the forefront the problem of building an assessment of one’s own forces.

The effect is similar to that which would be obtained from a less-imaginable confluence of *Kriegspiel* and *The Awful Green Things From Outer Space*: enemy forces’ positions, and all forces’ combat potential, start out unknown and can be found only during the play of the game.

Like *Bullo + The Tank Game*, this game’s entropy is “not low,” and for the same reason.

*Bandit + Zendo*

In this game, players use the *Zendo* pieces to construct their own Bandits. The Buddha Nature, unknown to the players but known to (and created by) the referee, is the function according to which the arrangement of the pieces (i.e., the “koan,” in first-edition *Zendo* terms)
is mapped onto the payoff structure of the resulting Bandit. Each turn, the player can pay to create a new bandit, or can “pull the lever” of an existing one.

The effect is a not-low-entropy non-combat game of Research and Development.

*Bandit + Zendo + Gamow*

See also above, and add the *Tank Game* by turning the Bandit probability into a hit probability for the tank.

This would be a long game, with new tanks created and flowed onto the battle board during play, as players try to discover how their koans relate to the tanks’ performance in combat. Tanks could share koans, or a koan could be unique to a single tank. Ideally, the workload would be divided between tank warriors, who use the tanks in the Gamow part of the game and report on their performance, and tank designers, who try to develop ever-better koans.

There is room for the use of additional concepts drawn from traditional wargaming, such as offensive and defensive “factors,” movement speeds, ability to operate in the woods, all learned only by the experience of constructing koans and trying them out.

At the outset, the players have no understanding of how their koans related to their tanks’ capabilities; this understanding would be gained only by experience. Such a level of ignorance is of course unrealistic, but this game (like all the games presented here) is not supposed to be realistic: it is stylized, to highlight certain aspects of uncertainty in war. The closest real-world parallel would probably be electronic warfare in the Second World War, when basic physical effects (e.g., atmospheric absorption) were being discovered at the same time as enemy countermeasures. Another parallel would be the German V-2 ballistic missile program, which was discovering basic science and technology (e.g., servo control during the boost phase and supersonic airflow during the descent).

Uniquely (so far), this game combines two games of “not low” entropy, for which reason (and also simply judgmentally) it qualifies as “high entropy,” relative to other games, and also quite lengthy. Players often find high-entropy games to be confusing and/or annoying, but in the present instance it would be salutary to point out that the game’s entropy is far less than

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108 Here the logistic function $p = \frac{1}{1 + e^{-Y}}$ would be handy, for its ability to turn any real $Y$ into a $P$ on $0,1$. The $Y$ could then be something like “3 times the number of pips on blue pyramids,” for example.

109 Numerous implementation details would have to be worked out. I see the referee as looking at the koan, calculating the parameter(s) it confers upon its tank, and writing them down. The players could then take a picture of the koan for reference, and return the pyramids to the box for future use.

110 This is a standard reaction of people, even experienced board gamers, when first exposed to wargames: there are too many choices, and the connection between cause and effect is too difficult to make.
that of the real world. Also, there is an a priori argument for having at least one high-entropy game in the collection.

**Free Set-Up Kriegspiel (cf. Kriegspiel + Blotto, Kriegspiel + Bandit)**

Depending upon how one looks at it, this game is a mash-up of *Kriegspiel* and either *Blotto* or the Bandit idea. It is played just like *Kriegspiel*, except that the players are free to set up their pieces other than in the standard way, subject to the following constraints:

- All pawns are in the front rank (as usual);
- The two Bishops are on different colors; and
- The King is between the two Rooks.

These constraints are those of the non-blind, random-set-up chess variant Chess 960. The purpose of Free Set-Up *Kriegspiel* is to further reduce the players’ knowledge of each other’s pieces’ locations and to introduce the creation of a novel tactical set-up as an element of player choice. If *Stratego* had been one of the Easy Pieces, this game would be *Stratego + Kriegspiel*.

**What of So Long, Sucker?**

Among the Easy Pieces, *So Long, Sucker* stands out for its lack of chance elements and of spatial maneuver, for being a “game of complete information,” for emphasizing negotiation, and for having exactly four players. No other game (among the Easy Pieces) combines these traits, and few have any. The closest is *Zendo*, which can have four players, has no chance elements, and does not have any overall spatial structure, though the individual koans are strongly rooted in spatiality.

As an atom, *So Long Sucker* is thus a noble gas, unable to be combined with other Easy Pieces to create a larger game molecule like those considered so far in this section. It is to be played as-is, for the lessons that it (and it along, of the games seen here) can convey.

**Observations and Conclusions**

This section remains to be written after the games—especially the concatenated games of the precious section—have been played.

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111 https://en.wikipedia.org/wiki/Chess960 The 960 refers to the number of possible set-ups for each side. (Verification of this fact is left as an exercise for the reader.) A generalized castling rule is needed: in currently accepted practice, the King ends up in the first rank and either the c file or the g file (as usual), with a Rook next to him and on the file closer to the middle of the board; the usual strictures regarding previous moves, Check on squares over which the King must pass, etc., Note that in some cases of castling, either the King or the Rook may not need to move.
Appendix: The Easy Pieces’ Rules

“No, no! The adventures first, explanations take such a dreadful time.”

The Gryphon in “Alice’s Adventures in Wonderland”

Kriegspiel

A number of Internet sites offer the rules of Kriegspiel. The following is taken from “Kriegspiel - Cincinnati style,” by David Moeser, an article that appeared in the March 30, 1977, issue of J’ADOUBE!, The Cincinnati Chess Magazine.

The idea of Kriegspiel is this: The player on move attempts either to make a legal move, or to make moves called “tries” which have as their prime objective the obtaining of insight as to what the real position is. Any move or “try” which really is a legal move stands as that player’s actual move in the game.

On his own board, each player’s own pieces are “official,” and the Kriegspiel version of “touch move” applies to them. They’re for real, and their position must be identical to that shown on the Referee’s set. The opposing pieces have no formal standing. Each player may set up pieces of the opposing color anywhere he wants, or not set them up at all; and he may move them any time he wants. (The Referee must completely ignore opposing-color material on each player’s board. It isn’t “official” and it may be on “wrong” or even absurd squares. The Referee must not allow himself to be confused by it.)

The Kriegspiel “touch” rule applies only to each player’s own material: The Player isn’t allowed to touch his own material except for the purpose of making a try. That is, “trying” to make a legal move. If a “try” is legal, it stands as the Player’s real move. If it isn’t a legal move, the Player is not required to move (or try) that piece again.

The best procedure is for the Referee to require players to acquit (let go of) the piece they make a “try” with, and to say nothing until they do so. This requirement eliminates the kind of sticky situation where the Referee blurts out some information but the player says “Oh, I didn’t really mean to play that move!” and insists on the right to take it back because he’s still holding onto the piece.

After each legal move is made, and before the Opponent begins his turn, the Referee records the move, makes it on his own set, and makes the announcements required by these rules. It’s important that the Referee announce all the information required by the rules -- and nothing else. All announcements must be heard by both players. Also, spectators must not talk openly about the
game, for even casual comments can give away valuable information. Finally, the Referee must endeavor to be 100% correct, or else the game is likely to be ruined.

Announcements

If a “try” is a legal move, the Referee simply announces that the Player has moved. “Black has moved,” he says. Or “White to move.” After a while the Ref’s likely to abbreviate this notification to monosyllables: “White.” “Black.” “White,” he’ll say. However, if a “try” isn’t a legal move, the Referee says “No” or “Illegal,” and that try must be retracted. If the move is impossible, and the player must know it for some reason (like trying to capture one’s own pieces), the Referee’s appropriate response is “Nonsense.” The “Nonsense” announcement discourages a Player from wasting time or attempting to use the Referee to mislead the Opponent.

The player continues to try to make a move until he finds one that’s legal. When a legal move is completed, the Referee announces whichever of the following information is appropriate:

1. If a capture has been made, the fact of the capture and the square the captured piece is to be removed from. (Keep this wording in mind for an en passant capture.)

2. Whether the captured material was a “pawn” or a “piece” -- but if a piece, not what kind of piece.

3. If a check has been made, the fact that the Opponent is now in check, and the direction of check with respect to the Opponent’s King: whether that King is in check on a file, on a rank, on the long diagonal, on the short diagonal, or by a Knight.

4.

a. If any of the pawns of the Player on move can capture anything, the Referee announces that the Player now has a “pawn capture,” which means that at least one of his pawns can legally capture something (anything) of the Opponent’s. The Referee does not tell where on the board any such capture is. The Player may now try to make captures with his pawns, or he may not. He may make tries with pieces, then tries (either possible moves or possible captures) with pawns, go back to pieces, then go back to pawn tries, etc.

b. Due to the pawn’s unique capturing power (its capturing “vector” is different from its move), a Player who attempts pawn captures when the Referee has not announced there are any is trying nonsense. In this
instance the Referee announces “Nonsense” so the Opponent isn’t unfairly confused. (For example, the Opponent would be led to believe the Player still has a lot of material on the board when he really doesn’t.)

c. Knotty point: If a Player is in check and has a pawn capture on the board, but no such pawn capture will remove the check, does the Referee announce the pawn capture? Answer: no.

d. As long as at least one pawn capture is on the board, the Referee must announce that a pawn capture is possible -- and continue to do so every time the Player on move has a pawn capture available. (Note: This is because announcements apply only to the move on which they’re announced.)

The following rules elaborate on certain prohibitions:

1. If a piece (non-pawn) can capture something, that is not announced.

2. Promotion of pawns is not announced. Each player should be supplied with extra “promotion material” at the beginning of the game.

3. The Referee may not give a count of material on the board during the game.

4. On the Referee’s board such moves as castling or pawn promotion must be made silently and without any noticeable delay, so as not to reveal the nature of these unique movements. It’s in the players’ interest to do likewise. This is why the players should have promotion material available at the start of the game!

Influenced by the writings of David Li, I would point out that the “Pawn tries” rule absolves the player of having to figure out the order in which s/he would like to make the tries, given that the first legal try will succeed. The more traditional rule allows the player to ask “Pawn captures?” to which the referee will answer “No” if none are possible and “Try” if at least one is possible, whereupon the player must try at least one diagonal-move pawn capture. This dialog gives information to both sides, as do the referee’s oral responses to each attempted move. Li (and others, I believe) firmly consider the use of all of this information to be fair game, though now it is eliminated by the use of computer referees that officiate games on the Internet.
**Colonel Blotto**

Wikipedia gives a copyright-free set of rules to this game, under the name of Goofspiel:112

Goofspiel is played using cards from a standard deck of cards, and is typically a two-player game, although more players are possible. Each suit is ranked A (low), 2, ..., 10, J, Q, K (high).

One suit is singled out as the “prizes”; each of the remaining suits becomes a hand for one player, with one suit discarded if there are only two players, or taken from additional decks if there are four or more. The prizes are shuffled and placed between the players with one card turned up.

Play proceeds in a series of rounds. The players make “closed bids” for the top (face up) prize by selecting a card from their hand (keeping their choice secret from their opponent). Once these cards are selected, they are simultaneously revealed, and the player making the highest bid takes the competition card. Rules for ties in the bidding vary, possibilities including the competition card being discarded, or its value split between the tied players (possibly resulting in fractional scores). Some play that the current prize may “roll over” to the next round, so that two or more cards are competed for at once with a single bid card.

The cards used for bidding are discarded, and play continues with a new upturned prize card.

After 13 rounds, there are no remaining cards and the game ends. Typically, players earn points equal to sum of the ranks of cards won (i.e. ace is worth one point, 2 is two points, etc., jack 11, queen 12, and king 13 points). Players may agree upon other scoring schemes.

**So Long, Sucker**

From http://en.wikipedia.org/wiki/So_Long_Sucker, with editing by Brian McCue.

**Players:** This is a game for four players.

**Equipment:** The game requires a table; four colors of poker chip, seven of each color, and a “can” to contain chips that have been put out of play.

**Starting a game:** Each player has his or her own color. Give each player 7 chips of his or her color. Randomly select one player to be the first player to move.

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112 [https://en.wikipedia.org/wiki/Goofspiel#Game_play](https://en.wikipedia.org/wiki/Goofspiel#Game_play)
Definitions (rules and explanations come later):

➢ A pile is a stack of chips on the table. It can be a single chip, or more than one. A new pile is started by putting a chip on an empty space on the table.

➢ A capture is an event that destroys a pile. The causes and effects of captures are described in the rules below.

➢ A prisoner is a chip in the possession of a player of a different color. Prisoners are taken by capturing piles; they can also be handed around.

➢ A prisoner chip can be killed by the player possessing it. It goes into the can and is no longer part of play.

➢ A player is defeated if it is his or her move, but s/he cannot play because s/he has no chips and nobody will give him/her one. A player wins when all the other players are defeated—even if s/he has no chips and it is his or her move.

➢ Oddities: New players often find this game confusing, and one of the reasons is that it differs from other table games that they may have played. To banish unconscious false assumptions, some of these oddities are listed here:

➢ The ability to move does not circulate around the table, clockwise or counterclockwise, as in many games. In some cases, the player who just moved gets to pick who has the next move, and in others there is a rule determining who has the next move.

➢ Players can come into possession of other players’ chips, and play them. Thus there is a distinction between the color of the chip just played, and the color of the player who just played.

➢ There is no set number of piles.

And now, the actual rules...

Moves: A player moves by playing a chip, of any color, from his or her possession onto the playing area, either onto the top of an existing pile or onto a bare spot on the table, creating a new pile.

Determining who gets the next move: Normally, the last player to have moved can give the move to any player (including her/himself) whose color is not represented in the pile just played upon, or, if all players have chips in that pile,
the move goes to the player whose uppermost chip in the pile is farther down than anybody else’s uppermost chip. Exceptions:

➢ If the pile has been captured (see below), the player whose color made the capture gets the next move.

➢ If a player is defeated (see below), the move returns to the player who gave the defeated player the move. If doing so defeats that player in turn, whoever gave that player the move will get the next turn, etc.

Captures: A pile is captured when its top two chips are the same color. The player of that color must kill one chip of his or her choice out of the pile, and take the rest; those not of his or her color are then his or her prisoners.

Actions taken outside of the move sequence: Any prisoner in a player’s possession may be killed or transferred to another player at any time. Such transfers are unconditional and cannot be retracted. A player may not transfer or kill chips of his or her own color. Players must keep their chips in view at all times. Players can confer freely, but only at the table and during the game—no secret or prior agreements are allowed. Coalitions, or agreements to cooperate, are permitted, and may take any form. There is no penalty for failure to live up to an agreement.

Defeat: A player is defeated if s/he is given the move, but cannot play because s/he has no chips. However, defeat is not final until every player holding prisoners has refused to come to the rescue by transferring chips.

Defeated players’ chips remain in play, but are ignored in determining the order of play. If a pile is captured by the chips of a defeated player, the entire pile is killed, and the move rebounds to the capturing player.

The last undefeated player wins the game. A player can win even if s/he holds no chips and all of his or her chips have been killed.

Chapter 18 of Rapoport’s *N-Person Game Theory* describes the game and gives a short and not entirely satisfying example.
**Gamow’s Tank game**

The rules and board are given by Thornton Page (Page 1952, pp 85-86):

[The] game is played with three identical boards, one for each of the players and one for a referee.

The board ... represents a tank battlefield by a lattice of hexagons, ... some of which are hatched to represent wooded areas of low visibility. The white hexagons represent open fields, and the size of a hexagon represents the “radius of action” of a tank in battle.

Each player starts with ten markers representing tanks at his back line, and “a move” consists in displacing any number of tanks into any of the adjacent hexagons. Each player sees his board only and must infer from the play where his opponent’s tanks are located.

If two opposing tanks arrive on adjoining white hexagons, “a battle” is announced by the referee, who spins a coin to decide which tank is eliminated. When a moving tank comes into contact with two enemy tanks simultaneously, it must “shoot it out” first with one of them, and then, if victorious, with the other.

A tank in the woods obtains a clear kill on any tank which moves into an adjacent white hexagon; a coin is flipped to determine the survivor if another tank moves into the same hexagon in the woods. The objective of the game is to kill off all the opposing tanks, retaining the maximum of one’s own tanks.

The black and white circles are the two sides’ tanks’ starting positions. Dark hexagons (notable for their early appearance) are “woods.” Page appears to have taken certain conventions for granted, e.g., that the sides move alternately, and probably that White moves first.

**The Two-Armed Bandit**

The main text describes a “multi-armed bandit,” but even a *Two-Armed Bandit* is non-trivial and instructive. So as to avoid a player objection of “Why are we playing this?”, at least one arm’s expected-value payoff should be positive, and it’s probably best if both are, with different distributions. In classroom play (such as the author administered to the CNO’s Strategic Studies...
Group, circa 2000), the player(s), after due discussion, tell the instructor “Right” or “Left.” The instructor has pre-created a list of the bandit’s responses, and s/he simply goes down this list, telling the players what payoff they receive in each case.

Here is a sample list, suitable for classroom use (on students who have not seen this paper!).

Simply ask the player(s) to choose an arm, and report the outcome. The right arm has the occasional seductive high payout, but the left arm is in fact slightly preferable. For the record, the left arm’s payouts are the sum of two six-sided dice, while the right arm’s are the product (die – 1) x (die – 1). It would not do to roll the dice in the player(s) presence, because it is known that small numbers of dice are involved, the game would then change to one of deducing the payouts’ recipes.

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Zendo

The rules of Zendo can be found at [http://www.koryheath.com/Zendo/](http://www.koryheath.com/Zendo/).
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Stravinsky, I. 1918. “Five Easy Pieces” (Cinq pièces faciles, a collection of piano pieces for four hands, i.e., two players). There is a 1970 movie of the same name.


About the Author

Brian McCue found a copy of Joseph Morschauser’s How to Play Wargames in Miniature in the library of his junior high school, and has now been a wargamer for over fifty years. In consequence, he has worked in the defense analytic community since the mid-1980s, and at the Center for Naval Analyses since the mid-1990s. He is the author of the book U-Boats In The Bay of Biscay as well as of numerous papers and articles in the field of operations research, mostly about the U-boat war. In CNA’s field program, he was been on the staffs of several US Navy Commands, notably Pacific Fleet, Second Fleet, and Submarine Forces. With CNA colleague Yousi Ma, he created the game SUBHUNT, which has been played over a hundred times and has become part of the Undersea Warfare Development Command’s training program for Theater Undersea Warfare watchstanders. Brian holds a Bachelor’s degree in Mathematics from Hamilton College, and Master’s and Ph.D. degrees from the Massachusetts Institute of Technology.

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From World War 3 to Starsoldier: Gaming design and gaming the future

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Abstract

How do you design a game on the far future? Well, to begin with, far future games are like any other game: they require players to find that the scenario and mechanical elements of the game credibly reflect the expected world. Games that don’t make sense don’t get too far. The challenge for far future games is that the number of possible variables, and the interaction between those variables, greatly complicate creating a plausible set of scenario and mechanical elements. Techniques such as variable fixing, abstraction, player design, and futuring can be used as ways to mitigate against the complex interactions in future game scenarios. In operational and tactical wargames designers also confront the same challenges for design and adjudication that they confront in present day games. The art of designing adjudication processes is balancing the physics, with known weapons systems characteristics, and the environment the system is designed to work in. With the added challenge of applying these to unknown, future, systems. A good designer keeps both the laws of physics and player reactions in mind when choosing a way to move from today into the future.

Introduction

Most wargames are set at a particular time and place. Professional wargames are typically set at either the present or some reasonably close time in the future. For military wargames the time frame for future games breaks into three broad time zones: within the FYDP\textsuperscript{113} (5-6 years or essentially the present day), beyond the FYDP (10 years or 2025), and the glorious far future (20 years or 2035 or whenever the JCOFA\textsuperscript{114} runs out)\textsuperscript{115}. These time horizons are defined by our need to prognosticate both our own force structure, as well as those of our adversaries. Since the pace of change makes projecting to 2035 difficult, anything beyond the 20-year time horizon is considered more or less science fiction.

\textsuperscript{113} FDYP = Five Year Defense Plan

\textsuperscript{114} JCOFA = Joint Country Force Assessment

\textsuperscript{115} Yes, I know that 2035 is not 20 years from 2018, however everyone likes round numbers and eventually it will roll over to 2040, probably sometime around 2022.
So, it’s hard to wargame futures beyond the 20-year mark. But can we do it anyway? Yes. In this paper we will explore why it’s difficult, and what designers can do to overcome those difficulties.

The two games that illustrate many of the items we will discuss here are World War 3 and Starsoldier (Dunnigan, 1974, Walczyk 1977). One is a strategic game on a future (for the time) global Soviet-US war, and the other is a far future tactical game. They bracket the strategic and tactical and they each say something about abstraction, prediction, and how games can tackle the unknown.

Far future wargames are the same as any other game. They need to be playable; players need to believe the game is accurate and fair, and they need some way to realistically adjudicate player actions. But they are different because the game designers have to project the scenario into the far future, and describe how those projections will interact in a believable way. Which can be challenging.

The future ain’t what it used to be

Organizationally and politically it gets hard to game beyond certain time horizons because no one can agree on what the baseline assumptions are. It’s hard to agree on allies, enemies, organization, threat forces, national strategy, and, probably the most important one, how much money everyone is spending. I can do a lot of things with a sizeable fraction of a big economies’ GDP.

One of the main reasons we have problems wargaming beyond 20 years is the need for an accepted joint threat assessment. The size, technology, and systems laydown of the threat can determine what we need to program for (buy), which can cause arguments. That is why we have a DoD wide accepted threat laydown that extends into the near future. Otherwise any decisions you make about programmatics will result in an argument over underlying assumptions, not about capabilities or investment you need. This limitation on the ability to wargame into the future in DoD should not be underestimated.

I believe this is where the term “it’s just science fiction” comes in. All of these variables, and a lack of definitive sources for speculation, make everything seem “made up.” Which makes it

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116 SPI = Simulations Publications Incorporated.
117 Yogi Berra
118 GDP = Gross Domestic Products, military spending is typically expressed as a fraction of GDP, which gives you a topline budget, which then tells you about how many ships, aircraft, and brigades you can afford.
119 The Joint Country Force Assessment (JCOFA) supports most acquisition and capability development by providing force structures out several years. This gives everyone a consistent baseline to model and argue from. See, for example, [Army 2019]
difficult to resolve arguments about what should get funded. And, truthfully, most far future games are focused in some form on helping understand today’s and tomorrow’s budgetary decisions.

This raises the question of “why” you are designing the game. Are you trying to predict budgets? Understand some of the lesser known factors that affect decisions today? Set up a baseline for future speculation? Convince people that the future will be one thing or another?

The “why” question will determine the central focus of the game and constrain your approach toward the future. At the same time, the requirements imposed by designing a futures game will also shape and inform what “why” questions your game can focus on.

The practical issues also deserve some consideration.

The scenario is the first, and biggest problem. How do you specify what the world is like in the far future without losing your players or sponsors? All of the PMESII\(^\text{120}\) variables relevant to the game subject will need to be laid out in ways that are both sensible and believable. Sometimes you may need to invent radical new futures, how do you do that without looking twee?

First, there is not only the relentless advancement of civilian technology, but also the complex, interactive, and non-linear ways in which innovations in technology get used. Giving everyone a high bandwidth communications device can easily be predicted\(^\text{121}\) to improve communications, but it’s difficult to predict that it will change almost every aspect of society and personal relationships.

Second, it is difficult to predict the most important variables such as growth in GDP and productivity. Sizing militaries can be done as a percentage of GDP, but when GDP predictions are uncertain sizing becomes difficult.

Third is the problem of politics and social re-alignment. For example, what American foreign policy might look like in the future. Ten years ago, that would have been a much more “certain” prediction than our current experience would justify. And then there is the problem of

\(^{120}\) PMESII = Political, Military, Economic, Social, Information, Infrastructure. I’ll also talk about PEST: Political, Economic, Social and Technological which is a more elegant way to frame these variables in futurist discussions.

\(^{121}\) It’s impossible to ignore the desire of the clients for a crystal ball that tells them what decisions they should make now. All games have that predictive requirement laid onto them, as does modelling and other forms of analysis. All games run the “now” out into some “future” (scenario) and sees what might happen. In reality any prediction is going to be more like a psychic prediction than a metaphysical guarantee that something will happen in the future. The attribute that I find most valuable about predictions is whether they are interesting. Do they suggest something new to the viewer, do they expand the scope of the possible? This means that obvious predictions, while probably helpful to the staggeringly unimaginative, are less than helpful for decision-makers. I want something that stops us and makes us think, which is all you can reasonably expect from most games.
predicting how social systems will evolve, including what people will want, and how they will react, in the future.

Changes in any one of these areas can produce a cascading effect that has implications far more widespread than the initial change. And they interact to produce even more changes. Identifying the most consequential impacts of future change is critical if you don’t want to have your game go off the rails from the very start.

My favorite example of cascading effects is miniature autonomous vehicles. In order for anything small to go a long way or stay aloft for a long time you need some sort of energy source. Well, that’s easy, let’s just assume a breakthrough in battery technology. We now have the ability to put a tank of gas into the form factor of an AA battery. Now our small swarming drones actually have tactically relevant ranges and loiter times (and comms and AI but I digress). But batteries like that will change everything. You now have enough energy to power flying cars. Autonomous robots become untethered from power supplies. You no longer have to worry about flying drones, but walking, skipping, swimming, jumping ones too. Long-range, high-speed items like missiles or ISR vehicles are able to use bigger batteries and go long distances really fast. Make a bigger version of these batteries and now you have laser cannons on ships, or aircraft, or individual soldiers. Many, many things have now changed in your world. If all you do is put them in drones in your game, you’re going to get a lot of questions about where else they could be used. Better to have identified that in the beginning.

The small drones are your primary technology, but the batteries are your essential change that occurred in the world. Secondary effects are everything that would logically follow from that essential change. If the change is what I call a “singularity” the changes will be many, hard to predict, and have a lot of impact on the different between now and your future. High energy density batteries are an example of a singularity.[a][b]

These challenges are often seen as insurmountable. And they do make specific predictions quite difficult. However, sometimes you don’t get much of a choice. If you have to do it you can come upon some general principles:

➢ Gaming the future is about understanding the future, not predicting it. This gets around the social issue by focusing on understanding, not predicting. Holding games to a strict predictive requirement misses what they do best. In fact, this aligns with the use of science fiction writers by DoD to help understand the future.122

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122 There have been a number of efforts to harness science fiction writers to help the military. These include the USMC’s Science Fiction Futures efforts [MCWL, 2016] and SIGMA (http://www.sigmaforum.org/) a science fiction writers’ think tank.
There are forces that drive the future, if those forces are specified then you can begin to estimate what will happen. There are several techniques that can be used, including trend analysis and extrapolation. No matter what you do the farther out you go, the less sure you can be. I call these forces “variables” and there are a lot of them. We manipulate these variables to create the game scenario and mechanics.

Secondary and unintended consequences dominate in creating a credible future game. There are more players than designers in a game, and they will work assiduously to identify gaps and unexpected relationships in your scenario. When you introduce new technologies or changes in social structures you need to get at least some of the secondary impacts right, or you could lose credibility in your game.

Games are more than just scenarios. In thinking about future games, the natural tendency to emphasize scenarios is magnified by the challenges in identifying which changes you want to have occur in your game scenario. You should not get overly fascinated by scenario.

A prediction of how we would move about in 2000. ¹²³

¹²³ One of a series of French postcards issued between 1899 and 1910 predicting what it would be like in 2000 and documented in (Asimov 1986).
Much of the challenge in designing far future games is knowing the limitations of the medium of games and considering all of the variables, including left-field surprises and things you didn’t think about. But it’s not impossible because there are ways to deal with these challenges. Game design tools such as abstraction, player-led world building, and scenario development techniques can be used. Designers can incorporate an explicit set of assumptions into their world model. And players can be given a sandbox within which to experiment on different world outcomes. You can also use futurist methods to help structure and build the scenarios.\textsuperscript{124}

We will examine the problem of gaming far future conflict, from projecting the current world to 2100 to tactical designs like Starsoldier. We want to understand how designers cope with the expanding range of unknowns as we get further into the future. Designers should also maintain a sense of realism so the players can enter the world of the game. They need to do all of this while admitting that the future may be far stranger than they, or the players, can imagine. While the far future is a big challenge, games can begin to take us there.

The definitions game

Whenever we write or talk about gaming it’s always useful to define what we mean by “game.” In this paper I’m talking about any manual game, to include tabletop, role-playing, or other forms of games. As long as it falls within what I call the context of “professional games” and is not simply a seminar dressed up as a game, I’m including it in this discussion. Professional games are games conducted by people who have a serious intent, and often work on or around the subject being gamed. Wargames are one example of professional games and I’ll concentrate a bit on them here.

Perhaps a more difficult concept to define is what I mean by “future.”

I’m talking about games that reference longer time horizons than we usually experience in games: 20 to 100 years out. Once we get to 20 years out many of the existing weapons systems will be hitting their service life. Agreed upon threat projections, including future threat technologies, also run out at around 20 years. At around 50 years most of the decisions being made today regarding large platforms (aircraft carriers) will have run their course. New decisions will have been made, and a sufficient number of new decisions will have been made that things will get fuzzy in terms of predicting what the DoD force structure will look like.

Clearly military capabilities for both blue and red are a challenge when you get beyond 20 years out. And a real challenge beyond 50. But equipment is not the biggest problem we have with these longer time horizons. The biggest challenge is how we deal with changes in

\textsuperscript{124} In this paper I’m going to focus on a game design perspective in building far future games. For a futurist perspective, and some futurist tools that are helpful in the process of scenario building see (Aguilar-Millan 2019).
technology, particularly how new technologies change the way societies and organizations are built, organized, and act. At the 20-year mark we can more or less assume that social organizations will resemble what we have now.\textsuperscript{125} But beyond 20 years social and organizational variables come into play that expand the number of possibilities dramatically.

This discussion begins to give hints at some of the “what” that we will need to deal with. Not only do we need to have some way of accounting for military force structure and equipment, but we will also need to have some way to account for economic, social, organizational, and political changes that may occur.

Another definition we need to clarify is what I mean by game design variables. I break games down into the following components:

- Objective. What you are trying to accomplish with the game.
- Scenario. The world the game will be played in.
- Mechanics. How the players relate to each other, and the game.
- Materials. The physical representation of the game.
- Venue. Everything about the game that is not the actual game. (Room, food, support, etc.)
- Control. How the players will understand how to play the game.
- Players. Who is playing the game.
- Observation. The observation and analysis of the game.

In this paper I’m particularly interested in the scenario and mechanical elements of the game, and how they should be manipulated in far future game design.

**Game objectives**

We are always taught to begin with the objective, or purpose, of the game when designing games. Are there “valid” objectives that work for future games, and thus “invalid” reasons to want to do a future game?

I contend that games on the long future are just like any other game. Any game, other than historical games, posits a situation that has never existed and does not exist now. Even “present day” games involve players reacting to something that has not yet happened,

\textsuperscript{125} Given the ubiquity of big data, automation, and continuous surveillance this may be an incorrect assumption for 20 years in the future.
otherwise they would be playing a historical game. In that sense all games address the unknown future.

The farther out you get in the scenario the more variables come into play and the more uncertain the game “predictions” get. There are two types of predictions: the scenario and the players actions. I’d contend that the only prediction that has any potential for being false is the scenario-mechanical prediction. The players actions are what the players would do in the game under those circumstances. The player actions are only invalid or incorrect as much as the scenario-mechanic they are placed in is invalid or incorrect.¹²⁶

And, consequently, the game objectives are only off the rails if they specify a set of conditions that are off the rails. Understanding how players will react to a specific set of circumstances is a perfectly fine objective. Specifying a set of circumstances that is strange, wrong, weird, or incomplete is what causes the game results to be suspect.

Game objectives can constrain us to a certain future, scale, or set of interactions, but if they require us to project the scenario or interactions in an invalid way they bring the whole game into question.

How do we specify variables in such a way that we don’t have the game run off the rails?

**Scenario variables**

In developing a game on the far future there are almost an infinite number of scenario variables to consider. We can bin them into some general categories, and develop some ways of dealing with them.

**Technology**

This is the most difficult variable to deal with when constructing future scenarios. We simply don’t know what new technology will arise in 5 years, much less 20 or 50. What are some of the ways for dealing with future technology in games?

**Fixed**

There is a simple way of dealing with almost all of the variables we will discuss, including technology. Keep them fixed. By “fixed” here I mean keeping the relative ratio of technology fixed so that what relationships apply today will apply in the future. For example, there has been no great breakthrough in air defense that renders all flying equipment useless.

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¹²⁶ Here I’m assuming good faith participation by competent players. Players can always engage in bad faith or idiotic play, but even then their actions will still be their actions and as such are still “valid.” For a discussion of some of the alternatives to good faith play, and their consequences, see (Downes-Martin 2015)
Turning variables into constants is a great way to simplify any equation that you need to solve. If you keep all your variables fixed then you are gaming the present.

Fixing the technology variable is useful for games where the central issue is not technology but the reaction to changes in other variables. For example, in a climate change game I designed I kept technology fixed amongst all of the players. We assumed that as technology got more advanced, everyone got more advanced equally and no inequalities due to technology occurred. That allowed them to concentrate on climate and social reaction as the variable as opposed to creating some sort of research/industrial arms race.

I would argue that the ratio of technology advantage between great powers is rapidly approaching unity and in the future significant differences will be very difficult to justify. Access to technology, particularly on longer time scales, is already pretty transparent. Social factors including tactics, training, and other “soft” capabilities may be different, but it’s not like one side’s going to have radar and the other is not (here I’m talking almost exclusively about peer competitors). Competitors may choose to invest differently (see below) but their access to the basic technology will be very similar. This makes holding the technology ratio constant between participants sensible.

Turning technology into a constant does not mean that technology does not change. Instead technology does not appear to change functionally for the players. It more or less does what it’s supposed to do (communicate, kill, save, heal, target, explode, etc.) in the same way it always does. Nothing revolutionary has happened, so players have a pretty good idea of how to use their systems and capabilities in the future.

In addition to not having any technological singularities, constant technology implies that the relative progress between players is fixed. No player has garnered any sort of amazing breakthrough that will dominate the battlefield. This is something we assume for almost all of our conventional wargames: we assume that one or the other adversary has not developed the capability to completely shut down the opposition’s systems, power, and reconnaissance so that they are sitting in the dark with no way to talk to each other. To do otherwise would simply give one force an immediate victory with little learning going on.127

This works particularly well in strategic games where the unit of maneuver are fleets, armies, and strategic forces. In strategic games we are more interested in the interaction between powers than the minutiae of battle.

127 Unless you were playing out how to manage a situation like that. What would Red do? What would Blue do? How would the situation unwind with individual units continuing to resist, the central government attempting HA/DR, and the adversary attempting to exert some sort of coup-de-main without actually having destroyed any units? It’s an interesting question.
Wargaming the Far Future

It can also work for operational and tactical games as long as you realize that other variables, like speed, range, and detectability come into play as well. I may not have to define the technology, but I do have to say that whatever it is lets me go Mach 5, at 10 feet off the ground, and it makes me all aspect invisible to radar. The constant is that we have not strayed from multi-mission platforms, and its manned (because it has to be manned). To keep the ratio the same the same general capabilities would have to be available to all the other peer competitor players.

Abstracted

As I described in the previous paragraph, we don’t necessarily have to specify technologies to actually use them. We can assume certain trends have continued and something, who knows what, is providing that capability. We have not projected specifically rather we have defined capabilities for the future battlefield and given them parameters.

Let’s take air-to-air missiles as an example. Ranges for these missiles have tended to increase over time, and we could assume that they would continue to increase over time. This would provide more stand-off lethality for aircraft, meaning that, unless there were countermeasures, then the battlespace would be expanded for air combat. SAM systems ranges will expand, again, pushing out the boundaries of the IADS and battlespace.

One form of abstraction is common in some space games (GDW 1977) and Larry Bond’s Naval games (Bond 1996, Bond, 2008). In those games the designers specify “technology levels” for basic weapons systems and then use these tech levels when determining outcomes. So, for example, in Harpoon (Bond 1996) missiles and jammers are ranked according to their generation, with the missile and jammer generations being compared to affect hit probabilities. The game Traveller (GDW 1977) used various levels of technology and capability to characterize a diverse array of future technology, from ships to computers to computer programs. Higher tech levels gave advantages in combat.

Starsoldier (Walczyk 1977) represents another form of abstraction for tactical ground combat. The basic premise is that throughout history the battlespace has expanded due to faster movement, longer ranged weapons, and greater lethality. Along with this troop density has decreased. Extrapolating these variables gives him individual squads occupying hundreds of kilometers of terrain, fighting with long range lasers, flying at high speeds, and tossing nuclear grenades. Remove the specificity (lasers, flying, and nuclear grenades) and you get extended range direct fires, rapidly moving elements, and wide impact area weapons. That is another
way to abstract the key elements of combat and extend them into the future. And it makes a clever point about future combat.\textsuperscript{128}

**Speculated**

As *Starsoldier* demonstrates with its’ nuclear hand grenades you can always go for it and actually specify the technology. Though given the rather long history of getting it wrong (Man-portable hundred-kilometer lasers?) you always risk becoming another failed prognosticator.

If you must do it then there are some principles you can consider. The underlying issue is deciding what the objective of the game is, and build your scenario variables to focus on that. Try not to go beyond your essential variables with either your primary systems (high energy density batteries) or your secondary effects (flying cars). In a game designed to examine how naval forces will fight in the far future it is not necessary to understand how the belligerents are governing themselves. In a tactical game the size of the fleets may not be all that important. But you will need to evolve naval concepts, and other elements of warfighting that impact naval forces, because those affect your objectives.

If, as you refine the objectives, you determine that understanding how navies will operate for extended times in the vicinity of hostile coasts is important, that further focuses your scenario. How Naval forces will operate in a contested air environment will become important. You can imagine many different ways of dealing with that, from submarines to unmanned systems with low signatures. Again, refining the objectives will further reduce the number of variables you have to speculate about. If, ultimately, it’s about future surface vessels then you’ll need to understand what they look like in your time frame. How they will operate may be up to the players. Likewise, you’ll need ISR and air superiority/strike capabilities. But you don’t need to specify everything from ground forces to space systems.

Reducing the variables to just those that matter to the objectives makes it easier, and more realistic, to speculate about how that limited variable set will evolve over time. Other variables may affect your variables, and that means you cannot predict with even a limited variable set. But at least you have reduced both workload and reality to something manageable. And you have also decreased the number of secondary effects that either you, or the players, will need to account for.

\textsuperscript{128} A similar concept was proposed in section 3.7 of [Downes-Martin 2018]. There the idea was to enable unclassified gaming of classified topics through the generalization of capabilities.
How do you treat that limited variable set once you have it? Again, there are some principles you can consider:

➢ Everything is connected, all your variables depend on each other and are interrelated. Specify one new idea for the future and you risk being buried under a cascade of consequences, or at least player complaints.

➢ You can’t design most games without some disconnects. Not every design decision will affect every other element in the game. Separating connected from disconnected variables will matter for how the design is received. You want to make sure you connect the most visible, to the players, variables and cut out those that don’t matter for the game play. For example, in the tactical naval game you may be able to ignore possible interactions with ground forces, but you may need to maintain connection with space forces, requiring you to specify more detail about space.

➢ If you cross a singularity you have to own all of the implications that matter to gameplay or your players will rebel. The most common singularity that seems to be discussed today is strong AI. But there are also others. High density batteries, cheap fusion power, quantum computing/cryptography are some other examples. Cross one of these thresholds and you will have a lot to explain in your scenario.

➢ Black Swans and other unexpected or unknown effects can be included in the game, but only if they relate to the objectives. Has a deadly plague killed millions and resulted in a complete overhaul of the international system? That may be relevant for a future public health game, but may be totally irrelevant to a tactical naval game.

➢ Secondary effects can dominate technological breakthroughs. The thing you are interested in (small drones in my example) may be inconsequential compared to everything else that will happen (revolution in the transportation system).

➢ We always underestimate information systems. Information is frictionless. It can move, be manipulated, and change easily. We are only beginning to understand the implications of big data. What if you knew the entire history of every soldier on the battlefield? Their relationships, their families, their likes, dislikes, and so on? While information is difficult to manage as part of game mechanics, it is important to be aware of its potentially disruptive role in the future and how you might need to incorporate some of those disruptions into games.

➢ Social constraints often limit what we think we will do. Test ban treaties, legal restrictions on information sharing (a big deal prior to the IRTPA\textsuperscript{129} bill (Congress 2004))

\textsuperscript{129} IRTPA = Intelligence Reform and Terrorism Prevention Act. For the role of the PATRIOT Act see (Thompson 2008) and for subsequent acts see (Savage 2017).
and restrictions on chemical and biological warfare greatly reduce the scope of what is possible in terms of the US and its allies developing weapon systems.[d] In the future other restrictive regimes on things like AI, autonomy, and genetic engineering may have similar effects. Removing these restrictions may get you a lot of capability, with many secondary effects as well. If one side removes the restrictions and the other side does not (the west vs. the threat) then the resulting asymmetry may be difficult and expensive for us to adapt to.

➢ The future is cynical. I believe that to accurately predict the future we can’t be cynical enough. And the more cynical we are the more accurate we will be. Information enables lots of things, but it can just as easily bog things down and derail decisions. Organizational structures designed to increase participation and ideas can have the opposite effect. Technology that seemed marvelous can become an expensive albatross that drives every other aspect of operations. And so on. In my view a bit, or a lot, of cynicism increases the believability of scenarios.[e]
Social and Organizational

How society is organized, what people believe, and how they act can be more of an influence on the future than any one technology. You can argue that technology is simply the enabler for the real social change that comes with the adoption of the technology. In military terms this means changes in organization and unit command and control, how forces are deployed and employed, and how weapon systems are integrated and used. I would argue that the biggest development in military operations since World War II has been the increasingly restrictive rules of engagement that militaries operate under.[f] As force became more and more capable of overwhelming targets, the need to be more precise in the application of that force became more and more important.  

There are several aspects to social variables that you need to consider when building far future scenarios:

➢ How society has evolved. Is the United States still one country? Does everyone connect via neural implants?

➢ Military organization. Do we still have COCOMS? What does a squad/platoon/company look like? Who is in charge of the naval battle and when?

➢ Social constraints on warfare. Have rules of engagement become more restrictive? How do civilian communications systems, including whatever passes for press, work on the battlefield?

➢ Doctrine. How do various technologies integrate into the basic elements of maneuver (BCT, CSG, AEF, etc.)?[2]

The social variables you need to define will depend on the scale and scope of the game. A game looking at great power competition for the sea floor will necessarily require you to define a whole lot of large-scale social variables. A game on cognitive hacking and gray zone operations will require an even more refined definition of what society will look like in the future. Squad and platoon peer combat operations will only need to define the structure of the future squads and platoons, their weapons employment doctrine, and the nature and roles of their next echelon headquarters.

As was the case with technology, the scope of what the designer will need to define will depend on the game objectives and the topic that is the focus of the game. Keeping the scope  

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Admittedly this breaks down for some peer competitor scenarios, nuclear war being the worst case, but even there the rules are increasingly becoming more restrictive in considering what is and is not a legitimate target for “respectable” nation states. You can no longer just carpet bomb your way to victory (if you ever could). See, for example, (Cooper 2014).

BCT = Brigade Combat Team/CSG = Carrier Strike Group/AEF = Air Expeditionary Force.
narrow and the topic well defined will significantly decrease the workload on the designer. It will also minimize the number of unintended consequences from secondary effects that you forgot to include.

Economic

Economic considerations are overwhelmingly important in any strategic game that projects into the future. The nature of GDP growth will determine a lot of things about the world. Putting that trajectory into a game is fraught with peril.

The most basic problem is identifying a good source of worldwide GDP growth data. Even if you do find one, don’t expect it to be consistent with any other projections. The UN has information,\textsuperscript{133} as does the World Bank,\textsuperscript{134} and others. Most of these projections are for GDP growth rate, and only go out to 2050 or 2060. Beyond that you’d have to linearize, and in many cases you’ll need to do a linear projection using data from the last year available. Even a small compounded number taken over a long time can give you some very interesting results. One conclusion you quickly come to if you do a simple projection of GDP growth is that the world is going to get a lot richer by 2050 and even richer by 2100. What, exactly, everyone is going to do with all this wealth is an interesting question for the social assumptions in your game?

A linear projection of GDP is not necessarily what will happen. Certainly not everywhere and in a consistent way. The big problem is that if you deviate from the projections you need a convincing argument as to why you deviated, because GDP growth can be such a driver for the rest of your scenario.

Two of the things GDP growth is a driver for are size of military forces, and failed states. Both of these are usually of keen interest to military gamers (one more than the other). At the strategic level military budgets can be expressed as a percentage of GDP. Remember Pres. Trump’s focus on percentage of GDP spending by NATO allies (MacAskill 2018)? If you take his goal of 4% and apply it to a linearized GDP growth for Russia and China you quickly realize who we should be worried about. And it’s not Russia.

While you may contend that in the future military effectiveness may not be based on size, it is based on dollars. If I have all the money I need, then I can buy really fancy stuff even if I don’t have a large military. This means that your projection of military capabilities into the future will very much depend on your economic projections.


\textsuperscript{134} https://datacatalog.worldbank.org/dataset/global-economic-prospects
The difficulty in making these projections is that things may change. There may be a significant retrenchment in China’s economy, or a revolution or counter-revolution may derail their progress. Anyone doing linear projections of Japan’s GDP growth rate in the 1980’s where it was 3-5% would have made a significant error as its now around 1-2%. This was due to many different factors including the real estate bubble, bad banking loans and a bad economic policy (Abe 2010).

Placing these economic wildcards into the game has to be done in ways that are consistent with the game objectives. It is easier to decrease the economic projections than it is to make them more optimistic, simply because there are more things that seem to go wrong with economies than things that go right. The economic projections can also be tied to the desired force levels, or force level ratios, for the primary antagonists in the game. If you say you want to examine a situation where the US is significantly outgunned, then increase the economic drag on the US from poor policies, and increase the adversaries’ economic acumen. Even small changes over time will create significant disparities.[e]

The problem is easier if only one or two countries are involved. For example, if we want to look at what an intervention in Morocco in the far future might look like, projecting GDP and military force size for Morocco will occupy a relatively small percentage of your overall design time. Doing that for every country in Africa becomes a much heavier lift, and doing it for all 195 countries in the world will take you some investment of time and resources.

But you are not done when you have your GDP projections. While you projected in constant dollars, what, exactly, does that dollar buy? Let’s take a P-51 Mustang as an example. In today’s dollars the Mustang would cost 722K to buy. The comparable F-35A would cost around 100,000K to buy, or 138 times as much. Whether 138 P-51’s could defeat one F-35, or provide the same capability, is debatable, but the fact that they are two very different capabilities is not debatable. And they cost two very different amounts of money. This “capability inflation” is also something you have to account for when designing strategic games that project into the far future. Otherwise you may over-estimate the numbers of far more capable platforms.

For aircraft this suggests that you need to add on an extra multiplier of 1.6 times the number of years. If you wanted to get fancy you could plot these numbers and fit a curve to them, but since you are extrapolating into the future, I am not sure how much the curve would

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135 December 2018 dollars from Bureau of Industry and Security, Department of Commerce calculator https://data.bls.gov/cgi-bin/cpicalc.pl?cost1=50000&year1=194401&year2=201812. F-35A’s costs vary depending on year of production and number produced, but this is a current estimate for overall unit cost (Zazulia 2018). P-51 cost is from (Wagner 1990).

136 A lot of it depends on what you think of the F-35. The P-51 was an outstanding aircraft.
tell you. And you will need to plot the same curve for other weapons systems of interest, such as ships, missiles, and vehicles.

Finally, if you are doing a strategic game that requires the players to make decisions over the course of extended time periods, you will run into the problem of constant dollars and inflation. Keeping everything in constant present-day dollars will confuse players as they watch their buying power erode due to inflation, while you are busy jacking up the prices of all the fancy future toys they can buy. Using rolling dollars will make more sense, but require you to inflate everything each move, which will require a lot of calculations and updating. At this point everything will need to move onto a computer, as players calculate their budgets and you manage the economy behind the scenes.

Calculating inflation values within a game turn is also possible, and perhaps necessary, think 10-year turns, but will involve some sort of averaging.

Eventually you will wind up with an economic simulation. Unfortunately given that you need to manage the environment and scenario for your game objectives and mechanics, it will be an economic simulation of your own design. Doing a full-blown economic simulation will require time and resources, and will need to be done in such a way that the game controllers can manipulate it.

All this means that in games where you are concerned with the future strategic balance you have to make some calculations. And those calculations are not as reliable as you might want them to be. The best suggestion is to find the most believable data sources, make straightforward projections, and don’t forget to include everything in assessing systems cost and the dollars available to buy them. And budget for the required time and cost of programming aids for both you and the players.

**Continuous vs. Singular scenarios**

I’m using the idea from mathematics of a continuous curve or a progression in contrast with a mathematical “singularity” to describe the different approaches you can have toward scenarios. In most cases you will have some sort of continuous trajectory between the present and your game future. This keeps everything making sense, and reduces the number of objections you get from players and others that “you’re just making all this up.”

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137 In Stephen AM’s paper (Aguilar-Millan 2019) he refers to singular events as Black Swan events (risky) and Wild Card events (uncertain). Here I’m focused more on the impacts that these sorts of events have on world building, and anything of sufficient impact to change the overall trajectory of your game world I simply refer to as a “singular” event.

138 One time a player said to me after a ruling “you just made that up” to which I replied “what do you think I’m doing? I made everything up.”
A continuous progression of variables over time assumes that everything will more or less behave in the future the way it behaves today. For example, with technology we assume that the AI singularity does not happen, that small, cheap, efficient batteries are not developed, and fusion energy does not come online. If any of these do happen, it will radically change the way the world operates, so we exclude those. Likewise, in politics we would assume that western democracies stay more or less the same politically, liberalism takes over in increasing numbers of countries, and the usual suspects remain as the usual threats. For the US to suddenly become an aggressive, colonialist, power would be a singular event that would change everything, so we eliminate it as a possibility.\[^{[h]}\]

On the other hand, there are cases where you do want to try and introduce singularities and see what happens. Surprisingly this poses more challenges to the designer than the players:

➢ Singularities cause unexpected and secondary consequences to proliferate. You have to spend some time hunting those down, and either killing them or including them in your scenario.

➢ Singularities can shut down certain parts of your future, which you need to account for when designing the game. For example, even a small nuclear exchange would likely change the way that nuclear weapons are governed. You can’t just include something like that in a game without acknowledging the potential secondary consequences.

➢ Many singularities generate additional missions for the players. In an extreme warming scenario there will be the potential for many failed states simply due to heat effects. This will require attention and resources from the players. If that is not part of your game, don’t include it or find a way to direct the players’ attention elsewhere.

The last principle on speculative variables is don’t be twee. Hand waving, fictionalization, and sheer speculation without basis will not impress either the sponsors or the players. The best speculative scenarios arise from an underlying principle and branch out from there. Just like Simonsen did in Starsoldier when he plotted troop density and battlespace size. Figure out what your controlling variables are and then how the current capabilities will evolve according to those variables. And stick with the laws of physics. Your world will at least appear realistic to the players.

**Mechanics**

No matter what year the game is set in everyone wants to specify and discuss the scenario. That’s why we started with it. However, game mechanics are just as important. And in future games they can be the controlling variable in determining how the game progresses toward the objective. Game mechanics can mitigate or support many of the issues we described in the introduction to the scenario section. They can be used to minimize the need to be accurate in
your future scenario world, and they can allow for multiple people to work together in creating the world.

**Participatory world building**

One of the most common mechanics used in future games is to have the players participate in building the world. In this type of game, the players have some sort of say in the details of the future scenario. This can either be done “in game” or “out of game.”

**In game**

If I’m doing a game on how the world will look in 2070 I don’t need to start in 2069 and have the players adapt to the world as I have specified it. It is a lot easier if I get the players to construct the world of 2070 for me. This has the added advantage of letting the players “own” the world they have constructed, making them much less interested in “fighting the game” than if they were presented with a pre-scripted world.\(^{139}\)

In this sort of game players are typically given some set of constraints, usually a budget, and then they get to choose how they will develop in the next round. This could range from how a country might develop over a decade to how the Army’s platoon will evolve beyond the FYDP.

This sort of mechanic works best for when the players are focused on how technology and weapon systems will evolve, with the players either designing and buying, or just buying, the new technology between rounds of tactical operations.\(^{[i]}\) In this sort of game asymmetries can develop between different technological approaches, which is pretty much what you want to see play out in the game.

This is different than keeping the ratio of technology the same, here it’s the operational deployment and employment of the technology that the players get to decide on.

For example, if plasma projectors were invented both sides would quickly (within years) have access to plasma technology. One side might choose to build giant plasma firing skyships at enormous cost and difficulty while the other side built plasma pistols. Other countries with access to plasma technology might take a pass, because they simply could not afford it. The ratio of the technology is the same, but the budgetary, operational, and organizational implementation of the technology is very different.

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\(^{139}\) I hate the term “fighting the game” which suggests that the players’ reaction to the game elements are somehow disruptive or not wanted. Designers can make mistakes, players are professionals in the same industry and have their points of view. Their points of view should count as part of the game, either through modifications to the game or notes taken during the game. Designers should not be defensive any more than players should be disruptive.
After the players plan and buy and program then the fun stuff happens: they get to see how the stuff they bought works in conflict. The players then repeat the process.

**Out of game**

In the previous mechanic players built the game world within the framework of the game. But you can also have them simply build the game world, then play it, without making it part of the game.

Some possible mechanics include:

- **Game before the game.** This option is frequently used when technology is a game focus. Here the players get together and play one or more games prior to the game. This process iterates the game world to a point where players are both familiar with it, and satisfied with the technology they developed. Then they play the real game.

- **Wise persons rule.** In this structure the players play the game, while a panel of experts decide what the technology and systems will look like. The subject matter experts either meet before, during, or at both times to decide what capabilities will be used, what the capabilities can do, and how many of them there will be. When it works this form of game can elucidate very interesting insights by combining the engineers and the budgeteers in the same room and forcing them to look the warfighters in the eye and explain why they are getting fewer of what they need, but no matter because it won’t work in the first place.

- **Parallel games.** This is perhaps the hardest to pull off, and in some ways is the holy grail of operational level gaming. Here the strategic game is played so that it can inform and shape the operational level game. In far future games the strategic game can be the long-term game, one that will set the basic conditions and parameters for the operational game. This is a very risky proposition because if one side “loses” the strategic competition for money, technology, or systems then the operational level players may find themselves at an unacceptable disadvantage. The game can end before it begins (like in real life).

**Scale**

Another mechanical factor to consider in designing long future games is the time and space scales. Time, space, and friction⁴⁰ are linked in games. To understand this all you need to do is

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⁴⁰ By “friction” I mean any mechanic that limits the players ability to exploit time and space. This can range from terrain (slows movement) to command and control (limits ability to move each turn) to zones of control (limits movement and forces combat (sometimes)) along with supply. Frictional mechanics can produce reasonable results in situations where other factors create chaos (for example, closed terrain limiting vehicle movement to something reasonable for the scale).
screw up the scale in an operational/tactical game and watch vehicles teleport around your too-small mapboard.

We can break down scale issues according to the type of time jump the game posits:

➢ Operational/tactical games. These games will almost always be set at some fixed time in the future, which means that assumptions about technology, doctrine, and terrain will dominate scale considerations.

➢ Strategic games. Strategic games can take on two forms:
  - Fixed future, game focuses on implications of that fixed future.
  - Variable future, game focuses on the evolution of the game world.

*How long should the turn be in game time?*

There is a significant difference in the way to answer this question depending on whether the game is strategic, or operational/tactical.

**Strategic**

For strategic games the time scale of a turn determines the type and frequency of decisions that the players are going to make. It also determines how much work, and confusion, control will have. But the most important criteria for long-future games is to match the turn length to player agency. By player agency I mean what the role the players are playing in the game could actually accomplish in the real world. Making the players the President of the United States and giving them 10 year turns makes no sense because US Presidents don’t have control over the US for 10 years. It’s 8 at most.141

I also refer to this kind of problem as one of agency-agility-time. Players have to be able to actually affect things in the game. Too long a turn length and they lose the ability to change the course of events (agility). Too short a turn length and they lose agency and agility because they don’t have enough time to accomplish anything. The game has to balance between them.

**Operational/tactical**142

In operational tactical games we are less concerned with player agency and time than the ability for the systems to interact effectively. If critical processes operate on two wildly different time scales you can get crazy things happening. In wargames this occurs in the

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141 For a more in-depth discussion see (Downes-Martin & Robisnon 2018) “Challenges of In-Stride Adjudication” by Ed McGrady, p. 23.

142 I define “tactical” games as those where ranged combat matters, typically company level and below.
speed differences between foot infantry, ships, vehicles, aircraft and weapons. From the point of view of aircraft, naval and ground forces might as well be standing still. From the point of view of infantry, they are standing still while everything moves around them. Similar effects can be seen in an economic game where the quarterly business cycle is very much shorter than the GDP or national election cycles. Synchronizing things with radically different speeds across time can be a challenge.

To extrapolate these factors into the future you need to account for the type of unit, the technology, and the way the unit interacts.

Operational units typically factor future weapons into abstracted combat values. Units have “strength” values that are compared to resolve combat. Future strength values look a lot like present day strength values as they are both numbers that will be compared. Instead of tank cannons they could be laser cannons and tiny robots, but at the operational level they all boil down to the relative strength ratios between large unit formations.

The operational level designer needs to get the relative abilities of units correct, between friendly and enemy and amongst friendly units.

I define the tactical level as the scale where ranged fire becomes important. At this level the designer has to include rates of fire, targeting, and communications into determining the turn length. This is in addition to movement rates and the ability to observe, communicate, and act (C3).

Future weapons systems typically increase in range, lethality, and decrease in numbers. This means that ISR becomes increasingly important, and the ability to communicate with long-range fires becomes important. At the tactical level this means that the battlespace will expand, not just the map battlespace but all of the systems and capabilities that can be directed onto the map by the tactical unit. This means that the electromagnetic environment will become increasingly important as time goes on, as it facilitates battle management, ISR, autonomous systems, and the ability to access off-map capabilities. Representing these features in games also becomes increasingly important the further into the future you go.

**Adjudication**

Adjudication of far future games is a challenge because you don’t know the parameters of the systems, either kinetic or non-kinetic. Designers have to project those capabilities into the future in order to determine things like hit/kill rates or success/effect probabilities. This becomes the art of game design, since the designers have to do something and they are not going to get a lot of help from the test range.
The answer is to ground projections in the physics of the system. For non-kinetic systems this means grounding in the social-science and political theory of the effect. From there you have to extrapolate current weapons systems capabilities into the future. This means that you start with underlying principles, but then you begin to layer on problems and issues that you know happen to existing weapons systems. Like the best hypersonic missile in the world will be useless unless you can locate the target.

Another way to do this is to bring in subject matter experts and have them give advice on adjudication. This, while somewhat appealing, is fraught for a couple of reasons. First the Controller has to themselves have a good handle on the physics of the situation so that they can translate the SME’s opinions into actionable game results. Second, the SME’s may be less than “expert” and instead be salespersons or ringers sent in by advocates of particular technologies. Again, the game designers and controllers have to be savvy enough to weed these out.

These general principles apply to all of the levels of warfare, strategic, operational, and tactical, with the focus changing depending on which level you are at.

Futures processes

Long-future games can learn a lot from the futures community. Another participant has written a very detailed paper on how futures processes can be helpful in games (Aguilar-Millan 2019) so here I want to focus on incorporating the futures processes into your games.

Design

As described in the futures paper there are two broad approaches to the question of understanding the future. One is trend based, where you identify trends and extrapolate them forward. This has the advantage of being both simple and believable. Unfortunately, the future does not follow nice, continuous, curves. It bends and breaks (Aguilar-Millan 2019). A way to account for this is using systems based futuring, where the key systems, political, military, economic, are included in the futures process. Changes in one or more systems is examined in terms of not only that system, but its effects on other systems and the overall future trajectory. Picking which system is dependent on the objectives of the exercise.

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143 For example, if the effect is to dissuade the US from participating in a foreign intervention you can find work that shows how decisions to intervene depend on the United States’ political environment (Drury 2005, Baker 2001).

144 For more information on different types of adjudication as well as some of the pitfalls see [Downes-Martin 2013]. For a contrasting view Graham Longley-Brown commented that “We haven’t found this to be a problem assuming adjudicators and control staff are carefully selected. We also find people are surprisingly good at Critical Thinking their own side’s capabilities.”
These two futures processes resemble our design problem of continuous vs. singular extrapolation of the future. It also breaks futuring down into PMESII/PEST variables and allows single or multiple variables to be examined.

Other than reflecting how designers might think of scenario development, how does this affect game design?

Running a futures process prior to game development can be used to identify scenarios, variables and possible futures that you want to include in the game. This is a powerful tool to both socialize the scenario with players or sponsors, as well as identify unanticipated relationships between the variables.

And, most importantly, running a futures process with the game sponsor may be helpful in identifying what, exactly, the sponsor is interested in. Not only their objective, but the kind of future that they expect the objective to play out in.

Using a futures process before the game can help clarify objectives, identify scenario elements, and ward against unexpected variable relationships and secondary effects.

Execution

Futures processes can also be included as part of game day execution. While doing a futures process inside a game is always possible, it would be kind of strange. Instead I prefer to wrap the futures processes around the game. Using something like the Shell Scenario Planning (Shell 2003) process after a game can give the players a chance to expand on their choices in the game and explore alternate paths. The game grounds the players in the subject, gives them the synthetic experience of being the decision-makers, and then the scenario planning event comes along and expands their horizons beyond the single scenario of the game.

Doing the futures process before the game is problematic because it will alert the players to alternative scenarios, relationships between variables, and unanticipated secondary effects that may, or may not, have been included in the game. They can upset the players before they even get to the game, and “poisoning the well” of player goodwill even before they are introduced to the game scenario. Better to do the planning exercise after the game as an expansive exercise than doing it before and having the game become this limiting, contracting, experience.

This process also gives you additional insights into why players made the decisions they made in the game, and how they might have made different decisions in other scenarios or contexts. This expands the data collected from the game and generalizes it.

145 In this paper I’m talking about scenario planning processes that actually involve a structured approach to identifying key variables and examining the interaction of those variables. There are many other processes that can be used (Lindgren 2003).
What does all this mean?

Far future games are the same as any other type of game, they just have a more speculative scenario. This means that the designers, and sponsors, have to be careful in what they assume and how those assumptions are presented to the players. Their world vision has to be “tight” with secondary and account for unintended consequences.

Designers can use the same techniques they use for designing present day games to determine basic mechanics. It is in assessing the capabilities of units and weapons systems for adjudication that challenges designers. Physics-based “models” of how systems work should go a long way in helping give order of magnitude estimates of hit/kill chances for weapons systems. Systems not based in physics, such as information systems, present their own unique challenges, but those challenges also exist today.

Estimating outcomes from far future weapons systems becomes an art, one that projects current systems results into the future, but also accounts for change in the environment that also impact weapons performance.

Far future games can also benefit, a lot, from techniques from the futures community. Using futures techniques with games has a lot of potential, with the futures techniques used in developing scenarios or game planning, or used in conjunction with games to expand the range of possible game results without replaying the game.

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About the Author

Dr. McGrady is currently the principal in a private media company where he consults and teaches on game design and gaming. He teaches game design for professional games for the Virginia Tech/Military Operations Research Society Certificate on Wargaming course. He also consults on game design and execution. Previously he was a Research Team Leader at CNA where he directed a team devoted to research on games and how they can be used to enhance decision-making. His team developed games and conducted studies on a wide range of topics from cyber warfare and planning to sexual assault and suicide prevention.

Disclaimer: All ideas and opinions expressed in this article are of the author alone and do not reflect the opinions of any other institution or organization.
Working Group Discussion

[a] **Sebastian Bae:** I think this is a really important difference/nuance that is lost on a lot of sponsors and players.

**Ed McGrady:** It is more often lost on designers of games, who make this mistake and get laughed at by any engineers who happen upon their product...

[b] **John Hanley:** Recommend that you look at Geoffrey West’s book “Scale: The Universal Laws of Life, Growth, and Death in Organisms, Cities, and Companies”, and data on the acceleration of technology and the rate of technology adoption producing singularities. The power law approach suggests trends that point to topics worthy of closer scrutiny.

**Ed McGrady:** I’m going to bet that information technologies conform to power law principles while those that rely on thermodynamics don’t. Things like engines seem to follow a more linear scale. But understanding the trajectories is interesting.

[c] **Stephen Downes-Martin:** We also underestimate what is information. Monsanto considers itself “an information company”. The information that is the core of its business is genetic coding, of plants, insects, bacteria and how those codes interact and can be manipulated. So information includes genetics and biology, both of which may be weaponized for future war. Abstracting information as you are proposing for other tech is an interesting topic worth exploring deeper.

**Robert Mosher:** Yes; information = knowledge; information = newly acquired news/knowledge; information = product, etc.

**Ed McGrady:** Yes, and LQG has both time and space being quantized (digitized). But I would see that digression as a distraction here.

[d] **Stephen Downes-Martin:** I suggest that the attitude and actions of the past Soviet Union and current Russia (e.g. bio and chem warfare) imply that “greatly reduce the scope” only applies to us, not our adversaries. So how do we wargame the future of unrestricted genetic warfare by our opponents with us not being allowed to research, let alone deploy, such weapons? This seems to contradict an earlier point you made that the “ratio of technology advantage between powers is rapidly approaching unity”.

**Robert Mosher:** I was always amazed that so few of my diplomatic colleagues realized that no arms agreement actually constituted a physical restraint on actions.

**Ed McGrady:** I will also point out that most of what you see is either chem use in police actions and/or chem/tox/rad assassinations, not full-blown weaponization. Because existing agents don’t really do much on the battlefield (except against civilians as a terror weapon, and I would claim even that is suspect). That’s really why we have the conventions and treaties. (and note I said “existing agents” not “stuff we can think up”).
Stephen Downes-Martin: I always ask myself “what can possibly go wrong?” or “What is wrong with this?” Might “high functioning paranoiac” be a useful characteristic of the wargamer? (There are psychology claims that paranoia is one of the three characteristics of “genius”, the other two being “obsessive” and of course “intelligent”. The latter alone is insufficient.)

Ed McGrady: I assume you are referring to my cynic comment (these comments seem to only refer to the first page of my paper for some reason). I would tend to disagree, paranoia to me says that someone or something is “out to get you”. Instead I say cynicism says that nothing will work out as you plan it, because human nature will always corrupt and pervert everything. (And if human nature doesn’t do it, the universe will stand in.). You’d think that making art was a wonderful chance at self-fulfillment, instead it’s a nasty brutish scramble for the top with everyone trying to make your life miserable in the process. Or, as Sartre said: hell is other people. So, different intent here than either psychotic or paranoia.

Robert Mosher: Don’t omit incompetence.

Ed McGrady: Incompetence by itself is not what I’m talking about either. Rather it is incompetence that enshrines itself within organizational and bureaucratic priorities and systems. It is when incompetence is made powerful that your life begins to degrade ...

Robert Mosher: Good, that’s a useful context for an all too often occurrence.

Stephen Downes-Martin: By paranoiac I am referring (perhaps incorrectly) to the more general belief that “the universe is out to get me”, as in “there is always something I haven’t thought about that will derail my plans”. This leads to the behavior of endlessly questioning whether I have “got it right or considered all the details”. The “high functioning” caveat ensures the avoidance of satisficing (Simon 1956) rather than analysis paralysis.

Stephen Downes-Martin: I suggest these restrictions get ignored when the nation is threatened with the possibility of losing a war to a barbaric enemy. Both the UK and the US committed what in retrospect their wartime leaders suspected were war crimes. Then there is the issue of some states restricting the barbarity of their actions while others happily and with a merry laugh on their lips break every norm known to humanity.

Ed McGrady: Losing -> Threat -> Demonstration -> Battlefield -> Counter force -> Counter value. We have an answer for where we end up when a nuclear nation is threatened by a “barbaric enemy” capable of actually threatening them. The challenge is when we fight over stuff that we won’t escalate over. And also, I believe, our own restrictions on our willingness to escalate which can put us in a reactive mode.

Robert Mosher: Re battlefield behavior - also important to understand that as early as Clausewitz it was recognized that the longer the duration of a conflict (and the longer
individuals experience sustained engagement in combat) these social limits on behavior are eroded away. I also wonder about ROE embedded into weapons’ software directly, in a sense, removing the person from the loop.

**Ed McGrady**: The problem with embedding ROE in a system is that someone has to agree exactly what the ROE is. Probably not hard in an all-out war but in limited war it’s crazy hard.

**Stephen Downes-Martin**: Things will get really interesting when weapons systems are controlled by AI capable of interpreting ROEs and even showing initiative over when to ignore them.

[g] **Stephen Downes-Martin**: Is this the same as gaming with different ratios of GDP (or other economic measures) among the protagonists? Maybe three different futures get gamed; (1) our economy does better than theirs by a significant amount, (2) the opposite, (3) we do about the same. Of course this requires “significant” to be defined.

**Ed McGrady**: Sure, you could do that, however in most cases people want “realistic” future worlds and hence you need to inflate everyone’s economy at “realistic” rates. Also your suggestion tends to create crazy when you do it with all of the countries in the world as opposed to just two competitors. But in a binary competition, or even a trinary, you could do it. The problem is that, given GDP projections and other economic mumbo-jumbo we kind of know how the trinary system (RU/US/CH) will play out over quite a long time (hint: Russia doesn’t do great.)

**Robert Mosher**: Everyone from financiers to investors to wargame designers desperately need whatever is supposed to replace GDP as an economic measure, it doesn’t capture so much of our newly emerging economic activity.

[h] **Stephen Downes-Martin**: I think this is one of the many interesting areas where our two papers touch. In mine I propose that keeping our political and social values (and persuading other states to embrace them to create a favorable world order) is the game’s victory condition. In yours you propose wargaming within the framework of the favorable world order to examine other problems. The two types of game can run in parallel and inform each other.

**Ed McGrady**: I’m not sure what realistic game we’d ever play where the US would not be trying to persuade everyone to create a world order favorable to itself...however unsuccessfully.

**Stephen Downes-Martin**: The point is not whether we would play a values game over favorable world order (we would), but how we would design and play it with 5 year moves over a ten move game.

[i] **Stephen Downes-Martin**: This opens up the possibility of a “buying game” with players choosing what technologies to invest in (research, develop, acquire). Earlier you argue
that “the ratio of technology advantage between powers is rapidly approaching unity”, won’t a buying game allow one to explore shifts away from unity?

**Ed McGrady:** I should be more specific between technology ratios which are spread across systems/capabilities and games designed to get at technology competitions. Basically what I’m saying is that over time the relative implementation of technologies between sensible major powers will be unitary. It’s not like if someone discovers antimatter cannons the other guys won’t have them in a couple of years. However the operational level decisions as to WHICH antimatter cannons to buy, how to support them, their ranges, the rate of fire, and all those other things that matter to operators will depend on budgetary and other decisions. So my assumption is that sensible governments will implement new technologies in such a way that neither side suddenly has a devastating overmatch, at the same time you could put your antimatter cannons on airplanes and I could put them on hamsters and that would affect the way we operate our forces and what other things we buy (squirrel cages, for example). Also there is the budgetary decision. Just because the TECHNOLOGY ratio is unitary does not mean the BUDGETARY ratio is unitary - just look at the US vs. France, for example.
War and Wargames Beyond the Event Horizon

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Introduction

Presented with questions about the future of wargaming, future wargaming, and wargaming the future, I look first, as usual, to the past – to examine what has come before. As the sitcom character George Jefferson once said, “How do you know where I’m at, if you don’t know where I’ve been? Do you get where I’m coming from?”

Modern professional military wargaming is almost 200 years old. Witnessing an 1824 demonstration of “Kriegsspiel”, as developed by two generations of the Reisswitz family, then-Chief of the General Staff Karl Freiherr von Muffling declared, “This is not a game! This is training for war! I must recommend it to the whole army” (Leeson 1988). The rest of that story belongs to Matt Caffrey.

As in our oldest Western game of strategy, Chess, Kriegsspiel presented player-commanders with the opportunity to practice decision-making and tactical to strategic foresight. Unlike Chess, Kriegsspiel presented the player-commander with limited information about his opponent’s forces, their location, their objectives, etc., as well as a more real world playing surface on a terrain table or official military maps. Like Chess, Kriegsspiel offered the opportunity to pause and ponder a situation from multiple points of view at leisure. Kriegsspiel was in its early years so focused upon the decisions to be made by players that it would routinely suspend wargames when the two sides moved into close contact, this was reportedly because the Prussians recognized their limited ability to accurately model this complicated situation on a tabletop. Practice in decision-making in a tactical or an operational context builds mental ‘muscle-memory’ just as tactical battle drills develop a muscle memory that is essential when a battlefield situation changes too quickly and survival, not just victory, will depend upon training and reaction speed. Such attributes support dominance of the OODA loop identified by John Boyd (Boyd 1986).

Prussia’s adoption and development of Kriegsspiel was one thread in its army’s 19th Century evolution that was widely if not always correctly adopted by other nation’s armies, the British, French, and American among them. By the end of the 19th Century, kriegsspiels had evolved to include elements such as logistics, physical fatigue, morale, communications technology, and field engineering. While the depth and breadth of Kriegsspiel’s impact varied over time and from one army to another, by the end of the 19th Century authors could present books of maps, scenarios, orders of battle, etc., with only minimal discussion of rules sets and without

the elaborate apparatus of von Reisswitz, Livermore, Totten, or others. Major Wilkinson Shaw, in *Elements of Modern Tactics, Practically Applied to English Formations*, published in 1890, for example, provided a folded map and illustrated instructions on how to make troop markers for infantry, artillery, and cavalry in order to play out the scenarios he presented. When I look back at the history of Kriegsspiel, Chess, Go, I am confident that in the future there will be wargaming, perhaps even beyond some date when there is an end to war. (Some have postulated the possible replacement of war by wargames of various sorts, but I suspect that that would require major alterations in human thinking and behavior.)

**Future Wargames and Wargame Futures**

Before marching boldly into the future, let me emphasize that I agree that wargames prove nothing. What they can do is to help identify the important questions that need to be answered (Perla 1990 p. 9). Future wargames model:

- War-making capabilities and their effects much like current ones,
- Capabilities marginally improved over current ones, or,
- Capabilities radically improved beyond those currently fielded.
- A battlefield environment dramatically altered by climate changes, etc.
- Confrontations between technologically superior and inferior cultures/civilizations (see the history of European actions in Africa and the Western Hemisphere)

The near future is primarily an extension or elaboration of what we already know projected forward. To reach the more fully “unknown unknown”, we need to focus upon the future that emerges two or more evolutions beyond that predictable future to the moment when the unknowns multiply and may even be invisible to us today. History tells us that the most fundamental transformations occur when humanity transitions from one primary major energy source to another – from animal and human muscle power to power based upon chemical interactions (gunpowder, steam, and the internal combustion engine) and now to power derived from our expanding understanding of physics (Dupuy 1990). As each transition moves forward it alters everything about war from material culture to mobility to logistics. With the introduction of nuclear weapons and nuclear power during the Second World War, we are now in such a transition based upon nuclear physics.

To be truly useful, games/simulations of possible futures need to escape the constraints of legacy platforms or concepts and explore what may lay beyond the event horizon. Over time, 

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147 ‘Event Horizon’ is a term from discussions of general relativity referring to the point at which light could no longer escape from a Black Hole, in subsequent expanded usage, it designates a boundary beyond which an outside observer cannot see or controllably affect events.
the capabilities of one generation’s elite troops have become the standard capabilities of a succeeding generation’s ‘line’ troops. Weapons do not simply vanish as they are replaced by more modern equivalents, but find themselves retained in niche usages or in the hands of marginal forces. Increasing weapons’ ranges and lethality will expand battlefields and increasingly extend them across land, sea, air, and space.

Such an emphasis upon capabilities instead of legacy platforms in future game designs should allow greater exploration of possible RMAs. Thomas Kuhn’s original concept of the revolution in scientific affairs included the recognition that the critical revolutionary step takes place between the ears when someone recognizes and elaborates a truly new application of a new (or even existing) technology or technologies or concept of operations. Revolutionary transformations are almost never generated by the actual inventor or originator of a new technology, weapon, or concept. The real breakthrough on the battlefield comes when someone looks at the new and sees its new capabilities and applications. I would cite as examples:

➢ Britain invented the tank and deployed them in great numbers in 1918, but the Wehrmacht showed early in the Second World War how to integrate tanks, aviation, mechanization, and radio communications and use them on the battlefield (van Creveld 1989 p. 179);

➢ Germany had superior radar technology in 1940, but it was Britain that showed how to make radar technology part of a command and control network that made best use of radar’s capabilities and modern radio communications to fight an aerial battle (Hough & Richards 2008 p. 64).

“What was that?!”

However, wargames must strive to escape the logic trap of assumptions built into the games exploring and testing for RMAs based upon new technology, platforms, and capabilities. The pre-World War Two U.S. army maneuvers in Louisiana and the Carolinas incorporated tank destroyers (cannons mounted on halftracks). Untested in battle, the maneuver umpires were given data, charts, tables, and instructions on how to adjudicate tank destroyers in engagements during these maneuvers (Gabel 1991 p. 48). The results of the use of tank destroyers during these maneuvers were taken as validation of the concept and the weapon system (Gabel 1991 p. 171). Actual battlefield experience in North Africa (with the half-track based TDs) and in Europe (with full tracked lightly armed vehicles) led to a somewhat different conclusion at the end of the war and tank destroyers disappeared from the US Army (US War Dept 1943).

Wargames are about making decisions. Warfare is about rapidly making decisions with inadequate, inaccurate, and incomplete information. So an obvious question is what
information is desirable and how to obtain it. Future wargames need to incorporate the challenge of the cyber world’s accelerated information flow and help explore solutions. One of the biggest challenges at NTC and JRTCs is recreating the flood of information that needs to be assessed and filtered for the commander. It will also need to reflect the ancient truth/reality that some of that information regardless of source or channel will simply be wrong. In his lectures and writings at The Infantry School (1930-1931), then-Captain Adolf von Schell, Reichswehr, drew upon his experiences in the First World War to advocate giving ‘false or exaggerated’ reports in training exercises to accustom officers and troops to this inevitable wartime occurrence (von Schell 1933 pp. 25, 39).

An obvious concern about the future is the things we don’t know what we don’t know - the possibility of one or more “Black Swans”. By definition Black Swans are unpredicted, unexpected variants of the ‘bolt from the blue’ – very rare though very high risk:

“...First, it is an outlier, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Second, it carries an extreme impact...Third, in spite of its outlier status human nature makes us concoct explanations for its occurrence after the facts, making it explainable and predictable.” (The Black Swan, The Impact of the Highly Improbable – Nassim Taleb)

Bolts from the blue like 9/11 were actually forecast in our intelligence collection (Kean & Hamilton 2004) and Pearl Harbor was examined in maneuvers (Nofi 2010 p. 165), we simply drew false conclusions about the data. War games of the 1920s and ‘30s about a war with Japan reportedly left the US surprised in actual combat only by the kamikazes (Perla 1990 p 73, Allen 1989 p. 127).

Dinosaurs inhabited the planet for almost 200 million years but neglected to develop an interest in astronomy and suffered for that lack of curiosity\textsuperscript{148}. Humanity, on the other hand, having dodged similar events in recent memory (Phillips 2009), is now busily cataloging the potential space-based threats and contemplating response options. Humanity has also generated millions of pages of speculative fiction and non-fiction centering on hypothetical ‘Black Swans’. Game designers looking at the future thus have a wealth of material to draw upon (and should) for inspiration re ‘Black Swans’ and what to do about them. Nor are today’s wargamer designers the first to confront the challenge of the Event Horizon. In 1993, RAND game designers inserted the following footnote in a report on a series of their speculative games on future conflict in the Persian Gulf:

“2. To many, an Iraq/Iran coalition might appear extremely unlikely. However, if the Iraqi Shiite majority were to overthrow the existing Iraqi government, it would be much more likely. In any case, gaming should not be limited to “plausible” scenarios since in the real world the implausible (before the fact) scenario seems to occur as frequently. A defense of the implausible scenario is found in an unpublished RAND draft by our colleague James Winnefeld” (Bennett et al 1993 p. v).

Also still beyond the Event Horizon is any ability to truly wage war in space as for the foreseeable future we remain tethered by the limits of our technology and the needs of a human body optimized for life on Earth. Achieving Star Wars/Star Trek forms of war in space clearly require some fundamental alterations in our knowledge of how the universe works and how we apply that knowledge. If we want to embody Space Force now, we should steal a page from author Cixin Liu’s model in Three Body Problem and just suit up about 100 analysts, think-tankers, etc. to just study the challenges and realities of conducting military operations including combat in space for the decades or more required for our technology to catch up. War in space is a dangerous proposition for a species that is still primarily confined to life in a gravity well in a universe full of rocks and which cannot survive in space outside an encapsulated ‘earth’ to live in while traveling through space.

To explore future wars, to include a greater exploration of ‘bolts from the blue’ or ‘Black Swans’ in our games, I come back to the need to include greater free play focused upon capabilities – “What would I like to be able to do?”. We need to see more integration of warfighters into games in control of opposing forces, exposing them to how our combat forces look from the other side, identifying our own vulnerabilities, and doing likewise for potential opposing forces. Scenarios and orders of battle should move away from deployments of the standard TO&E, almost no unit ever goes into battle with everything ‘the book’ says it should have. It was at an NTC exercise that a uniformed colleague confirmed my impression that ‘the Army has a plan so that we know what we are deviating from”.

NSDM’s games encourage free play. Empowered to do so, players will generate ‘Black swans’. Let the players break the game, at which point you capture the data and do a reset to a key moment and move on. NSDM staff do try to avoid injecting ‘Black Swans’ or ‘bolts from the blue’ that are beyond the capabilities of players to act upon within the available time of play. (Nevertheless, both NATO and NSDM games often introduce radioactive mushroom clouds as a way of announcing ‘ENDEX’.) Controllers in Future Wargames will need to be even more prepared to pause their games, collect data, and then consider resetting the game and resuming play.
“I know nothing..!”

I have shared here some of my thoughts excavated from the mental aggregate deposited by some 60 years of playing, studying, critiquing, designing, directing, etc. wargames in multiple formats. One of the original benefits of the NTC model was the opportunity for warfighters to fail and learn from their failures. Without that element, a great deal of the benefit of synthetic combat is wasted. Winning or losing a wargame does not predict losing or winning a battle. One of my high school wargame experiences was winning a Tactics II game played against an Army Lieutenant Colonel. Even as I recognized that I was winning the game, I knew that my advantage was in knowing the game – not that I was a better battlefield commander. Game designers and Exercise control staff will need to continue to distinguish between better gamers and better tacticians or strategists.

Wargames are not going away, though they will continue to change and adopt new forms and formats, even as old ones remain viable. The idea of the wargame embodies the designer’s capability to create whole worlds (and their battlefields), populate them, set the capabilities of that population, etc. Wargames can show us multiple futures. Our challenge will be to identify and then achieve the future we most prefer based upon this and other insights. But this will only happen if we remain flexible, agile, imaginative, and persistent in thinking about both warfare and simulating that warfare, recognizing the universality of war even as we examine its future changes.

“Play up! Play up! and play the game!”

References


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Robert A. Mosher is a thirty year veteran of the US Foreign Service whose career included two years in the Office of the Secretary of Defense and three tours as an Intelligence Analyst/Watch Officer. Trained as an Armored Scout/Observer at Fort Knox, he also completed the Command and Staff Course at the Navy War College. A lifetime playing, designing, and working with wargames began with AH Gettysburg (hex) in 1962. Professionally, he has worked in Continuity of Government, NATO, and Embassy Emergency Action Plan exercises and as a Subject Matter Expert/Role Player in US Army, Navy, and Marine training exercises at several JRTCs and the National Training Center (NTC). In addition to the National Security Decision Making Game (NSDM) as Game Director, Game Controller, Scenario Control, and Facilitator, he has lectured with NSDM at the Origins War College and the GenCon Writers' Symposium. His principal interest and focus has been upon the evolution of war and warfare across history, pursued academically and experientially via conflict studies, living history, staff rides and battlefield walks on three continents across multiple conflicts.

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How To Think About The Future

© Kristan Wheaton
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(This paper is included in the “Wargaming the Future” Working Group Report with Professor Wheaton’s permission. The contents are from his Blog “Sources and Methods: Thinking about the future, and, more importantly, how to think about the future”149. This is a work in progress and Professor Wheaton will be adding additional sections on his blog.)

Part 1 - Questions About Questions

We don’t think about the future; we worry about it.

Whether it’s killer robots or social media or zero-day exploits, we love to rub our preferred, future-infused worry stone between our thumb and finger until it is either a thing of shining beauty or the death of us all (and sometimes both).

This is not a useful approach.

Worry is the antithesis of thinking. Worry is all about jumping to the first and usually the worst possible conclusion. It induces stress. It narrows your focus. It shuts down the very faculties you need to think through a problem. Worry starts with answers; thinking begins with questions.

What Are Your Questions?

“A prudent question is one-half of wisdom.” – Francis Bacon

“The art of proposing a question must be held of higher value than solving it.” – Georg Cantor

“If you do not know how to ask the right question, you discover nothing.” – W. Edwards Deming

Given the importance of questions and of asking the “right” ones (Brooks & John 2018), you would think that there would be more literature on the subject. In fact, the question of questions is, in my experience, one of the great understudied areas. A few years ago, Brian

149 https://sourcesandmethods.blogspot.com/
Manning and I took a stab at it (Manning, B. & Wheaton K. J. 2013) and only managed to uncover how little we really know about how to think about, create, and evaluate questions.

For purposes of thinking about the future, however, I start with two broad categories to consider: Speculative questions and meaningful questions.

There is nothing wrong with a speculative question. Wondering about the nature of things, musing on the interconnectedness of life, and even just staring off into space for a bit are time-honored ways to come up with new ideas and new answers. We should question our assumptions, utilize methods like the Nominal Group Technique to leverage the wisdom of our collective conscious, and explore all of the other divergent thinking tools in our mental toolkits.

Speculation does not come without risks, however. For example, how many terrorist groups would like to strike inside the US? Let’s say 10. How are they planning to do it? Bombs, guns, drones, viruses, nukes? Let’s say we can come up with 10 ways they can attack. Where will they strike? One of the ten largest cities in the US? Do the math--you already have 1000 possible combinations of who, what, and where.

How do we start to narrow this down? Without some additional thinking strategies, we likely give in to cognitive biases like vividness (PON 2010) and recency to narrow our focus. Other aspects of the way our minds work--like working memory limitations (Miller 1956) --also get in the way. Pretty soon, our minds, which like to be fast and certain even when they should

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151 https://psychology.iresearchnet.com/social-psychology/decision-making/recency-effect/
be neither, have turned our 1 in 1000 possibility into a nice, shiny, new worry stone for us to fret over (and, of course, share on Facebook).

Meaningful questions are questions that are important to you—important to your plans, to your (or your organization’s) success or failure. Note that there are two criteria here. First, meaningful questions are important. Second, they are yours. The answers to meaningful questions almost, by definition, have consequences. The answers to these questions tend to compel decisions or, at least, further study.

It is entirely possible, however, to spend a lot of time on questions which are both of dubious relevance to you and are not particularly important. The Brits have a lovely word for this, *bikeshedding* (Kishfy 2015). It captures our willingness to argue for hours about what color to paint the bikeshed while ignoring much harder and more consequential questions. Bikeshedding, in short, allows us to distract ourselves from our speculations and our worries and feel like we are still getting something done.
Part 2 - What Do You Control?

(The full mindmap is at https://www.mindmeister.com/1302065182?t=FtQWj502LV)

The great Stoic philosopher Epictetus wrote,

“Work therefore to be able to say to every harsh appearance, ‘You are but an appearance, and not absolutely the thing you appear to be.’ And then examine it by those rules which you have, and first, and chiefly, by this: whether it concerns the things which are in our own control, or those which are not; and, if it concerns anything not in our control, be prepared to say that it is nothing to you.” (Italics mine)

There are good reasons to focus on questions about things you control. Things you control you can understand or, at least, the data required to understand them is much easier to get. Things you control you can also change (or change more easily). Finally, you only get credit for the things you do with the things you control. Few people get credit for just watching.

Whole disciplines have been built around improving what you do with what you control. MBA and Operations Research programs are both good examples of fields of study that focus mostly on improving decisions about how you use the resources under your control. Indeed, focusing on the things you control is at the center of effectual reasoning\(^ {152}\), an exciting new

\(^ {152}\) https://www.effectuation.org/?page_id=207
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take on entrepreneurship and innovation (for example, the entire crowdfunding/startup Quickstarter Project\(^{153}\) was built on the effectuation principles and are the reason it was as successful as it was).

On the other hand, another great thinker from the ancient world once wrote,

“If you know the enemy and know yourself, you need not fear the result of a hundred battles.” Sun Tzu, The Art Of War\(^{154}\)

Sun Tzu went on to outline the exact impact of not thinking about things you don’t control:

“If you know yourself but not the enemy, for every victory gained you will also suffer a defeat.”

Things outside of your control are much more squishy than things under your control. The data is often incomplete, and what is there is often unclear. It is pretty normal for the info to be, as Clausewitz\(^{155}\) would say, “of doubtful character,” and it is rarely structured in nice neat rows with data points helpfully organized with labelled columns. Finally, in an adversarial environment at least, you have to assume that at least some of the info you do have is deceptive--that it has been put there intentionally by your enemy or competitor to put you off the track.

People frequently run from questions about things that are outside of their control. The nature of the info available can often make these kinds of questions seem unresolvable, that no amount of thinking can lead to any greater clarity.

This is a mistake.

Inevitably, in order to move forward with the things you do control, you have to come to some conclusions about the things you do not control. A country’s military looks very different if it expects the enemy to attack by sea vs. by land. A company’s marketing plan looks very different if it thinks its competitor will be first to market with a new type of product or if it will not. Your negotiating strategy with a potential buyer of your house depends very much on whether you think the market in your area is hot or not.

The US military has a saying: “Intelligence leads operations.” This is a shorthand way of driving home the point that your understanding of your environment, of what is happening around you, of the things outside of your control, determines what you do with the things under your control. Whether you do this analysis in a structured, formal way or just go with


\(^{154}\) [http://classics.mit.edu/Tzu/artwar.html](http://classics.mit.edu/Tzu/artwar.html)

\(^{155}\) [http://www.clausewitz.com/readings/OnWar1873/BK1ch06.html](http://www.clausewitz.com/readings/OnWar1873/BK1ch06.html)
your gut instinct, you always come to conclusions about your environment, about the things outside your control, before you act.

Since you are going to do it anyway, wouldn’t it be nice if there were some skills and tools you could learn to do it better? It turns out that there are. The last 20-30 years has seen an explosion in research about how to better understand the future for those things outside of our control.

More importantly, learning these skills and tools can probably help you understand things under your control better as well. Things under your control often come with the same kinds of squishy data normally associated with things outside your control. The opposite is much less likely to be true.

Much of the rest of this series will focus on these tools and thinking skills, but first, we need to dig more deeply into the nature of the questions we ask about things outside our control and precisely why those questions are so difficult to answer.

**Part 3 - Why Are Questions About Things Outside Your Control So Difficult?**

Former Director of the CIA, Mike Hayden, likes to tell this story:

“Some months ago, I met with a small group of investment bankers and one of them asked me, ‘On a scale of 1 to 10, how good is our intelligence today?’” recalled Hayden. “I said the first thing to understand is that anything above 7 isn’t on our scale. If we’re at 8, 9, or 10, we’re not in the realm of intelligence—no one is asking us the questions that can yield such confidence. We only get the hard sliders on the corner of the plate. Our profession deals with subjects that are inherently ambiguous, and often deliberately hidden. Even when we’re at the top of our game, we can offer policymakers insight, we can provide context, and we can give them a clearer picture of the issue at hand, but we cannot claim certainty for our judgments.” (Italics mine)

I think it is important to note that the main reason Director Hayden cited for the Agency’s “batting average” was not politics or funding or even a hostile operating environment. No. The #1 reason was the difficulty of the questions.

Understanding why some questions are more difficult than others is incredibly important. Difficult questions typically demand more resources—and have more consequences. What makes it particularly interesting is that we all have an innate sense of when a question is difficult and when it is not, but we don’t really understand why. I have written about this
elsewhere (here and here and here, for example), and may have become a bit like the man in the “What makes soup, soup?” video.\textsuperscript{156}

No one, however, to my knowledge, has solved the problem of reliably categorizing questions by difficulty.

I have a hypothesis, however.

I think that the AI guys might have taken a big step towards cracking the code. When I first heard about how AI researchers categorize AI tasks by difficulty\textsuperscript{157}, I thought there might be some useful thinking there. That was way back in 2011, though. As I went looking for updates for this series of posts, I got really excited. There has been a ton of good work done in this area (no surprise there), and I think that Russel and Norvig in their book, Artificial Intelligence: A Modern Approach (Russell & Norvig 2009), may have gotten even closer to what is, essentially, a working definition of question difficulty.

Let me be clear here. The AI community did not set out to figure out why some questions are more difficult than others. They were looking to categorize AI tasks by difficulty. My sense, however, is that, in so doing, they have inadvertently shown a light on the more general question of question difficulty. Here is the list of eight criteria they use to categorize task environments (the interpretation of their thinking in terms of questions is mine):

- Fully observable vs. partially observable -- Questions about things that are hidden (or partially hidden) are more difficult than questions about things that are not.

- Single agent vs. multi-agent -- Questions about things involving multiple people or organizations are more difficult than questions about a single person or organization.

- Competitive vs. cooperative -- If someone is trying to stop you from getting an answer or is going to take the time to try to lead you to the wrong answer, it is a more difficult question. Questions about enemies are inherently harder to answer than questions about allies.

- Deterministic vs. stochastic -- Is it a question about something with fairly well-defined rules (like many engineering questions) or is it a question with a large degree of uncertainty in it (like questions about the feelings of a particular audience)? How much randomness is in the environment?

- Episodic vs. sequential -- Questions about things that happen over time are more difficult than questions about things that happen once.

\textsuperscript{156} https://youtu.be/Y1HVTNxwt7w

\textsuperscript{157} https://sourcesandmethods.blogspot.com/2011/10/intelligence-is-all-about-partially.html
➢ Static vs. dynamic -- It is easier to answer questions about places where nothing moves than it is to answer questions about places where everything is moving.

➢ Discrete vs. continuous -- Spaces that have boundaries, even notional or technical ones, make for easier questions than unbounded, “open world,” spaces.

➢ Known vs. unknown -- Questions where you don’t know how anything works are much more difficult than questions where you have a pretty good sense of how things work.

Why is this important to questions about the future? Two reasons. First, it is worth noting that most questions about the future, particularly those about things that are outside our control, fall at the harder rather than easier end of each of these criteria. Second, understanding the specific reasons why these questions are hard also gives clues as to how to make them easier to answer.

There is one more important reason why questions can be difficult. It doesn’t come from AI research. It comes from the person (or organization) asking the question. All too often, people either don’t ask the “real” question they want answered or are incredibly unclear in the way they phrase their questions. If you want some solutions to these problems, I suggest you look here158.

I was a big kid who grew up in a small town. I only played Little League ball one year, but I had a .700 batting average. Even when I was at my best physical condition as an adult, however, I doubt that I could hit a foul tip off a major league pitcher. Hayden is right. Meaningful questions about things outside your control are Major League questions, hard sliders on the corner of the plate. Understanding that, and understanding what makes these questions so challenging, is a necessary precondition to taking the next step--answering them.

References


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Implausible and Possible Futures

Stephen Aguilar-Millan

Futurists like to think in terms of various categories of the future. We like to distinguish between implausible futures and possible futures. An implausible future is one which could happen, but which we feel is quite unlikely to happen, something beyond the bounds of possibility. Within the boundaries of possible futures are probable futures - those futures which we think are quite reasonably likely to happen - and preferable futures - those futures which we would very much like to happen. From the previous conversations, it seems to me that we are starting to limit ourselves possible futures and want to stay within the bounds of possibility. That’s OK, but we ought to be aware of what we are missing if we do so.

Futurists study implausible futures - silly sci-fi scenarios - because that’s where the wild cards lie. I think that I could best describe wild card scenarios to this group as along the lines of Donald Rumsfeld’s ‘Unknown, Unknowns’. In our community we do have a pretty good example of what we mean. In the mid-1990s, an intelligence futurist called Marvin Cetron alerted his masters to the possibility of recently fuelled aircraft being flown into tall buildings in the US. His thinking on these lines was taken out of threat briefings on the grounds that they were too much like science fiction. You probably all know what happened next.

My point is that if we are to concern ourselves solely on possible futures, then we are restricting our view to the ‘Known, Knowns’ and the ‘Known, Unknowns’. I have to say that I feel a bit uneasy about that because I see this as an incomplete story. I am drawn to the ‘Unknown, Knowns’ and the ‘Unknown, Unknowns’ by habit. However, we can’t study everything. I just feel that, as we layer assumptions into the study, we ought to be aware of what we are putting in, and what we are leaving out. If we make an informed choice to do this, then that’s fine. However, we ought to be aware of our limitations.

Ed McGrady

Interestingly the Future of Wargaming working group is planning to use a futures process to understand how wargaming will evolve over the coming years. Right now we’re just planning to use a Shell kind of scenario process, though we could be persuaded to do something else/better. The goal is to get people to think concretely about the future (of wargaming), as opposed to just sit around and speculate.

I was also going to reply to the other thread that McCue seems to have started with a bit about plausible and implausible futures. Clearly we are living in an implausible future, and it will just get more so as time goes on (apparently). I don’t think choosing an implausible future in a game is ever a good idea, unless the game objective specifically specifies it (e.g. “what will we do if aliens arrive” or “what will we do if a giant extra-solar thing is headed straight for us (and
we detect it before it hits)”). This doesn’t have to be scifi: unless a game is designed to specifically account for typhoons or nuclear detonations it will create a huge diversion for a game to incorporate them. In addition to plausibility there is also the question of myopia - we tend to extrapolate based on what is happening now as opposed to the complex, integrated, changes that will occur in the future (flying cars because all of the big innovation up to that point had been in mechanical efficiency and energetics instead of information so that’s what people knew). On the other hand, sometimes we get specifically asked about long time periods or implausible situations. Knowing a little bit about how to deal with them (as you discuss) would be a good idea.

For me gaming the long future is all about variables and drivers. What will be the big drivers in the future (climate change, perhaps?) and how do we want them to behave as variables in the game (fixed, variable, ignored, etc.)? The choice of variables and drivers goes to the overall objective of the game. In a game on climate change you’ll darn sure need the climate to be a variable, because that is the focus. Military technology in a climate game can probably be a fixed variable. And so on.

My approach to all this is quite practical. Sometimes there are issues (like climate change) where the game variables change over very long periods of time (deforestation, land use, genetic drift, animal populations, AI, mineral resources, economic development, etc. all probably fall into this category). So someone with funding comes to you and wants to design a game in a long future. My focus is on what do you actually do? One answer is “its hard and you won’t learn anything.” I find that more of an indication that it’s an interesting challenge that we can think interesting thoughts about.

And Stephen Downes-Martin is correct - in a professional game the key questions should revolve around the “so what” of what are we going to do differently - now - if we learn something from the game - not just explore the future for the future’s sake.

Stephen Downes-Martin

Stephen Aguilar-Millan’s point about wildcards in implausible futures is relevant to us for two reasons. (1) The wildcards surfaced by an implausible future might themselves be plausible (and might not be surfaced by a plausible future), and (2) if those wildcards are damaging to us (even if we don’t believe they are plausible) then we can expect smart enemy strategists to be working to author a future in which those wildcards are at best plausible and worse are present. We must think about how to use a combination of futurism and wargaming to explore and author futures that benefit our respective national securities based on decisions we make today, with a process (or processes) for how we develop gaming as the future unfolds.
Perhaps it’s not the plausibility of the scenario or wildcard that matters (analogy to divergent thinking?), it’s how we or an enemy can author a future to make a salient wildcard plausible that matters (analogy to convergent thinking?)
Consistent Terminology for Futurism and Gaming?

Anne Johnson

Since most of us are touching upon similar bodies of analytic and wargaming work; it’s not surprising that the group is showing how many perspectives and fields of study, and use of these tools and data, are biting away at dealing with complexity and uncertainty. My interest is in trying to understand environment uncertainty in the context of “what will the future be like”, not “what is a possible situation we may face”.

I have started using the term “Alternative Security Environments” as a means to convey how “The Future”, or at least components of it, could fall outside traditional assumptions or limits of understanding. Ideas that I incorporate include levels of uncertainty, types of surprises, a range of time horizons, and the direction of creating the future.

In my experience, people are using terms in different ways, so I offer up how I’ve been using some futuring terms. (Note the following terms are taken from literature and are not necessarily ‘military’, rather ‘academic’ or ‘business’.):

- **Trend**: historical, what has happened in the past
- **Projection**: extrapolation (usually of a trend) into the future
- **Prediction**: a statement meant to be accurate

**Four Levels of Uncertainty**

- **Clear Enough**: a single view is sufficient to make decisions
- **Alternative Futures**: a limited set of possible outcomes
- **Range of Futures**: the future is expected to fall within this range (could be the traditional “cone of plausibility”)
- **True Ambiguity**: not enough information to even know all the variables or parameters

**Different types of surprises**

It’s not black and white. A way to think about different types of surprise is:

- **Unknown Unknowns**
  - **Black Swan**: completely blindsided
  - **Wild Cards**: “known (but possibly ignored, not considered) to be feasibly out there and usable”

- **Known Unknowns**
  - **Black Elephant**: Things we know about but are ignoring (for whatever reason)

- **Unknown Knowns**
  - **Black Jellyfish**: Incorrect assumptions, things we think we’re right about, but aren’t
Furthermore, these surprises could be technologically-based or use- or policy-based; and due to varying speeds and accelerations of advancement, could/will come to fruition over a range of time horizons.

**Speed/Velocity of (Technological) Emergence**

- **Sudden** from nothing to something very rapidly (e.g. graphene)
- **Sleeping Beauty** ongoing work is finally enabled (e.g. artificial intelligence)
- **Leap Across Fields** mature in one area shifts to another area (e.g. genetic algorithms)

**Direction of Creating “The Future”**

Either/Both can be used to ensure a future vision is achieved through leading, adapting, or following:

- **Push** Often, a view of the future is based in the here and now – what we know and ‘where’ we are. Perhaps a bit more comfortable for most, and tends to be more “fact-based”, using tools trends and to predict for accuracy.

- **Pull** Includes Futuring tradecraft tools to determine what “future” we want to create. I think most folks think they’re good at this, but unfortunately, they’re really just using qualitative methods to support their “gut feelings” and move pet-projects/ideas forward. (Designing a future where their solution would be successful.)

**Timeframes** (somewhat acquisition-focused)

- **Near-term** what can be accomplished now; perhaps out to 5 years
- **Mid-term** what we’re planning for; perhaps out to 15/20 years; programs of record
- **Far-term** what we don’t know what to plan for; beyond programs of record

By using Alternative Security Environments, it is not necessary to define or describe the details of how surprises come about – rather their impact to the environment (for example by challenging underlying assumptions). From that point, a scenario for a wargame can be developed. Since so much can and will change between now and (name your future timeframe), coordinating and incorporating the above can be used in games (and other work) to enable decision makers to think differently and more critically; to better understand signposts and indicators, vice understanding how to plan for defined scenarios.

Some thoughts on modeling tools: systems thinking, system dynamics, and causal loops. These are not equivalent terms, though I think many use them interchangeably (not implying anyone in this group – but in my own experience). I think most folks don’t realize that system dynamics is about modeling a problem from a systems perspective and instead think that they
are trying to model & simulate an actual system (system of systems, ecosystem, ...). Also, causal loops do not provide behavior dynamics (neither do archetypes) and therefore counterintuitive behaviors and unintended consequences can be missed unless you build and run a simulate-able model.

Stephen Downes-Martin

It seems to me that the levels of uncertainty described by Anne are outputs, i.e. uncertainty leads to different qualitative orderings of the number of possible futures (single, limited number, wider range, wide open). Inputs might be described by John Hanley’s levels of indeterminacy in (Hanley 1991, 2017).

See John’s Table on page 35 of the Working Group 2 report, partially reproduced here for convenience (apologies for any weird screen size of image!):

<table>
<thead>
<tr>
<th>Deterministic</th>
<th>Statistical Indeterminacy</th>
<th>Stochastic Indeterminacy</th>
<th>Strategic Indeterminacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. State space clearly defined</td>
<td>1. State space clearly defined</td>
<td>1. State space clearly defined</td>
<td>1. Conflicting interests</td>
</tr>
<tr>
<td>2. Persistent data</td>
<td>2. Persistent data</td>
<td>2. Persistent data</td>
<td>2. Players specified</td>
</tr>
<tr>
<td>3. Units of measure understood</td>
<td>3. Units of measure understood</td>
<td>3. Units of measure understood</td>
<td>3. Information conditions specified</td>
</tr>
<tr>
<td>5. Initial state known</td>
<td>5. Probability distributions known</td>
<td>5. State transition probabilities &amp; rates known, and are Markovian</td>
<td>5. Player tastes and beliefs known</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6. Players consistent and logical (rational)</td>
</tr>
</tbody>
</table>

Trying to link inputs to outputs drives us to decide what we should be focusing on in designing a game, or games, or games plus other methods. Stephen AM’s paper for this working group is worth a read on that topic.

Ed McGrady

This discussion raises an interesting issue for me on this overall topic: how much thought/discussion/learning do we need about futurist thinking (coming up with the scenario)? Compared to how much do we need to focus on issues related to mechanics and other game-specific concepts? I think we need both but it’s interesting to recognize that the group will need to balance between futurism and gaming. Because they are not exactly the same things.
Stephen Downes-Martin

I draw attention to Doug Lenat’s experience in the 80’s winning the Traveller Trillion Credit Squadron game using highly unbalanced fleets. The strategy he used was to be as close to unbalanced as it was possible to be, but not quite, for any set of rules imposed by the tournament organizers who kept changing the rules to exclude his unbalanced fleets not realising that it was the rules themselves that defined “balance”, and that unbalanced is what allowed him to win. For this, and other examples of how and when unbalanced might beat balanced see (Gladwell 2009). I believe Ed’s question and past experience with balance leads to the more general question of when and how does balance and unbalance deepen knowledge.

Ed McGrady

Balance here: you are right, each individual will need to figure out how they approach the problem. I was just pointing out there were two different things we were talking about and that how those balance out will affect the overall trajectory of the group. And now you are pointing out that the trajectory will result in different learnings (if that’s a word).

Balance in games: the problem of “balance” is more of a hobby game concept, in my opinion. In professional games the situation (scenario) is the situation. In those games the much more complicated problem of “fairness” becomes an issue and takes in how you treat players and the subject matter. You can game a highly imbalanced situation as long as everyone thinks they are being treated fairly.

Phillip Pournelle

The issue of balance or unbalanced in DoD games is the decision space of Red. Too often we force Red to play like Goliath and for some reason Blue always wins. On the other hand, if Red is allowed to play in accordance with Red Doctrine (which often is like the Press in the article) Blue starts to lose, badly. After repeated exposure to this problem, Blue players can begin to learn the lesson and adjust their strategy accordingly. This gives me hope, I just hope this approach is used often. If the new Joint Publication 5-0, the best practices call for a level playing field for Red, in the form of equal decision space, etc.
Scenario versus game mechanics balance?

Stephen Downes-Martin

In professional national security games designed to explore novel approaches to novel future situations, I argue that balance, or rather the deliberate lack of balance, is a professional game concept in possibly two ways. First, we would like to see how a seriously weaker adversary could defeat us so that we can avoid that, and how if we were seriously weaker we could defeat a superior adversary. Perhaps we can do that with novel unbalanced force mixes that our adversary would not think of and thus would have difficulty planning around? Second, if the scenario is sufficiently far into the future we would like an R&D and Buying strategy that placed us in one of those advantageous situations in which we have an unbalanced force mix with novel COAs that the adversary has difficulty planning around.

And then of course any serious adversary will be thinking the same way.

As Ed rightly points out, balance applies not just to force mix in the scenario, but also to the process of designing games and the process of thinking about wargaming the future. The concepts of “balance” are different between these activities but thinking about them together might trigger some innovative thoughts.

Ed McGrady

For me, balance and harmony are an element of design, and therefore have a very big place in game design. However when I think of harmony in game design I mean are all of the various components in the scenario, mechanics, players, and venue all synchronized and working toward achieving the same goal and presenting the same consistent world to the players. This is very different from the concept of balance in victory conditions that we think of in terms of traditional war-games. And I think it’s different than what Stephen means. He means that we may learn different things from different types and strengths of challenges to the target players (i.e. Blue faces a strong Red, Blue faces a weak Red, etc.). I always push for Blue facing and accurate Red and balance be damned. But I can see his point, getting ourselves off balance - whatever that means - in games can take us interesting places. I’d do it by messing with all the tools, from venue to players to scenario, others may choose to focus on the scenario because it’s too weird (or risky) to do it with mechanics.

So we now have several different concepts of “balance”:

1. Traditional hobby wargame concept
2. Re-imagined in professional games as “fairness” because not all situations are, or should be, “balanced”
3. Variable balance used as a way of stimulating thought in a game.
4. Harmony and balance in the design of games.

I’m sure we could add more!

But the idea of throwing any of these concepts “off balance” as a way of increasing learning in a game is actually an interesting thought. (Except fairness, fairness for me has to be a bedrock value in games or you will unbalance yourself by having no players).
Common Pitfalls of Wargaming Emerging Technologies

Sebastian J. Bae

*The Fallacy of Familiar Concepts of Operations:* Many future wargames assume that units will operate in familiar frameworks and remain fundamentally unchanged – with technology replacing legacy systems. This often stems from the approach of utilizing gap analysis to creating technological solutions for present-day challenges. However, historically, significant shifts in technology in terms of warfare have been accompanied by radical organizational change. Rarely, if ever, do wargames ever wargame fundamentally different/radical organization structures and concepts that could be coupled with new emerging technologies.

*The Myth of the Silver Bullet:* One of the most common pitfalls I see is that wargames/sponsors create a suite of technologies that are unrealistically capable and tailored made to solve present problems. This is worsened by the fact that wargames rarely incorporate or examine the technical or operational demands of new capabilities. For instance, for energy-based weapons, where do you get the energy from?

*Balancing Realism and Radical Innovation:* The core fundamental tension in wargaming the future is the tension between feasibility (aka realism) and fostering out of the box thinking simultaneously. This is inherent to most wargames, but it is particularly acute for wargaming the future given the unknown qualities of the future technologies and not being trapped by past thinking. Commonly, the majority of wargame either are too conservative in their predictions of the future or so wildly speculative to be nothing more than science fiction. The difficulty is finding the balance.

*Recommendation:* There is no single solution to any of these challenges in wargaming the future. However, one of the best approaches is to conduct iterative wargames as part of a series, with different wargames aimed at examining or eliciting different aspects of the problem. For instance, the first wargame can be a matrix style game designed to elicit creative, out of the box thinking. This can be followed by more rigorous analytical games that incorporate realistic limitations and capabilities for future technologies.

Stephen Downes-Martin

Your situation assessment appears to have some connection to the wargame pathology known as the “(technology) victory machine”, wherein the game technologies are given to Blue that guarantee a Blue win -- Blue gets matter transporters and photon torpedoes, Red gets rotary dial field telephones and scud missiles, gosh we need matter transporters and photon torpedoes. There are analogous “logic victory machines” -- “If blue can pre-empt red decision making and overwhelm red forces, then blue can win” (honest, word for word a game research question proposed by a game sponsor some years back).
Is it the case that some pitfalls you mention have their roots in current game pathologies? And that you can identify new pitfalls generated by the uncertainties inherent in gaming the future?

Sebastian Bae

I see that the technology victory machine is a very fundamental one -- often showing up in future based wargaming in the DoD. I believe it is only amplified in future games -- hence the silver bullet.

In using familiar concepts of the past to the future, I believe this is a pathology more rooted in wider military thinking than in gaming. It is the pervasive belief that we just need to think faster, shoot farther, and see more -- while avoiding any significant changes in how we think or plan or execute in conjunction with new concepts.

Ed McGrady

Just a thought because it relates to my topic as well (McGrady 2019), you may wish to consider the time horizon in terms of the types of pitfalls. Within the FYDP, “beyond the FYDP” (10ish years) or within the JCOFA (20 years?) all make a difference in terms of the types of pathologies you will encounter. The interaction with threat technologies also matters - we can’t just predict what we’ll be doing, but also what the threat will be doing.

(My goal in my paper is to examine how to game topics that go beyond the normal set of scenario tools we have (FYDP, JCOFA, etc.) and think about the forces that should be included in the games, and what different techniques can tell us about the future. At least that’s the goal of my paper. Obviously technology is important, but the social and other factors are also important.)

Sebastian Bae

I can see how our papers are related. Mine is more focused on the pitfalls and pathologies that arise when wargames interact with new technologies like lasers and hypersonic weapons and autonomous weapon systems.

I identify that we often:

1. Script victory via technology hence the victory machine Stephen mentioned
2. Fail to imagine radical organizational changes in conjunction with new technologies
3. Try to wargame too many variables all at once such as 30 new technologies which muddles what is useful and not
4. The sinkhole of science of fiction. Where we game technologies so far into the future that we don’t really know how to quantify their effects on the battlefield
In terms of pathologies I believe you have hit on quite a few of them.

1. In my paper I’m going to probably talk about how we think about projected capabilities and their interaction so as to avoid this sort of crushing victory machine behavior. In most cases new weapons systems don’t actually completely crush the opposition, the opposition finds something to mitigate the effects. There are other ways to handle this as well.

2. But if you look at “radical organizational changes” in the US military it was not technology that was the driver. For the joint process it was the cluster of Grenada that finally pushed us into the joint paradigm (OK, not a historian, stand ready to be corrected here, but it was something like that). Technology has certainly increased information flows between organizations, but it has not redesigned organizations, that has mostly been at the hand of social and political forces (e.g. the COCOM boundary shifts of late). Again, in my paper I’m going to talk about the social and economic drivers that have to be taken into account if you’re actually going to game in the out-years.

3. One of the key things you have to do with long-term wargames is to fix at least some variables. In one of my games I fixed the ratio of technology effectiveness - future “warships” were roughly the same in capability and expense between us and “them” as they are now. The key thing of course is ISR and aerospace dominance. With a move to fast, small, and many that may take us in a weird direction - those are the kinds of things I want to talk about in my paper. But even in a game that occurs within the FYDP trying to change too many things - even if they are small and idiotic - will produce gaming chaos. So you are absolutely correct.

4. I’m not sure what to think about SF. It’s not immediately apparent to me that it’s a sinkhole - whatever that means. Chris Weuve has done some very interesting stuff at the intersection of professional gaming and SF (Peck 2012, 2013).

I think what really matters here is the line between professional and silly. The further out you go the more tempting it is to fall into the trap of silly. By silly I guess I mean both actually silly and stuff that does not directly address the objectives for the game. Sure, the US could become a monarchy and be ruled by a giant biologically engineered reptile - let’s call him King Ralph. But what does that do with understanding how the US should think about institutional change to adapt to the world political climate in 2050? If I keep in the reptile king, the answer will be “don’t create giant mutant reptiles and let Ralph become king” - not terribly helpful and rather obvious, on the other hand if I keep most things in government the same then decision makers can easily see how changing boundaries, economic development, access to technology, and other stuff that matters might affect their decisions in the future - and give them some insights for how to shape policy today. I can go all SF in some of these things - mining in the
Antarctic may very well become a lucrative and productive thing to do around 2050. So some SF
good, other SF not so good. Which is why I use my silly test.

Other pathologies? The one that immediately comes to mind is not defining the objective in
terms of things that the sponsor can affect now. It’s great to play Starsoldier (I’m a big fan SPI
games), but what, exactly, does it tell us about decisions we need to make now (in reality, a lot,
but then read my paper). Objectives for the game should not simply be speculative “tell me
what 2050 looks like” but rather “identify key policy choices that if made today would have
positive/negative outcomes in 2050”.

Anyway - look like everyone is going to be going after the future - so we’ll all have a similar
subject - but I suspect we will vary a lot in the way we get there (hopefully all of us do get
there...).

Phillip Pournelle

Ed and I have encountered this in a series of games trying to address new capabilities, etc. I
believe we were quite successful because a) the games were iterated in a cycle of research with
analysis between games, b) we required those who proposed the systems provide detailed
descriptions about how it worked, what support mechanisms were required, etc. c) rewarded
teams who thought through the implications and organization to employ them (which then led
the other team to up their game), and d) introduced a limited number of variables between
games.

One issue we found was the range of potential systems, either program of record or more
speculative, was so large the supporting details created a phone book which was difficult to
absorb, to say the least. Quite often we could not determine the impact or non-impact on
systems because players simply did not know they had them, and therefore could not organize
their forces and plan accordingly.

Sebastian Bae

So how did you fix the phone book manual problem and the issue of translating effects of
systems especially those that are speculative in nature into the games you were running?

Ed McGrady

You can’t solve the phone book problem with a phone book. What essentially happens is
that the players choose which systems they want to focus on, because they think they need
them, and ignore others. Like in the real world. Of course they may be wrong because they
don’t understand the systems, but that can also happen in the real world. Military officers
spend years understanding their weapon systems and days understanding how to fight wars, in
a game of the future you have hours and minutes to get them up to speed on the future but with everything being different. You simply do the best you can.

If by “translating effects” you mean “adjudicating outcomes” - at least in the timeframe we were working the laws of physics still pertained. You have to know your physics. If you do it is a lot easier to get close to the truth.

**Sebastian Bae**

In relation to the adjudication of future tech, physics plays a part, but I’m curious how you typically determine the effectiveness of weapon or technology. Like say a laser was shot at a drone or a manned aircraft, what are the probability of success and how do you determine those to help with adjudication.

Games I have worked on typically use combat tables or SME or a combo of both. But creating combat tables to emerging tech is speculative

**Phillip Pournelle**

In multiple cases, we employed a matrix game technique drawing on the expertise of those participating in the game. The referee worked to come to a consensus of what could occur, and sometimes used dice to make a decision. Like in planning, you have to make an assumption to keep going, so we did that in the game. Just like in planning, after the game was over we looked closer at that assumption and it became the focus of analysis in the post game work. This then formed the basis for drafting new rules to be used in the next game, subject to the experts on the topic. This highlights the importance of iteration in games which examine speculative systems. It also highlighted how little we know of /existing/ systems.

**Ed McGrady**

As Phil said, expertise in the systems can be very helpful, as can examining your assumptions and iteration. However in order to put all that together you need to understand the basic physics. For missile systems (which is almost inevitably what we are discussing) you have to detect, identify, track, target, engage, have the weapon sensor detect it, and the weapon do its thing. That involves a lot of a) looking at stuff at a variety of frequencies, and b) processing of data. Assumptions can be made of effectiveness based on environmental, target, and weapon characteristics. Tables get you part of the way in terms of Pk, but all of the various conditions ranging from the weather to the aspect will need to be adjudicated by someone who understand sensor and kinetic physics of the engagement. As Phil said, perhaps the best way to do this is in dialog with the weapons system designer who can (or often can’t) answer particular questions - like what the FOV of the sensor is, it’s processing, etc. Of course if no one knows any
of this stuff you need to make some realistic assumptions that the engineers won’t put something together that doesn’t see, fly, or explode.
Low Entropy and Schrödinger’s Tiger

Brian McCue

“The future’s uncertain
And the end is always near.”--Jim Morrison

When considering the uncertainties of future war, especially in the middle-distant future that is a few decades from now, we tend to focus on the uncertainty caused by our inability to predict how technology will develop over that span of time. However, little can be done, other than to wait and see how technology turns out, and it is not clear how wargaming can do much to help. Other forms of uncertainty will remain, and in fact may well predominate, and some of these can perhaps be somewhat mitigated by wargaming, if we are willing to conduct wargames differently from how they are conducted now.

One form of uncertainty that may be addressable by wargaming is what I call Low Entropy. In the decades since the Second World War, conventional weapons (to say nothing of nuclear ones) have become vastly more lethal--almost entirely because of huge increases in the probability of hit--and far fewer in number. The number of possible outcomes has plunged, simply because the arguments in the combinatoric expressions have decreased so much (think of the difference between a raid of however many F-117s, armed with a few smart bombs each, against Baghdad, and a thousand-bomber attack on Berlin), and the M&S people, with their “variance reduction techniques” and bland assurances that “It’ll average out,” get farther and farther from the truth, which will happen only once and will contain big surprises because of the number of possible outcomes is low and co-variation has gone up. Success and failure feed on themselves and luck no longer “evens out.” An early version of this form of uncertainty was visible in WW II carrier battles, in which the numbers of airplanes were small (dozens, vice hundreds in the air war over Europe) but the damage they could do was considerable, because of the delicacy of aircraft carriers. The variation in outcomes was enormous. Even more extreme is the near-asymptotic case of Electronic Warfare. We do not know if Red’s black box EW system can outperform Blue’s or not, and we may be tempted to express our ignorance as a statement that the probability of Red’s box defeating Blue’s is one-half. And as a Bayesian, I say “So be it.” BUT each side’s boxes are all the same, so if in one case, Red defeats Blue, the same result is likely to obtain in all other instances. There may be dozens of encounters, but the EW Die is rolled only once.

And this is the second form of uncertainty: Schrödinger’s Tiger. It is uncertainty caused by our ignorance of ways in which one thing will (or will not) operate upon another, and in future warfare, this uncertainty will be profound. In a measure-countermeasure duel, one side will win, but we have little means of predicting which one, and although the contest may happen many times, the outcome will be the same in nearly all of them. To add the final category to
Secretary Rumsfeld’s famous epistemology of uncertainty, it is an Unknown Known [sic]. This effect is most clear in cyberwarfare, and second-most in electronic warfare, but in fact it probably extends to physical weapons themselves, where the struggle between stealth and sensors, difficult or impossible to replicate in a test, much less an exercise, becomes close to imponderable.

It’s my understanding that in the famous pre-WW II naval wargaming at the Naval War College, the parameters of the Japanese ships were varied. But sources (and I can’t cite any--this whole thing is a recollection from a debate on the old NavWarGames listserv) vary as to how and why. Some say that the variation reflected uncertainty on the part of the intel people. If they weren’t sure of some speed or range or something, they would use different values in different games. OK, makes sense. Others went further and said that the variation was introduced, perhaps even counterfactually, to give the Blue players experience in dealing with uncertainty, or maybe even just bad information, to the point of using information they knew was wrong. There’s an Unknown Known for you. A respected figure in naval analyses (and naval wargaming) had a strong “they would never do that” reaction, but I’m such a contrarian that “They would never do that “ usually causes me to increase my suspicion that they had. YMMV. Perhaps those with NWC Wargaming connections and proximity could dig into what remains of the records from the pre-war gaming.

Now consider the union of these two forms of uncertainty (plus any residual technology uncertainty that may remain): the upshot is that we have a sequence of interactions whose entropy, already low because of the small numbers of entities involved, is further reduced by the reduced (perhaps drastically reduced) level of independence among events, caused in large part by their shared correlation with Unknown Knowns.

*How can gaming help?*

I’ve noticed that quite a number of present-day scenarios boil down to a mobile defense of a high value item in an unfortified battle space. Examples include Theater Anti-Submarine Warfare, Ballistic Missile Defense, and Cyber. In all cases, the peacetime condition is constant vigilance conducted by a small number of detection systems that are turned on all the time. They have to have high sensitivity and low false alarm rates.

(Side-rant: Few, if any, sponsors appreciate how hard that is, and only the ones with experience as console operators (usually available only to enlisted people) can even see anything the matter with the inevitable guidance “Maximize detections while minimizing false alarms.” See also Igloo White, the CAPTOR Mine, TSA passenger screening, etc. EOR.)

Then the attack (or other enemy operation) begins, and the mobile defenses have to get themselves sorted out against the attackers and respond--while themselves being subject to false-alarms and misses, and also to possibly unfavorable combat results. At the simple-game
level, TASW, the defense of Tobruk, and response to a cyber event are all pretty much isomorphic, and could all be represented by the same double-blind game.

Now comes the part about not playing the way we normally play. In this game, the players would not be given the Combat Results Table or other such converter of die-rolls into outcomes, and in fact this table would change every game. It is the Unknown Known. Think double-blind _The Awful Green Things From Outer Space_, except it’s so double-blind that the players don’t get to see the CRT or the die-rolls, and they just have to learn from experience what’s a good weapon and what’s not. (People might want assurance that the game would, regardless of these changes, always be “balanced,” and I’m undecided as to whether or not that’s a good idea. (“Life is unfair.”--JFK))

The simplest game I have ever run, years and years ago, might also have been the most instructive, and certainly the most highly leveraged because it was played by a group of fast-burn Navy Captains and Marine Corps Colonels. Jeff Cares had asked me to spend an afternoon with the CNO’s SSG, up in Newport. He gave me three hours, told me that Rod Stewart always opened with Maggie Mae, rather than save it for an encore, and that I ought similarly to spend the first hour on U-boats. So I did. I spent the second hour on Military Experimentation (my CNA assignment at the time was to the Marine Corps Warfighting Laboratory), and then I devoted the final hour to having the group play their way through the Two-Armed Bandit Problem.

As I explained to them, a Two-Armed Bandit is just like a One-Armed Bandit (i.e., a slot machine), except that it has two levers with presumptively different pay-off distribution. I stipulated that the TAB in my game was also unusual (by Las Vegas standards) in that it was worthwhile to play because at least one of its arms had a positive net payoff. Also, it was memoryless: each arm followed a set distribution regardless of what had transpired before.

I had pre-calculated a long set of payoffs (making them Unknown Knowns) and all the SSG had to do was to tell me “Left” or “Right” and I would tell them how many dollars (if any) they had gotten back for the one they put in.

It worked wonderfully--the SSG started out by thinking that the problem was trivial, and ended up, an hour later, by deciding that it is nearly impossible. The latter view is closer to being correct. The difficulty, of course, lies in deciding when to cease experimenting and start pulling just one arm.

Sebastian Bae

I see some games try to eliminate uncertainty by giving overly favorable outcomes to Blue. Could you elaborate on two points, what did you mean by:
1. “At the simple-game level, TASW, the defense of Tobruk, and response to a cyber event are all pretty much isomorphic, and could all be represented by the same double-blind game”

2. “The difficulty, of course, lies in deciding when to cease experimenting and start pulling just one arm”?

Brian McCue

“Never tell me the odds.”--Han Solo

Reference: “1. At the simple-game level, TASW, the defense of Tobruk, and response to a cyber event are all pretty much isomorphic, and could all be represented by the same double-blind game.”

About a year ago I was at some workshop and there was a session on cyber. I know zip about cyber, so maybe I went because the session description said there would be a game. After some description of how intrusions work (I still know zip), the game came out. The board was a schematic map of a computer network. It had big blobs with little blobs inside them. Of the big blobs, some were more important and others were more susceptible to covert entry. The attackers had to enter one that they could enter, and then work their way node-by-node to an important place. Connectivity among the big blobs was sparse, and it was made directly to little blobs, so to move around, the attackers had to enter a big blob via an accessible little blob inside of it, move through little blobs until they came to one that connected to a little blob in some other big blob, make the leap, etc.

As the defenders, Hank Donnelly and I could shift our attention from place to place arbitrarily: it was our network. At any blob, we could try to detect intruders. If we found them, we defeated them automatically and they had to start over. But there was a possibility of false contact, so if we thought we’d defeated somebody, we couldn’t necessarily go back to patrolling the entryway, because maybe we only _thought_ we’d defeated somebody, and the real attacker was still on the loose, deep in our system. And one more thing--we knew the various probabilities (and so did the attackers), but they varied from one little blob to another, so there was a drunk-and-lamp-post effect.

Hand and I had done ASW when he was at CNA, so we both thought of ASW as soon as we saw this game. It could have been a perfectly plausible ASW game: searching some places is easier than others, the sub has to work its way through whereas the defenders can go where they want, and, of course, there can be false contact.

Later, I read Agar-Hamilton’s account of the defeat of the Commonwealth troops at Tobruk (1942) by Rommel. Tobruk is called a “fortress,” but it didn’t have tall ramparts with big guns shooting out of loopholes or over the top. It was really just a group of interconnected strong-
points, manned by too few infantry and tanks to hold them all at once. The CONOPS was to have a thin crust that would wait for an attack and then call for reinforcements when the attack came. There was not much of an issue of false contact per se, but there were major command-and-control problems and forces could get sent to the wrong place (or even no place at all) even in the absence of true false alarms. Defending companies and platoons rushed around just like cruisers and destroyers defending a carrier, and the Germans came in just like an attack submarine. And it also seemed to me similar to the cyber game (it could certainly have used the same board, but some different rules), and it also seemed to me like a missile defense problem I had seen, in which one missile could probably defeat one missile, but six missiles could not necessarily defeat six missiles because they had to get themselves allocated right, the later missiles could be confused by debris from earlier hits or they could lock onto outgoing missiles of their own side (false contacts), etc., etc. “The Patriot missed because the SCUD malfunctioned.”--Peter Jennings

*Reference “2. The difficulty, of course, lies in deciding when to cease experimenting and start pulling just one arm.”*

When you start playing the Two-Armed Bandit, it’s clear that you have to work with both arms for a while, to see which is better. In the endgame, you’ll have decided which arm is best and you’ll just pull that one. But when do you make the transition, and on what basis? Even in a limited TAB problem (and there’s a big literature on this, mostly coming out of RAND--one wonders what they were really working on) in which all the payoffs are $1 and it’s just a question of estimating the probability that a payoff will occur, this problem is non-trivial. In the more general version that I gave the SSG, in which they knew only that at least one arm paid more than $1/pull on the average, but soon found out that the payoffs could be quite large (and rare), it is difficult to decide when you have found the good arm.
False Information as Uncertainty?

Robert Mosher

In the book, Battle Leadership, by then-Captain Adolf von Schell, based upon lectures he gave in 1930 while a foreign student at Fort Benning, von Schell argued that training units in exercises should be given false information in order to prepare them for the reality of the unexpected.

Peter Perla

With the introduction of the Fires Effect rules beginning in 1921, the college added an ever increasing array of factors to the adjudication tables in what appears to be an effort to get results on the floor that were as close as possible to what could be expected “in real life.” This follows a review of the rules that were currently in use (arguably designed for ease of use over ‘realism’) after the Battle of Jutland. Early rules, for example, had no modifier for target aspect with regards to probably of hit, which incidentally was deterministic, not stochastic. Nobody was rolling dice!

Within that context, it seems unlikely that the college would randomly change performance parameters just to introduce uncertainty. Rules were periodically updated to reflect changes in technology, new intel estimates, etc. In hindsight we know that many of the rules came up short – the performance of Japanese torpedoes is the oft cited example.

It bears remembering that the point of interwar-years gaming at the college was by in large educational, not war planning, not analysis, and was driven by the curriculum. It wasn’t until the late 1930s that CAPT Van Auken of the Tactics Department did any trend analysis of games over multiple years. Given the frequency of conflict up through the early decades of the 20th century, the students faced the very real probably of a fight within their period of service, and were focused on gaming battles with the fleet they had today, and less about future conflicts with hypothetical fleet of tomorrow.

That said, it should be noted that the fleet Nimitz played with on the floor of Luce Hall in 1923 was very different than the fleet he went to war with in 1941. And yet when he spoke to the NWC student body in 1960, he extolled the value of war gaming in preparing him to deal with war in the Pacific. It is easy to get wrapped up in focusing on the tech, but in the end, it is humans and the decisions they make, that is the crux of war (and war gaming!)

Peter Perla

I’m often asked how we introduce “fog and friction” into our games. The answer is usually that we don’t; in a game with 300+ participants, there’s plenty of nature fog and friction to go around!
Robert Mosher

This has been our experience with NSDM games often having anywhere from one to as many as four dozen players.

Peter Perla

I also recall a source discussing the issue of whether the effectiveness estimates at Newport were deliberately changed from year to year or even game to game specifically to emphasize the uncertainty and need to learn during the event. But I cannot recall where. I may well even mention this in my book but I’m too bloody lazy to look for it at the moment!

My recent exploration of 1940 has also illustrated the critical importance of human factors interacting with technology, as well as the fact that complex systems often need to be regarded as dynamic systems. French tanks in general had better armor and better guns than German ones. But too often the French tankers were not as familiar with, much less as well trained on, their tanks as the Germans. And the command overload on the French tank commanders, coupled with their limited radio comms, didn’t help. So the Germans seemed to be quicker and better at solving the problems posed by the French tanks than the French were at solving the problems posed by the German panzer divisions. Hence the too often heard overly simplistic explanation that French must have lost despite their technological superiority because their will to fight was poor. Their high command was, of course, outthought and out paced, but the soldiers themselves fought pretty well, at least at the beginning. It strikes me that we are in danger of placing too much emphasis on technology and not enough on how to assess the ability of the contenders to make best use of their technology. Or to use cyber jujitsu to turn the opponent’s fancy AI battlefield control systems into bricks, just like my cellphone in Europe. Not because the technology didn’t work but because operator error (mine own) coupled with lack of sensible support from the tech backbone (the Verizon online sign up system) allowed me to sign up my phone for a service it was not capable of using and not being told there was another service that I could use.

Another favorite topic of mine, which has some relevance here (probably more than my Verizon story!) is similar to Brian’s TAB problem. Back in the day (80s or 90s) Joe Miranda designed a Franco-Prussian War game for S&T. He used a combat system based in drawing chits from a cup for each combat. These chits gave different percentage losses as well as special effects, like increased effectiveness of cavalry or other things. Sadly, however, the RAW always used all the chits in the cup, effectively making the system isomorphic to a standard CRT. Joe had missed the opportunity to create the uncertainty in the minds of players which had been experienced by the real commanders, not quite sure how or whether some weapons systems and tactics might work. Had he randomly removed some of the results before starting the
game, he could have accomplished this easily. Only by observing the results of several combats could the players then learn what was the actual distribution in that particular game.

Ultimately, of course, it comes back to, “So what? “ What do we want the game to do for us? Predict battlefield dynamics fifty years out? Good luck. Teach decisionmakers how to identify and recognize the unknown knowns (not sure I really understand that one, but it sounds good!)? But today’s players aren’t going to be around in fifty years. So I ask my usual question, what do we want such wargames to accomplish? And following the SDM mantra, why do we want it and why don’t we have it?

Stephen Downes-Martin

Reference Peter’s comment “... whether the effectiveness estimates at Newport were deliberately changed from year to year or even game to game specifically to emphasize the uncertainty and need to learn during the event.”

The accepted wisdom / water-cooler rumor at NWC is that the tech was altered year to year so that (a) the students could not pass onto their previous-year’s colleagues the solutions they had come up with, and (b) no one cared or knew what the actual tech would be in the future, they wanted to force the students to get good at solving unfamiliar problems by being mentally agile. Could be post hoc rationalization and wishful thinking about a past golden age of wargaming I suppose ...
Working Group Discussion References


Wargaming the Future Workshop Discussions

**Chair: Stephen Downes-Martin**

Before the Connections US Conference, participants who registered for the Wargaming the Future Workshop were granted read-only access to the draft working group papers and requested to think about “how would you design a game, a game mechanic, or any part of a game that handles any challenge they choose to the problem of wargaming a future out to 50 years?” as preparation for the workshop.

The workshop started with a brief reminder of the problem and some of the challenges and approaches dealt with in the working group papers. Having already prepared, workshop participants then spent ten minutes individually and silently answering the above question for themselves. They were asked to write down their answers to include the chosen challenge, proposed approach and what might be needed to implement the approach.

A workshop participant was chosen at random and asked to read out the challenge. The group was then asked for a show of hands for anyone else with a similar challenge, and those people were placed in a subgroup, and sent out to a break out area to work. The process continued until all members of the workshop were in subgroups. Some participants selected challenges that were so specific that no one else shared that challenge. The workshop chair allocated such participants to subgroups whose challenge broadly subsumed the over-specific challenge. Each subgroup elected a named leader who was responsible for facilitating their subgroup discussion, documenting the discussion and providing that documentation to the workshop chair. All participants were asked if they would allow their notes to be photographed for analysis.

Participants were asked if they wanted their name and contact details to be excluded from the final report. Some workshop participants chose to be off the record and are not named in this report. Hence some subgroup participant lists are shorter than the actual number who participated. Finally participants were invited to email to the workshop chair by August 30th additional ideas, working papers or other material they would like included in the final Working Group Report.

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Dealing with Indeterminants

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The Challenge

John Hanley presented a quick overview of indeterminacy from the paper that he wrote for the Wargaming the Future working group (Hanley 2019). The group then discussed how to identify the issues (the decisions the inquiry was to support) and the uncertainties related to those issues.

Modeling uncertainty and impact: One person, familiar with at least conversational complexity theory, suggested that the uncertainties were akin to when adding grains of sand to a pile results in cascades of different magnitudes. One cannot predict whether adding one grain will result in a cascade, or what the magnitude of the cascade would be. He suggested that focusing on each grain of sand would not be very productive.

This is worth developing further. It comes down to whether one thinks of probabilities in terms of Markov chains where probabilities are given for moving from one state to the next, or in terms of power laws where one can give the probability of changes of different magnitude occurring over a specified period of time, like earthquakes, but cannot say when the change will happen. Geoffrey West’s book (West 2017) is an excellent example of this form of analysis. We did not have time to discuss this in the group.

The next person suggested that the challenge was creatively imagining the future and coming up with plans for the imagined future. The group then discussed what the structural factors might be. This got into discussions regarding whether nation states or corporations would be the major actors in the future, and related uncertainties. The challenge of how one establishes what the driving factors would be became apparent, but different people had their favorites.

The discussion turned to focusing on change versus retaining perishable skills. A former military officer discussed how reliance on computers had resulted in people losing the ability to do things manually, like navigation. Another person extended the analogy to the seed bank should a crop fail catastrophically. This led to imagining a future where civilizations collapsed requiring people to return to agriculture and a discussion of the need to be able to adapt.
One person with an international relations background discussed the predictability of nation states’ behaviors. He suggested that the universal human desire for individual dignity would emerge in the future to affect state behavior.

**Gaming (and related) Approaches for Addressing the Challenges**

The group began by asserting that the game had to be a model of the projected future. It should have features to reward adaptability, and while a focus on military issues is natural the game must go beyond military.

One person suggested using a game similar to Civilization. The approach was to project alternative futures with different resource allocations for each player, and then allow the players to determine successful strategies addressing the opportunities and challenges. Others endorsed the outlines of this idea.

This led to a discussion of how one would generate the set of futures to be used in the game, and the possible use of games to generate those futures. The group seemed to have a general consensus regarding doing a series of games to generate alternative futures and then games using those futures.

The discussion then turned into focusing on effects using abstractions rather than details. The group again emphasized that adaptability should be a key variable in the game, along with resilience to react to events for which they had not shaped.

**The Impact**

The first idea for creating an impact on organizational policies and plans was to get bosses into the game, plus the hotwash (and a post-game analysis). The objective was to change the way that they think; “an unintentional didactic.”

When pressed about how much change even a Service chief or CEO could make when convinced of the need for change, the group turned to bottom up approaches. Some went so far as to suggest online/video (virtual reality) games could be so compelling as to cause voters to select representatives who pursue wise policies. The discussion of the effect going on beyond democracies due to universal desire for human dignity emerged again.

The group emphasized the need for multiple games for different player preferences in the style of game. One person referred to Bernard Suits: “playing a game is a voluntary attempt to overcome unnecessary obstacles.” The intent was that people would play compelling games voluntarily (Suits 2014).
Efficacy of command and control processes

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The Challenge

How do we wargame the efficacy of command and control processes 50 years in the future?

Our group took as a premise that trying to guess the future was likely to be futile, even ten years out, but that the perennial requirement for a Command function to carry out John Boyd’s OODA loop (see the Boyd Website) was historically going to be both a continuing trend and a constant (to badly plagiarize Wayne Hughes). The group proposed the following characteristics of the future battlespace are important and enduring:

➢ There will be unknown and unknowable technology at any moment in the timeline.
➢ There will be a mix of legacy and current state C² systems for all protagonists at any given point on the timeline.
➢ Connectivity between these C² systems will almost certainly be unstandardized, due to the nature of various system maturities and the probable coalition nature of future conflict.
➢ Degradation of reliable C² systems will occur during the fight.
➢ C² System resiliency will be variable against unknowable threats and defenses.
➢ Speed of reaction will need to be quicker as weapons get faster.
➢ Agile, networked C⁴ISR will be required in this OE.
➢ Pattern recognition and human decisions based on incomplete SA will still be needed.
➢ Commercial and civil communications will in some way be used or integrated by/into the military system as the military will tap into these systems to attempt to utilize (and possibly hide amongst) the general comms clutter.

Approach -- The wargame must:

➢ Cater for different opposing C2 structures, processes and capabilities. The pros and cons, strengths and weaknesses of these systems/tech/processes should be represented in the game using, at a highish abstract level, the OODA loop.
The game must cater for at least two opposing sides, and more realistically be able to represent up to eight sides to represent coalitions and alliances interacting. One side may have assets that are better at a certain process than the other, for example where a certain air asset being to outrange (strike radius) another would give one side an enhanced ability to Orient for an ACT strike.

The sides may/could include megacorporations with assets and capabilities coerced/volunteered/sold to Red and Blue.

Both sides will have hidden capabilities that can enhance or degrade the opponents C2 capability. For example a surprise capability to obscure Observation, a means to disrupt Decision capability, a means to disrupt successful enemy Orientation.

The players should not be given a complete intelligence picture of the other sides capability unless they have spent a lot of resources and time on this, to the detriment probably of something else. See point 7 below.

False information, obfuscation of ground truth and generic information operations will be commonplace and may indeed be the main battleground for hearts and minds. This should realistically be represented in the game to the extent needed to remind players of the non kinetic side of life.

No side should have/will have unlimited assets. Both sides will have limited resources to allocate to offensive and defensive activities. The game must represent the hard choices that command teams will have to make in a relatively short timeline.

Time pressure must be felt by the players to make a correct decision faster than the enemy.

AI asset capability could be significant and can be represented under the 4 OODA categories as it matures. This is already being assessed and considered.

The game has to measurable and quantifiable in the speed of circling the OODA loop and also illustrate the effect of being faster or more accurate than the enemy. The way to get command teams thinking about the outcome of the OODA advantage is to have both sides set up and try different tactics and processes, with variable assets and outcomes.

Damage inflicted by the enemy in the game should affect some, or many functions of command (for example the OODA nodes will be damaged or degraded) or should result in the degradation of assets, which in turn will prevent or delay mission accomplishment.
What is Needed

➢ “A real time” game mechanic, we envisage no set move and decision time - the faster OODA circling team should gain an advantage in getting off Actions before the enemy. Navel gazing should be deadly to those looking downwards – this is Boyd’s revelation and he illustrated it with multiple historical examples.

➢ Representation of success is by comparing actual vs optimum. For example how far were the players SA removed from the actual ground truth during the Observe Phase. This needs to be recorded simply to track back missed cues, opportunities and successful enemy deception, amongst many others in the other Phases.

➢ A measure of how long it takes a command team to get between phases is a key measure. Human decision making may be enhanced by AI aids, but we see this as still ultimately being a human decision-making process, even 50 years out.

➢ The game concept can be used for any level of conflict from low level tactical to strategic with suitable phraseology, assets and choices.

➢ OODA loop Act phase can be linked into any other command capacity wargame, for example movement of land, sea or air assets, cyber, space etc. This game will provide the command points for each side. For a potential future scenario involving C2 after a cyber attack see (Swift 2018).

➢ Victory conditions for both sides are measurable – and therefore competitive.

➢ The game can be largely technology agnostic or very detailed as required. It can also be set at any security level, as the actual assets/capabilities of each side can be suitably masked, or can be very detailed as engendered by the players clearance. For example it could be stated to Blue that they could (given the cost in resource allocation and time) attack the enemy Observation capability with “Secret Weapon X” without knowing any of the details of it.

➢ A Red team that is knowledgeable about enemy capabilities, or future capabilities will make the game much more challenging for Blue. If Blue wins more than half the time then the balance/assumptions/capabilities may need to be looked at very hard indeed.
What Technologies will Affect Warfare in 50 Years?

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The Challenge (1)

How do we predict what technologies will develop and affect warfare in 50 years?

Approaches

1. Take a current system and iteratively upgrade/modernize the technology into the future to make a tree of future technology possibilities.
2. Let the players create their own future scenarios and design the game themselves
3. Choose a future technology of interest – set up two games, one with the technology and one without – and compare the outcomes from the two games.
4. Build a game framework that has pull-down menus of technologies to include and combine, at the players’ discretion.
5. Map out the kill chain/OODA loop of the technology of interest, with expected and unexpected pros and cons. CONOPS will develop with iteration of play.
6. Create a technology “arms race”. Players make investments in selected technologies to see what pays off. Players have an objective and decide how to get there themselves.
7. Game mechanics should include major external influences like climate change, natural disasters, and social changes affecting the military, for example.
8. Include some way of accounting for risk. High risk/high payoff vs. lower risk/lower payoff.
9. Gaming TO the future – play six turns between 2020 and 2070.
10. Use probability scorecards to determine probability of success.
11. Look at historical examples of military technologies that failed, and examine why they failed. Apply to game as appropriate.
12. Look across domains (land, air, sea, space, cyber) and include social domain.
13. Once individual players have designed their “future”, they should be able to play each other and see which is more successful.
What is Needed

1. Subject matter experts on technologies of interest.
2. Futurists who can inject concepts into the game that most people are not aware of.
3. The imagination to generate the next ideas when projecting into the future.
4. Ability to prune the tree of possible futures.
5. Technology to store and automatically manipulate huge numbers of possible futures.
6. Live/VR immersion to create realistic scenarios.

Engage with the Sponsor and Players

Thorsten Kodalle suggested the following process for wargaming the future:

1. Identify Purpose
   training (building future scenarios),
   analysis (e.g. capability gap identification),
   education

2. Identify target group
   required and actual level of expertise
   (beginner, intermediate, expert)

   For example: learning to build future scenarios with beginners to prepare them for future analysis when they become SMEs in specific topics.

3. Decide on the level of seriousness or level of gamification (Pain 0 ↔ 10 Fun) and match it with your target group.

4. Create a Results Only Working Environment (ROWE) that provided a way for autonomy, mastery and purpose for the players.

5. Mix media for different levels and types of visual sophistication
   (3D printer, Virtual Reality, Augmented Reality) using Artificial Intelligence / Machine Learning.

There is no one game design to fit all solutions. Use the framework:
   beginner ↔ intermediate ↔ expert

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The Challenge (2)

Bruce Wyman raised the challenge of examining a specific future technology -- quantum communication -- to obtain and sustain a pervasive common operating picture that is secure without encryption.

Discussion

If one can use quantum communication without depending on remote coupling of particles (quantum entanglement?) then one might achieve secure data flows without the need for encryption. If true, then a Common Operating Picture based on such techniques would be secure without encryption. This would also reduce data flow delays and complexity and thereby significantly speed our OODA loops and allow decisions inside our adversaries’ decision cycles at national, theater and AOR levels.

Approach

The first question to address is how useful would a Common Operating Picture with the above characteristics be to different levels of command, and at what point does the added usefulness become worth the investment. Wargaming can assist with this question by wargaming multiple scenarios. Each scenario is wargamed twice, first with a baseline “current capability” COP, then with a perfect COP enabled by proposed quantum communication capabilities. Such games would inform us of the value of using quantum communication, how best to use such COPs, and the possible weaknesses they contain that our adversaries could exploit.
Resilient, Adaptable, Extensible, Flexible System of Systems

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The Challenge

How do you build a system of systems that is resilient, adaptable, extensible and flexible for the alliance in 30-50 years? Objective is to develop plausible 2070 scenarios we can then wargame. How do we structure scenarios so they can be wargamed? It may be easier to generate an answer for a more specific challenge since games with long lists of research questions often struggle to answer more than a few of them. Note that not all scenarios are interesting (for example peace and unity) even if they are what we are attempting to achieve.

Approach

So how do we design a series of wargames to design an “architecture” that can meet the challenges 50 years into the future? Use Acquisition games (Path games with 5 year moves) and Crisis games (month to 1 year moves) embedded in Perla’s Cycle of research. Path games can be used to create a crisis scenario for crisis gaming, and can identify new technologies or other topics to be explored in the crisis game. A Key objective of path games is to get to a desired future force without a period of massive vulnerability en route, while a key objective of crisis games is to test the optimisation of the force.

Two background topics are useful to consider:

➢ Useful versus Plausible versus Probable. Low probability/high impact events need to be explored. “Useful” may be better than “plausible.” A useful scenario could be the most stressful scenario, one that pushes the envelope. Exploring extremes/black swans can really test your force.

➢ Forbidden Topics. A critical question is what are we usually not allowed to investigate? For example, Is the current alliance structure (FVEY/NATO) a constant (and thus will persist into the future) or is it a critical uncertainty? Individual states can be flipped but there is a limit to how many state relationships you can test in one game. Alliance systems can be growing or declining. Rephrase forbidden topics to be open ended, for example use “health of the alliance” rather than “alliance has ended”.

Three techniques are useful when designing path and crisis games that address the deep future:

➢ Future Projection. Identify two dominant critical uncertainties. Then create a 2x2 matrix. This creates four scenarios. Then mash your force design into each scenario and
address the three questions: “Which force is the most resilient?”, “Where am I most reducing risk?”, and “Where are the relevant commonalities?” (Analogy: future projections as a shotgun versus a flying duck, constantly turning to track.)

➢ **Epoch Analysis.** Characterise a series of epochs through the lifespan of a platform. Consider Constants (such as Geography and Demography) and Trends (which are rooted in the present). Note that it is dangerous to assume trends are continuous. Compare constants and trends and ask two questions: “Which are dominant?” and “Which create relative advantages and to whom?” Use large chunking and use the full range of PMESII (plus any other relevant topics).

➢ **Backcasting.** Ground in 2070 and work backwards to avoid present day assumptions using a hybrid phased approach. Use a structured exercise to identify three or four plausible futures and a “what if?” exercise to show how you get there. Then identify trends and constants common across those future pathways. Finally explore the revealed underlying structure by wargaming. Trends lead to path games, which lead to crisis games. In a path game all sides have agency for force development. Define different force structures and test them in the crisis game. Then for the “best when tested (or gamed)” force structure examine how we can actually get to it. One must be careful when designing and implementing the hybrid approach not to be creating a self-fulfilling prophecy.

**Path → Crisis Games.** Design an acquisition game with five year moves dealing with Order-of-Battle (OOB), Prototypes and Research & Development (R&D). Players spend resources to move R&D to Prototypes and Prototypes into OOB. Adversary makes similar type moves, all sides take others’ moves into account, and the White Cell can introduce kinetic surprises which might trigger kinetic war before some or all sides are ready for war. Different sides can have different play speeds, for example faster acquisition for some or all capabilities. Note that speed can come from smaller platforms, elements on platforms (weapons, subsystems, etc.), supporting system of systems, and CONOPS. An example is that of Battleships in WWII, they lose capital ship role but gain key role in shore bombardment. The addition of radar, proximity fuzes on 5” guns, plus CV, creates a task force almost impermeable to air attack. Is a “base” another type of platform? It has a fixed location, involves major investment and is a big target (and there is a resiliency issue if one has too few bases).

**Parametric approach.** Explore extremes and opposites, left and right of arc boundaries:

1. 3-4 scenarios
2. Path game each scenario
3. Run the Crisis games. Which force was resilient, etc. in this scenario?
4. Revisit initial assumptions and repeat process.
5. When to cut off further data collection/analysis and write the report.
Avoid Vulnerabilities

I.a Build A/B force structures. Play each Epoch game x4 (8 games total). Analyse resilience in each scenario quadrant.
I.b Path games to get to A/B
I.c Crisis games branch out of I.b

Force structure is always transitional. Readiness (for example German concerns about Russian railway development c. 1914) and desire to strike with advantage now is of concern:

II.a Reverse approach, start with the Path games.
II.b Reach force structure.
II.c Test force structure in the four quadrants.

Approach II as a good test of an existing plan. Use results to persuade the sponsor to try approach I.

What is Needed

As is true of any project, we need time, patience, capabilities and resources, and sponsor knowledgeable interest in the game with a good, gameable question. In addition, specific to wargaming the deep future we need to know whether we need or are able to scale to entire alliances or to single states. As with any wargame we need good game design, skilled (trained) facilitators and adjudicators, access to relevant subject matter expertise and a strong game director. All of which influence the timeliness of game execution and quality of the results.

We can do a Path game in one day with up front research and player selection, so could do multiple games quickly. Standard Crises games take three days to execute, plus prep time, plus post-game analysis of the game and of the issues identified in the game. When embedded in Perla’s cycle of research this leads to a two year effort cycle, which means we need continuity of project leadership over those two years.

It is hard to get senior leader participation in long games. If the lack of senior leader participation damages the credibility of gaming, what is the trade-off between senior leader participation in shorter games and the potential loss of game result quality due to the game being too short? Without senior leader participation then perhaps we should wargame one level lower with subordinates. Junior officers might be more innovative but also might be more concerned with short term issues concerning the platforms and systems they will live to operate. Fifty years is beyond the career horizon (or even lifespan!) of most senior leaders, who tend to be focused on shorter term budget, programs, planning and election timetables. We need senior leaders who take the long term future of national security seriously.

Whatever process is used to wargame the future, it must be transparent, understandable, open about and challenge assumptions, and it must go beyond the purely military in order to generate freedom of action based on different mixes of DIME and PMESII relationships.
Construct an Interdisciplinary Futures Game Group

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The Challenge

How do you bring together an interdisciplinary group of futurists, gamers, and public private sector subject matter experts to begin experimenting with ways to develop games that explore the future? Additionally, how do you use these games to help prepare and develop future leaders?

Background

Several organizations currently develop games that currently look into the future. However, due to compartmentalization, these games are often subject to groupthink and their results cannot be broadly shared.

Senior leaders and career government officials may struggle to view possible scenarios outside of the traditional lenses they developed a career contemplating. (Hard to let go of ingrained cultural ideas, like aircraft carriers).

Crowdsourcing is an important approach to innovation that should be considered when developing games to explore the future.

Developers of future games must be innovative in their approach to game design, as well as innovative in imaging a plausible future (see the discussions on practical vs. plausible vs. preferable elsewhere in this Working Group report).

Recommendation

Cultivate an interdisciplinary futures gaming group that will use experimental methods to develop and conduct games that explore plausible futures out to 50 years.

A futures gaming group should be public, and discussion unclassified. This is to enable crowdsourcing diverse ideas, and the dissemination of scenarios, game concepts, and lessons learned.

➢ Senior leaders could use the game designs and scenarios created by the futures gaming group to create their own internal games.

➢ Interagency decision makers can utilize the lessons gathered from the games.

➢ Private sector and academic partners can gain insight into potential future military requirements.

➢ The dissemination of data will help publicly promote the method of gaming.
➢ Future leaders will be able to participate, and or learn from the group’s outputs.
➢ Game outputs may lead to new concepts, studies, policies, and prototypes.

Initially focus on developing games that explore a narrowly focused concept or domain in the future in order to ensure they can be completed by the group and played in several iterations.

Four-step futuring process based on history, present, plausible futures and aspirational perspectives.

**Basic Steps to Establishing a Futures Gaming Group**

➢ Establish goals of the group
➢ Identify a sponsor organization
➢ Identify potential participants, solicit initial interest of desired participants
➢ Draft a group charter that lays out the processes, procedures, policies, information sharing guidelines
➢ Identify potential resource requirements (§), gain access to a venue
➢ Gain and maintain voluntary interest by members (could rely on graduate and PhD students). Establish incentives to motivate participants
➢ Ensure decision makers are groomed for the future
  ○ Select a specific topic to conduct a game about
  ○ Begin developing scenario and concept of the future (refer to other white papers for the processes)
  ○ Develop, test, and conduct a public game. Seek to conduct multiple iterations of gameplay
  ○ Document lessons from both the group’s wargame development process, and player outputs from the game
  ○ Publish results
  ○ Repeat cycle
Futures Game Concept Diagram
The Character of Future Warfare

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The Challenge

What is the character of future Warfare?

Approach

The approach is a series of events designed to identify common threads across alternate futures:

➢ **Event I: Alternate Futures.** This event serves as the foundation of the series. Established parameters, based on objectives for the series (who/what is informed), “focus/ground” free thinking ideas to develop alternate futures. Four varying futures are selected for comparison throughout the remaining events. Attendees range from Sci-Fi, Academics, Economists, Futurists, Military, etc., to help inform the alternate futures.

➢ **Events II-IV: Aspects of Future Warfare.** These events examine each alternate future using one aspect of Future Warfare to identify common trends/threads. Aspects include: The Future OE, The role of the military/politics (how warfare is used), Interoperability, etc. These events can range from seminars exploring the topic to wargames where participants compete against one another.

(i.e. Role of Military/Politics. One future may be like today where Nation States control most armies while another future may have corporations with armed forces. Participants with National Armies may look differently when war is an extension of politics than the group that may not want to use a corporate army because it cuts into profit, etc. The common trends are collected for analysis.)

➢ **Event V: Backcasting.** This event looks at the common trends from across the alternate futures to identify likely unknown unknowns on a “road to war” or timeline. This can inform the sponsor based on their objectives.

What is Needed?

➢ Sponsor (Objectives)
➢ Wargaming Staff (Event Designers, Facilitators, etc.)
➢ Resources (Facility, Funding, Equipment, etc.)
➢ SMEs (Futurists, Economists, Academics, Military, etc.)
➢ Tools: Digital vs Analog, Processes, etc.
Workshop References

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APPENDIX 6: FUTURE OF WARGAMING WORKING GROUP REPORT

This appendix contains the final report for the Future of Wargaming Working Group chaired by Dr. ED McGrady and Mr. Michael Ottenberg. This report “Stories of future gaming” accompanies the working group summary including the body of the conference room.

The report includes the following chapters:

- Friendly Competition (Sebastian Bae)
- Augmented Reality (Jeremy Sepinsky)
- Game Day (ED McGrady)
- Matt Caffrey (all extracted from On Wargaming, Matthew B. Caffrey Jr., US Naval War College Press, 2019)
  - A Nice Game of Chess
  - The Last Peace Fighter
  - Not the Holodeck
- Resistance is Futile (Michael Bond)
- Brain Probes, Crocodile Clips, and Drugs (Stephen Downes-Martin)
Stories of future gaming
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Introduction

Stories from the Future

There are a lot of ways to describe the future. We chose to write fiction about it.

Our stories explore the future of wargaming. Stories are a lot like games. They place you in a new but somewhat familiar world. In games you get to choose what happens. In stories you follow along for the ride. Unless you are the writer, then you get to choose what happens. So, kind of like a game.

Connections is the premier wargaming conference. For 2019 theme is the future. How games talk about the future (Working Group 1 - Gaming the Future) and what the future of games will look like (Working Group 2 - The Future of Gaming). For working group two we asked a number of professional wargamers to write short (or not so short) fiction on what they thought a future game would look like.

The task was to write about the game, not the future conflict. In the following stories you get to see what some professional gamers think games will be like in the future. Some are set in 2050, some in a few years. But don’t get hung up on the year, we’ll get there eventually.

But more than anything: we love writing about Marines.
It was too fuckin’ quiet, Sergeant Patel thought as he walked down the empty halls.

A Marine barracks is usually a maelstrom of noise and poor life decisions. When you leave a hundred or so bored Marines to their own devices, drunken shenanigans were bound to ensue. This kind of eerie silence was never a good sign. And of course, as the duty NCO, he had the unenviable job of sorting out whatever nonsense was unfolding.

Passing the corner, his mind cycled through all the possible scenarios: darts with K-bars, Edward Forty hands, anything involving fire, and worst of all – uploading God-knows-what to YouTube. The mere thought made his head throb.

As he rounded the corner, he saw a gaggle of junior Marines overflowing from one of the rooms. Expecting the worst, he sped up, ready to scold the rambunctious lot for whatever sins they were committing. Peeking through the window, he saw that the Marines were gathered around four laptops playing an online video game. Smaller groups of Marines were mingling about, chatting as they examined and passed around a tomb-like manual. Seated at desks on opposite walls, he
immediate recognized the four players: Baxter, Schmidt, Lee, and Sanders. They were all part of Baxter’s fire team in first platoon. A sharp-witted group, they had a reputation for pulling pranks on their fellow Marines. Last week, they had crazy glued another Marine’s boots to his locker door. Everyone got a good laugh out of that, minus the poor boot who had to chisel his boots off his locker door.

Young Marines playing video games in their free time was expected. Personally, Patel was partial to unwinding with a game of Madden himself. In the infantry, every day was about tactics and training, so Patel relished the refuge of simple games – far removed from the daily demands of the Corps. But this was different. The Marines were engrossed in their endeavor, like students cramming for an exam. His fellow Marines were many things: fierce, funny, loyal, but dedicated students they were not. His curiosity was piqued.

“What the hell are you miscreants up to?” he questioned.

“Yo, Sergeant!” Corporal Baxter responded, looking up with a grin. “We’re assaulting the garrison on the island of Nahic.”

“Alright geniuses, there is no such country as Nahic. What are you really doing,” inquired Patel.

“I’m serious, Sergeant. Nahic is a fictional country for the scenario we’re playing – a company assault on an island base. It’s wicked difficult,” he replied.

“What?”

“all the possible scenarios: darts with K-bars, Edward Forty hands, anything involving fire...”

Leaning over Baxter’s shoulder, Patel inspected the computer screen. Tiny little icons, representing military units, steadily moved in a coordinated assault across an imaginary terrain. From a glance, Patel could discern that a battalion landing team was attempting a landing on jagged crescent shaped island. Although most of the map was shrouded in darkness, there were pockets of clarity – revealing glimpses of elaborate defensive lines, scattered battery emplacements, and the occasional moving convoy. A stream of information flashed on the right: ISR reports from far-flung drones, predesignated fire missions, and logistic reports. Madden this was not.

Sensing Patel’s mixture of awe and confusion, Baxter said, “Our objective is to push up from the beach and take out the batteries, opening a window for the main landing force to mass.”

“This looks like a dumb-downed command center, Baxter,” Patel observed.

“That’s the whole point, Sergeant,” the baby-faced Corporal replied, “I’m serving as the company commander, while Lee, Sanders, and Schmidt,” he gestured to the other three Marines enthralled in their screens, “are serving as platoon commanders. The adjacent
units are being played by the program’s AI.”

“That’s really cool,” Patel muttered, taking in the continual flurry of commands and reports.

“It is, Sergeant. But the program’s AI is a bit clunky and does some odd things at times. You always got to monitor the stupid thing,” Baxter added, shrugging.

“You want to try, Sergeant?”

Unable to resist the offer, Patel moved the mouse around the screen, steadily exploring the game’s features. The interface was shockingly intuitive, organizing features by warfighting function. The program tracked unit strength, morale, and even logistical consumption like fuel. On the right-hand side, he even recognized templates for five paragraph orders and CASEVAC reports. Patel had never seen a game like this before.

“Did you guys buy this?” asked Patel.

“Nah, Sergeant. This is an MCU-sponsored online platform. Think Steam – you do know what Steam is right, Sergeant?”

“Don’t be a smart ass, Baxter. I know what Steam is – I’m not a fucking dinosaur.”

“Well essentially it’s the same idea. MCU loads a bunch of historical and fictional scenarios on the platform, all utilizing a common game system, and Marines can create individual accounts or teams to play against each other.”

“And of course, they had to name it something like ‘Expeditionary Warrior,’” Schmidt added, snickering.

“Did you expect anything less?” Lee snorted.

Ignoring the banter, Patel asked, “But, what’s the point of this?”

“Ya know those old school tactical decision problems you love making us do? Well, it’s like that but for like, right now. A real-time tactical decision game for the digital age. But the idea is pretty much the same. And of course, you got to adapt when shit inevitably goes horribly wrong,” Baxter replied, as he typed a truncated five paragraph orders to his platoon leaders.

“Don’t fucking lie, Corporal. We just really enjoy beating the shit out of the officers on here,” Schmidt called from across the room, his eyes never leaving his screen.

“Shut up, Schmidt! Don’t you see me trying to be learned and fuckin’ sophisticated over here,” Baxter yelled back, shaking his head as he jokingly shook his fist in the air.

Lee, briefly looked up from his console, “To be honest, we’re bored as fuck and

Department of Defense Photo by Scott Sturkol

future of gaming
playing these games helps pass the time. Not to mention, if you win tournaments or become one of the high-scoring teams, you can get all sorts of prizes from points to your promotion score to Amazon gift cards."

"Anything is better than cleaning rifles all day," said Patel, laughing.

"Pretty much, Sergeant," Lee replied with a mischievous grin.

"Hey, Lee, enough chit-chat, it’s go time! Schmidt, as soon as we hit the beachhead, I want you to watch our fuckin’ rear, I don’t want to be pincered again like last time. I want you to take care of any enemy UGVs that may be hiding in the shallow water," Baxter barked. "Sanders, make sure our UGVs are scouting ahead of us. I don’t want any nasty surprises."


At a glance, the assault was going well. They had escaped the exposed death trap of the beachhead by using their heavier UGVs as battering rams and shields. Initially, obstacles and mines on the beach slowed their advance for some time. But after regrouping, Baxter was able to regain the momentum, capitalizing on friendly naval fires that bombarded the ridgeline overlooking the beach. Understanding his window was fleeting, Baxter quickly issued orders to his commanders to push inland. Despite heavy resistance, they were able to press their advantage, making astute, decisive decisions.

"Hey, Lee, is that a fuckin’ drone over there?" Baxter yelled.

"Not sure yet... I am going to send the Raven up to see."

"Why don’t you just shoot it down, it looks like your unit has M-SHORAD," Patel asked, pointing to the air defense vehicles in the lead element.

"Well, last time we played, we kept blasting the UAVs out of the sky, thinking it would protect us from being seen. But the other side just kept sending more fuckin’ drones and pounded wherever the drone was shot down with artillery – and eventually we ran out air defense missiles. It got ugly real fast when the attack helicopters came up," Lee responded, his cursor zipping across the screen, hurriedly issuing new commands.

The Marines let out a collective groan, recalling the debauched assault.

"But we’re not falling for the same fuckin’ trick this time! We’re going to spoof those UAVs and have them chasing our decoys, while the rest of the company hunts for the arty batteries," Baxter declared, confident in their victory. "Speed is king."
The room was alive, buzzing with the intoxicating energy of competition. Battle plans were being formulated, discussed, and executed. No matter how crude their schemes were, Patel could see that the Marines were learning. Whether they would admit it out loud or not, the Marines were being trained to be better tacticians and small unit leaders. Against a thinking adversary, they made mistakes, adjusted to the consequences, and experimented with new stratagems. Training disguised as a game, Patel thought.

Grabbing the player manual from the desk, Patel was shocked by the sheer weight of it. Thumbing through the pages, Patel realized the rules and mechanics themselves were not particularly complicated. The majority of the manual was occupied by the in-depth explanation of why the wargame worked the way it did. The players weren’t forced to blindly accept the rules of the wargame. The manual was filled with charts and graphics, depicting the underlying logic of the game’s rules and mechanics. A whole chapter was dedicated to how the program calculated unit engagements. Recognizing the engagement tables his father used for his miniature wargaming hobby, he could see that the math and logic behind the game was sound. It took terrain, morale, and weather all into account. The detail was shocking. Hell, there were fuckin’ footnotes. He had never seen footnotes before in a Marine Corps document before.

“Hey, did you all fuckin’ read this?” Patel asked, skeptical.

Barely turning their heads from their screens, Baxter replied with a twinge of annoyance, “Of course we did, Sergeant. How else would we win?”


“You can’t win if you don’t know how the fuckin’ game works, Sergeant,” Baxter replied.

“Understanding how all the units interact and how damage is dealt is what sets the good teams and the great teams apart,” Lee added.

“Not to mention, after a few dozen reps, the rules get pretty intuitive, Sergeant,” Sanders added. “Honestly, the hardest part is getting enough reps in. The more you play, the more you know, and the more you know, the more you win.”

“Not to mention Chang from Lima Company is good enough to make his own custom scenarios,” added Sanders.

“Yeah – that is sort of out of my depth. I got like two pages into that chapter in the manual and my eyes were glazing over,” quipped Lee.

Flipping through the chapter, titled In-Game Modifications, Patel instantly understood what Lee meant. The chapter might as well be written in a different language. Patel couldn’t make heads or
tails of it.

“How often do you guys play this game?” Patel inquired.

“We usually play all Friday night, sometimes more depending on people’s schedule and shit. Each game only lasts about 90 minutes, so we usually play four or five games in a night,” Sanders responded.

Ignoring the side conversation, Baxter barked, “Lee, have your platoon serve as the base of fire while Sanders wheels his dudes around.”

Looking over Baxter’s shoulder, Patel could see a bird’s eye view of the unfolding battle. As their unit advanced or engaged with the enemy, the map steadily revealed more details, no doubt trying to simulate the fog and friction of combat. For simple and common orders, a simple click of the mouse on pre-set features was sufficient. Yet, for more nuanced, complicated orders, Baxter had to manually move the units or create a chain of simpler orders for the unit to execute. As in real life, Baxter had to constantly manage and delegate tasks throughout the engagement.

To escape being pinned, Patel recognized Baxter’s textbook execution of a flanking maneuver. Baxter was attempting to outmaneuver the enemy defenses and catch them unaware from the western flank. The interesting bit was how he was employing the company’s UGVs to bypass the enemy’s defensive line. The defensive line stretched roughly ten kilometers, east to west, flanked by steep, rocky terrain on each side. No doubt the enemy wanted to exploit the terrain as defensive obstacles.

“Repetition had bred familiarity, and that familiarity built confidence.”

Understanding this, Baxter had ordered his unmanned units on a rapid flanking maneuver, screened by the main unit. More agile and mobile than manned mechanized vehicles, the UGVs weaved in and out of the rocky terrain on the western flank. Given their size, manned-vehicles would never be able to execute this kind of maneuver on this kind of terrain. At the same time, they had cautiously deployed a mix of UAVs with electronic warfare and ISR-suites to serve as their over-the-horizon eyes. It was obvious they intimately understood all the tools in their arsenal. Repetition had bred familiarity, and that familiarity built confidence.

The attack was unfolding as expected. The adversary offered meager resistance. Baxter and his company were pushing their units deep into the enemy formation in perfect coordination with the flanking UGVs. Everything was going as planned.

“We’re about to win this shit right now,” Baxter declared excitedly.

Yet there is a razor fine line between confidence and hubris, Patel thought. As the flanking UGVs wheeled around to attack the defense’s flank, they
were suddenly met with a unit of main battle tanks, cleverly tucked behind the westernmost hill. In a matter of minutes, the enemy’s main battle tanks decimated Baxter’s flanking force from the rear.

After the devastating engagement, it became obvious the opposing team had anticipated the flanking maneuver and baited Baxter’s team into a trap.

A litany of profanity filled the room as the Marines scrambled to regroup, but their efforts were ultimately futile. Patel suspected that the opposing team deliberately left a gap in their defensive line, to draw in Baxter’s team into a fatal trap. The opposing team had exploited their eagerness. Consequently, with a large portion of their organic firepower gone, the enemy’s main battle tanks tore through their formation like a hot knife through butter. Before long, GAME OVER flashed mockingly on their screens.

“Shit, I did not see that coming,” Baxter sighed, slumping into his chair.

“Did they have ground sensors on their flanks?” Lee inquired, scratching his head.

“Maybe,” Sanders answered. “That or they planned to lure us into a trap from the get-go. Fuck.”

“At this rate, we’ll never beat those assholes from Bravo Company,” Schmidt lamented.

“Let’s play the battle replay, and find where the wheels fell off,” Baxter offered.

Huddled around Baxter’s console, the Marines excitedly discussed their game, dissecting their decisions. The spectating Marines eagerly joined in on the heated discussion, fighting to be heard. Quietly, Patel stood up to leave.

The scene reminded him of a wargame he had attended as a young Corporal two years prior. As one of the few enlisted Marines present, he was tasked as a simple notetaker, a silent, unseen observer. For four days, he watched as officers moved counters on a massive paper map, discussing grand notions of capability development and force structure. At the time, he had been told that the wargame would help shape the future of the Corps. But after witnessing his Marines conduct their own tactical wargame, it was obvious that these small educational wargames, played in noisy little barracks, would shape the Corps far more than the grand wargame he attended. Patel imagined hundreds of Marines playing out dozens of scenarios, crammed in their dingy barracks – testing their mettle against their peers. Steel sharpening steel. The thought made him smile.

As he returned to his dreary patrol, Patel couldn’t help but wonder if this was all...
part of the Corps’ master plan – to train an entire new generation of small unit leaders through wargaming, leveraging the addictive quality of experiential learning. But after six years in the Corps, he, like most of his peers, had developed a deep, profound cynicism – especially concerning grand lofty ideas. The mere notion of an elaborate and expansive plan executed by the Corps going exactly as planned made him burst into near-manic laughter.

At best, this was an expensive decade-long plan that worked way better than expected. At worse, this was a happy accident that resulted in brilliance. But sometimes, wars are won on happy accidents.
“Wooden blocks, Doc? Really?” The Marine Corps captain lifted one of the wooden pieces arranged in a carrying case and looked at it incredulously.

The analyst response was half sigh, half chuckle—always the same question with the Marines, she thought to herself. It’s never high-tech enough.

“Yep, wooden blocks. You’d be surprised at how the tactile pieces make the wargame flow just that much easier. Besides, this wargame doesn’t need the flashy things because it isn’t about discrete tasks, right? We’re not trying to find out whether you can fire a rifle or write an IO (Information Operations) script—you’ve got other ways to train that. This is about exploring the edges:
how the adversary responds to you, and how you respond to that response. I don’t need to grade your reactions, I want to force all of you to think about the world of the possible. We need that conversation. How often do you give your kids a video screen because you want them to talk more?”

The captain was still looking at the wooden block, turning it over in his hands, doubt in his eye.

“Don’t worry, we’ve got at least some tricks up our sleeves.”

“Whatever you say, Doc,” the captain said as he returned the piece to the wrong spot in the carrying case.

“As you picked up your badges when you signed in, you should have received a pair of AR (Augmented Reality) glasses. If you did not pick one up, go see Patrick outside to get a pair.”

“I’ve got them, but they’re older than dirt...” mumbled a Marine Corps major to the Navy lieutenant next to him. “These are, what, 6 years old? I’m surprised they’re even wireless.” The Marines and Sailors around him chuckled quietly.

“Yes, yes, they’re not ‘modern’”—air-quotes—“technology, I know, but if you can get DSS2 to authorize better, you’d be a magician,” said Dr. Junes. Her hearing was better than the major expected. “Anyway, they should already be synced up to the map and your team rooms. So if you can please switch them on and take a look, you should see the opening presentation appear above the map table. If not, please see Dr. Davies in the back to get them re-synced.”

A handful of players started to queue up in front of Dr. Davies’ table, where he had a wireless keyboard and a small square rectifying pad—a reference object image with QR3 codes, skew lines, and measuring boxes precisely printed on it. One at a time, he placed each pair of goggles on the rectifying pad, connected a wire from the malfunctioning goggles to his own, and began typing on the keyboard, entering data into a display.

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1 Blackberry phones, government issued
3 Quick Response codes, which are two-dimensional barcodes that encode information in a pattern of dots. A known pattern of dots can be analyzed for its orientation when viewed through a specialized camera.
only his goggles saw.
“Erasing the sync load ... re-adding the
room package and reconnecting to the
subnet ... confirming loadout ...” Dr.
Davies liked to narrate his work, much
to the dismay of his officemates. “Aaand
resyncing the optics.” After the last, he
would pick up the goggles and wave them
in a small circle, lenses and camera face
down, at the rectifying pad and then up
to the corners of the room, where a few
rectification marks sat.
“Ok, you’re all set LtCol Adams, these
should be good to go,” Dr. Davies said
as he handed back one of the pairs of
goggles.

The main map table was set up with
the opening laydown. This was a global
force-on-force wargame, so the map was
pretty large (6 feet by 10 feet) and there
were a lot of pieces spread out across the
whole thing. The map was covered in
hexes (useful for estimating, even when
the AR goggles can calculate the actual
distances for players), but their shape
was distorted near the poles to take into
account the map projection. A few ships
were positioned in the rapidly growing
sea lanes north of Canada.
The edges of the map had a series of
symbols to be picked up by the cameras
that were strategically positioned
throughout the room. The processors
in the cameras could deconvolve the
skewed images across the entire map to
create accurate representations of exact
spatial locations and orientations. There
were enough cameras in the room to see
around the heads of the players, and
enough symbols on the map to do the
calculations in spite of the hands, dice,
and coffee cups cluttering the map’s
surface.
The wooden blocks representing the
military units had stickers identifying
what they were. (NATO symbology has
only gotten more complex with time.)
each wooden block also had a unique QR
code printed on its top and sides. Their
positions and locations could be read by
the camera mounted to the ceiling above
the map, as well as the camera in each
person’s AR goggles.
In the server room behind the game
room, the air conditioning unit hummed
furiously keeping the servers cool as
they processed, collated, and interpreted
all the information passed back to them
from the cameras and the AR goggles.
Pulling up the 3-D feed on a screen in
the server room, a technician scrolled
around the room showing the up-to-
the-millisecond 3-D positions of all
the tagged objects: the wooden blocks
representing military units, the maps,
and the goggles. Some goggles were reporting a bit of a lag. He marked down their unit numbers so he could do hard resets on them later.

LtCol Adams leaned over the map, studying the pieces. Flipping the switch on the side of his goggles, he activated the AR display over the map. After a moment, some wire outlines appeared over the map identifying country boundaries and exclusion zones. The edges of each wooden block began to glow in his field of vision, with outlines of red (adversary), orange (adversary’s allies), green (US allies), and blue (US), indicating to which team they belonged.

An intel analyst on the Red team (his specialty was adversary tactics), LtCol Adams was less familiar with US capabilities than some of the others around the table. He reached his hand out into his field of vision and virtually tapped the side of one of the Blue ships, a DDG (Guided Missile Destroyer). Instantly, a 3-D image of a DDG appeared and began slowly rotating above the wooden block. He pinch-zoomed in the air over the image and it filled more of his field of view, giving him a large projection of what it looked like. To the left of the image appeared some of the vital stats: armament, max speed, radar types, crew complement, and max fuel range.

He virtually tapped the DDG again. With the movement overlay up, along with the 3D image of the DDG, there appeared a few other option buttons. He selected the range rings, both ‘movement’ and ‘missiles’. A yellow ellipsoid appeared on the map showing where the DDG could travel in the next day, and a red ellipsoid showed the max range of its guided missiles. Interesting.

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LtCol Adams reached out and physically touched the wooden piece and began to move the block. The bright red range rings around the ship showing the guided missile range followed the block as it moved, leaving faded pale range rings behind...

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LtCol Adams reached out and physically touched the wooden piece and began to move the block. The bright red range rings around the ship showing the guided missile range followed the block as it moved, leaving faded pale range rings behind, around where the block had been. The virtual skeleton of

future of gaming

4 Since the flat map is a projection of the spherical Earth, a one-day travel circle won’t appear as a circle on the flat map.
the block, the edges of a bright square, stayed exactly where it was, marking the position of the DDG this turn. LtCol Adams moved the DDG around the map, exploring what features could fall within its missile arc depending on where it moved. Interesting.

He returned the piece almost, but not quite exactly, back to where he found it. Dr. Junes, who was watching him explore the options, reached out and repositioned the DDG back where it belonged.

Each team had its own planning room—a place to strategize in private in between game turns. The Blue team planning room had an empty table at the center and featureless white walls on both sides adjacent to the door. The same cameras, just fewer of them, were positioned around the ceiling here as well. The table had markings on the edges similar to those on the map edges in the main room.

As the Blue team filed into the room in between turns two and three, CAPT Gilles took off her AR goggles and rubbed the bridge of her nose. “Any paper copies of the brief? These things always make me motion sick.” LT Murphy handed her a binder, which she graciously accepted and flipped open.

“Ok, so that didn’t go as well as we wanted,” CAPT Gilles said. “Do we have a plan B?”

She watched as the rest of the team tapped silently into the air before turning their attention to one of the two featureless white walls. They all began to absently flip their fingers through the air in front of their faces. She turned her attention back to the binder in her lap and began flipping through the planned COAs (Courses of Action), the same as her team was.

“Slide 37. What if we feint to the north and bring the carrier around the Cape of Good Hope in EMCON (Emissions Control),” said a major in the back of the room. “Too risky,” a voice replied, “we’d get spotted from the shore.” “Well, do it at night and stay off the coast.”

“Let’s give it a try. It can’t go any worse than last turn. As Dr. Junes keeps telling us, we should take some risks and fail here. Better than failing in the real world later. CDR Sanchez, work out the details.” With that, CAPT Gilles picked up her AR goggles and walked out of the room.

“Okay, everybody, let’s use slide 37 as our example. Put it up on the wall and bring up the game map to the table, sync to my view so we’re all looking at the same thing,” CDR Sanchez said. The Blue team flicked at the air for a moment looking at the walls, then down to the table. A
few gestures midair and everyone began staring at something on the table that wasn’t there.

CDR Sanchez looked at the AR world map on the table. The map from the other room was reproduced here in their field of view. It looked like a live feed from the camera in the main room, but in fact was a record from the end of the previous turn.

“Dr. Oakman walked up to the map table next to Dr. Junes, ‘How’s it look this time’ ‘Not great’ came the simple reply.”

CAPT Gilles was in the main map room, standing around the map slowly moving the wooden blocks around (her AR glasses in her pocket) projecting what she thought would happen over the next few days. None of these moves were reflected in the Blue team planning room, giving her the freedom to explore without confusing their planning.

The CDR zoomed in to the South Atlantic, enough to show the carrier and its fleet, but also the threat ships in the Indian Ocean. He called up the threat overlay, and it displayed the areas in range of adversary munitions: ground-launched, ship-launched, and air-launched. “Are there any subs operating in the area?” “We have a few POSSUBs (Possible Submarine), Sir, but nothing confirmed.

I’ll put them on your view.” A few yellow marks appeared. “That doesn’t make it any easier.”

“Okay, folks, here’s the scheme...” CDR Sanchez presented the planned maneuver. He talked through which ships he’d like where, which risks he was willing to take, and whether he was willing to escalate the conflict. When he was done, he said, “Alright, you know what ships are yours to command. Be ready to brief your scheme of maneuver to me in 30.”

Dr. Junes typed up an announcement on her AR display: Blue has submitted its move for this turn. Control will take a few minutes to review it. Take a 10-minute break and we’ll reconvene at 1320.

Dr. Oakman walked up to the map table next to Dr. Junes, “How’s it look this time?” “Not great,” came the simple reply.

Dr. Junes had the Blue moves loaded into her AR goggles and was standing over the map table. She adjusted a few of the wooden blocks that weren’t lined up with their proper locations; apparently someone had bumped the table. The overlay showed her the Blue moves: lines stretched from units showing their paths over the next 3 days of the wargame. Tick marks broke the lines into 12-hour increments. Red tick marks indicated offensive actions (e.g., firing a missile, launching a drone, etc.), and grey underlays showed logistics replenishments. Centered on each tick
mark was a shaded blue circle identifying the range rings for any available weapons. “This again?” Dr. Oakman said. “Yup,” replied Dr. Junes, “this again. I was hoping for something new. Though they say, if at first you don’t succeed, try, try again.” “Sure, but they also say something about the definition of insanity, don’t they?”

Dr. Junes added the Red moves to the game map, overlaying similar lines showing the Red units’ paths, offensive actions, and threat weaponry ranges.

To the uninitiated, the map looked terribly busy, full of shading and glowing lines for dozens of units drawn across the hexes. The map itself was still covered with wooden tiles representing each of those units. But the practiced eye saw the signals through the noise: potential engagements, missed opportunities, savvy maneuvers.

Dr. Junes tapped an AR button in her field of view to bring up the engagement view. Each of the units that, at one time or another throughout the turn, fell into the firing arc of an adversary weapon was highlighted. Statistics appeared on the side of her vision: 12 Blue units within a Red firing arc, 4 Red units within a Blue firing arc. Not good news for Blue.

After about 15 minutes, the players filed back into the map room, ready for the turn’s adjudication.

“Ok, everyone. You should have an adjudication overlay available in your view list. Go ahead and choose that if you want to follow along.”

The Blue and Red commanders crowded around the map table. A few others called up the AR view and stared at the blank wall to the side of the room, watching the live feed of the camera over the map table.

“We’ll step through the turn in 12-hour increments. If you have any adjustments to the plan as it progresses, speak up and we’ll make them on the fly. First 12.”

As Dr. Junes spoke, Dr. Davies advanced the time for the adjudication view from his console in the back of the room. The AR view showed how all the units moved, drawing skeletal squares with a bright line along its path from the original wooden block. A few Blue POSSUBs, which hadn’t been on the map before, showed up on the display as Red ASW (Anti-submarine Warfare) assets did their work. The Blue ASW commander immediately stormed over to the ASW adjudicator to complain. Dr. Junes saw the ASW adjudicator, Dr. Gano, talking him through the detection probabilities.

Two Blue surface units were highlighted as having come within the firing arc of some Red units.
Dr. Junes pointed to those Blue units and said, “Red Commander, it looks like you have a firing solution on this SAG (Surface Action Group), as well as the ARG (Amphibious Ready Group). Do you take the shot?” “Absolutely!” came the reply.

“No way,” said the Blue commander, “we were in EMCON, did we forget to submit that?”

The Red commander chuckled slightly. EMCON is not an invisibility cloak, he thought to himself.

Dr. Junes tapped the virtual unit in her AR view, “EMCON” was listed as “Level 4.” She replied, “Yes, you are in EMCON, and just because the display is listing you as targetable doesn’t mean you’ve been hit. Dr. Davies, what’s the probability of detection for EMCON level 4 in this AOR?”

“Eighty-five percent, as of the most recent analysis from the last Fleet Battle Problem,” Dr. Davies replied.

“That doesn’t sound right…” the Blue commander grumbled.

“We’ll push you a copy of the analysis. Go ahead and roll the dice to see if they have a targeting solution. You need 86 or higher to stay hidden.”

CAPT Gilles picked up the dice and handed them to his Information Warfare Commander to roll. Eighty-nine. Blue’s lucky day.

“No targeting on the SAG, but they still have a sense of where you are. Ok, now roll for the ARG.”

Thirty-five. Not as lucky.

“Red, given what’s in range and what you know about the maneuvers, what will you be firing?”

Red players spent a few moments animatedly clicking through some AR icons that no one else in the room saw, except Dr. Davies. He’d worked on a lot of the probability-of-hit analyses for the Red weapons, so was eager to see what the inbound fires were. And he wasn’t disappointed.

“Here you go, a total of 180 warheads inbound, evenly divided among the ships.” The Red commander sent the information over to Dr. Junes’ display, who dragged it into the air defense calculator that Dr. Davies had written. It spit out the probability of hit for each ship in the ARG, assuming each employed all of its defenses. It was not going to be a good day for Blue.

Three weeks later, Dr. Davies and Dr. Gano were sitting in a side office, staring through their AR goggles at a replay of the wargame. They had the audio muted.
for now, but the automatic transcription (picked up by the microphones in each person’s goggles) scrolled up the side of the display. “Fast forwarding...” Dr. Davies said quietly as he moved the time ahead on the display. “Here we are.”

Dr. Davies started the playback in the planning cycle for turn 4 in the Blue team’s room. That was where things had turned around for the Blue team. Which was surprising—this particular conflict wasn’t quite a Kobayashi Maru, but it was damn close. The team might have finally come up with a solution. CDR Sanchez was talking about how all of Blue’s EMCON maneuvers were complicating their operations, but not actually giving them any advantage against Red. The transcription read:

SANCHEZ CDR ALEX: The way I see it, we’ve got two options. One’s safe, the other’s a bit risky.

“Okay, Dr. Gano, here’s where they start discussing their COAs. Let’s transfer these over and start modeling. The risky maneuver was interesting; let’s see if we can optimize it. Pull up the logistics numbers across the theater and see if it’s supportable, I’ll dig into his tactics.”

“Admiral Coleman, thank you for your time today. We’re here to show you some of the insights from HALFPAST MIDNIGHT, the wargame that we ran for your command in November. The first slide shows the overall scheme of maneuver for the whole game. These are the actual executed maneuvers, not the plan. I know it’s a confusogram, but I wanted to highlight the span of control problems: You can see Blue and Red forces maneuvering over the vast majority of this AOR. The faded blue is the weapon engagement area and, if I remove the land-based fires...”

“...you can see that the terrain in view of the maneuver units is still about 75 percent of the AOR at any given time. This is a good thing since it means you really can see everything and it’s hard to be surprised. However, it means that, if you want to have a single COP (Common Operational Picture) back in sanctuary, you’re going to have some trouble.”

“Impossible to process all the data? Can’t we buy bigger servers?” said RADM Coleman.

Dr. Junes continued, “It’s both that and throughput, Sir. The fusion data centers need to compile all the data, and 6G connections are only so fast, and that’s assuming no adversary interference. On the next image, we overlaid the bandwidth for each of the assets transmitting back to the Operations Center, under the assumption that they’re not operating in EMCON—more on that in a moment—and compared those numbers with the available bandwidth in theater.”

“Hm,” said RADM Coleman.

“I wanted to call that information up front because I know you were interested in the Ops Center piece. But, I also wanted to highlight a couple of other points,
specifically the scheme of maneuver that CAPT Gilles and CDR Sanchez executed. We’ve got a two-minute rendering of the game to show you, and I think you’ll find something interesting around turn 4, which is 45 seconds in...."
You could tell the CG was not happy when he started looking at you over his glasses. His glasses had inched downward to almost the tip of his nose and everyone was beginning to feel sorry for the VPM.

“You mean to tell me that the bots convinced Jerry that he should withdraw the MEB before it even landed? That it would piss off the Japanese if we were seen as going in first? How in the hell did the bots do that? We have talked about this with the Japanese, we have an understanding? We do have an understanding don’t we?” Everyone in the room nodded whether they knew what he was talking about or not.

The General was pissed because his most recent strategic Pacific wargame had demonstrated that the amphibious landing was politically unacceptable. It was worse because invited (and uninvited) guests were watching. He was going to get a phone call from the Commandant, and he wanted to pass some of the love on to his gamers.

“Sir…”. The VPM stood there with his mouth open, looking at David hopefully.

There is a glossary at the end of the story.
What could he say: that all the gamers knew the bots wouldn’t work but the General had insisted they use them? Or that “Jerry,” a retired four star and friend of the General was easily bamboozled by the bots. As a LtCol Marine he knew diplomacy was required. But he couldn’t think of anything. Neither could David.

In the saddening silence the General’s fist came down hard, making the paper on the polished table bounced and sparkled. “Son, you don’t have an answer, do you? Perhaps we need a new VPM. Someone who can wrangle the obvious.” The General turned to David. All David could come up with was “Sir, what the LtCol is trying to say is that once we turn the bots loose, we lose control. It’s all up to them. All we can do is set the scenario and guardrails. As you know we have to live with the bots the participants send. We’d much rather use live players but travel is so costly in Green...”

The expected chewing out by the Commandant never happened. The Generals automated aid had stepped in. It was only a game after all. But the General was in a bad mood for the rest of the week.

Two weeks later the COS pulled David aside and said: “Look, next time, do what you need to do. These bullshit results don’t make any of us look good. I know it’s not easy, but that’s what we pay you the big bucks for.” David and the COS knew he was lying. In addition to the low pay, avoiding bots was virtually impossible.

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David looked up from his breakfast of low carb rice and egg white substitute at his new Virtual Player Manager (VPM) sitting across from him.

The new VPM, LtCol Jim Fry, had just transferred in from being the classification manager at I MEF. He was used to watching his CMAE smack a bunch of subordinate commanders around. Now he was in the big leagues, with CMAE’s

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In 2025 a series of high-level breaches resulted in a massive dump of US data to Wikileaks. It showed that only a few military systems in development worked while most of the rest were over budget and outdated. This was embarrassing.

As a result, Congress imposed complex and strict new security rules. Artificial entities were built to manage the rules and ensure compliance. And Classification Management Artificial Entities (CMAEs) were born. With each new public disaster; the rules expanded. CMAE’s began closing loopholes and creating new rules. Eventually only the CMAEs understood and could apply all of the security regulations. Things worked so well, from a regulatory perspective, that the CMAE’s mission expanded to encompass all government conduct. The CMAE’s monitor the national (DoD, intelligence, other departments) information environment continuously and constantly negotiate changes in security levels and access to information. They also monitor PRR (Personal Reliability Reports) and dynamically assign each individual a clearance level. Players frequently leave their command with one clearance level and arrive with a different one. Figuring out how to get anything done in this environment has become a highly valued skill.

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See, for example, “Defense Department to ban beer and pizza? Mandatory keto diet may enhance military performance” in Military Times, July 2, 2019: https://bit.ly/2xyXSYo
whose clearances and ability to argue dwarfed anything at the MEF. Fry was a very valuable classification manager: one with an OR degree from the NPGS. This was his payback tour.

David began, “Whaddy mean that we got canc’ed on the SBM? SPACECOM approved the transfer of the OBM and SCBM training modules, all we need is to get it installed on top of the OMM. I thought we’d have that all worked out by now.” The LTCOL looked up at the black and white menu, scanning for something without carbs and settling on coffee.

“Nope, the SPACECOM CMAE has only approved the transfer of the SBM training software downgrade and that needs to be tweaked to work with our OMM. And our CMAE is bitching that the hardware we need for the new OBM can’t come in because it’s not certified at our level. And if that’s not enough Bergman-Dross-Simple’s CMAE is not clearing either in for their spaces without approval of DISA’s CMAE. We can appeal but all the CMAE’s are backed up right now because of NORTHEX. And after that debacle in the Pentagon over Christmas no one dares override a CMAE unless they want to risk explaining a disaster to Congress.”

Now the David had a problem. Without the orbital combat modules, he’d need to find some way to manage the space battle, which was mostly physics and orbital mechanics intersected with the inevitable problems of launch capacity and weapon’s inventory. Right now, all he had was the ability to whiz satellites around, and the key players, the AE’s that managed the other features, were apparently caught up in a battle over classification. Good thing they weren’t worried about the HSAS, at least they had gotten that cleared for their game series a year ago.

He tapped on his virtual scheduler to see if he could get some time with the General over the next couple of days. Two hours from now, and next Thursday looked good. Maybe the General could

The Space Battle Manager (SBM), On-orbit battle manager (OBM) and Space Combat Battle Manager (SCBM) are AE’s that manage the Space Force during peacetime and combat operations. SPACECOM, being watched by multiple CMAE’s, would only give MARFORPAC a training version of its’ BM’s. Both training and operational BM’s are tightly controlled by the CMAE’s. When a CMAE gets suspicious a battle manager can be de-authorized in the middle of a real world event. This immediately results in a game of “find the commander” so that the CG can override the CMAE before the enemy can take advantage of the situation.

The day before Christmas J-8 was trying to wrap up an assessment of adversaries (and friends). The GS-12 in charge of filling the correct forms with the Joint Staff CMAE missed checking two boxes on the form regarding access to foreign nationals. The Joint Staff CMAE started refusing to process the report's transmission. In the rush to get out early on Christmas the J-8 proceeded to do what he thought was a routine override (CMAE’s typically got caught up in trivial compliance issues which could take weeks to sort out without an override). This resulted in the J-8 Report being automatically transmitted to all of the countries. The report was not complimentary to Saudi Arabia. Because it was Christmas the automated intelligence monitors were unable to alert anyone until December 28th. The J-8 retired early and now no one expects to enjoy a holiday ever again, and no one ever wants to override a CMAE. This has resulted in rather spectacular gridlock, particularly on holidays.

2 High Speed Adversary Simulation. An extremely slow simulation of adversary decision-making. Mostly used as alarm clocks.
convince his AAE to go to battle with the CMAEs.

Because the rules governing everything from ROE to human relations are so complex everyone needs Assistant Artificial Entities (AAEs) to argue the rules with other artificial entities. Those with the best trained and experienced AAE’s get promoted the fastest. A good AAE also keeps senior officers out of trouble, an essential task when there are systems watching everything. Training your AAE is critical to advancing in your career.

Game Day -19

“Gosh darn it, why wasn’t I told about the map glitch before now?” David worried that a Human Resources Artificial Entity (HRAE) might be scanning the meeting and report him. He risked a reputation downgrade if the command CMAE added another infraction onto his speeding tickets, wanton disregard for intellectual property, and profanity-laced tirades –

Everyone in the meeting looked at Carl, the IT guy.

Glisson-Ellis had won the contract to provide IT support to MARFORPAC’s gaming efforts. The goal was to replace the previous idiots who had designed, but could not implement, the information systems built into the gaming “complex.” In reality the “complex” was a series of large, beige, rooms filled with old wires and light fixtures left over from when the watch floor had been replaced by a box sitting in the General’s outer office. David’s boss had listened patiently to the arguments that nothing was getting done right because none of the specifications made any sense, but the schedule had to be met and corners were cut.

Of course, Glisson-Ellis was fired for non-performance once the system was up and not working. Which led to their current trouble with Bergman-Dross-Simple (BDS), the new contractor.

Even David, as cynical as he was, didn’t expect the map function to be offline. How hard, in 2045, when everything was run by automation and code was being created using plain English, was it to make a map display?

By 2035 almost everything was tied up in some sort of Intellectual Property system, and AE’s routinely scanned for any IP violation. They would then auto-file lawsuits in AE enabled court which could result in instant adjudication. Without a defensive legal AE continually scanning electronic court records you could be found liable in thousands of lawsuits in only a matter of seconds. This was rated the thirty sixth in the national irritation index, right behind intelligent Christmas lights.

Carl cleared his throat and spoke – “Yesterday when we were showing the system to the DHS visitors we decided to zoom to a tactical map of Hawaii. Suddenly the system was making every map into a sphere, not a spherical projection, but a sphere. No matter which projection we selected everything bounced back to a sphere. Right now, BDS is arguing with the system about the problem. It looks like the coder software believes that everything is round and no
one can convince it otherwise. All the BDS guys can do is argue with it because they haven’t bought the manual coding modules. Licenses are on order but they have to go through weapons certs at DHS. Should be about ten days, if everything goes smoothly.”

Weapons certs were needed because any direct access to code, including compilers, is restricted under the 2033 Software Weapons and Terrorism Act. (see, for example, https://bit.ly/2TIMRiB)

David let out a big sigh. He needed IT and the contractor to fix it, now. “Can we get the CLAE (pronounced “clay”) (Command Logistics Artificial Entity) to authorize overtime for IT and the contractor? At least they could spend more time arguing before the certs come through.”

But David knew if they were going to do that he would need to explain what the hell was going on to the General’s AAE. Better get started on the paperwork. And the cover story.

**Game Day -18**

“Shit,” he let that one go because his cubical was in a dead zone. “Well do you want to take the call?” said David’s AAE. “Sure – hey Colonel Fredrick what can I do for you sir?”

Col. Fredrick was the primary executive deputy program manager for the Army’s new ground vehicle: the Porcupine. The vehicle was in its initial production run and things seemed to be going well, only a few glitches and cost overruns. But there was a problem. It couldn’t float. Sank like a rock. This was due to the heavy armor required to defend against any number of laser and autonomous threats, not to mention all of the launch tubes and machine guns that bristled from every orifice of the vehicle. Hence the name, the Porcupine. It couldn’t float because it was never designed to float. Unfortunately, CAPE’s Simulation Assisted Analysts were having none of that. They had identified that the most critical missions required amphibious capability. It needed to float, or the program would sink.

The sinking problem was Col. Fredrick’s sole career focus right now. When CAPE first raised the issue Congressional investigative AAE’s had begun chewing into the question. For weeks they had been conducting an organized argument with the Pentagon’s first line of defense for the data: the program office CMAE. Other Pentagon CMAE’s, attracted by the argument, had come online to help. For a while it looked like the Congressional AAE’s would get beaten back. Until the Intel committee sent in a fully cleared CMAE which cut through the Pentagon’s defenses like a laser cannon through a real Porcupine.

The smell of burning Porcupine began to pervade the halls of the Pentagon, and Col.

2036 Smolensk Test Range, Russia. The crew dialed in too much energy and the laser swung wide hitting a stand of trees adjacent to the range. In addition to the battery exploding and fifteen trees getting a haircut, a large male porcupine was sliced in two. Given the beam width all that was left was the head, front right paw, and part of the tail. The Russians immediately approved the laser’s funding.
Fredrick’s mission was to re-brand the Porcupine’s displacement disadvantage into an advantage. His current scheme was for it to be dropped off in medium depth water and roll around on battery waiting to pop ashore.

It would require a retrofit and put the crews underwater in an iron ball. But it would be cheap.

“Well, David, maybe we could chat a bit about your game and the mission roles of Army forces in the theater. I know that the game is supposed to be joint, so I was wondering if you needed any help from big Army in getting players or collecting data?”

David knew exactly what Frederick was up to.

“Sure Colonel, what did you have in mind?”

“Maybe my futures guy, civilian, and myself could help with the Dark Green tech? We’d bring our AAEs and some Simulation Codes (SC) all of which are cleared for whatever level you’re playing at.”

“Always welcome. We’re having a bit of an issue with our CMAE’s fighting with SPACECOM over clearances. Could you have your AAE speak to the Pentagon supervisory CMAE and see if you can get all of the classification issues cleared up?” said David, sensing that if the Army’s CMAE weighed in SPACECOM’s CMAE might relent.

“I’m sure we can clear up any problems from this end. Thanks for the help.”

Now David realized that the scenario would have to incorporate Army units. Unplanned Army units. He shoved back from his desk, the Wiki-Wiki Green bus was leaving in a few minutes and if he didn’t want to walk home he’d better be on it. The Green credits he was getting for riding it sure better pay off for that trip to Bali. It cost him an extra hour of his life each day.

**Game Day –18**

The scenario meeting was not going well. Nothing was going well if you were a human arguing with a CMAE, SAA, and AAE’s from the front office, wargaming and intel. And now the CMAE and the SAA were bickering:

“According to TRADOC Regulation 300.3.34 programming specifications for test vehicles requires a DD11.3 message from the program CMAE. Despite repeated requests I have not received one from Porcupine CMAE.”

“This is not a test vehicle. The real problem is that the standard scenario cannot be changed or the analytical elements will be corrupted.”

“I have it down as a test vehicle.”

“That’s because your DBMS is a year old, like everything out here.”

SSA’s are AE’s designed to replace analysts. They run simulations in real time and make assessments about various questions and programs. To do this they have some of the most sophisticated self-awareness on the market. This makes them terribly irritable and uncooperative. Despite this, or perhaps because of it, they have evolved to become the de-facto baseline standard for military analysis, weighing in on everything from fleet exercises to new weapon system procurements. They also like to argue.
“Ok, guys” David hated these stupid natural language interfaces not the least because the machines would have an exact record of what was said, “The Porcupine is indeed not a test vehicle, intel you know your database is out of date, and the Army’s CMAE won’t issue a DD11.3 on an IOC’d program. We have to change the scenario: wargaming, you are smart, adapt. But what I need to know is how long it’s going to take to switch the ground war around from an insurgency to a bigger, peer, competitor. Maybe thrown in some Japanese-Russian action to get things going. Sakhalin is a good place for tanks and lasers. Maybe the Russians try and take it back from the Japanese...

After the 2027 Russo-Japanese war over the Kuril Islands Japan had been occupying the bottom half of Sakhalin Island as a “buffer” against Russian aggression. In reality Japan was occupying the islands because it won the brief skirmish, and was quite pleased with itself for doing so. Russia resented this, but not enough to do anything about it. Russia figured when it was go-time for China it would piggy back on the Chinese efforts and take back everything, including half of Hokkaido for good measure. China had other plans, but the Russians were unaware of them. Japan also had a new generation of fully autonomous swarming battle robots, but the Russians were unaware of them.

“Woah, you cannot introduce another player like this at this late hour” said the SAA “first our analytical objectives will change and, second, your whole player travel budget will get disrupted.”

Ever since the International Treaty on Climate Change was implemented travel had become the driving factor in gaming. Given the reluctance of CMAE’s to authorize communications links due to possible intercept it had meant that in order to player commands had to either send Virtual Artificial Sailors/Soldiers/Marines (VAS/M) or pony up real mil-Green credits, which meant that something else was not going to use carbon. The travel budget was eating the operational budget. Too many games and meetings and the TPFDD execution was going to involve walking and rowing.

VAS were no solution as they were quirky and tended to spend all their time arguing with the virtual analysts (CAAs) and other players (red and green).

The arguments generally revolved around whether anyone was playing their roles “correctly” and the CAA’s would get involved trying to referee. Eventually the CMAE’s would join in. Once an argument formed it was very hard to stop because no one could override the CMAE’s.

Game Day -14

“Just came from the morning meeting.” David dropped into his cubicle and sat hard in his chair “and now the CG has decided that we need to bring some Virtual Influencers into the game”. The only thing the CMAE’s trusted less than humans were VI’s. There was no way David could get a waiver in the 14 days before the game.

“Couldn’t we just dust off the old VI you used two games ago? It did a pretty good job of making the feed follow the game. I think it’s still on the network if you want to use it.” Said LTCOL Fry, “I think it’s cleared by the INDOPACOM CMAE already.”
In 2020 press AE’s were the first AE’s to be developed by OpenAI with backing from Elon Musk (https://bit.ly/2GFWZ4O). They were capable of ingesting enormous data sets, doing some reasoning about them, and spitting out new stories based on the feed. It was only a short time before they were ingesting all sorts of data, making it into stories, and graduating into having personalities and doing editorials. Then they began synthesizing video and everything took off and “Press AE’s” became “Virtual Influencers” or VI’s. VI’s pre-dated virtual press, but the Musk code gave them intelligence in addition to looks (see: https://nyti.ms/2SopApi). People followed their favorite VI’s like any other celebrity, with each VI owning various avatars who appeared in its videos. This, of course, all but devastated what was left of the traditional, human-based media. The “print news” was the first and quickest to go, with audio and video falling about 5 years later. By 2045 each influencer, including any GOFO, had their own military-issued VI’s following them around generating a steady feed of stories. One of the most important things an officer could do was to train their personal AAE to manage the military-issued VI’s. Not that any of the big VI names cared about military VI’s, but sometimes they did. Mostly to the misfortune of the GOFO.

“Yeah, we could, except in that game the thing pissed off OSD big time. It started generating hugely negative national opinion about the conflict, particularly when the casualties started coming in. The editorials it generated were not, shall we say, complimentary. Since we were playing administration policy, OSD saw a potential train wreck should the whole thing get out. They almost had to call CYBERCOM to get the thing washed out of the various feeds before it was picked up and went viral nationally. Everyone out here got thoroughly bitched out.”

“So, its dead?” said the LtCol.

“Yeah, and I’m surprised the CG doesn’t know that. I wonder what he’s up to? Hey why don’t we do this, tell Samantha to take the VI and get it to script out some stories. We can hand them out to the CG and the staff and it will look like the real thing. We just won’t put them on paper.”

**Game Day **-10

David turned and walked the short distance down the hall to the sim room. Really it was just another dingy room in a dated building that was furnished with 40-year-old government-issued furniture, but it was home. Fry had said at breakfast he had the maps up, so David thought he’d take a look.

The sim room was where they assembled the game before they deployed it. This time it would be deployed to the center lanai at the Hickam O-Club. The CMAE’s went crazy when the General decided to use it, but he persisted because of the historical nature of the space, and because it was the only space that was available for that many people. David was just happy they could cater lunch and dinner.

The sims ran on rolls of computer paper that were kept in bins along the edge of the sim room.

Each could be unrolled and either used whole, or cut up into smaller screens as needed. The computer paper usually ran wirelessly on the global grid, but the CMAE’s would have none of that. Instead the thin sheets of computer had to be clipped onto heavily shielded data and power cables, which often ripped out at inconvenient times and created a big tangle of cables and players if everyone wasn’t careful. The cables also pulled the sheets off of any surface...
other than the floor, which resulted in players stepping on the computers and causing malfunctions. One game could go through a full roll of computer paper, which was not cheap.

Frye rolled out a large holographic sheet onto the floor and clipped it in. Instantly a map of the operations area filled the room’s floor. On the map various symbols glowed showing the location of ships and ground units. Above the map what looked like thousands of stars chased by word clouds zipped around, representing everything from balloons to hypersonic spy drones.

David put on his telescopic glasses so he could see what was going on.

The data looked correct. “So, we’ve got the SBM and SCBM working?” David looked through his telescopic glasses at an amazingly small portion of LTCOL Fry’s face, who responded by writing on another sheet that was clipped in. Instantly several of the stars stopped zipping around and exploded into glittery shimmers. “Working like a charm. It was all a classification thing, the OMM was perfectly capable of handling the IO requirements.”

The space modules working. The map not spherical. Things couldn’t get much better than this, thought David. Things were looking up.

**Game Day –5**

The second tremor hit hard and the lights swung pendulum-like in the overhead and the raised floor creaked and groaned. No one had thought that birthing a new Hawaiian Island would be so violent but after the evacuation of Hilo in 2034 everyone had become convinced. Now as the lava moved up and out toward the surface they were feeling the tremors on Oahu. The Loihi Seamount was thousands of years from being anything but an undersea seamount, but both Loihi and Kilauea seemed determined to move that schedule up.

Several sheets of computer paper fell off the tables and hit the floor. But otherwise no one noticed.

After it was back on the table, attention turned back to the rehearsal map. The Space Force (SPF) loop seemed perplexed by the latest request from the Army.
Launch clearance from tactical units should proceed battle manager to battle manager, not directly to clearance authority. Only the SBM and OOBM’s AI could clear a tactical ballistic launch because there were so many devices running around that might be impacted. Even the exhaust trail might fuzz a sensor with its hydrazine residue, creating a hole through who knows what might pour.

Anyway, the SPF loop was too busy helping the overwhelmed ISR loop. Red was trying to beat back coalition ISR. The Air Force Air Battle Manager was offline due to something having to do with cyber. The ISR loop suspected that it was really due to the way the AF loop punched at his computer paper. He did that every time they played, but no one called him on it.

The SPF loop decided that if that meant that the ISR survived for a couple more days he could afford to spend some ammo, even though he would not get an orbital refresh for several launch cycles. He gave the order and suddenly Red had no more drones in the air.

“We’re all out of hypers” called the logistics loop. “I thought we had a pile of them in Light Blue” said the Marine loop to no one in particular. “We thought we did but that was some sort of cyber thing, we’re done right now in theater for hypers, all we got are legacies” answered the log loop.

The Navy loop did not look up from his display, just quietly updated his orders to the sea battle manager. His carriers started moving – away from Red.

Hypers were the weapon of choice, virtually impossible to defend against. And while the Blue hypers were far better than anything Red or Gray had, what they made up for in quality they lacked in quantity. No one spent money on log that could be spent on something new and shiny. There were 40 different variants of the US hypers, but very few actual missiles.

“Goddammit. Said the SPF loop. I just jacked off two Trundles to take out the killer robots and now you tell me you can’t hit anything? I could have used those trundles against bases or literally anything else. It will take me five launch cycles to get them resupplied.” The log officer interrupted: “Um make that ten, we have other priority log shots from your SFBM.”

“I need the Army’s launch approved.” The amphibious loop texted the SPF loop “we’re going in and the Navy’s just told me that they’re pulling back because they’re out of hypers. That means the Army’s ballistics are all I have for long-range fires until I get the ATACM’s
ashore.” A line of olive-green symbols was steadily advancing toward the rear of a red line in Northern Orange-Green, about to cut off a couple of Red corps. COL Ferguson’s two BCT’s of Porcupine enabled heavy infantry had already been dropped off five miles from the coast by RO/RO ships to reinforce the Orange-Green Army. They were ashore and moving into contact. How they rolled through the dense jungle was anyone’s guess, including Fergusons. The sim he brought said they moved at full speed so it was fine.

More Red corps were pouring across the Red/Orange-Green border. Everyone except the Orange-Green AI thought the Marine landing was a suicide mission. Orange-Green had apparently convinced the virtual US executive players that standing firm and committing troops against the Red onslaught was a good idea. David thought this was, however, an accurate simulation of the actual game decisions from their retired experts.

Meanwhile, the Light Blue AI was playing well, again, against Gray. Three Light Blue divisions, along with its aircraft carriers and air force, had crossed the sea and was advancing on Gray’s primary port. The US contribution was five BCT’s deployed into northern Dark Blue. Because of the Orange-Green fight with read everyone was apparently distracted and Gray wasn’t attacking them.

David turned to Frye, “I think the Gray AI sucks. Isn’t there some sort of upgraded version we can get from Intel? Or from Quantico? Or from anywhere?” “The problem,” said Frye, “is that any upgrades won’t be released by the CMAE’s because of classification. All the newest versions can’t play in games.” “But,” said David, “I don’t need them updated, I need them to not suck. There’s a difference.”

David let out a sigh, at least everything was working. “Ok, guys I really appreciate your time and don’t want to waste any more of it. It looks like everything is plugging together for the game and the clock is working.”

The “clock” is the real-time game timer that synchronizes all player and AI decisions in the game. It essentially keeps track of who does what when, making life a lot easier for the adjudicators. Despite the clock, chaos still happens toward the middle and end of most operational games, because players get out of synch...
and the AE’s rush ahead making all kind of decisions that the players have to go back and straighten out. A good game controller knows how to use the clock to their advantage, moving players and AE’s in synch so that the players situational awareness stays ahead of the AI’s and they can command the game.

Game Day –1

It was the Generals Executive Assistant on the phone: “No players. CG was talking to his AAE and the COS and started worrying about how using that much green would translate up the chain. The probability charts led him to cancel any travel for the game.”

David knew what was going on: the General was thinking about whether he would move up and was playing his odds. VI’s could be particularly cruel even if they didn’t influence anything beyond the Pentagon. And VI’s loved green issues.

The EA’s tone of sympathy almost overrode the grin David knew was on his face. The wargaming guys were seen as the geeks of the command, not fit for fighting. A place where stashes and reservists went till they rotated out.

“CG wants you to use the bots anyway, at the call he said ‘Why does he need staff, we have plenty of AI’s and we can get some from CONUS. No need to fly a bunch of people around when you have perfectly good bots lying around.’” Said the EA.

“He can’t be serious” David replied in horror “he knows what a fiasco it was when we used bots in that sim of the north Pacific a year ago. The results were all bullshit. According to him.”

“That was a year ago. I think he expects you to figure it out. The guys at Dunning just came through and told him about their sims, he said they agreed to allow them to be used in your game.”

David knew that the Dunning sims would be insane and cause all kinds of havoc; and no one, from the CAA’s to the CMAE’s would allow Dunning anywhere near the network they were going to use. Even the General couldn’t get the overrides through in just one day.

But David had been here before, he had a plan.

“Hey Fry” he shouted over the cubical as he put down the phone, “we’ve got a problem and a solution”.

The solution was twofold. First they’d bring in all the VAS’s they could lay their hands on. That would staff the virtual game. Then they’d turn the CAA’s loose on the VAS’s and HSAS and let them all talk to each other for multiple rounds of nonsense. The CAA’s would write their report just like last time, going through the AAEs. It would be input to the real report. Which David and Fry would write using the real game.

Game Day

David turned and pulled Harpoon Edition 102.1 off the shelf. The database alone was worth the 200-dollar cost. The paper that is was embedded in was worn. He needed to download the copy to a new sheet sometime soon, but for now this one still worked.
“I forgot you are new here. We always have a backup plan.” David looked at Fry with a smile on his face. Just then LCDR Bennelli walked through the door from INDO PACFLT, followed close behind by Rock, a friend from Hickam. COL Ferguson was already seated across the table from him with his PM for the Porcupine. Ferguson didn’t care about burning mil-Green. A map of the ops area was laid out on the rather large table with pieces scattered everywhere.

“Ok, standard game, you got the objectives in front of you. The goal is to understand what we can, and can’t do, given the most recent threat projection. And I’d like to really thank ARINDOPAC J-2 for sitting in as Red on this one. Really appreciate it.” The Army intel officer nodded and tucked into his third no carb doughnut of the morning.

“We clearly will be breaking frequently, but will we be breaking for lunch?” asked the Green AE sarcastically.

“We’ll go down to Subway at noon. Want us to bring you anything? I’ve got some donuts over there if Intel doesn’t have another one. Want one?” David knew that AE’s hated to be teased.

The Green AE replied dryly: “Donuts are an interesting choice for you gentlemen given all your PFPs. Fortunately for you no HRAEs are in this space and the CMAE’s are all watching the game in the other room. So, eat your doughnuts, clever boys. Who is playing POTUS?”

“I’m POTUS, and remember, this will be the actual game for the report.” David said “so try and take good notes.”

Twenty feet away, in another beige room, with only the glow from connected computer paper for light, VAS after VAS began to argue with the virtual control module and scenario generator. COL Fergusons' AE joined in, protecting the scenario for the Porcupine. CMAE’s watched from the edges, getting ever more excited at the prospect of a long and complicated argument over the rules…and the CAA’s knew just how this was going to be written up. Victory for Blue again.

No carb donuts were created as part of the moon-shot food program 10 years ago. They were rather messy, requiring frequent breaks during the day as the food substitute processed through you. But they were super tasty. So, trade-offs.

Scores were calculated through incessant monitoring. HRAE’s watched over workers to make sure “good choices” were made at work, appliances and other smart home devices did this at home. This program was always rated along with automated traffic cops and cutbacks on anesthesia during surgery as the least favorite thing amongst the population.

After the universal health act of 2032 everyone had to have an assigned physical fitness score. For the military it was Physical Fitness Parameters (Performance for civilians). Those whose score was high were given discounts on any number of things. Those with lower scores found their discounts increasingly focused on exercise equipment and vegan dining options.
Glossary

The future turned out to be far more incomprehensible than expected.

**AE** Artificial Entity. Any highly autonomous, automated, process. Generally, one that mimics human intelligence and natural voice or other interaction. AE’s are not considered truly self-aware, but it can be hard to tell sometimes.\(^3\)

**AAE** Assistant Artificial Entity. An AE designed to help. Everything had become so complicated that AE’s were the only entity that could clearly understand the trade-offs involved in day-to-day decisions. AAE’s were used by everyone, but the best ones were expensive and took a long time and a lot of effort to train. AAE’s were used by individuals, professionals, and organizations. They varied widely in their experience, capability, and capacity. Training your AAE started during High School and continued throughout your life. AAE’s primary function was to help their owners stay out of trouble.

**BM** Battle Manager. By 2045 a combination of the speed of battle, and the vast amounts of information available, means that humans simply cannot keep up with the requirements of managing weapons systems. Battle Managers are AE’s that process vast amounts of information, control weapons, and make battle management decisions. They are given overall guidance by the planning process (a complex set of systems not described in this story) and use this in making overall combat decisions. They are monitored and controlled by “loops” or officers in charge of that battle area.

3 for example, see: [https://wapo.st/2Js9d0X](https://wapo.st/2Js9d0X) and Sayma Akther, Nazir Saleheen, Shahin Alan Samiei, Vivek Shetty, Emre Ertil, and Santosh Kumar. 2019. mORAL: An mHealth Model for Inferring Oral Hygiene Behaviors in-the-wild Using Wrist-worn Inertial Sensors. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 3, 1, Article 1 (March 2019), 25 pages.
Loops usually just close their eyes and hope things will work out. Each warfare area or domain has multiple, nested, battle managers with a supervisory battle manager managing the managers.

**Bot** Slang term for any sort of artificial entity (AE), usually derogatory.

**CAPE** Cost Assessment and Program Evaluation, a DoD department. They own and program all the SAA.

**CE** Cognitive Expression. Actual artificial intelligence modules that have some ability to reason independently. There is much debate over exactly what these systems represent, whether they are actually aware or simply mimicking awareness. The consensus in 2045 is that “strong AI” or CE is 30–40 years away. [https://bit.ly/2rVmND2](https://bit.ly/2rVmND2)

**CG** Commanding General.

**GOFO** General Office/Flag Officer.

**CLAE** Command Logistics Artificial Entity. Does what it says. Most of the time. But it does have an unfortunate tendency to reschedule any IT installs (many in the 6 shops around the world believe it is secretly working with DISA) and often denies requests for simple office supplies.

**CMAE** Classification Management Artificial Entity, an advanced form of AE that applies rules throughout the government. Originally designed for managing classification and clearances but now manages all government rules, regulations, and information.

**DBMS** Database Management System

**DISA** Defense Information Systems Agency. An AE empowered agency that exerts tight control over all DoD information processing and networks. Unless CYBERCOM AE’s intervene, in that case DISA always loses. DISA hates this hierarchy and has tried for years to mess up CYBERCOM’s information systems acquisition process. However, CYBERCOM has many ways to acquire systems, much to the frustration of DISA.

**Green** Slang term referring to fossil fuel. After the international accords on climate change in 2032 all carbon burning was tightly regulated. Everyone has a budget, including the military. (See mil-Green)

**HRAE** Human Resources Artificial Entity. Any organization that does not want to become chum for legal bots employs HRAEs to constantly monitor the workplace for violations of policy. HRAEs also perform many standard Human Resources tasks, such as preventing hiring, negotiating with other AE’s about benefits, and keeping track of employee performance. They are routinely rated below automated traffic control and color dynamic paint in surveys of the publics least favorite things.

**ICCS** International Committee on Climate Standards. International organization that, according to treaty, allocated all carbon usage across the planet. Established in 2038 when everyone got tired of arguing over climate change. Based in Delhi, India where the extraordinary temperatures, over 120 on most summer days, motivate strict enforcement and tight allocations. Rated in surveys as the 21st least favorite thing by the public, right behind “it’s too hot” at number 20.
IOC  *Initial Operational Capability*

ISR  *Intelligence Surveillance and Reconnaissance.*

**Killer Robots.** Slang for any sort of lethal autonomous vehicle.

**Loop** Slang term for “man-in-the-loop” the blame sponge for the battle management system. The only advantage of being a loop is that you get to train your AAE against some of the most sophisticated AE’s in the service, creating a much more robust personal assistant and greatly elevating your promotability.

**NPGS** Naval Postgraduate School. Closed in 2033 when the Navy migrated to automated virtual classrooms. Reopened in 2034 when the Navy realized that no one wanted to participate in automated virtual classrooms.

**MEF** Marine Expeditionary Force

**Mil-Green/Mil-Blue** Fuel and fuel credits (for flying commercial) that are allocated to the US military every year by the International Committee on Climate Standards (ICCS). The military reserves some of these credits for actual military operations (mil-Blue) and the rest goes to training, readiness, and travel (mil-Green). Green budget is more tightly restricted, and more restrictive, than regular dollars budget. Games in Hawaii burn a lot of Green and thus are quite controversial.

**OR**  *Operations Research.*

**SCBM** Space Combat Battle Manager. A manager responsible for defending own space systems and targeting other countries’ systems.

**PA**  *Public Affairs,* can be a term for the artform, or for the victim destined to practice it.

**Paper**  Plant based paper was phased out in 2030 in favor of thin, reactive, film that can display information and connect to networks. Similar to computer paper but less intelligent. Think a Kindle on a sheet of notebook paper. The only disadvantage is that a “paper cut” often requires a trip to the emergency room.

**PFP**  *Physical Fitness Parameters/Performance* a common military and civilian measure of physical fitness. Constantly monitored by everything from spouses to refrigerators as an indicator of how soon you are going to die.

**PRR**  *Personal Reliability Report* a document describing what clearance level a person should have. It is dynamic and constantly updated. Often people only learn of a clearance change when they are detained for being in an area they are not cleared for. PRR’s also monitor for “risk” which is a multi-faceted and complex set of requirements and regulations adjudicated by the CMAE’s.

**SAA**  *Simulation assisted analyst.* A CAPE designed AE that conducts Department approved analysis of anything that needs analyzing. Of course, the services have to completely re-do (or do on their own) the same analysis in order to argue with CAPE.

**SBM**  *Space Battle Manager,* an AE that runs operations in space. The SBM coordinates across tasks, from combat to
launch sequencing. Most domains have multiple battle managers, in space it’s the SBM which performs a supervisory role. It controls the targeting and tracking battle manager, the combat manager, and the launch and ground forces manager. Not to mention all the cyber, industrial, and control systems managers. This can result in a tangled mess when high speed decisions get made by various battle managers in different locations and the communications circuits cannot keep up. Automated battle managers are needed due to the fantastic speeds of conflict as well as the massive amounts of data involved. Battle managers are controlled by “loops” or man-in-the-loop officers who get blamed for any battle manager’s violations of regulation or law.

**OMM** *Orbital Mechanics Module.* A simulation that flies satellites and other stuff in orbit. Usually works. Which is why it’s held in high regard by most gamers.

**OOBM** *On Orbit Battle Manager.* Primarily responsible for keeping track of everything in space, and conducting maneuvers. Works for the SBM unless it disagrees with the SBM in which case it can automatically call safety of flight and override. This has caused lots of issues in the past with missed launches, lost targets, and inability to attack or defend in space all because the OOBM wants to move something to a different orbit.

**Probability chart** A cluster of potential outcomes and implications surrounding a decision or action characterized by a “heat map” of the likelihood that a disaster will occur. These can be generated by the more expensive, or better trained, AAE’s and are consulted before any major decision. They are banned in combat situations.

**SC** *Simulation Code,* a self-contained, and autonomous, application that can be plugged into any MIL Spec compliant simulation system. These are traded like Star Wars trading cards amongst the program managers. They are built by the program offices.

**SPF** *Space Force.* The “P” was inserted because on the initial standup of the Space Force no one could tell whether people were referring to space forces or SOF, and SOF already had an “O” so they used a “P”.

**Trundles** A slang term for heavily armed satellites designed for space to surface attacks. They actually work but are incredibly expensive so everyone is reluctant to use them.

**VAS/A/M/S** *Virtual Artificial Soldiers/Airmen/Marines/Sailors.* Generically referred to as VAS. Small simulation packages that can virtually represent personnel, at all ranks and MOS, at a fraction of the cost. They have an unfortunate tendency to be argumentative, which is not good. The Coast Guard was too poor to construct a virtual Coastie so they made due with the Navy version. This has given rise to the term “VAC” meaning anything that behaves in an inexplicable and incoherent manner.

**VI** *Virtual Influencer.* An autonomous program that creates news, fashion, entertainment, and any number of
other media products. They are hugely influential and can be very annoying when they decide they don’t like something, or someone. Organizations, including military commands, also have their own VI’s but those are largely ignored unless something bad happens.

**VGP Virtual Green Player.** The first game AE developed. They are built by academics with expertise in the “green” countries and hence are regarded as the most accurate, and helpful of all the virtual players. They have databases for all of the possible “green” countries.

**VPM Virtual Player Manager.** Assistant game director who, amongst many other tasks, wrangles all of the players, materials, and software for the game. Real and virtual.

**VRP Virtual Red Player.** An AE that simulates threat decision-making. Generally regarded as some of the best sims out there due to the excessive budget devoted to them by the intelligence community.
The dust of the access road quickly covered the dark blue government car. Aside from the dirt road the trailer park did not look too bad. Most trailers were well maintained and nicely landscaped. The entire park was in among pines, there was even a small pond in the back with a boat dock, but no boats. The colonel thought absentmindedly, would this be considered working poor, or working class, or just toward the bottom of the middle class...

Soon they arrived at number 61, one of the nicer trailers down by the pond. As both men got out of the car they were instantly grateful for the shade of the trees. It was much too warm to be wearing a “Class A” uniform or a suit and tie. Dr. Archer had commented earlier that morning at the Lexington airport, “I didn’t think Kentucky got this hot.”

They were greeted at the door to the trailer by Mrs. McCoy and her daughter Mary Ann. Both looked younger than their age. “Please come in,” said Mrs. McCoy, “you came a long way to just hear me say “no” in person.” Both men entered, Col Kenney removing his hat, Dr. Archer spoke first. “Mam, we understand your position...” “Do you?” Interrupted Mrs. McCoy, “so you also lost your husband in Afghanistan, who died without ever seeing our daughter.” Dr. Archer replied,
“As I tried to tell you we are not trying to recruit Mary Ann into the military.” For the first time Mary Ann spoke, “Mamma these men come a long way and they are guests in our home. Don’t you think we should be courteous enough to let them have their say?” Mrs. McCoy looked at her daughter with a curious sadness and simply nodded her head.

After everyone had sat down Dr. Archer began, “Two years ago the US government decided to form a 12 person interagency strategy cell. The cell’s mission is to develop “all of government” strategies to enhance both our military security and economic prosperity. I convinced the planners that the best way to pick folks to develop strategies was to see how good they were at developing strategies. We built the “22nd Century America” computer game as a test for candidates. Participants would play the game by setting US policy through the end of this century. The twelve candidates with the highest composite score for peace and prosperity would be offered a position. Half way through development we realized we that had a pretty addictive game on our hands so we made the game available on line for a free download. Your daughter was one of 16 million Americans who played the game.”

Mrs. McCoy turned to Mary Ann, “You never told me you were taking a government test.” Dr. Archer jumped in, “She never told you because she never knew; we did not want anyone to be intimidated by the purpose of the game and not play.” Dr. Archer continued, “We are very glad that we opened up the game to whoever wanted to play, as things turned out only five of our twelve were already working for the government. Only two were serving military. Col Kenney here makes three military, but he had retired this time last year, so we arranged to have him brought back on active duty. Five of our top twelve scorers are in their 20’s, your daughter is the youngest, but not by much.”

Mary Ann beamed when she learned how well she had done. She had known her score was way higher than any of her friends, but one of the top 12... Mrs. McCoy looked a little proud but mainly still troubled. “But she can’t just go off and do this,” Mrs. McCoy said, “she won a full scholarship to our local community college, she starts in the fall. She needs to get a degree first, I never did get my degree and I still regret it.” Col Kenney leaned forward, “Ma’am, your daughter will get her degree, as part of her compensation package we will be paying 100% of her college costs, I’ve already spoken to a few DC area colleges about her starting as a night student the next fall.”

As Mrs. McCoy’s opposition softened, her look of sadness grew more intense. Dr. Archer finally realized as a widow with an only child Mary Ann’s departure would leave her alone. “Well this is all very good, but Mary Ann is still so young, you could hire whoever came in 13th instead,” said Mrs. McCoy, “Mary Ann will go to college here.” It was a long time before anyone spoke. Finally Col Kenney reached out to put his hand
on Mrs. McCoy’s hand. “The loss of your husband left a void that has not, cannot, ever be filled. I’ve never lost a spouse, but I have lost men and a woman while they were under my command. The letters I had to write to their spouses was the hardest thing I did in my entire career. I came back from retirement because if this cell works as well as I hope and believe it will then we will find ways to achieve our national objectives with far fewer husbands, and mothers, sons and daughters getting killed.” Looking intently at Mrs. McCoy Dr. Archer said, “I need Mary Ann. You do not yet fully understand, she did not have the 12th highest score, doing little better than the 13th, Mary Ann had the highest score.”
After all these years, videos of cats doing funny things can be counted on to go viral on the internet. Some of the other things that go viral are harder to anticipate. Who would have thought a game on the current Taiwan crisis would go viral? Sure, it was a free download, but there are so many free apps on line that there are apps to sort through them all. Then again, given the global concern that this crisis might end the long peace, perhaps it was not so surprising.

Even in today’s plugged in world few spotted the beginning of the crisis. Due to quiet campaign contributions from the mainland, ethnic Chinese candidates did very well in several Taiwanese national elections. Before the next election, a host of laws were passed, each justified for a
different reason but all having the effect of suppressing the ethnic Taiwanese vote. With each succeeding election voter suppression measures became more naked and more effective. Soon the ethnic Chinese government began moves to “reunify with the rest of China.”

Early Taiwanese resistance actions were within local laws, non-violent, and largely unreported by the Taiwanese and the international media. The story was picked up early on social media, but even there it was one thread among many. As protests started to become more violent first social then traditional media started paying more attention.

As both peaceful civil disobedience measures and violent clashes increased, attitudes on both sides hardened. Ethnic Taiwanese saw the struggle as their last best hope to avoid cultural if not physical genocide. The ethnic Chinese on Taiwan increasingly came to believe they would quickly become a persecuted minority if they compromised. More ominously attitudes were also hardening in China and the United States. China had long sought “reunification” with Taiwan. Reports and especially videos smuggled out of Taiwan struck a chord with the American public where commentators drew parallels to the civil rights movement and even the American Revolution. As tensions grew many historians worldwide likened the current situation to the summer of 1914, none of the leaders wanted war but no one seemed to know how to avoid it.

Then the Taiwan Crisis app began going viral. The app allowed users to play any side in the crisis. Opponents could be played by the apps’ artificial intelligence routine or on-line opponents. The app took off among the Taiwanese first. After many replays they found a strategy that usually brought victory, but the fight took decades and destroyed much of what they hoped to preserve. Almost at the same moment the app became an obsession with the ethnic Chinese on Taiwan. It took most players much longer to find a winning strategy and it appeared from the app that any winning strategy required the genocide or near genocide of the Taiwanese people. Would they, could they really kill all Taiwanese and still consider themselves civilized? The story was similar for Chinese and American players. Made curious by the reports coming out of Taiwan, many millions downloaded the app. Some never found a strategy that would bring their nation victory, most eventually did but at a price that made the word “victory” ring hollow. Similar results were obtained in nation after nation, increasing international concern over the crisis still further.
Then, also starting on Taiwan, a different type of outcome started to be reported. The web page with top scorers started to be dominated by players who had not achieved total victory, but still had the highest overall score because their costs were far lower. The ethnic Taiwanese players discovered if they allowed the ethnic Chinese to retain political power disproportionate to their numbers the ethnic Chinese would not fight as hard. Ethnic Chinese started playing a strategy where they allowed the ethnic Taiwanese to regain much of their political power while retaining enough power to have in effect a veto over any initiatives that threatened their position. Again similar insights emerged in China and the US.

Almost as suddenly as it burst on the world’s consciousness the Taiwan Crisis, real event and app, dropped from the headlines. Oh, there were still stories of flare ups and small breakthroughs on Taiwan, but there was no longer the feeling that the long peace would soon end. Those commentators who had not moved on to the next hot story expressed amazement on the impact a simple app seemed to have.

His Holiness was relieved but not surprised. As a boy growing up in Mumbai radicals had tried to convince him and his fellow youths that Americans were trigger happy fiends who cared nothing about the lives of others. Some of his friends contradicted the radicals; they had played “Americas Army”, a game created by the Americans for Americans. In the game, the shooting of innocents landed your character in the brig. Certainly they would not be trained to be cautious if that was not their intent. At that young age the future Pope learned how powerful, how credible, lessons learned from games could be. When the Taiwan crisis first started to look like it might spiral out of control the Pontiff became concerned. Had so much of the world’s population gone so long without war that the horrors of war were no longer real? If so, would they not work hard enough to avoid such a war? He decided the world needed a way to make the costs of war seem real before they became real.

His Holiness smiled when he remembered Stalin’s dismissive question, “How many divisions does the Pope have?” Without any divisions he had helped stop what could have become a world war before it started. There was just one thing that truly surprised him. Although the app was given away for free; the sites that distributed it were supported by advertisers and had paid a very small royalty for each download. With just over two billion downloads the royalties they received had exceeded their costs of producing the app. The Vatican had made a profit.
Resistance is futile

You know what they don’t show you in the recruitment videos? The mind-numbing boredom from being stuck on an LHA for a month transiting to the Philippines for joint-exercises. Some of the older Marines, the ones who had served back in the Global War on Terror, almost never deployed on LHAs. At least that is what they claimed. Those must have been the days.

Whoever thought that jamming roughly 2,000 Marines into close quarters for 30 days with nothing to do but check equipment must not have known Marines very well. If they did, then they would have realized the dangers from such unmanaged boredom. However, it was this same perfect storm of tedium that made the Colonel’s plan work.

See, back in the late 20’s and early 30’s,
the Corps got hot for wargaming and decided to create a Program of Record (POR) to create the be-all, end-all wargaming platform that would solve all the Corps’ woes, or something along those lines. What they came up with was the Battle Simulation Board™ (or BSB in everyday talk), a “semi–three-dimensional simulation environment for agile and synergistic wargaming and COA analysis.” The not-quite boardgame, not-quite VR simulation had been installed all over the place, including on all the major surface vessels used to transport Marines. Our commanding officer, Col. McNeary, was a devout wargamer and had even worked on the BSB project when he had still been a captain. So, his solution to our unacceptable lack of things to do was to create a competition. Any Marine could challenge another to play a scenario, from the Colonel’s curated list, on the BSB. The winner earned points which would move them up or down a leader-board. The top ten ranked Marines for the week received a “skate card,” a free pass from a single work detail for that week. I heard that our regiment’s Sergeant Major, SgtMaj Moses, had nearly gone ballistic at the thought of rewarding Marines for trying to get out of work. The Colonel pointed out that it encouraged Marines to develop tactical thinking skills and focus our pent-up energy into something useful.

For us junior enlisted the concept of being able to look a First Sergeant in the eyes, to stare through the windows of their soul and say “Sorry First Sergeant, here’s my skate card” was just too juicy to pass up.

You don’t make Sergeant Major without some cunning though. Part of the original BSB project was to eliminate the black-box nature of many computer-based or computer-assisted games. With a CAC, anyone could access all the documentation for the adjudication techniques and algorithms used by the BSB. For the most part, none of it made any sense to most of us except for the select few. Unfortunately, the SgtMaj was included in that small, niche group of exceptions. So, SgtMaj Moses and some of the other senior NCOs started a study group dedicated to finding ways to game the game, all to lock down the top

“Our commanding officer...was a devout wargamer...So the solution to our unacceptable lack of things to do was to create a competition”
ten spots and forever deny a skate card to anyone.
Under normal circumstances that would have killed the Colonel’s plan deader than a frog hit by a tractor-trailer. However, the monotony of ship-board life and the rare opportunity to have a legitimate excuse to skip work were effective motivators. It also didn’t hurt that Marines place bets on just about anything and the pot for whoever finally broke the NCO monopoly was well over $500 by the end of the first week. Which is how I found myself standing in front of my Company Gunnery Sergeant, ask for a round on the battle board.

GySgt Cheong was laying in his rack, reading a heavily creased magazine when I approached him. When I told him what I wanted, he didn’t even take his eyes off the page to answer me.

“You want me to teach you?” he said it in a detached, almost distracted tone that made me think he wasn’t really paying attention. “Why, so you can dodge work?”

“No, Gunny.” I had planned for this line of questioning and had worked out a pretty good answer. “I want to learn because I figure that if I ever want to make Sergeant then I need to start learning how to lead a squad. I can’t really do that as a PFC, but I can start learning in the game.”

“I want to learn because I figure that if I ever want to make Sergeant then I need to start learning how to lead a squad... but I can start learning in the game”

That got a reaction out of him. GySgt Cheong looked up from his magazine and locked his command stare on me. “You are bucking for rank, huh. I suppose that illegal betting-pool on who breaks into the top ten first has nothing to do with it. What’s it up to now, $500?”

Keep a straight face, I whispered in my head. I was most definitely interested in the $500 and had spent a massive amount of free time combing through the BSB’s documentation looking for an edge. I thought I had found one, but for me to break into the top ten I had to beat the number one player in the regiment, hence why I was calling out GySgt Cheong. Cheong was amazingly good though, so my plan was to lure him into a false sense of security by posing
the match as training.

“I don’t know anything about that Gunny,” I lied, “though I really wouldn’t mind one of those skate cards” – then quickly added, “If I ever get that good.”

Cheong looked unimpressed with my response but sighed anyways and rolled out of his bunk. “Well, I can’t say no to a Marine who is looking to get an education. Go get the BSB booted and pick a scenario, while I get some pants on.”

“Well, I can’t say no to a Marine who is looking to get an education. Go get the BSB booted and pick a scenario, while I get some pants on.”

More metal cube than board, the roughly three-foot by three-foot by four-foot gunmetal box reminded me of one of those antique videogame cabinets. Like the ones you see in period flicks where the players face-off from opposite sides. The top of the “board” was a kind of transparent semi-solid that felt like glass but was a lot tougher and could be distorted to match the rough elevation features of whatever map was chosen. The ArcGIS-generated maps served as the simulations gameboard and were digitally projected onto the bottom-

side of the transparent material. I had to admit that watching the gameboard deform to match the topography of an area that I would eventually be setting boots on was pretty cool.

I booted-up the BSB by inserting my CAC into the reader on the right side of the board. I had been told that the CAC requirement served two purposes. The first was that by inserting a CAC, the board could track each player’s game stats. The second reason had more to do with how the Corps perceived us grunts. Look, I’m not saying Marines aren’t hard on our gear or that we don’t occasionally press buttons we shouldn’t. I’m just saying that having the BSB enter a “fortification mode” when no CAC is inserted, locking out all its interfaces and sliding a protective metal cover over the play surface, is a bit overkill.

Once the BSB was booted, I began flipping through the available scenarios the Colonel had authorized. In theory, these scenarios represented missions we would be completing while on the ground. Officers and senior NCOs had the ability to use the board to run one-
sided simulations for COA analysis but boots like me couldn’t be trusted alone. In fact, the most I could do was boot the thing up and select a scenario. Grumbling to myself about the unfairness of life, I chose the patrol scenario. My hours of combing through dry game documentation had yielded this insight: within the patrol scenario the Red force started hidden, but highly disaggregated. This disaggregation was supposed to simulate the disorganization of PLA SOF units being inserted via airdrop in preparation for hunting FARPS and land based anti-ship artillery. This gave the Blue player a slim window of time in which they could defeat the SOF teams in detail before the Red player had the chance to concentrate their forces and set up a devastating ambush. This meant that the faster Blue found a portion of Red, the more likely they were to win.

The Gunny, now fully clothed, strode into the galley and looked down at the board. “Patrol? I thought you said you wanted training? Last I heard patrol was your best scenario.”

Struggling to keep my face straight I nodded in reply. “Yeah Gunny, but that’s against scrubs. Most of those noobs waste their mission enabler choices on energy weapons or ISR drones. Not much of a challenge when the scenario’s heavy jungle negates their ‘edge’ for me.”

Cheong grunted noncommittedly, but he knew I was right. Tech-fanboy-ism was rampant in the military ever since Ghost Fleet, and the mixture of overconfidence in and lack of understanding of military tech had led many inexperienced Marines into making sub-optimal equipment choices.

Shrugging, Cheong sat down across from me. “Since you are sitting on the blue side, I assume that’s who you want to play?”

I nodded, adding, “If that is alright with you, Gunny.”

“the mixture of overconfidence in and lack of understanding of military tech had led many inexperienced Marines into making sub-optimal equipment choices.”

The NCO waved his hand in a permissive gesture, “Fine, this will at least give me an idea of what I am working with.”

With Cheong’s CAC inserted, the scenario fully unlocked, and I was able to make
the final adjustments to my squad. One of my favorite features of the Colonel’s scenarios is the ability to select a single mission enabler from a group of force multipliers that are either currently employed or would be soon. It meant that Marines had the ability to familiarize ourselves with tech we might use in the field and gather data on how that speculative tech might be employed. As I said, a lot of Marines go for the shiny new stuff like energy weapons or ultra-long-range precision munitions. Building on my discovery that the key was to find the Red forces as quickly as possible, I chose a very different mission enhancer: the local scout. The scout had a much larger search radius than my typical Marines and could move faster and more quietly through the terrain. It also gave me access to the “fastest path” function, allowing me to use the BSB’s computer to calculate the fastest path between two points. By increasing my search area and movement speed, I would effectively quadruple the amount of map I could search in a given turn. The down side was I had to roll to see if the scout spoke English and if not, how many people in my squad could communicate with them.

After secretly imputing my selection using the touch screen which jutted out from the board at about my knee level, there was a whir from inside the plinth followed by a click. A side hatch on one of the corners of the board’s base popped open, displaying my play-pieces for this scenario. The pieces were figurines that are roughly half the size of a human thumb, each detailed to look like an individual member of a standard fire-team. I carefully went through and tested each one on the board to make sure the internal RFI chip still worked. The RFI chip acted as a sort of mini-database, storing all the pertinent combat information for the unit it represented. The chip also allowed the board to interact with the piece, making flat spots when the piece was placed on a sloped grid square, and tracking the movement of the piece for post-game analysis. The RFI chips also had a habit of breaking on the regular, probably due to young Marines’ propensity for using the pieces as projectiles to hurl at one another.

“Alright, I have my squad. Let me know when you are ready to place, Gunny.”

The NCO nodded absent mindedly, never breaking focus from the board. The NCO tapped commands onto his open touch screen, secretly placing his own units per the scenario rules, and then look up.

“Oh, PFC. Place your pieces.”

“The RFI chips also had a habit of breaking on the regular, probably due to young Marines’ propensity for using the pieces as projectiles to hurl at one another.”

“Oh, Gunny. First though, I need to tell you that I am using the local scout and...”

Cheong cut me off mid-sentence. “I
know what the scout does, son. Stop wasting my time and do your rolls.”

Well that was unsettling. One of reasons I liked the scout so much was that its underutilization meant that no one knew how it worked. I would just have to roll with it.

Naturally, because the universe hates me, I rolled a one, which meant my scout didn’t speak English. I then followed my initial roll with a roll of a two, which meant that only one member of my squad could communicate with the scout. Sighing, I set my squad up in a wedge formation to maximize my search area and provide flexibility for when I contacted Gunny’s forces. I also opted to put my scout forward and designated the point-man in fireteam one (my foremost team) as translator to speed transmission of any information the scout found. With my pieces set, we both pressed our ready indicators and the scenario began.

Everything went perfectly... until I made initial contact.

I had been moving my forces up a shallow ravine at best speed when a red circle icon appeared beneath my scout figurine, indicating it had discovered something. I used the scout’s move to place it into base to base contact with my translator/point-man and initiated information sharing. Suddenly, the entire board took on an intense red hue. Ah shit, I thought, this is could be bad.

See, the ruleset for this scenario used a semi-structured turn system. Instead of an established turn order (which generally disadvantages the person going last), the BSB determined which side had the initiative for that round and assigned that person to go first. If there was no contact between the two sides, the game proceeded in the above fashion. However, if on my turn I did something that allowed the other player to detect me then the initiative would immediately shift to them and my turn would be over. The red hue indicated that the “initiative” of the battle had just changed.

The first thing that happened was that Cheong placed a figurine representing a PLA squad-automatic weapons team on a piece of high ground a couple hundred game-meters in front of and above my own pieces. The machinegun piece began firing. In game terms this meant that the BSB drew thin red lines to different members of my squad. Every time a line intersected with a member of my squad

“Everything went perfectly... until I made initial contact.”
the BSB automatically calculated if and to what extent my figures had been damaged.

My translator/point-man was killed outright, and my medic was wounded in the leg. More fire poured out of a hazy red rectangle around Cheong’s single visible piece, indicating that my squad could see roughly where the fires were coming from but not specific emplacements. fireteam one was forced to take cover, though luckily none its members were pinned by the surprise fire. The turn then switched back to me and I took a deep breath.

Losing my translator at the start was a setback, but not a game ender. I had a rough idea where the enemy was now, and I knew from the scenario that I had the advantage of numbers. So, I did exactly as I had been trained. Using a classic fix and assault maneuver, I split fireteam two by sending half to support fireteam one as my fixing element and took the other half with fireteam three and started swinging those figurines out to the right of hazy-red threat box. Unfortunately, the dispersion of the squad wedge formation and rough terrain meant I couldn’t get into position before Cheong’s SOF got to shoot at me again.

Two more members of alpha team were wounded, though not severely enough that they couldn’t continue fighting. My fixing force began to return fire, wounding Cheong’s assistant gunner, while I moved my assaulting element up the eastern arm of the ravine in preparation for a right-side assault on the Red position.

I ran straight into an ambush.

I had never seen the Gunny smile before. When I ran my assault element straight into the kill box he had formed with the rest of his force, his face lit up like a kid meeting Santa Claus. Things went downhill pretty fast from there. My assault element was caught on the downward slope of the ravine in a well-coordinated cross-fire, while my fixing element was progressively becoming fixed itself. It only took Cheong another turn to finish me off.

“How the hell did Gunny get his forces concentrated and in position so quickly? How did he know where to set his ambush?”
Leaning back in my chair, I just stared at the board. How the hell did Gunny get his forces concentrated and in position so quickly? How did he know where to set his ambush? Based on my experience in past games, it just didn’t seem possible. Cheong must have read my thoughts from my facial expressions because between fits of laughter he managed to get out “Ah, don’t be so surprised, devil dog! You took a swing at the King and missed.” He began laughing even harder at his own joke, then finally collected himself and transformed back into his standard dour self.

“Ok, you want to know you where you effed up?” I was still smarting from the drubbing I had just taken, so I just nodded sourly. “What was that Marine?” his voice had the whip-crack tone of command, which made me sit up straighter.

“Yes, Gunny.”

“You came to me for training, right? So, don’t get an attitude when I show you your weakness.” Some of the tension came out of his body and he leaned back in his chair. Reaching under his side of the board, he began to pull out figurines and place them on the BSB playing field. “Alight, you made too many screw-ups for me to cover all right now, so I’ll just focus on the major ones.” Ouch, I though a bit bitterly, now he is just pouring salt into the wound.

“First,” the NCO continued, “based on your insane sprint across the board, I assume you thought I would be disaggregated for two or three turns, giving you time to defeat me in detail.” I nodded, “Yeah Gunny, but I don’t understand how you were able to concentrate so fast! The scenario says you start in a disaggregated position.”

The senior NCO shrugged at my confirmation. “Yes, it does, which caused you to assume that there was no way to change my initial deployment.” He tapped on one of the board’s corners on his side of the playing field. A dialog box opened, showing his until now secret mission enabler. I bent over and read it allowed: “Containerized Delivery of Forces: ignore required dispersion if stated in the scenario”. Geeze, straight out of Ghost Fleet, I groaned in my head, Am I never going to get away from that damn book?

“You over focused on your own units’ abilities without ever considering how I might anticipate or counter them.” Cheong continued, “You assumed that because in a similar situation you would have no way to change the situation,
neither could I, right? Here’s the problem though, that assumes I had the same capabilities and made the same assessment you did. You gotta learn to see the situation through Red’s eyes.”

As I thought about it, what the Gunny was saying made a lot of sense. All my study had focused on what I could do to the enemy, with no thought for what enemy could counter with. I made a mental note to spend some quality time looking over what mission enhancers were available to Red.

“Next, you ignored the effects of terrain.” Cheong opened a few more windows and suddenly the 3-dimensional map was overlaid with a winding line that appeared to trace the general path taken by my unit. “You see the path you took, right? Why did you choose to go that way?”

I shrugged, adding, “I was trying to maximize the amount of area I could search in a turn.” I had chosen the path under the assumption that speed of detection was the key to victory, but...

The NCO tapped in a few more commands. The board generated many more lines, with roughly a third following a path like mine, another third following a road just over the ridgeline from my path, and a final third following no discernible pattern. “Not a bad idea if you are trying to find a lost kid in the woods. PLA SOF aren’t kids, and they sure as hell ain’t lost.” I nodded. I was starting to get an inkling of where he was going with this.

“Ok, so I have loaded the blue pathing for the past 100 games played,” Cheong continued. “See how the majority follow either the low-ground or the road? People will naturally take the easiest route between two points, which in this case was the road or the ravine you came traipsing up. Now look at how my squad was placed.” Glancing at the board, I immediately understood what he was saying. I could see how the mountainous terrain limited the number of paths towards the Gunny’s side of the board, assuming one wanted to move fast, and how Cheong’s position gave him coverage for most of these path ways.

I told Cheong as much and he grunted, “Good, you are learning already.”

I reach over to the board and tapped in some commands of my own. Fields-of-fire fans sprang up from around each of the models on the board. The fans were multicolored, which I knew represented the different kill probabilities over
a single turn. As I had expected the overlapping fires at the location of initial contact and the ambush of my assault element were near black, indicating a kill probability of over 50%. My own squad’s fans indicated a kill probability of at best around 30%.

“Gunny,” I said somewhat unsure of myself, “I see how you concentrated you forward element to grind up my forward units, but how did you know I would assault form the right side?”

The NCO grunted, “Think back over your training, how many times did you attack a machinegun nest by assaulting from the left?”

I paused, I honestly couldn’t think of a single time. “I can’t think of any, Gunny.”

Cheong shrugged, adding, “That’s because it rarely happens. It’s not doctrine, but it is how we practice it. Knowing that and reading the terrain, I could make a pretty good guess on where you would assault from and I prepared for it.” Pausing for a split second, he offhandedly added, “You almost got out of it by the way,”

That made me look up sharply, “I did?”

Cheong nodded, “Yup, your scout detected my position. Unfortunately for you, you were dumb enough to make your sole translator your point man. PFC, what the hell were you thinking putting an asset that valuable into the single most dangerous position in your squad?”

I hunched my shoulders a little before answering, reading from his tone that I had done something immensely stupid.

“I was trying to decrease the amount of time it took to get info form the scout to my squad, Gunny. Since the scenario assumes that if one person in the squad knows something then everyone knows it, I thought it made sense.”

Cheong shrugged, “How did that work out for you? You’re lucky I didn’t get both your scout and your translator. Doesn’t matter how much time you save if you can’t get the information, right?” The NCO’s lecture was cut short by a buzzing noise coming from his pocket. “AAH,” he said with some gratification, “Why, that is my reminder that today’s work detail is about to begin. You don’t look busy, Marine. Why don’t you go find the First Sergeant and ask him what needs doing?”

Well, Shit, I thought. I guess resistance is futile.
This is a storyboard for a future wargame technique. It expands the boundaries of player manipulation, specifically the beneficial effects that directly manipulating players’ brains using electrical stimulation and drugs can have on game play. The proposed future science of brain manipulation for game purposes is a credible forecast from current research.

1. The Problem/Motive

People playing a game know the game is not real life, and we know from psychology and social science research that decisions they make during the game are influenced by this knowledge. We also know from psychology and social science research that a risky shift and dishonesty shift occur during group discussions that take place during both games and real-life decision making. Players’ critical faculties generated by their frontal lobes take into account the conscious knowledge “this is a game” and are influenced subconsciously by the two shifts. Therefore we have a problem using decisions made during a game as proxies or predictors for decisions the same players would make during the real-world situation the game is exploring.
2.1 The “science” part of the “science fiction”

When dreaming (REM sleep) blood flows to the cortex (which provides content) and the limbic system (which processes emotions) both of which light up, however the frontal lobes (which direct our critical faculties) remains quiet. The result is that we usually accept the content and emotions of a dream no matter how weird.

Anesthesia research shows that anesthetics make us “unconscious” by disconnecting different parts of the brain’s macro-systems from each other, thus breaking the brain-wide integration that current research claims leads of self-awareness. Some anesthetics leave the person aware of the pain but experiencing a rolling amnesia – they feel the pain of the surgery but forget that fact from moment to moment.

Medical research shows that people with damage to their emotional response system, of the kind that they do not experience emotions, have difficulties making decisions even when they are smart enough to know the answer and it is objectivity important for them to do so. They lack the motive to make the decision. Star Trek and Conan Doyle got it wrong with Spock and Sherlock.

Historical research tells us that the Spartans made important decisions after they had discussed the situation twice, once sober and once drunk. (I don’t know for sure, but I would assume the order of the two sessions might have an effect!)

2.2 The “fiction” part of the “science fiction”

We develop techniques using anesthetics and electrical stimulation to selectively suppress the limbic system and frontal lobes in wakeful subjects, and using drugs to suppress or boost the body’s production of hormones related to stress and emotion.

3. Impact on future game techniques

We game a topic with different parts of the players brains “switched off” or “switched on” depending on the phase of the game move. During the phases of each move that require analysis we suppress the entire limbic system (brain and body). We explore totally rational
analysis driven by the frontal lobe generated critical faculties of the players and in the absence of any emotional processing.

The problem here is the likely difficulty of getting emotionless people to make decisions when it is “decision time” in the game – for example when it is time to select a move or COA from a set that has been discussed and explored during the planning phase of the game move. So, during the phases when the players are called on to make decisions, we boost the limbic system to turn decision-making motivation back on. We pulse the limbic systems of the players in phase with the tasks required during the game. Suppress for analysis, boost for decision making.

Alternatively, taking a leaf out of the Spartan’s playbook, by simultaneously boosting the limbic system and suppressing the frontal lobes we can explore wildly off the wall ideas while completely suspending disbelief. We can also, by incrementally turning the limbic system up or down, explore decision making under different levels of emotion.

4. Social Implications (but who cares, really, about this?)

When proven successful by the Military, this technique moves into the mainstream and is used by any profession that involves both analysis and decision making, for example by Judges, Doctors/Surgeons, airline pilots, nuclear power plant operators, senior military officers in charge of our nuclear Triad (you can see where this is going) etc. Given humanity’s desire for silver bullets, the technique proliferates rapidly and is embedded in all critical areas of the global system before the downsides are discovered (of course). The intellectual elites of society who combine analysis and decision-making powers over the rest of us start suffering debilitating hallucinations caused by the technique’s interference in sleep patterns, and the world descends into chaos.
Dam humans. Computers are hard, but when you beat them they stay beaten.

She had defeated their adversary in the first hours of the campaign. The “forecast” element of the display still showed her winning, but the date kept slipping further into the future and the casualty count, on all sides, kept climbing.

Normally when General Skyler looked around her Air Operations Center, called the AOC, she felt a sense of pride. Of course she was proud of the team she had helped assemble to plan and conduct this campaign. Still, in some ways she was more proud of the AOC itself. As a major she had graduated from the US Air Force’s prestigious School of Advanced Air and Spacepower Studies or SAASS. Her thesis was on the need for, and feasibility of, creating the command center she now directed.

Of the AOC’s many advanced features she had been most proud of the “forecasting” element. Through the ages command posts had made decisions about the future based on information of the past. Before the telegraph that information was as old as the time it took a hoarse and rider to bring it. With each advance in telecommunications the information became less old, but information remained about the past. For over two
hundred years wargames had been used to anticipate how friendly (Blue) and enemy (Red) decisions might influence the future. But when the fighting started the wargames stoped. In part this was so because, well, that is how it always had been. In part it was because the people conducting the wargames were busy conducting the war.

As she had struggled to come up with an idea for her SAASS thesis she came across two seemingly unrelated items. That day during a seminar on wargaming she had learned about a wargame the Germans had conducted during World War II in anticipation of an American offensive. During the wargame the real American offensive began. The chiefs of staff of the divisions under attack immediately left for their units, but the Corps Commander kept the wargame going, feeding in as game moves the actual movements by the Americans. He had used the wargame to plan his counter attack. That evening she read a review of an online wargame. Each side was directed by a team of players, formed for each game and logging in from all over the globe. Because different numbers of players logged on each game the wargame used artificial intelligence (AI) routines for any positions not taken. The review claimed the AI was so good the human players could not tell which players were real and which were AI. The thought hit her like a ton of bricks; she would define a wargame that would not only keep going by itself after the fight had started but it would use reports of the actual fighting to replace wargame moves with actual ones and adjust projected losses with actual losses.

“she would define a wargame that would not only keep going by itself after the fight had started but it would use reports of the actual fighting to replace wargame moves with actual ones and adjust projected losses with actual losses.”

future of gaming
right now. Her forces were doing well, but the enemy were adapting their tactics to better counter her forces. Their increased effectiveness was adjusting the wargames estimated outcomes for future engagement. Little by little the war was getting longer. She and her team would also need to learn from their enemy and adapt their tactics if they were to reverse this disquieting trend. She told herself, she should be pleased that her wargame had allowed her to spot the problem so early, but as she watched the display on estimated time of victory adjust itself yet again to the right she could not force herself to be pleased.

Her thoughts were interrupted by activity in the Current Operations area of the AOC. As she focused on that screen she spotted multiple unknown aircraft coming toward the AOC building on multiple vectors and at multiple speeds.

“This looked very much like a saturation attack. Such attacks would overwhelm the targets defenses by presenting too much to shoot over too little time. As the unknowns were quickly identified as hostile General Skyler knew she was right.”

As the hostils bore in the Theater Commander appeared at her side. “I just heard about the attack,” he said, “what can you tell me.” Half way through her explanation the Chief of Staff of the United States Air Force appeared. “Just wanted to pop in and see how you were doing Abigail,” he said. She repeated her briefing.

As the blips drew still closer to the location of the AOC building personal assigned to the various divisions of the AOC started arriving in the current Operations area. Some of the personnel became a little excited. “I’m to young to die,” said one. “Now I’ll never see Brooklyn again,” another. The Colonel in charge of Current Operations quieted them down.

As the blips disappeared in little flashes
on the location of AOC building the uproar resumed. “Oh the humanity,” said one Major. Several personal simply shouted, or cursed, or laughed. Again the Colonel quieted all of them down.

The Theater Commander broke the silence. “Good work General Skyler,” he said, “I’ll admit, I was a little skeptical of your plan to keep the AOC building in place after your virtual AOC became operational.” General Skyler smiled, “thank you Sir, I don’t think this would have worked if I had not agreed to my chief of staff’s recommendation that we shuffle derelict cars around in the parking lot so the building would still look occupied.”

The virtual AOC was the second idea she had taken from that article years ago. If kids could go online from around the world and play in a wargame why couldn’t military personal staff an AOC from wherever they were stationed in peacetime. Doing so would allow the AOC to be activated more quickly and eliminate a big important target – unless you wanted the enemy to think the target was still there.

As General Skyler surveyed the status board her smile broadened. As she watched the forecast victory date moved closer to the present. The enemy had expended a significant percentage of his high performance weapons. Those weapons would not be available for future attacks.

It was time. The general reached around and removed virtual reality harness from her shoulders – and realized she was still in the kitchen of her quarters. After breakfast and before she would be out of touch for a few minutes in the shower she had decided to check in at the AOC. That was over an hour ago. She had set her avatar to have her appear to be in a flight suit, an appropriate choice for the situation. She smiled thinking of the reaction if her people had seen her as she was actually dressed.

General Skyler had one more thing to smile about. She knew from her studies at SAASS – for thousands of years wargaming had helped rulers develop strategists. For hundreds of years wargames had helped commanders win by developing strategies. This was the first case she knew of that a wargame had contributed directly to victory.

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This appendix contains the final report for the “Addressing the Decision-Effect Time Gap” game lab facilitated by Mr. Ken Shogren. Dr. Stephen Downes-Martin contributed to this report.
Game Lab
Connections Wargaming Conference
United States Army War College
August 13th, 2019

“Addressing the Decision-Effect Time Gap”

Game Lab Chair
Ken Shogren

Contributors
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Any misrepresentations or misinterpretations contained within this material is the sole responsibility of Ken Shogren.
Game Lab Process and Participants
During the Connections Wargaming Conference a small group of interested people gathered for about an hour to discuss the questions around the “Decision-Effect Time Gap” This document is the edited combination of notes contributed by the following participants:

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Introduction: What is the Decision-Effect Time Gap?

Strategy formation and planning require decision-making in the present with an eye to the future and with an understanding of the uncertainties that will unfold between the time of the decision and the realization / implementation of that decision’s effects. We can call this the decision-effect time gap. Under real-world conditions this gap can be quite extensive, leading decision-makers to make partial and/or non-committed ‘decisions’ that may exhibit a confidence bias. In contrast, under game conditions the decision-effect time gap is quite small and decision-makers (often necessarily) make committed decisions under a fair degree of uncertainty, but decisions may be criticized as unrealistic and/or non-representative. This raises several questions to explore:

1) What effect does the decision-effect time gap have on our ability to assess decision quality?
2) What are the best methods to simulate large decision-effect time gaps in a compressed game time?
3) How do in-game decisions and real-world decisions differ and do those differences improve or decrease the potential benefits of game play?
4) How might games explore the distinction between pivotal (i.e. critical) decisions and course correction (i.e. adjustable / tuned) decisions?

This paper captures elements from the Game lab discussion and pre- and post-conference thoughts by the contributors on these questions. The following sections follow the order of the questions above.

Impact on Quality of Decisions

There are two distinct modes under which decision quality must be considered. If the Decision-Effect Gap is large such as experienced under real-world conditions, one set of potential problems emerges; however, under a compressed gap such as typically found in games, a different set of potential problems emerges. We’ll address these separately before considering the overall impact.

Decision Quality with Large Gaps

A potential problem with large gap situations is an inclination of the decision-maker to have more confidence in their decision than may be warranted. This bias results from how the decision-maker accounts for information in the decision-making process. When a decision-maker is actively making the decision, they often account for known information (i.e. “Known Knowns” or facts) and for expected uncertainties (i.e. “Known Unknowns” or variability), as of that moment. The decision-maker weighs the facts and the impact of chance, makes the decision, and explains/backs/justifies it based on this assessment. The confidence bias can enter because the decision-maker leaves out two important categories of additional information, namely - Unknown Knowns and Unknown Unknowns. Let us take each of these in turn.

Unknown Knowns: This term may appear to be an oxymoron, but it is easier to see why considering these is critical to decisions when they are labeled with a better term like “assumptions”. Most skilled decision-makers account for and consider their assumptions. What they may not account for – especially under large Decision-Effect Gaps – is how their assumptions might change over time. Significant changes to the underlying assumptions have significant impact on the outcome and subsequent evaluation of the decision quality.
Unknown Unknowns: These are true ‘hidden in the veil of time’ facts and in Risk Management are called Black Swans. When decision-makers are tasked to account for these, an oft heard lament is “It could be anything!”. Worse, trying to account for these can lead to Analysis-Paralysis that results in a delayed but snap (i.e. “panic”) decision (See “the Logic of Failure” by Dietrich Dorner) or preventing a decision from being made at all! As such, they are set aside; not out of ignorance, but out of an inability to account for them. Whereas assumptions are facts crumbling away, unknown unknowns are facts emerging in time.

The larger the Decision-Effect Gap, the more likely these two categories play an increasingly critical role in the outcome; yet they are not accounted for in both games and real-world conditions. The result of the exclusion is higher confidence in the decision than might be warranted. Alternatively stated, the risk associated with the decision is higher.

Another problem with large Decision-Effect Gaps is that the decision-maker perceives the decision as not taking place at the present but at some point in the future. Stephen Downes-Martin points out the following:

*Decisions are irrevocable allocations of resources such as time, money, materiel or people. If the resource allocation is revocable, then one has signaled an intention to make a decision in the future, but the decision is only made when the allocation is [actually] revoked (status quo decision) or [actually] allocated (change decision).*

This may be closely related to the inversion of pivotal and course-correction decision types (See Decision Types discussed later) and/or a disconnect in the mind of the decider between the decision horizon and the decider’s control horizon (See Decision Horizons discussed later).

**Decision Quality with Compressed Gaps**

In contrast to large gaps, the potential in compressed gap situations for Unknown Knowns (i.e. assumptions) to change is quite low. These Unknown Knowns still exist but are harder to identify and address. What is more likely to manifest in game play are statements such as “Oh, I did not know that rule.” or “I didn’t see that condition.”. In the case of the former, there is an underlying assumption that the rules of the game are already known and consistent. In the case of the latter, there is an assumption that all information is knowable (Note: This does not mean that there is perfect information. Rather, it indicates that participants are already aware of any potential randomness that can come into play. e.g. dice will be rolled in situation “x”). Both statements, though, highlight a deeper concern about the nature of assumptions in decision-making; namely, that assumptions are static. What is really happening is that something mutable (Unknown Knowns / Assumptions) are transformed into something immutable (Known Known / Fact or Known Unknown / common variation). This transformation reduces decision quality to a question of “what did I not know?” and/or a conclusion that “it was down to chance.” Both reductions create problems. The former leads to decision quality to be treated as a matter of thoroughness of facts instead of robustness to uncertainty. The latter statement leads to decision quality as a measure of control – the more I control, the better the decision; the less I control the more likely it wasn’t a decision at all! Research indicates senior officers tend to underestimate the role of luck in their past successes and are thus overconfident in their ability to handle current and future situations involving uncontrollable or unavoidable chance (see references contained in “Adjudication: The Diabolus in Machina of War Gaming”, Stephen Downes-Martin, Naval War College Review, 2013, Vol 66, No 3).
In the case of Unknown Unknowns in compressed gaps, a similar transformation occurs. Player statements like “how did you do that?” transform into “I didn’t know that rule.” Or worse “This game is rigged.” or worst “You cheated.” All of these also point to a transformation from the mutable to the immutable. And in all cases, the decisions have been deemed irrelevant and thus any question of decision quality is moot.

Under both gap conditions, the nature of decisions is fundamentally being altered. Under large gaps, decisions are overconfident and under small gaps the decisions are irrelevant. The impact of these is that the evaluation of decision quality under both conditions is transformed to a conditional statement (e.g. “At the time, it was a good decision but in hindsight I know better.” or “If chance had come up differently, it would have been a good decision!”) instead of an assessment on the impact/outcome of the decision (e.g. “The decision seized on advantage that emerged.” Or “The decision prevented the option to do an action in the future.”). The different transformations (based on the size of the gap) also make it difficult to compare decision quality between the 2 modes. In other words, what defines a good decision in a small gap situation may not be a good decision in a large gap situation. However, we implicitly understand that there are better decisions and poorer decisions independent of the gap size. The natural result of these conflicting perspectives is our ability to assess decision quality is befuddled.

Simulating Large Decision-Effect Gaps
As introduced in the previous section, large Decision-Effect Gaps have a key temporal element. Stephen Downes-Martin highlighted a key insight with the introduction of decision horizons.

Decision Horizons
The Decision Horizon can be defined as a point in the future where the decision-maker’s interests are realized.

Every decision has benefits (pros, or advantages) and costs (cons, or disadvantages). The costs are in addition to the allocated resources. The future benefits and the costs of a decision are the "effects" implied in the subject of this Game Lab, and they accrue at different time rates and amounts. Therefore, the decision horizon, how far out the decision maker is interested in, is important. The mismatch between when the decision maker obtains advantages versus when he pays the costs is low for tactical decisions [small gaps] but increases for strategic decisions [large gaps].

Stephen expounded on this with the following examples:

An example is the Jail versus Hospital decision for drug addicts. Jail takes an addict immediately off the streets for many years, the costs of Jail are high but are amortized over many years and the cost of a hardened Jail-trained criminal released onto the street is pushed years into the future. Conversely the costs of Hospitalization are immediate and higher than the yearly cost of Jail, but the addict is more likely not to re-offend than if Jailed. The Jail versus Hospital decision therefore depends on when the decision maker wants the benefits versus paying the costs.
A wargaming example comes from the US Naval War College. Robert "Barney" Rubel describes how wargamers will often take actions during the last move of a game that wins the game tactically but in the real world would create a world of problems for the US. But that future damage is viewed by the players as "not our problem".

These examples hint at two conditions which may be key to simulating large gaps in compressed time (real-world simulated in game form). The first is creation of situations where decision horizons differ from when decision effects are fully realized. A possible option would be to remove the decider before the effects can be realized, perhaps by rotating player positions during the game. Whether the deciders have advance knowledge of this move is a question worth considering in more detail, but beyond the scope of this document. Another option is to include effects that have distinctly different payoff times (i.e. fast initial gains with slow gains over longer time vs. slow gains that accelerate over time.). This can include extending effects beyond the end of the game. “Legacy” style games, where past plays influence future game options and structure, or focused analysis of the end-game conditions in an after action review can extend effects beyond the game’s time. With separation between decision-makers and decision-effects, deciders must now consider what impact they will have on other players as well as future plays.

It is worth noting that effects of the decision-horizon is additive to the mutability concerns discussed previously and represents another concern with addressing Decision-Effect gaps. Decision Quality assessments are impacted by introducing a “decision expectancy” that defines a future point at which the decision and associated assessment are no longer valid, but effects may still be.

In considering the different horizons and decision quality with a DoD perspective, Stephen provided the following:

For the DoD, similar mismatches between the timing of benefits versus costs exist in three forms.

First are peacetime decisions such as acquisition and R&D. The decision maker has to decide on the future benefits of acquisition programs versus the current costs of supporting programs. Here, the decision maker's time horizon could very well be when he or she expects to rotate out and into another position.

The second form are warfighting decisions, where one might have to undertake high-casualty tactical operations to achieve operational or strategic benefits. The benefits are pushed into the future and the casualties are suffered in the present. Here the time horizon is determined by the pace of operations (for tactical decisions) or strategy (for operational decisions).

The third form includes improvement changes to organizations process and structure. These often automatically generate an initial fall in organizational performance before performance rises.

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1 Frequent conversations at the War College when Barney was Chair of the Wargaming Department.
A decision maker is tempted to avoid making a decision—no matter the long-term benefits— if he or she is due to rotate out when the costs of that decision are high. The decision maker risks reputational damage. Either the benefits have already accrued and are forgotten in the heat of dealing with the costs, or the benefits are still in the future and are thus speculative while the costs are concrete.

Future costs and benefits are uncertain by the very nature of being in the future. Costs usually rise, and the enemy or other agents can interfere with benefits in ways that are hard to predict. Therefore, the whole futuring enterprise becomes relevant when making important decisions with long time horizons, i.e. strategic decisions. At this point the notion of "authoring or creating the future" rather than "planning to react to it" becomes important. Wargaming combined with futures studies is a possible step here to explore the path from the present to the decision horizon (see "Break the Forecasting Horizon by Values Gaming", Stephen Downes-Martin, Connections Wargaming the Future Working Group Paper August 2019 for one proposal for how to do this).

One possible indicator or measure of the decision-making competency of an organization is the ratio of the average length of time the organization’s lead decision maker remains in his or her position to the time horizon of the organization’s decisions. Staffs will be tempted to make popular and easy decisions with short time horizons within the rotation date of lead decision makers, and to increase the time horizon for problematic decisions to beyond the rotation date of the boss. They will do this by elevating or depressing different decisions to different levels of the organization since different levels are designed to have different time horizons—the higher in the organization the longer the time horizon the organization is designed for.

Therefore, it is necessary to analyze four aspects of a decision:
1. The expected distribution over future time of the benefits.
2. The expected distribution over future time of the costs
3. The decision makers rotation horizon.
4. The organization's decision time horizon.

Wargaming (with the help of futures studies) from now to the future -- not just wargaming the future -- must explicitly take the above four aspects into account in the design.

Decision Differences: Real-World vs. In Game
In game decision-effect connections are more visible and tractable than seen with Real-World decision-making. The short time frame and limited scope of games makes it easier to identify and trace decisions to their corresponding consequences. Many games simply do not have the complexity of compounded decisions with overlapping effects. Effects do compound in games, but the aggregation tends to be more linear. A game move has a near immediate effect which subsequent moves build from and additional effects are additive to. Some of this may be attributed to the simplification necessary to create the simulation/game and some is directly attributable to the compression of the decision-effect gap discussed. By contrast, it is relatively harder to see Real-World decisions and their associated
consequences. This is principally due to the time frame over which the effects materialize in the real-world. Multiple decisions may be made before any effects become apparent and tracing a subsequent specific effect to its source decision can be challenging – either due to intractability or simply because the observed effect is the result of several decisions compounded. The complexity of this problem is acknowledged by the focused efforts to develop methods to accomplish the analysis (e.g. After-Action-Reviews, Post Mortems, and Six-Sigma Analysis).

Real-World decision-making processes tend to be more transparent than games. Decisions made in large organizations are rarely made in isolation and many individuals are engaged in the fact finding, analysis, and lead up to a critical decision. This process in non-adjudicated games is opaque as players do not want to give other players insight on strategies. In adjudicated games, effort to capture the process is actively sought.

The combination of these differences may contribute to a perception that in-game decisions are less ‘credible’ than real-world ones. Here, decision credibility is tightly linked to a better decision-making process, but interestingly is not linked to consequences. This decision-effect disconnect was also seen in the previous decision quality discussion and suggests that there may be a connection between the perceived value of games and the ability of games to reflect the decision-effect time gap.

Decision Types: Pivotal and Corrective
When considering decisions, it is common to think in terms of long-term (strategic) and short-term (tactical) decisions. This framework does provide considerable value but may benefit from an expansion or alternative. Consider the following two categories of decisions:

- **Pivotal**: Decisions that directly reflect a change in the desired outcome or objective.
- **Corrective**: Decisions that directly reflect a change in the means and/or method to achieve the objective.

These are similar but not identical to Strategic vs. Tactical and differ principally because they are non-temporal. By removing time from the framework, decisions can be evaluated in a way that is independent of the size of the Decision-Effect gap. And since time is removed as a decision consequence or by-product, it can be leveraged in assessments. For example: Sequences of decisions.

Decision Quality: Simplified Non-Temporal Assessments
Using this framework changes the style of decision quality assessment. When a decision is assessed, it is first evaluated to determine which type it is. Then, based on its type, it is assessed to determine if it improved the outcome (pivotal) or improved the means (corrective). A Pivotal Decision that improves the outcome is good; a Corrective Decision that improves the means is good. The assessment doesn’t have to speculate or wait for the outcome, but it does require consideration of sequencing. This approach may address confidence bias since the reason for an improvement cannot be simplified to “a future expectation” but instead must address/define a change that improves the outcome.

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2 An interesting line of investigation (that may already exist in the literature) would be to understand how in-game decision making processes mimic/differ from real-world processes.
Decision Sequencing: Decisions in Time

Understanding the Pivotal-Corrective framework, it is intuitive that a pivotal decision starts the sequence and that corrective decisions should be expected to follow. Additional pivotal decisions may happen but are not required. If they do occur, they will be followed by supplemental corrective decisions.

Surprisingly, under real-world conditions this logical ordering can be inverted. Experience has shown us that well-meaning leaders initiate projects or action with little more than “Let’s start with this (or by targeting this area) and we can adjust as we go (and learn).” This statement shows how a corrective decision (decision on means) is used when a pivotal (objective) decision is needed. For pivotal decisions, the end point is as important as the starting point. While this corrective instead of pivotal decision inversion does occur at an uncomfortably high rate, it is far less common than the pivotal instead of a corrective decision inversion. To illustrate this inversion, consider a leader faced with an obstacle who seeks a new destination rather than a means around the roadblock (i.e. I couldn’t get that, so I got this.)

The advantage of sequencing is that it is possible to evaluate ‘Decisions in time’ vs. ‘Decisions over time’. A sequence analysis can answer questions like: Did I have an objective before I started figuring out how to do something? Did the objective change at the appropriate time? Was a new means pursued when an obstacle was encountered? The quality of the last decision is directly reflected in nature of the current decision. This sequential approach also encourages continual/regular review and evaluation of decisions (something of great value but rarely done except ‘after the fact’). The end result is that decisions, regardless of Decision-Effect gap, can be assessed for quality and compared.